

Louvain School of Management

How does supply chain integration translates in Sonaca Group?

A look at the micro level practices

Project Master's Thesis submitted by
Jeremy Tintinger

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Supervisor:
Prof. Constantin Blome

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Abstract

Today's competitive environment has turned increasingly global. Companies serve world-spread customers and as such, rely on global supplier bases. This globalization is reflected by a corresponding trend in supply chains. Information and material flow now come and go all over the globe. Consequently, supply chain management has intensely complexified in the last decades. As a response, supply chain literature allowed for the emergence of a new concept: supply chain integration. This concept fosters enhanced collaboration among supply chain partners and the breaking down of organizations' functional silos. Sonaca Group, among many others, has seen its operations deeply impacted by globalization. Having now to manage suppliers and manufacturing plants in Brazil, China, USA, Belgium and several other countries, the aerospace-active organization embraced supply chain integration. This thesis will depict the micro-level practices of supply chain integration within Sonaca Group. A comparison will be drawn between the supply chain literature and the empirical situation. Ultimately, this thesis will advocate for further integration at Sonaca and will detail how to reach it.

Keywords – *Supply chain integration; Micro-level practices; Empirical analysis*

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Acronyms

BoM - Bill of Materials	- 55 -
CRS - Coordination and Resource Sharing.....	- 45 -
EDI - Electronic Data Interchange	- 20 -
EI - External Integration	- 13 -
ERP - Enterprise Resource Planning.....	- 20 -
II - Information Integration.....	- 45 -
II - Internal Integration	- 15 -
IS - Information System.....	- 20 -
IT - Information Technology	- 20 -
JIT - Just In Time	- 64 -
MES - Manufacturing Execution System	- 80 -
MRP - Material Requirement Planning	- 35 -
ORL - Organizational Relationship Linkage	- 45 -
OTD - On-Time Delivery	- 68 -
QMS - Quality Management System.....	- 80 -
RA - Resource Advantage.....	- 12 -
RBV - Resource Based View	- 12 -
RV - Relational View	- 12 -
SC - Supply Chain.....	- 3 -
SCM - Supply Chain Management.....	- 5 -
SI - Supplier Integration	- 14 -
SRM - Supplier Relationship Management	- 64 -
VE - Virtual Enterprise.....	- 21 -
VMI - Vendor-Managed Inventory	- 65 -
VUCA - Volatile, Uncertain, Complex, Ambiguous.....	- 3 -

Introduction

Over the recent years, globalization has pressured organizations to find more ingenious ways of operating. As such, supply chain management has become one of the company's most important department and, as Johnson and Flynn (2015) highlight, one of the most value-adding activities within organizations. Consequently, the supply chain related literature has been booming in the past decades. The concept of supply chain management is further broken down into several activities. Some authors focus on the indispensability of procurement activities (Johnson & Flynn, 2015) while others stress the added-value planning and logistics activities can bring (Christopher, 2016). Recently, a trend has settled in both in the literature and in the corporate world. Overall, there is growing interest for the concept of supply chain integration. Many perceive it as the answer to the ever more demanding and world-spread environment companies now have to evolve in (Alfalla-Luque et al., 2012; Boon-itt & Wong, 2011; Frohlich & Westbrook, 2001; Yu, Jacobs, Salisbury, & Enns, 2013).

Despite all the studies that were conducted and the frameworks that were developed, the notion of supply chain integration remains vague. How does it actually unfold in empirical situations? What are companies implementing in terms of supply chain integration? What are their motives for it? Are there fostering factors or contrariwise, hindering factors that organizations need to navigate through to reach their objectives? Those are questions that were many times discussed in the literature but do not resonate in organizations.

Hence, this thesis will linger on echoing the literature findings with an empirical situation. To do so, I had to focus on an organization that was facing globalization and that has operations all around the world. As such, I decided to draw on my past internship experiences at Sonaca Group and to gear my analysis towards the Belgian aerospace company. Having subsidiaries in many countries and serving worldwide customers, the group appeared as an ideal fit for this project thesis. More precisely, the research will be articulated around the following question:

“How does supply chain integration translates in Sonaca Group: A look at the micro-level practices”

Not only will this thesis look into the practices implemented at Sonaca to enhance collaboration with its supply chain partners. It will also endeavor to understand the rationale behind the development of an integrated supply chain, its facilitators or barriers and its likely implications. Most importantly, I will rely on Alfalla-Luque et al. (2012) framework to evaluate Sonaca's supply chain integration and try to be a force of recommendation for further improvement.

The next chapters of this thesis will be organized as follows: Chapter 1 will review the literature and will define the concept of supply chain integration along with several ways of considering it. Chapter 2 will focus on the use of IT tools and especially ERP systems in supply chain integration. Chapter 3 will close the literature review by identifying the implications of supply chain integration, its requirements, facilitators and barriers. Chapter 4 will develop the methodology I will use to evaluate Sonaca's supply chain integration and will focus on framework explanation. Chapter 5 will present the organization I decided to collaborate with on this thesis and the projects I conducted within it. Chapter 6 will draw the comparison between what has been identified in the literature review and the empirical situation at Sonaca. Ultimately, Chapter 7 will expand on the literature the recommendations for further supply chain integration improvements within Sonaca Group.

Literature review

Chapter 1: Supply chain integration

The global sourcing trend and increasingly performance-based competition, along with rapidly evolving technologies and the VUCA (Volatile, Uncertain, Complex, Ambiguous) world (El-Sakty & Osama, 2015) companies now live in, all contribute to greater market uncertainty. This uncertainty necessitates greater flexibility from companies in their supply chains (Mentzer et al., 2001). In this sense, supply chain integration might represent an answer to this need of greater flexibility.

Nevertheless, it is paramount to build up solid foundations and a common understanding of the Supply Chain (SC) function before getting into the details of Supply Chain Integration (SCI). In order to do so, and in accordance with several authors (Esper, Defee, & Mentzer, 2010; Mentzer et al., 2001; Stevens, 2007; Yu et al., 2013), I distinguish between supply chain, supply chain management and supply chain integration. This chapter aims to explore these concepts.

1.1. Supply chain and supply chain management

The supply chain literature is quite extensive. Over the last decades, many authors have discussed and defined the notion of supply chain. For instance, La-Londe and Masters (1994) defined supply chain as a set of firms that will pass materials forward. By the same token, Lambert, Stock, and Ellram (1998) considered it as the alignment of firms that brings products to market. Others consider supply chain as a network of organizations that are involved through upstream and downstream flows in the different processes and activities that will deliver value to the final customer under the form of products or services (Christopher, 2016). Note that these definitions, although time-distant from one another, all integrate the final customer as part of the supply chain.

Given all these definitions, I would like to adopt the same definition of a supply chain that was given by Mentzer et al. (2001, p. 4):

“A supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.”

Building on this, I would like to refine the concept of supply chain and break it down to three complexity levels: a direct supply chain, an extended supply chain and an ultimate supply chain (Mentzer et al., 2001). A direct supply chain, as shown in Figure 1.1.1, consists of a chain formed by a company, its suppliers and its customers, all involved in the upstream or downstream flows of materials and/or information.

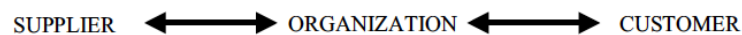


Figure 1.1.1: Direct supply chain (Mentzer et al., 2001)

An extended supply chain goes beyond the scope of a direct supply chain model as it will include the suppliers of the immediate supplier and customers of the immediate customer (Figure 1.1.2). All are involved in the upstream and downstream flows of products, services, finances, and/or information.

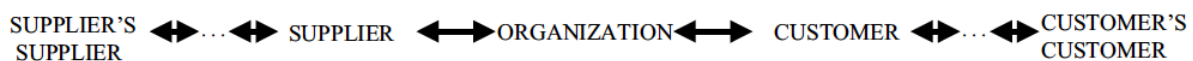


Figure 1.1.2: Extended supply chain (Mentzer et al., 2001)

Finally, an ultimate supply chain will include all the organizations involved in upstream or downstream flows of materials and/or information, from the ultimate supplier to the ultimate customer (Figure 1.1.3).

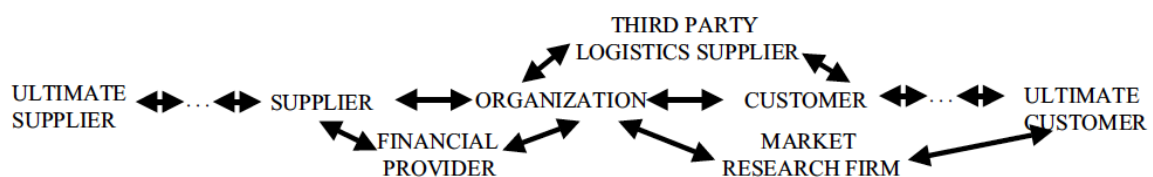


Figure 1.1.3: Ultimate supply chain (Mentzer et al., 2001)

Supply chain management (SCM) has long been discussed in the SC literature. Over the years, many authors have given their definition of the concept. Table 1.1.1 resumes some of the definitions I found in the literature.

Jones and Riley (1985, p. 17)	“Supply chain management deals with the total flow of materials from suppliers through end users...”
Cooper, Lambert, and Pagh (1997, p. 2)	Supply chain management is “... an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user.”
Gunasekaran and Ngai (2003, p. 269)	“Supply chain management is defined as the integration of key business processes from end user through original suppliers that provides products, services, and information and hence add value for customers and other stakeholders.”
Rai, Patnayakuni, and Seth (2006, p. 226)	“Supply chain management (SCM) is a digitally enabled interfirm process capability that has been receiving significant attention.”
Stevens (2007, p. 3)	“The objective of managing the supply chain is to synchronize the requirements of the customer with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost.”
Kim (2009, p. 328)	“Supply chain management (SCM) seeks to enhance competitive performance by closely integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers, and other channel members.”
Richey, Roat, Whipple, and Fawcett (2010, p. 238)	“Supply chain management (SCM) is the coordination of the chain of events associated with the movement of goods from raw materials to the ultimate customer.”

Table 1.1.1: Definitions of supply chain management

Some authors such as Jones and Riley (1985) or Cooper et al. (1997) defined SCM in a holistic way, only stressing the importance of end-to-end material flows from suppliers to final customers. Others dug deeper and delivered more detailed definitions. Among these authors, some already encompass the notion of integration in their definition of SCM (Gunasekaran & Ngai, 2003; Richey et al., 2010; Yu et al., 2013). This concept of integration within the supply chain will be further developed in the following chapter. Hence, I will not expand on those definitions in this section. Kim (2009) is also one of the few authors who emphasizes the competitive performance in his definition of SCM. I believe it is worth noticing that the notion of profitability is also embedded in the management of supply chains. As the supply chain area represents the largest single category of spend in almost all corporate organizations (Johnson & Flynn, 2015), ranging from 50 to 80 percent of the total revenue, I believe an effective and efficient management of the supply chain can considerably reduce companies' costs and thereby, improve their competitive positions.

Mentzer et al. (2001) also described other factors that enhance or impede the development of an effective SCM. They state that trust and commitment lead to cooperative behaviors and the success of long-term relationships which are both components for the implementation of SCM. Interdependence which is defined as a firm's need to maintain a relationship with its partners to achieve its goals is also seen a requirement for SCM. This dependence will create willingness to share key information and participate in joint activities. Obviously, top management support and organizational compatibility, defined as the alignment of SC goals, vision and key processes, are also required to achieve SCM.

Taking everything into consideration, I agree with the definition of supply chain management that was given by Mentzer et al. (2001, p. 18):

“Supply chain management is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.”

Accordingly, I would also like to adopt their model for SCM which is depicted in Figure 1.1.4.

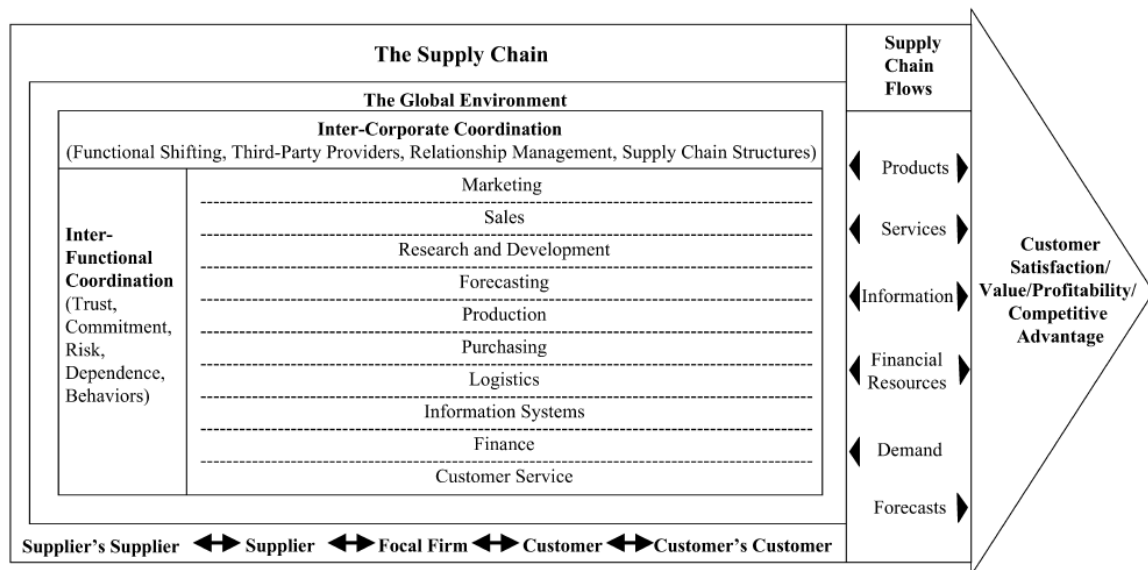


Figure 1.1.4: A model for supply chain management (Mentzer et al., 2001)

1.2. Supply chain integration

Supply chain integration is encouraged by the increasing global competition and shortening product life-cycle (Tarifa-Fernandez & Burgos-Jiménez, 2017). These two factors combined together drive companies to change their focus and to switch from traditional competitive rivalry to mutually beneficial relationships and cooperation. In this sense, as Richey, Chen, Upreti, Fawcett, and Adams (2009) describe, companies need to be more responsive to their environment in order to remain competitive. Hence, organizations within supply chains would need to align their strategies with other supply chain members if they desire to reach such higher market responsiveness. Similarly, Zhang, Huang, Humphreys, and Botta-Genoulaz (2010) state that competition is no longer among firms but well among supply chains. Manufacturers today must not only be busy managing their organization but rather act as part of a network of organizations and be involved in the management of both upstream and downstream firms in their network.

The concept of supply chain integration, although more recent than the notion of supply chain management, has evolved over the years. A rapid literature review made clearly apparent that the definitions of SCI are numerous and the concept has different meanings to different

authors and organizations (Alfalla-Luque et al., 2012). As stated in the previous chapter (see Table 1.1.1) some, such as Gunasekaran and Ngai (2003); Richey et al. (2010); or Yu et al. (2013) consider the concept of integration as embedded in the very definition of supply chain management. Others defined SCI more specifically. Flynn, Huo, and Zhao (2010, p. 59) consider SCI as “the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer”. Some authors even defined integration before stepping into the definition of SCI. By this token, Jayaram and Tan (2010) define integration as the extent to which distinct organizations will work together and cooperate to reach mutually acceptable outcomes. Consequently, they consider SCI as a set of coordination and cooperation mechanisms under the form of business processes that should be streamlined and interconnected both within and outside a company’s boundaries.

Table 1.2.1 summarizes the definitions of supply chain integration the literature review has revealed.

Flynn et al. (2010, p. 59)	“Supply chain integration is the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer”.
Jayaram and Tan (2010, p. 262)	“Supply chain integration refers to coordination mechanisms in the form of business processes that should be streamlined and interconnected both within and outside company boundaries”.
(Boon-itt & Wong, 2011, p. 254)	“Supply chain integration involves the processes of collaboration across functional departments, suppliers, and customers to arrive at mutually acceptable outcomes”.
(Yu et al., 2013, p. 347)	“Supply chain integration is conceptualized as a process of redefining and connecting entities through coordinating or sharing information and resources. This includes collaboratively managing intra- and inter-organizational processes to achieve effective and efficient flows of products, services, information, and money with the objective of providing maximum value to customers”.
(Leuschner, Rogers, & Charvet, 2013, p. 34)	“Supply chain integration is the scope and strength of linkages in supply chain processes across firms. Information, operational and relational integration facilitate the linkages in supply chain processes between firms. The scope of supply chain integration can be integration with customers, suppliers, internal or external”.

Table 1.2.1: Definitions of supply chain integration

Overall, it appears to us Chang et al. (2016) seem to have given the most complete definition of SCI. Hence, I would like to adopt their definition for this thesis (Chang et al., 2016, p. 282).

“SCI is a firm's strategic collaboration and coordination with its suppliers and customers and the management of internal and external organizational processes. The essence of SCI is that streamlining core business processes within and between firms yields advantages over competitors through cost reduction or superior customer value creation that are associated with superior firm performance.”

1.3. Different perspectives on supply chain integration

Nevertheless, even if there seems to be a consensus around the collaborative essence of SCI, different perspectives can be used to break SCI down to a finer level. Alfalla-Luque et al. (2012) have identified in their literature review three main approaches to SCI:

- i.* The first approach draws a clear distinction between **internal integration** and **external integration**. External integration is further refined into **supplier integration** and **customer integration**. SCI needs both intra- and inter-company integration across the whole supply chain in order to work as a single entity and deliver superior performance (Pagell, 2004). The role of SCI is thus to break down the organizational boundaries between functions and between companies (Alfalla-Luque et al., 2012).
- ii.* The second approach understands SCI from a **process integration** perspective. Lambert and Cooper (2000) state that in order to reach a successful implementation of SCI, companies need to break down their functional silos and adopt a process approach. This implies collaboration from the focal firm both with upstream and downstream organizations in its supply chain in order to streamline the business processes and develop common systems and shared information. The key processes that can be integrated across the SC typically include customer relationship management, joint product development, demand management, order fulfilment and supplier relationship management (Alfalla-Luque et al., 2012).
- iii.* The third approach they identified is focused on **information/data and physical/materials flows integration**. These studies are less numerous and will mainly focus on the integration of information and physical flows through two manufacturing

improvement programs that are lean production and ERP systems (Cagliano, Caniato, & Spina, 2006).

These different approaches were taken up by other authors such as Rai et al. (2006). They consider SCI requires information sharing among SC partners in order to develop globally optimal plans. It also demands to leverage the visibility of resources to optimize the staging and flow of materials. Additionally, they also consider SCI as a way to streamline the financial processes such as billing and payments that are interdependent on other activities such as ordering and delivery. In summary, their vision of supply chain integration encompasses the integration of physical flows, information flows and financial flows between a focal firm and its supply chain partners. Their definitions of physical, information and financial flows integration are given in Table 1.3.1:

Construct	Definition
Physical Flow Integration	“The degree to which a focal firm uses global optimization with its supply chain partners to manage the stocking and flow of materials and finished goods. Downstream flows consist of raw materials, subassemblies, and finished goods, while upstream flows consist of products that are returned or need to be repaired. Specific initiatives to optimize physical flows include just-in-time delivery, automatic replenishment, and vendor managed inventory programs.”
Information Flow Integration	“The extent of operational, tactical, and strategic information sharing that occurs between a focal firm and its supply chain partners. Specifically, I consider the sharing of demand-related information, inventory and sales positions, production and delivery schedules, and performance metrics as indicators of information flow integration.”
Financial Flow Integration	“The degree to which financial flows between a focal firm and its supply chain partners is driven by workflow events. Important downstream flows to be managed include prices, invoices, and credit terms, and essential upstream flows to be coordinated include payments and account payables.”

Table 1.3.1: Construct definitions (Rai et al., 2006, p. 230)

Building on the distinction between internal integration, supplier integration and customer integration, Leuschner et al. (2013) consider supply chain integration can be analyzed through the lens of the Resource-Based View (RBV) with the extensions of Resource-Advantage (RA) theory and Relational View (RV). The RBV posits that organizations can be seen a set of resources and that a subset of these resources can be considered as strategic. According to Barney (1991), strategic resources are valuable, rare, difficult to imitate and substitutable. As these resources can be distributed unequally among firms, they can result in sustained competitive advantage. Through this lens, SCI can be seen as an internal strategic resource that could result in sustainable competitive advantage and therefore improved overall performance (Barney, 2012).

As an extension to the RBV, RA theory focuses not only on resources per se but more specifically on the advantageous resources which give organizations a competitive advantage (Hunt & Davis, 2012). Under this theory, resources are linked to their contribution. It is perceived these resources help produce a specific offer on the market that is valued by customers. The competitive advantage for companies then arises from the availability of these advantageous resources (Hunt & Davis, 2012).

The RV, which is another extension of the RBV, postulates that inter-firm integration and strategic partnerships can benefit companies through the acquisition of valuable resources they lack in-house. Unlike the RBV which exclusively focuses on internal resources the RV posits that competitive advantage can also emanate from interfirm resources that cannot be captured or owned by an isolated firm (Lavie, 2006). Overall, inter-firm integration is often mutually beneficial for the SC members as it will grant them access to difficult to imitate, specialized assets skills and information.

Having reviewed a lot of other theories and views on supply chain integration, it appears to us the distinction stated by Alfalla-Luque et al. (2012) between internal integration on one hand and external integration on the other hand is the most commonly used in the SCI literature. Hence, I will adopt this view and develop both these dimensions in the next sections.

1.3.1. External integration

When a company desires to integrate its supply chain, there are two levers it can pull. Supply chain integration can happen either at the internal level, which will be further developed, or at an external level. Such external integration means the focal firm will have to manage more accurately in- and out-flows and collaborate more narrowly with both its upstream and downstream supply chain partners. The integration with upstream partners refers to supplier integration whereas the downstream partners integration refers to customer integration.

As such, External Integration (EI) has been defined in various terms in the SC literature. Zhao, Huo, Selen, and Yeung (2011) refer to it as an inter-organizational integration process with suppliers and customers. As such, external integration will extend the scope of collaboration and information sharing in order to include customers and suppliers (Boon-itt & Wong, 2011). Chang et al. (2016) refined the concept of external SCI by stating it refers to a

firm's coordination and collaboration with its key supply chain partners (suppliers and customers) of inter-organizational information flows, processes and behaviors. However, the most complete definition I found in my literature review is the one given by Flynn et al. (2010, p. 59):

“External integration is the degree to which a manufacturer partners with external partners to structure inter-organizational strategies, practices and processes into collaborative, synchronized processes.”

Supplier integration (SI) involves more than simply buying and selling activities. It involves core competencies derived from interactions with critical suppliers (Flynn et al., 2010). SI requires close relationships with suppliers and the involvement of those suppliers in joint activities such as product development or manufacturing support (Leuschner et al., 2013). According to Boon-itt and Wong (2011), supplier integration is the most common form of supply chain integration. It demands an effective alignment of behaviors between the focal firm and its suppliers, the sharing of information and an active participation of both parties in the interactions. Yu et al. (2013) go the same way and indicate that SI is characterized by a cooperative relationship between the focal firm and the upstream suppliers. It entails information sharing and a direct participation in the decision-making processes. They state that these cooperative relationships can potentially include initiatives and program fostering linkages between the partners. Examples of these linkages are vendor-managed inventory or joint product development.

At the other side of the spectrum, Customer Integration (CI) is the mirror image of supplier integration (Leuschner et al., 2013). It involves core competencies derived from narrower collaboration with critical customers (Flynn et al., 2010). CI requires the proactive determination of the requirements and collaborative relationships with the customers in order to ensure meeting those requirements. Through customer integration, companies can delve deeper into their customers' organizations which will help them get a better understanding of the products, culture, markets, and organizations. This will enable them to respond faster to their customers' needs and requirements (Boon-itt & Wong, 2011). Yu et al. (2013) stress the importance of including customers in decisions pertaining to product sold by the supplier. They state that CI entails for a focal firm to understand the interaction between its supplier's products and processes and its customer's business. They argue the attention and resources committed

by the supplier for these activities are meant to help the customer improve its competitive position.

1.3.2. Internal integration

In contrast with external integration, internal integration (II) is focused on the activities within a company and refers to the intra-organizational processes (Zhao et al., 2011). Some authors have defined it in a very succinct way. Leuschner et al. (2013) for instance consider II as the integration between several functions or departments within the same company. Others, such as Boon-itt and Wong (2011) expanded on the concept and stated that the integration of all internal functions is paramount in order to meet the customer requirements at the lowest total cost. II is thus characterized by full systems visibility across all functions in the organization. Similarly, Chang et al. (2016) refer to internal integration as a firm's coordination and collaboration of its organizational information, processes and behaviors within its own boundaries. Yu et al. (2013) consider the purpose of internal integration is to ensure all functions and departments within a single company to work as one cohesive process. Once again, as it appears to us to be the most complete definition, I will stand by the definition of internal integration given by Flynn et al. (2010, p. 59):

“Internal integration is the degree to which a manufacturer structures its own organizational strategies, practices and processes into collaborative, synchronized processes, in order to fulfill its customers' requirements and efficiently interact with its suppliers.”

As a summary, while internal integration is geared towards the inside of a company and considers its departments and functions should operate altogether as part of an integrated process, external integration focuses on the upstream and downstream SC partners and stresses the importance of close and interactive relationships with both the customers and the suppliers.

1.4. Arcs of integration

Going in this direction, I would like to further refine the concepts of internal and external integration. As such, Frohlich and Westbrook (2001) forwarded the concept of arcs of integration. They developed scales for measuring SCI and identified five different strategies when it comes down to integrating the supply chain. Characterizing each of these strategies is

the very concept of arcs of integration. An arc of integration represents the direction (towards the supplier or customer side) and the degree of the integration activities. They consider supply chain integration as a set of shared operational activities and state that when companies need to develop such collaborative activities, the strategic issues they will encounter is to decide to which direction and to what extent should the integration be developed. Taking this pair of decisions can be visually represented by an arc, as depicted on Figure 1.4.1.

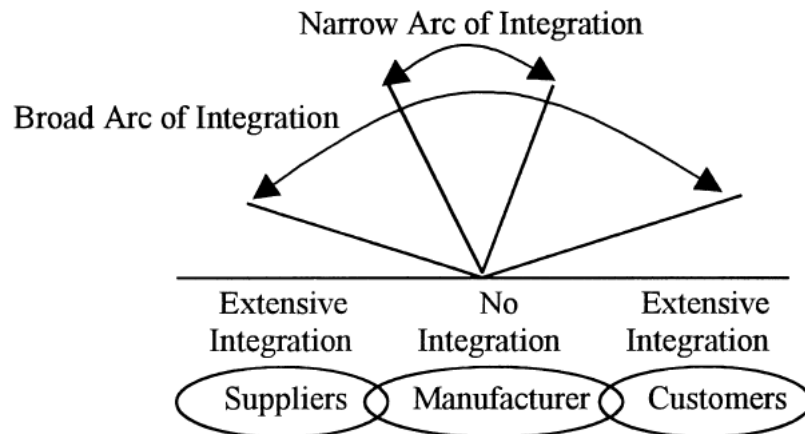


Figure 1.4.1: Arcs of integration (Frohlich & Westbrook, 2001)

Building on their concept of arcs of integration, Frohlich and Westbrook (2001) tried to operationalize it. Doing so, they found five exclusive groups that depicted the major integration strategies they came across through their researches. They conducted their study on 322 manufacturers which were each assigned a score for their supplier and customer integration using a 1-5 Likert-type scales from (1) none to (5) extensive integration activities. The factor score was then used to classify each manufacturer into the lower-, middle- or upper-quartiles. The five strategies they came up with are as follow:

- i. Inward-facing arc of integration** for companies classified:
 - a. In lower quartile for supplier integration activities, **and**
 - b. In lower quartile for customer integration activities.

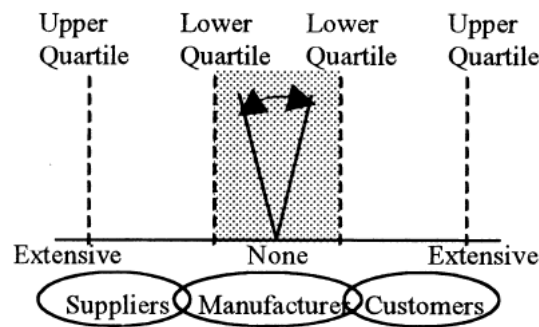


Figure 1.4.2: Inward facing arc of integration (Frohlich & Westbrook, 2001)

ii. Periphery-facing arc of integration for companies classified:

- a. Above lower quartile for supplier **or** customer integration activities, **but**
- b. Below upper quartile for customer **and** customer integration activities.

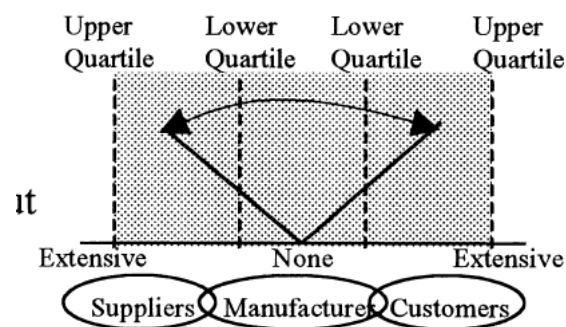


Figure 1.4.3: Periphery facing arc of integration (Frohlich & Westbrook, 2001)

iii. Supplier-facing arc of integration for companies classified:

- a. In upper quartile for supplier integration activities, **and**
- b. Below upper quartile for customer integration activities.

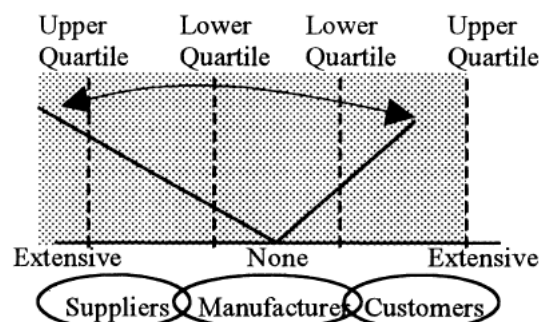


Figure 1.4.4: Supplier facing arc of integration (Frohlich & Westbrook, 2001)

- iv. Customer-facing arc of integration** for companies classified:
- Below upper quartile for supplier integration activities, **and**
 - In upper quartile for customer integration activities.

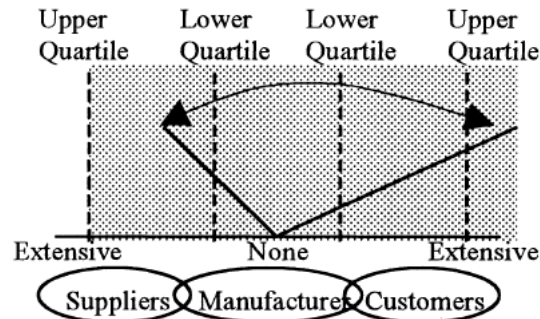


Figure 1.4.5: Customer-facing arc of integration (Frohlich & Westbrook, 2001)

- v. Outward-facing arc of integration** for companies classified:
- In upper quartile for supplier integration activities, **and**
 - In upper quartile for customer integration activities.

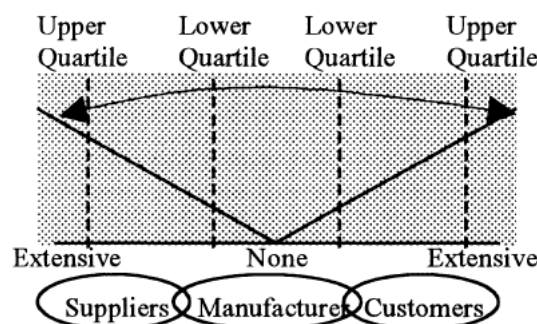


Figure 1.4.6: Outward-facing arc of integration (Frohlich & Westbrook, 2001)

Ultimately, they found that companies having the greatest arcs of integration experienced the largest performance improvement which might entail stronger coordination along the supply chain leads to reduced overall uncertainty.

Building on Frohlich and Westbrook (2001) research, Schoenherr and Swink (2012) raised some limitations to the model and addressed them. First, unlike their predecessors' sample which was exclusively made of metal products, machinery and equipment manufacturers, their sample included manufacturing industries as well as distribution and retail firms. Second, Frohlich and Westbrook (2001) analyzed responses from manufacturing

managers exclusively. By collecting data from supply chain professionals as well as from purchasing and marketing directors, Schoenherr and Swink (2012) expected to increase the validity of the model. They also extended the notion of performance, which was earlier confined to marketplace, productivity and non-marketplace measures, to the four operational dimensions of quality, delivery, flexibility and cost. Finally, they criticized the early-millennium research exclusive focus on external integration. Accordingly, they built upon the RBV and added internal integration to the model.

In spite of these changes, Schoenherr and Swink (2012) reached the same conclusions as the previous study. Their results showed that greater arcs of supplier and customer integration were associated with greater quality, delivery, flexibility and costs performance. Nevertheless, and additionally to Frohlich and Westbrook (2001) conclusions, they found the relation between external integration and performance is moderated by internal integration for both the delivery and flexibility performance but not for the quality and cost performance. External integration's effect on delivery and flexibility performance is actually enhanced when companies undertook higher than average internal integration initiatives. This might be explained through the heavy reliance of both these performance dimensions on time and process improvements. Time savings can be achieved if no firm along the supply network represents a bottleneck for the information to flow swiftly, especially not the focal firm. Internal integration is also likely to improve the processes within the firm which might positively impact the delivery and flexibility performance.

Chapter 2: Information technology and supply chain integration

Several authors highlight the relevance of Information Technology (IT) tools in the management of supply chains (Gunasekaran & Ngai, 2003; Rai et al., 2006). Indeed, supply chains have become increasingly global. Companies now have to manage a supplier base that is spread all over the world. Since suppliers are now located all around the world, it has become impossible to achieve an effective supply chain without IT tools. The complexity of supply chain models nowadays has forced companies to go online for communication systems (Gunasekaran & Ngai, 2003). This requires the sharing of information on different value-adding activities along the supply chain through an integrated Information System (IS). Enterprise Resource Planning (ERP) systems, for instance, can help a company break down its functional silos and integrate its different activities via instant information sharing. ERPs or Electronic Data Interchange (EDI) technology can greatly contribute to overall better supply chain performance by reducing uncertainty and enhancing shipment performance from suppliers.

Moreover, IT has transformed the way companies operate. Goods moving along the supply chain will be reflected by corresponding movement of information (McDonnell, Sweeney, & Kenny, 2004). The moment an item is sold, it can be entered in an information system via a bar code reader or via manual input. Since computers constantly communicate with other computers via local, national or even international networks, this information becomes immediately available anywhere along the supply chain. This information moving more swiftly along the supply chain can translate into better decisions. As Su and Yang (2010) highlight, providing instantaneous information can help link the entire organization together and avoid having specific information enclosed to specific departments.

2.1. IT and supply chain management

It is widely agreed across the literature that information technologies yield many benefits in SCM and SCI (Stevens, 2007; Su & Yang, 2010). Yet, some issues can easily appear when developing an IT-integrated SCM. Gunasekaran and Ngai (2003) identified the lack of integration between IT and the company's business model, the lack of proper strategic planning, poor IT infrastructure or inadequate implementation knowledge of IT in SCM as some of those issues. They built a framework for addressing these issues and developing an IT-enabled SCM. This framework is represented in Figure 2.1.1 and is built around 6 axes:

- i. ***Strategic planning for IT in SCM:*** Strategic planning is a critical task because it has long-term implications on the performance of IT in SCM. It should support the long-term objectives of SCM in terms of flexibility and responsiveness to changing market conditions.
- ii. ***Virtual enterprise and SCM:*** A Virtual Enterprise (VE) is a network of independent companies, sometimes former competitors, who come together to exploit market opportunities. A VE is based on the concept of outsourcing to take advantage of the core competencies. This pursues the objective of bringing flexibility and responsiveness against changing market requirements. IT tools and ERP systems especially will ease the formation of partnerships by making the right information available at the right time and hence developing a virtual enterprise.
- iii. ***E-commerce and SCM:*** The development of internet-based technologies has made the integration of e-commerce with SCM a necessity. Gunasekaran and Ngai (2003) claim B2B e-commerce can have a tremendous influence on integrating partners to achieve an effective SCM. Communication and coordination need to be maintained through E-commerce tools (EDI, direct link-ups with suppliers, electronic catalog ordering) in order to support the sharing of information and competencies in a network structure.
- iv. ***Infrastructure for IT in SCM:*** Having insufficient knowledge on the type of IT-infrastructure or systems required to achieve an IT-enabled SCM that fits their business model will harm companies. Hence, in order to fully utilize the IT available for SCM, a training and education cell for IT might be required.
- v. ***Knowledge and IT management in SCM:*** Since companies are operating in an information intensive world, there is a need for knowledge workers to contribute the value-adding activities. This requires a systematic approach for educating and training workers to be innovative.
- vi. ***Implementation of IT in SCM:*** Implementation of IT in SCM requires a project management approach with the right team for the planning and implementation of IT projects. Top management support is also paramount to bring moral, technical and financial support to the development of an IT-enabled SCM.

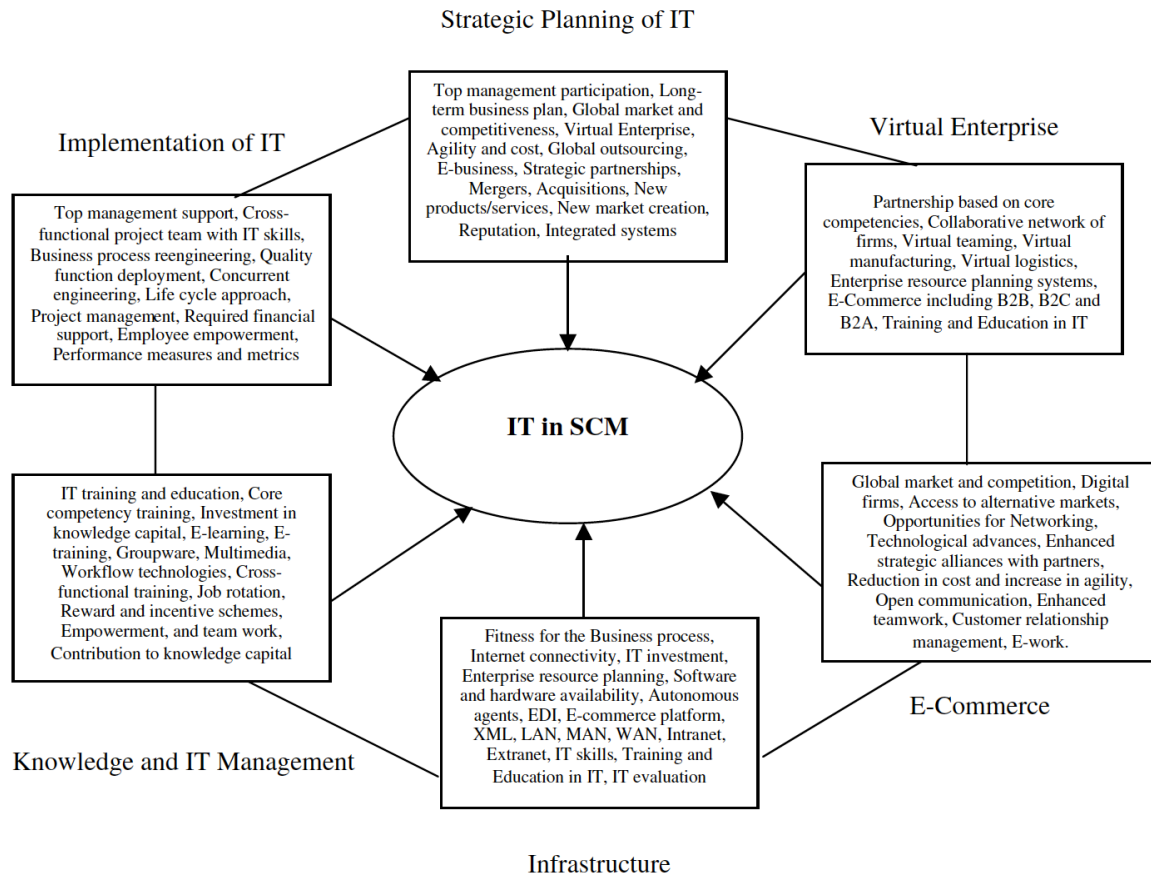


Figure 2.1.1: Framework for the development of an IT-enabled SCM (Gunasekaran & Ngai, 2003)

2.2. ERP systems and supply chain integration

The globalization of competition implies that companies that want to survive on this global market not only need to ensure their own successful operations but also need to collaborate with both down- and upstream partners to improve responsiveness along the supply chain. As such, ERP systems, which are specifically designed to integrate and optimize business processes both within and beyond a firm, represent a tool companies can leverage in their supply chain integration (Mabert, Soni, & Venkataramanan, 2001). Such systems allow the sharing of large amounts of real-time data across the entire supply chain which greatly enhances collaboration between supply chain partners (Su & Yang, 2010).

There actually are two types of IT solutions that can help companies digitalize their processes: point solutions and enterprise-wide solutions (McDonnell et al., 2004). Point solutions are specifically designed to fulfill the needs of a particular function within the supply chain. According to McDonnell et al. (2004), there are 4 such functions: buy, make, move and

sell. Even if this segmentation of the supply chain into 4 functions is debatable, I believe this type of solution is very specific and hence only offers firms limited integration capabilities. Accordingly, I will not expand on this aspect and will rather develop the concept of ERP systems.

The definitions of ERP systems are numerous (Table 2.2.1). Yet, as it appears to be the most complete definition, I would like to build this section upon the definition that was given by Wallace and Kremzar (2001, p. 5):

“An enterprise-wide set of management tools that balances demand and supply, containing the ability to link customers and suppliers into a complete supply chain, employing proven business processes for decision making, and providing high degrees of cross-functional integration among sales, marketing, manufacturing, operations, logistics, purchasing, finance, new product development, and human resources, thereby enabling people to run their business with high levels of customer service and productivity, and simultaneously lower costs and inventories; and providing the foundation for effective ecommerce.”

McDonnell et al. (2004, p. 15)	“ERP attempts to integrate all departments and functions across a company into a single computer system that can serve all those different departments’ particular needs”.
Baymout (2014, p. 3)	“ERP systems provide an organization with a single platform system responsible for the coordination and integration of key-business processes. ERP systems ensure the smooth flow of information within various levels of the organization thus leading to more focused and precise decisions for the company”.
Adaileh and Abu-Alganam (2010, p. 274)	“ERP is an integrated information system that integrates enterprise internal function working processes, standardizes internal data processing procedures, and combines the operational data generated by different functions”.
Forslund (2009, p. 353)	“An ERP system is a business management system made up from a collection of applications or modules that integrates company functions. ERP uses database technology to control and integrate information related to a company’s business”.

Table 2.2.1: Definitions of ERP systems

The overarching feature of such systems is that they deliver many benefits to companies. Su and Yang (2010) state that ERP systems when fully realized in business organizations can reduce cycle times, induce faster and better transaction management. More precisely, ERP benefits in supply chain management are often associated to supply chain integration and standardization (Baymout, 2014; Su & Yang, 2010). Some even go further and state that ERP systems can be considered as the backbone in organizations for supply chain integration (Baymout, 2014; Su & Yang, 2010). They state that ERPs will allow process standardization, information transparency, real-time information sharing and synchronous decision-making which is likely to break down the functional silos and will induce internal integration. They also consider ERP systems’ benefits can be extended beyond the boundaries of the focal firm.

By allowing companies to respond more swiftly to their customers and suppliers, ERPs can bridge the gap between supply chain members and allow for external integration.

The positive relationship between ERP and SCI has been proven by Adaileh and Abu-Alganam (2010). They hypothesized a positive association between the implementation of ERP systems and internal integration through the improvement of information quality. They also tested the existence of a positive link between ERPs and external integration with both suppliers and customers through an enhanced system quality. Both hypotheses were verified as the authors identified significant positive relationships between ERP systems and both upstream and downstream integration of the supply chain.

Even if these positive relationships need to be further analyzed, some, such as Baymout (2014), consider ERP should be incorporated in the very notion of SCM in order to foster supply chain integration. This would create the intermediary concept of E-SCM. Building upon the SCM definition given by Mentzer et al. (2001), which is also the one I considered¹, he claims SCM uses integrated business processes in order to simplify daily operations. Hence, he states E-supply chain management uses the advances in technology to further simplify SCM by utilizing those technologies to make information flow more swiftly to the different supply chain members. The primary effect of E-SCM is that it will improve the information sharing and collaboration along the supply chain. As supply chain integration requires collaborative behaviors between partners and continuous information flows (Lambert & Cooper, 2000), linking ERP and SCM in such a way is likely to benefit supply chain integration as well.

Taking everything into consideration, it appears ERP systems are sine qua non condition for SCI. Without ERP systems, internal departments would not be aligned and share the same information. Besides, the sharing of information and collaboration with other supply chain partners would be heavily complicated since it would require to first align all independent information systems. ERP systems call for system, process and information standardization not only within the focal firm, but also across the supply network.

¹ Cf. 1.1. Supply chain and supply chain management

Chapter 3: Components of supply chain integration

As the SCI literature is quite extensive, many authors and researchers have analyzed the potential benefits supply chain integration can have on a firm's performance. Others have looked into the requirements for a company to integrate its supply chain, and the factors that could foster or hinder such integration.

3.1. Implications of supply chain integration

Many authors have tackled the linkages between supply chain integration and performance. There is a whole bevy of research papers investigating the implications of integrating the supply chain. As such, it is paramount to break the notion of firm performance into two dimensions: operational performance and business performance (Flynn et al., 2010). They suggested SC indicators should include operational measurements such as customer service or the ability to respond to a changing environment. As such, they listed cost, time, quality, delivery, and flexibility as indicators for operational performance. They also suggested that the primary motive for supply chain is the shareholder profit. Hence, they also considered the impact of SCI on a firm's financial (business) performance.

Flynn et al. (2010) also insist on the importance of considering all three dimensions of SCI (II, SI, CI) when assessing the relationship between a firm's performance and the integration of its supply chain. They state that the neglect of one of the three dimensions might lead to misleading results interpretation. They thus assessed the effects of internal, customer and supplier integration on both the operational and business performance of firms. In their research, they found that internal, supplier and customer integration were positively related to both performance dimensions. However, in their analysis, supplier integration seems to have a lesser impact on operational and financial performance than internal or customer integration. A possible reason for this might be the high costs associated with supplier integration.

On one hand, Flynn et al. (2010) state developing closer relationships between a manufacturer and its customers can lead to improved accuracy of demand information. This, in turn, can help the manufacturer be more responsive to customer needs not only by reducing its

product design and production planning time but also by having a positive impact on the inventory obsolescence. Customer integration is thus positively related to customer satisfaction, both directly and indirectly through innovation and product development (Song & Benedetto, 2008). On the other hand, developing closer relationships with suppliers will allow them to get a better understanding of the manufacturer's needs and therefore help them anticipate and meet the manufacturer's changing requirements more accurately. The mutual exchange of information about processes, schedules, capabilities and products will help the manufacturers develop better production plans and improve their delivery performance. Thus, by developing a better understanding of the manufacturer's needs, suppliers can improve their customer service which translates into more efficient customer service on the manufacturer side and hence better overall performance (Flynn et al., 2010).

Yu et al. (2013), in their analysis of the effects of SCI on customer satisfaction and financial performance, came across slightly different results. In the same way as Flynn et al. (2010), they identified supply chain integration as an enabler for improved performance at the firm level. More precisely, they found internal integration is positively related to both customer and supplier integration, suggesting II is a prerequisite for external integration. They also identified customer satisfaction as an intermediary factor affecting firms' financial performance. In their research, they found a significant and positive relation between customer satisfaction and firm's financial performance. They also found that SI will have a direct positive impact on financial performance while CI alone doesn't. They actually identified an indirect positive link between CI and financial performance through customer satisfaction. In fact, customer integration will positively impact customer satisfaction which will in turn lead to better financial performance. This tripartite relationship can be explained by the increased mutual knowledge customer integration will lead to. The information shared between a manufacturer and its customer will lead to increased probabilities of common understanding of both parties' needs. Hence the customer expectations are kept consistent with the supply chain's ability to meet these expectations. This information gleaned through improved partnering could then be embodied in the offered products and services which might thus lead to a superior offering through which higher customer satisfaction can be reached. High customer satisfaction will drive loyalty up which in turn will yield repeat purchases and a steady stream of future cash flows (Yu et al., 2013). This could also translate into fewer promotions required to ensure purchase or the extraction of a price premium for the manufacturer.

Additionally, Boon-itt and Wong (2011) claim customer delivery performance can be enhanced through supply chain integration. The delivery performance can be measured in terms of on-time delivery, delivery lead-time and delivery reliability. They state that SCI will increase the collaboration between the focal firm, its suppliers and its customers. These entities will act together and better coordinate the information and material flows so that the supply chain as a whole is able to achieve on-time delivery. Otherwise, the lack of information sharing along the whole supply chain might lead to inefficiencies in customer services (Boon-itt & Wong, 2011). In particular, their research revealed that internal and supplier integration are positively associated with customer delivery performance while customer integration doesn't have a significant impact on it. They claim II breaks down the functional silos within an organization which is likely to engender coordination and collaboration. This lets information flow swiftly within the company, hence avoiding delays and ensuring on-time delivery. On the supplier side, Boon-itt and Wong (2011) claim objective alignment, information sharing and frequent interactions between a company and its suppliers enables frequent deliveries in small lots, use of single or dual sources of supply, evaluation of alternative sources of supply on the basis of quality and delivery and not exclusively on price. It also allows the development of long-term contracts with suppliers. All of these improves the delivery performance.

By the same token, Sun, Zhao, Huo, and Zhao (2013) found that supplier, internal and customer integration are the most important drivers for schedule attainment, competitive performance and customer satisfaction, respectively. Supplier integration, through the sharing of information regarding inventory data, production plans and demand forecasts can help reduce upstream complexity and the bullwhip effect which are highly related to schedule attainment. The positive link between internal integration and competitive position can be explained through the fact that the internal cooperation and coordination of different functions can help solve conflicts, improve delivery speed and flexibility in response to customer needs. Eventually, they join Yu et al. (2013) on their analysis and state customer integration helps get better understanding of the customer wants and needs which makes it easier for manufacturer to meet those customer requirements and thus increase customer satisfaction.

Finally, Chang et al. (2016) find that all three types of integration are positively associated with firm performance. Moreover, they also find II, SI and CI all have an indirect positive effect on firm performance through three intermediary performance measures: operational, relational and strategic performance. They also identify other mediating factors

such as time, relationship quality and national culture. Their results show that the relationship between internal integration and firm performance strengthens over time, which suggests internal integration is more of a long-term process. They also highlight that supplier integration strengthens as relationship quality improves and that all three types of integration (II; SI; CI) are stronger in Asian cultures than in Western cultures. Their conceptual model is depicted on Figure 3.1.1.

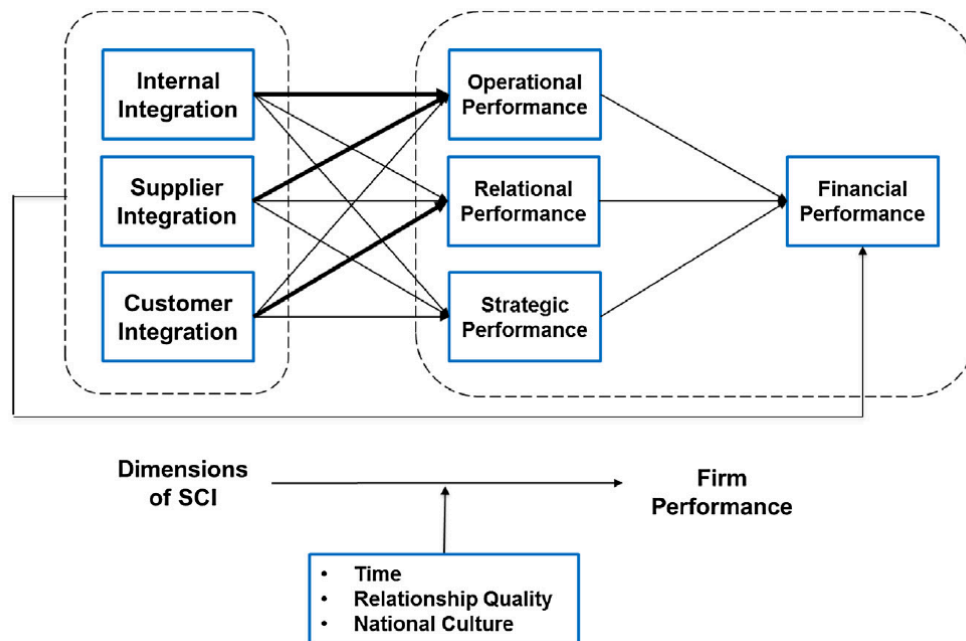


Figure 3.1.1: SCI conceptual model (Chang, Ellinger, Kim, & Franke, 2016)

However, all these implications are only likely and need to be balanced by the existence of moderators. Huo et al. (2014) for instance tried to assess the effectiveness of various SCI practices under different competitive strategies. In particular, they looked at the effects of internal integration, process integration and product integration on firm's financial and operational performance given the competitive strategy they are pursuing. They defined process integration as the creation of collaborative and synchronized processes with both the suppliers and customers with the aim of supporting manufacturing and delivery while product integration is seen as the involvement of both upstream and downstream partners in the supply chain for new product development. In their researches, they identified two different strategies. Companies whose goal is to reach a competitive advantage through cost reduction or product premium are following a cost leadership strategy (Porter, 1991). Companies pursuing a differentiation strategy do not try to gain competitive advantage through cost minimization but

rather through a premium quality (Porter, 1991). As such, the differentiator is unique in the market in terms of product features, services or flexibility.

Their results showed that the impact of SCI practices on firms' performance is moderated by the type of strategy companies pursue. Their conceptual model is represented in Figure 3.1.2. More precisely, they found that competitive strategies have no significant impact on the relation between SCI practices and operational performance but rather affected the relation between SCI practices and firms' financial performance. They actually found that the positive link between internal integration and financial performance is strengthened when companies follow a cost leadership strategy while process integration will improve the financial performance of differentiators. Internal integration will allow companies to reach common standards and work in a centralized system. This will foster information transparency and will allow companies to better forecast demand, improve warehouse management and reduce waste and production costs (Swink & Nair, 2007). This might be the reason for which the effects of II on financial performance are enhanced for cost leaders. Unlike cost leaders, differentiators are faced with high technological and demand uncertainties (Olhager & Prajogo, 2012). To cope with such challenges, differentiators must collaborate with both their suppliers and customers to develop processes that will allow them to react swiftly to market changes. This might explain the enforced relation between process integration and financial performance for differentiators.

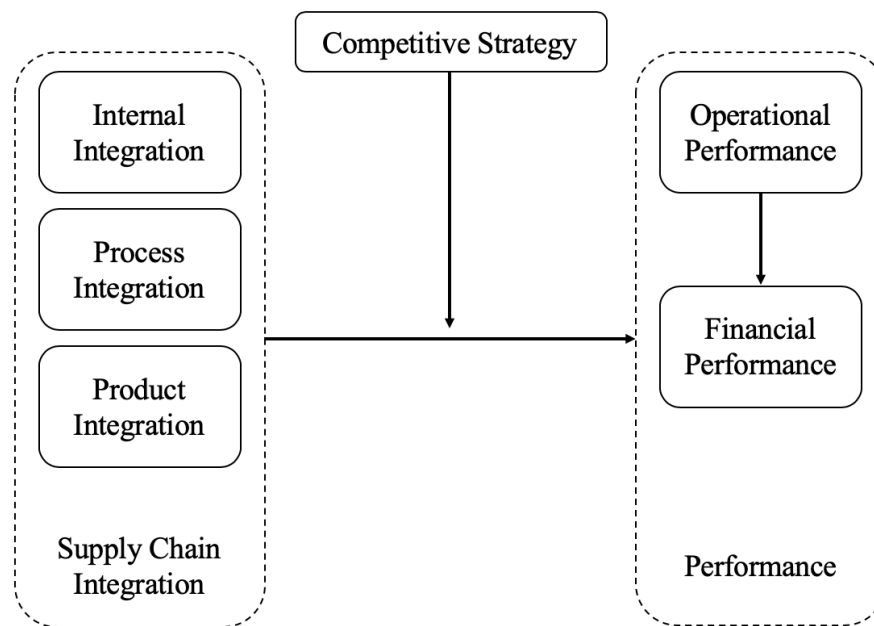


Figure 3.1.2: The moderating role of competitive strategy (Huo, Qi, Wang, & Zhao, 2014)

Other authors also identified technological and demand uncertainties as moderators for the impact of SCI on firm performance. As aforementioned, Boon-itt and Wong (2011) identified a positive impact of internal and supplier integration on firm performance through the improvement of delivery performance. Yet they found that these relationships are moderated by the presence of technological and demand uncertainties. Lu, Ding, Asian, and Paul (2017) go even further and found in their researches that the relationship between SCI and performance is positive but nonlinear and that this relationship can be inverted by market uncertainties. If the environment companies are evolving in becomes too uncertain, SCI could hamper firm performance.

Caniato and Größler (2015) also found product complexity to have a negative moderating impact on supply chain integration. They identified new product development and supply chain integration as having both positive impacts on firm performance. Nevertheless, they also found that even though product complexity does not affect new product development, it will negatively impact supply chain integration. They state that the higher the product complexity, the higher the supply chain complexity and hence, the most difficult it is to integrate both within and outside the company's borders.

Table 3.1.1 summarizes the likely implications of supply chain integration my literature review has revealed. Overall, many authors seem to have come across the same results. There seems to be a consensus about the positive effects of supply chain integration on firms' performance. Whether the integration happens internally or externally, it is likely to improve a company's performance. These findings must however be put into perspective by the existence of moderating factors.

Yet, there is an important implication of supply chain integration that remains under-analyzed. To my knowledge, very few studies looked at the effects of SCI on the relationship between a firm's headquarters and its subsidiaries. I know organization are most of the time reluctant to change (Richey et al., 2010). Hence, I could conceive this relationship would be subject to deterioration due to the subsidiaries' perception of change as compelling which could even further lead to insubordination. Nevertheless, this needs further investigation in order to be approved or refuted.

Flynn et al. (2010)	– Internal, supplier and customer integration are all positively related to operational and financial performance. – Supplier integration seems to have a lesser impact on operational and financial performance than internal or customer integration do.
Yu et al. (2013)	– Internal integration is positively related to supplier and customer integration. Internal integration seems to be a prerequisite for further external integration. – Supplier integration has a positive impact on financial performance while customer integration alone doesn't. Customer integration will increase customer satisfaction which will translate in improved financial performance.
Boon-itt and Wong (2011)	– Internal and supplier integration will improve customer delivery performance while customer integration does not. – These relations are moderated by the presence of technological and demand uncertainties.
Sun et al. (2013)	– Supplier integration is positively associated with schedule attainment. – Internal integration is positively associated with competitive performance – Customer integration is positively associated with customer satisfaction.
Chang et al. (2016)	– Internal, supplier and customer integration are all positively associated with firm performance. – Internal, supplier and customer integration all have an indirect positive effect on financial performance through operational, relational and strategic performance.

Huo et al. (2014)	– The positive link between internal integration and financial performance is strengthened when companies are pursuing a cost leadership strategy. – The positive link between process integration and financial performance is strengthened when companies are pursuing a differentiation strategy.
Caniato and Größler (2015)	– Supply chain integration has a positive impact on firm performance but product complexity negatively impacts supply chain integration.

Table 3.1.1: Implications of supply chain integration

3.2. Requirements for supply chain integration

Many studies have identified internal integration as an absolute requisite for further supply chain integration. Gimenez and Ventura (2005) showed in their study that one of the reasons companies fail to reach high-level external integration is often a low-level of internal integration. Alfalla-Luque et al. (2012, p. 802) even state that “intra-company integration is the starting point for broader integration across the supply chain”. By the same token, Yu et al. (2013) found that internal integration will positively influence both supplier and customer integration. They state that a firm’s ability to use information to benefits depends on how effectively this information is organized. Information must first be easily accessible and exchangeable within a company before external information sources can add to it. Zhao et al. (2011) build on this and established empirically that the development of internal integration capabilities through the integration of system, data and information flows is a prerequisite for the integration with external partners.

Power (2005) joins them in their analysis and considers that the key to successful SCI is for companies to focus first on implementing changes within their own boundaries before extending the processes to their external partners. Flynn et al. (2010) also suggest companies should start integrating their supply chain with internal integration. They consider this will lay the foundation upon which external integration can be build. They consider external integration as the extension of internal integration’s elimination of a company’s functional silos across

organizational boundaries. They state that a manufacturer's fit with its external environment reflects consistency between its internal structure and the strategy it follows in response to its external environment. From a supply chain point of view, a manufacturer's external environment is made of the characteristics of its upstream and downstream SC partners. Hence, if a manufacturer wants to maintain external fit, it should respond to any change in its environment by adapting its internal structure and processes accordingly. Thus, internal integration should come before supplier or customer integration.

Going in the same direction, Stevens (2007) gave us a 4-stage framework for integrating the supply chain (Figure 3.2.1):

- i.* **Stage 1 – Baseline:** The company gives responsibilities for the different activities in the supply chain to separate and almost independent departments. In this situation, the company planning is very short term, almost reactive. This will obviously give rise to inefficiencies but will also increase the company's vulnerability to changes in its environment.
- ii.* **Stage 2 – Functional integration:** This stage involves the integration of the company's functional silos. The idea is to break down the barriers between independent departments. This will typically increase the level of control and planning companies have over their supply chain. The focus here is mainly on the inward flow of goods. At this stage, companies will use Material Requirement Planning (MRP) techniques.
- iii.* **Stage 3 – Internal integration:** Companies realize that there is very little point in being exclusively focused on the flow of goods into the organization. They will focus on outward goods management and will try to integrate the supply and demand along its own supply chain. When a company achieves this level of integration, it can be qualified as synchronized demand management. It will synchronize customer demand with the manufacturing plan with the flow of materials from the suppliers through master schedule plans.
- iv.* **Stage 4 – External integration:** Finally, it is not until the last stage that a company can achieve full supply chain integration. Only now can it extend the scope of integration outside its own borders and integrate its suppliers and customers.

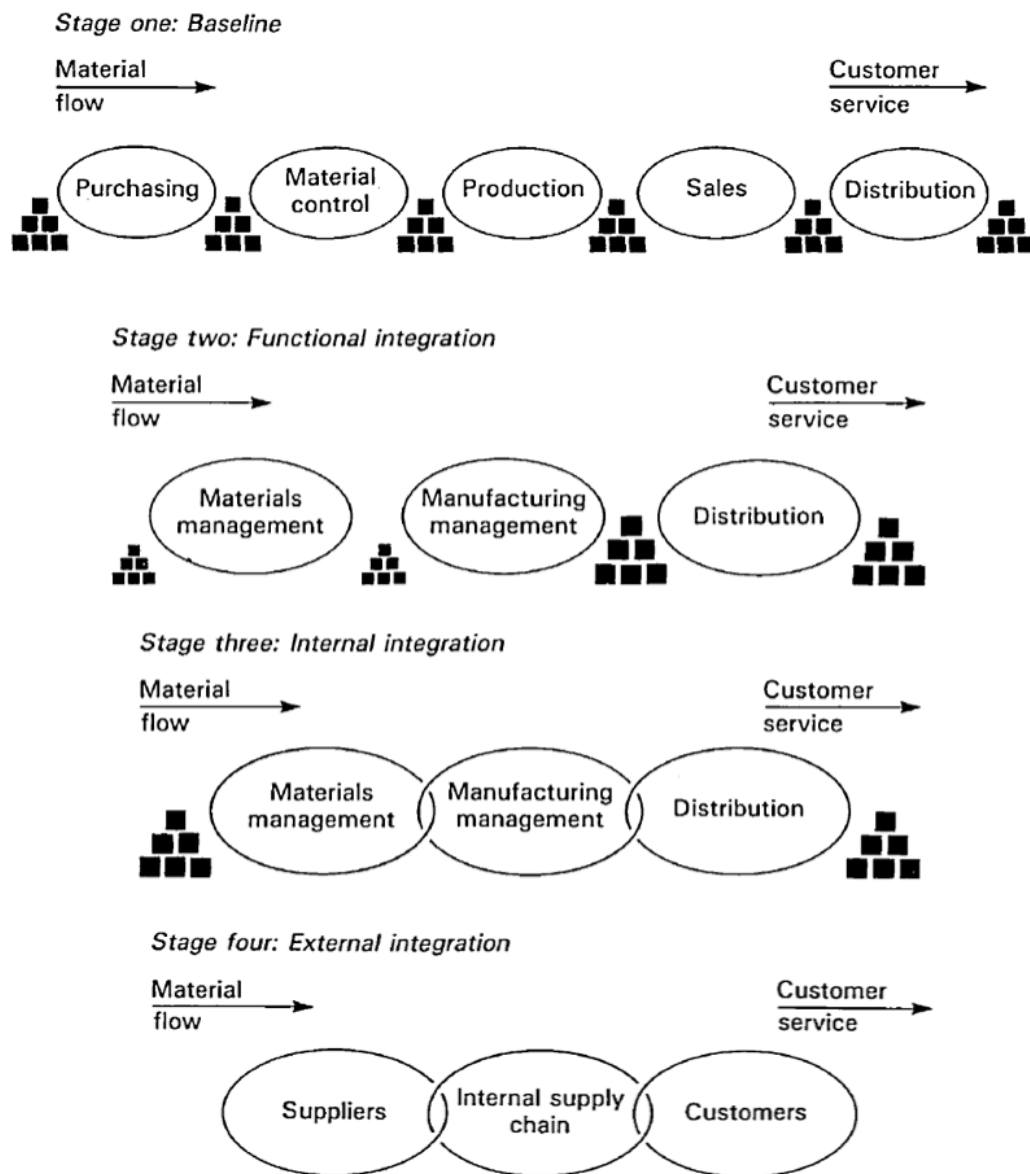


Figure 3.2.1: Supply chain integration framework (Stevens, 2007)

In light of this framework, Stevens (2007) also considers internal integration as a necessary step before external integration. Some may even consider integration of the functional silos within the company as first steps of internal integration. Others went even further and stated that internal integration is an essential prerequisite for further SCI (Tarifa-Fernandez & Burgos-Jiménez, 2017). They mentioned that external integration, when carried out before internal integration, can be prejudicial to a firm's performance.

Another requirement for SCI often mentioned in the literature is the need to shift away from managing individual functional processes to the management of integrated supply chains (Power, 2005). The integration is thus characterized by information sharing, trust, partnerships, technological exchanges among SC partners, collaboration and cross-company coordination. Fawcett and Magnan (2002) stress the importance of adopting a process approach and state that coordination between functions at the internal level is critical in achieving internal integration. Alfalla-Luque et al. (2012) also insist on the importance of adopting a process integration perspective. They consider that the successful integration of the whole supply chain requires all companies within the same SC to overcome their functional silos and to adopt a process approach geared towards collaboration.

Ultimately, the complete integration of materials and information flows across the SC requires an alignment of the internal management systems of the individual firms (Mentzer, 2004). SCI requires partners to share information and to develop globally optimal plans (Rai et al., 2006). Accordingly, firms must be able to acquire, integrate and use the information embedded in their environment. As such, companies need to make strategic moves related to IT resources. A well-integrated IT structure will allow the sharing of real-time and consistent information between SCM-related applications and functions that may be distributed across SC partners. Power (2005), among others, also stressed the importance of improving information flows through the use of technologies such as ERP systems. The use of such systems will enhance data sharing between buyers, focal firm and suppliers which will foster supply chain integration. Indeed, information flows need to flow swiftly across the whole supply chain. Whereas material flows will only flow upward the chain and financial flows only tend to flow downward the chain, information flows are omnipresent along the chain. They can come from and go to any SC partner (Christopher, 2016), as represented on Figure 3.2.2.

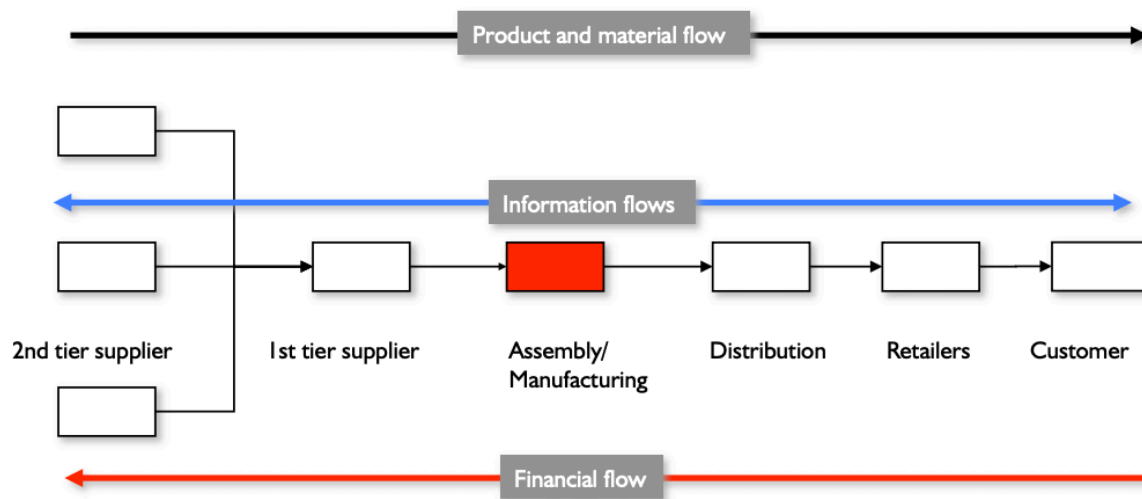


Figure 3.2.2: The three flows model (Christopher, 2016)

3.3. Facilitators and barriers for supply chain integration

In spite of all the positive impacts SCI can have on firm's performance, companies need to be aware that the path to a fully integrated supply chain is not without pitfalls. There are factors fostering SCI but adversely, there also are hindering factors to this integration. Several authors identified such factors in their researches. Richey et al. (2010, p. 237) for instance, broadly defined facilitators as "something that assists the bringing of an outcome" and consider barriers as "something that inhibits an outcome". They suggest integrating the supply chain entails managing both the facilitators and the barriers to internal and external integration. Their research revealed however that the positive impact that facilitators have on SCI outweighs the negative impact that barriers have on the integration of the supply chain. Hence, managers should gear their efforts towards the strengthening of facilitators rather than the weakening of barriers. Table 3.3.1 summarizes these facilitating and hindering factors.

3.3.1. Facilitators to supply chain integration

Richey et al. (2010), as many others, have identified the improvement of communication and information flows as facilitating the integration of the supply chain (Chang et al., 2016; Power, 2005; Rai et al., 2006; Zhao et al., 2011). They state that improved communication will set the basis for common understanding and common measure development. By better communicating with their supply chain partners, firms can reduce the need for interpretation which will lead to better decision making and better performance. Ellinger, Keller, and Hansen

(2006) joined them in their analysis and found that inclusive communication could help integrate on an internal level between logistics and marketing functions. They also identified other factors such as senior management involvement, strong working relationships and joint accountability as facilitating internal integration. When it comes to inter-company relationships, Barratt (2004) also consider information sharing and communication sharing as enablers for external integration. They also state that interdependency and common goals and objectives will help achieve EI.

Cao et al. (2015) analyzed the impact organizational culture has on all three dimensions of SCI. They defined organizational culture as the values and beliefs that are shared by all members within an organization. They identified four dimensions of organizational culture, each reflecting specific values and beliefs:

- i. **Development culture:*** It emphasizes future developments and encourages firms to integrate their supply chain, both internally and externally in order to improve the information sharing to better react to opportunities.
- ii. **Group culture:*** It encourages collaboration and team spirit and is hence driving employees to integrate with internal and external partners.
- iii. **Hierarchical culture:*** It emphasizes top-down decision making and control. It might act negatively on the employees' motivation to take risks and hence be detrimental to SCI.
- iv. **Rational culture:*** It will use incentives to motivate employees towards the integration with internal and external partners.

They found that development and group culture will both facilitate the integration of the supply chain, whether it is inward- or outward-looking. Rational culture however was found to only have a positive impact on internal integration. Their results are summarized in Figure 3.3.1.

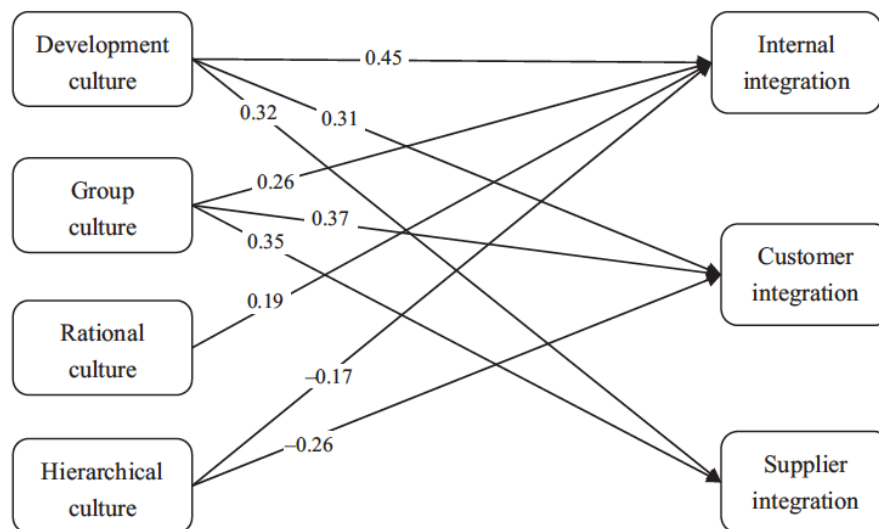


Figure 3.3.1: The impact of organizational culture on SCI (Cao, Huo, Li, & Zhao, 2015)

When it comes down to SCI facilitators, Eckstein, Goellner, Blome, and Henke (2015) have identified supply chain agility and supply chain adaptability as having positive impact on cost performance and operational performance. They defined supply chain agility as a firm's ability to recognize short-term changes in its supply chain such as demand fluctuations or supply disruption, and to rapidly react in a flexible way to these changes by using its existing supply chain. Supply chain agility thus encourages firm to react within their own supply chain structures to react to changes in their environment. Supply chain adaptability, on the other hand, is defined as a firm's ability to recognize long-term changes in its supply chain (demographic change, technological advances) and to respond to these changes by flexibly adapting its supply chain structure.

I believe supply chain agility, by helping firms to react cost-efficiently to supply chain disruption (Blome, Schoenherr, & Rexhausen, 2013) and by enabling them to better synchronize supply and demand (Christopher, 2000) can also be considered as a potential facilitator for SCI. On an operational perspective, supply chain agility will help firms meet delivery deadlines and ensure service accuracy which is likely to foster the creation of better relationships between a firm and its SC partners. Hence, collaboration and coordination between firms is more likely to arise and supply chain integration might be more easily attained. I also consider supply chain adaptability as being a potential enabler for SCI. By stressing the importance of adapting the supply chain structure to a firm's environment, I believe supply

chain adaptability is likely to foster narrower collaboration between a firm and its SC partners which might lead to the premises of supply chain integration.

3.3.2. Barriers to supply chain integration

Richey et al. (2010) have identified short-term instead of long-term focus, failure to understand the importance of supply chain integration and the fear of losing control as barriers to SCI. Adversely to what they identified as facilitators, Ellinger et al. (2006) consider insufficient knowledge about the other functions, conflicting goals, lack of communication and information sharing, poor working relationship and lack of senior management commitment as important barriers to SCI.

Hierarchical culture, as depicted on Figure 3.3.1 is also considered as a barrier to the integration of the supply chain. Cao et al. (2015) consider companies having a hierarchical culture as more likely to operate around functional silos. The stronger this organizational culture trait, the more difficult it will be to break down these silos and to integrate the supply chain. They also state that employees in such companies will be used to following rules and regulations and might therefore feel reluctant to adapt to changes. Change, however, is unavoidable when integrating the supply chain. Without a cooperative behavior from all people involved, SCI is less likely to happen.

Tarifa-Fernandez and Burgos-Jiménez (2017) argue that SCI might also have negative consequences which might hinder its implementation. They claim that it might imply additional coordination and control activities which might lead to higher managerial costs. Developing cooperative processes with SC partners might require time and training which are also likely to raise costs. Obviously, if the total managerial cost increase is too high compared to the benefits companies can reap, SCI is unlikely to happen.

Power (2005) also identified implementation issues as hindrances to supply chain integration. He states that the lack of identification of the key risks and the active management of those risks before they become issues can hinder SCI. Absence of an implementation plan or roadmap for SCI with a succession of milestones to reach can break people's confidence in the project. He also considers the lack of clear, pre-emptive communication between supply chain partners as a barrier to the integration of the supply chain.

Finally, Sun et al. (2013) found that supply chain risks are negatively related to supply chain integration. They identified two types of risks: supply delivery risks, mainly caused by delivery failures and demand variability risks mainly caused by demand instability. Under high supply delivery risks, manufacturers are unlikely to share inventory information and customer orders with suppliers as their lead times and delivery might not be stable. This will hinder collaboration between partners and thus act as a barrier to SCI. Unstable deliveries from suppliers might also negatively affect internal integration by deteriorating coordination between purchasing and manufacturing departments within a firm for instance. On the other hand, with high demand variability, information manufacturers can send to their suppliers about their material requirements is likely to change quickly which might make supply chain integration much more complex as well.

All the information gathered through this literature review will reveal its usefulness in the comparison with the empirical analysis. I will strive to adopt a neutral position both with regards to the literature I perused and the company I collaborated with for this thesis. This theoretical knowledge will serve as groundwork information against which the consideration, the micro-level practices, the motives of Sonaca Group's supply chain integration will be assessed. Further, it will lay the ground for recommendations of improvement for Sonaca's integration efforts.

Facilitators		Barriers	
Richey et al. (2010)	Improvement of communication and information flows.	Richey et al. (2010)	Short-term focus, non-understanding of the importance of supply chain integration, fear of losing control.
Ellinger et al. (2006)	Senior management involvement, strong working relationships and joint accountability as enablers for internal integration.	Ellinger et al. (2006)	Insufficient knowledge about the other functions, conflicting goals, lack of communication and information sharing, poor working relationship and lack of senior management commitment.
Barratt (2004)	Information sharing, communication, interdependency and common goals as enablers for external integration.	Power (2005)	Lack of identification of key risks and active management of those risks.
Cao et al. (2015)	Development and group culture will help supply chain integration. Rational culture only helps internal integration.	Cao et al. (2015)	Strong hierarchical culture.
Eckstein et al. (2015)	Supply chain agility and supply chain adaptability.	Sun et al. (2013)	Supply delivery risks and demand variability risks.

Table 3.3.1: Facilitators and barriers for supply chain integration

Methodology

Chapter 4: Framework and methods used

For the purpose of this project thesis, I wanted to compare the information gathered through my literature review with practical situations. In order to gain this real-life, empirical information, I collaborated with Sonaca, a Belgian aerospace organization. I will linger on the explanation of Sonaca's supply chain integration efforts and micro-level practices and will compare it to the information found in the literature. I will also evaluate Sonaca's supply chain integration. As evaluating an organization's integration demands rigor, reliability and requires validity I cannot bring on my own, I will rely on a framework identified during my literature review. Most importantly, as I believe in the many benefits of supply chain integration, I will provide Sonaca with recommendations for further SCI improvement.

4.1. How to evaluate Sonaca's supply chain

Having reviewed many papers and articles, the framework for supply chain integration evaluation developed by Alfalla-Luque et al. (2012) appears to be most convincing one I came across. Firstly, it is aligned with the consideration many authors and I make of supply chain integration. By considering all three dimensions of SCI, namely internal, supplier and customer integration, the model covers the entire spectrum of integration along the supply chain. Secondly, the model details several aspects of integration. The framework's authors cover the integration of information and data, the sharing of materials and resources and also include the concept of relationships between and/or within firms along the supply chain. Ultimately, the framework extends on many variables to assess an organization's supply chain integration. Even though some variables tend to slightly overlap each other, I still consider this framework to be very thorough, comprehensive and rigorous. Yet, this framework lacks an explanation on how to evaluate each variable. Hence, I decided to assign each variable a score, on a 1-5 scale. This prevents losing track of the essence of the framework due to a highly granulated scale.

4.1.1. Model to evaluate the integration of the supply chain

Through their literature review, Alfalla-Luque et al. (2012) have constructed a framework for SCI evaluation. Drawing on their literature review, several constructs arose for companies who want to evaluate their supply chain integration. Rosenzweig, Roth, and Dean (2003) looked into how integrated a business unit really is within its own organization. They also raised the question of how closely integrated the business unit is with its suppliers, distributors and customers. Similarly, Vickery, Jayaram, Droge, and Calantone (2003) looked into three items, namely supplier partnering, close customer relationships and cross-functional teams. From a very different perspective Frohlich and Westbrook (2001) looked into the access to planning systems, the sharing of production plans, knowledge of inventory level, delivery frequencies and common use of third-party logistic providers.

Building on their literature review, Alfalla-Luque et al. (2012) identified three dimensions through which SCI is broken down:

- i. Information Integration (II):* II² refers to the sharing of information and data both within the organization and beyond its boundaries, with its supply chain partners. This ties back to inventory status, demand information, sales forecasts, production schedules.
- ii. Coordination and Resource Sharing (CRS):* CRS refers to the realignment of decisions and resources both within and beyond a company's boundaries. Reorganizing the logistics and outsourcing is especially significant here.
- iii. Organizational Relationship Linkage (ORL):* ORL refers to transparent and stable relationships among supply chain partners. This will lead to common objectives, sharing of skills and ideas, incentive realignment.

They consider each dimension can then be independently applied to internal, customer and supplier integration. They have defined variables through which each dimension can be evaluated. Figure 4.1.1 represents their framework and Table 4.1.1 shows the variables for SCI evaluation. As it appears to be the most complete one, this framework is the one I will use to assess Sonaca's supply chain.

² II stands here for Information Integration.

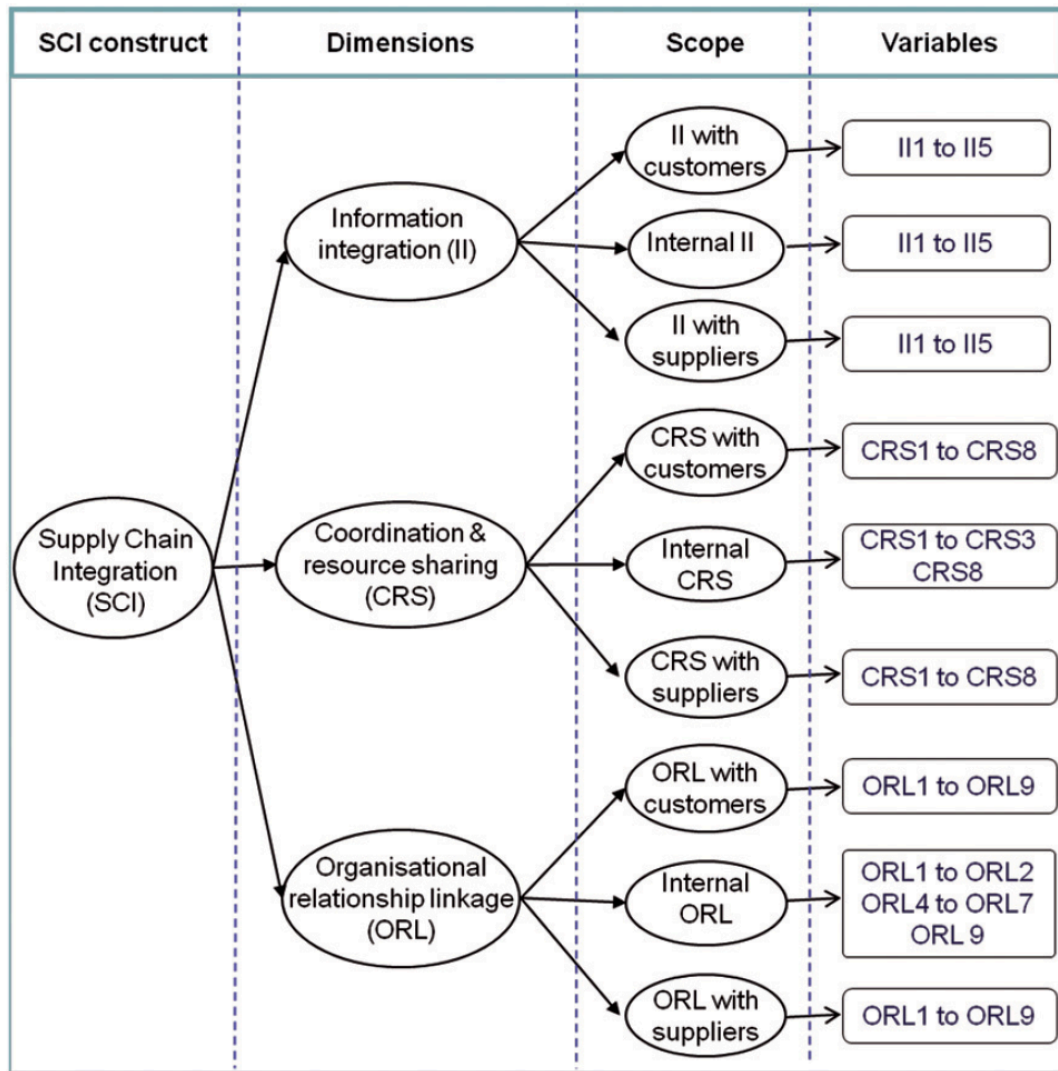


Figure 4.1.1: Framework for SCI evaluation (Alfalla-Luque, Medina-Lopez, & Dey, 2012)

Dimension	Variable	Scope	Definition
Information Integration (II)	II1	S/I/C ³	“To share information across the various functional departments of the organization and with supplier and customer organizations to improve decision-making”.
	II2	S/I/C	“To make compatible the information systems so as to allow access to information concerning the activity of the company from different departments and companies that make up the SC”.
	II3	S/I/C	“To make available to the various companies with information that allows joint planning that takes into account the constraints of the companies involved and seek to improve the planning process of comprehensive SC”.
	II4	S/I/C	“To have real-time information directly from the end customer to make a common demand forecast in order to avoid disruptions.”
	II5	S/I/C	“To have sufficient information to perform the procurement activities that meet real needs.”
Coordination and Resource Sharing (CRS)	CRS1	S/I/C	“To involve to the SC members in decision making and to delegate to the member with the best negotiating position to lead the relevant decision making.”
	CRS2	S/I/C	“To realize of joint actions to achieve the same end.”
	CRS3	S/I/C	“To plan the workload in a balanced way among the links in the SC.”

³ Supplier / Internal / Customer.

Dimension	Variable	Scope	Definition
	CRS4	S/C	“To search for an optimal subcontracting for the entire SC, with special emphasis on logistics providers.”
	CRS5	S/C	“To design and joint development of packaging to facilitate handling and transport, reduce costs and ensure quality.”
	CRS6	S/C	“To search optimization in the procurement and distribution of materials throughout the SC.”
	CRS7	S/C	“To use of containers, packaging and transportation common to facilitate handling operations, loading and unloading.”
	CRS8	S/I/C	“To use a process approach that allows the direct interconnection between departments and companies and avoids duplication.”
Organizational Relationship Linkage (ORL)	ORL1	S/I/C	“To communicate using active communication channels with members of the SC.”
	ORL2	S/I/C	“To establish common performance indicators and aligned/consensus that reveal the evolution from the stated objectives.”
	ORL3	S/C	“To share risks, costs and rewards (operational and strategic collaboration).”
	ORL4	S/I/C	“To promote attitudes and plans of action to promote an integrated business performance.”

Dimension	Variable	Scope	Definition
	ORL5	S/I/C	“To guide organizations towards a joint search for the end customer satisfaction.”
	ORL6	S/I/C	“To disseminate of best practices among members of the SC.”
	ORL7	S/I/C	“To establish procedures under the normal order of the company against possible environment or business unexpected situations.”
	ORL8	S/C	“To establish stable links with partners to enable mutual trust.”
	ORL9	S/I/C	“To encourage team building to allow for coordination and active cooperation between members of different departments and companies in the SC.”

Table 4.1.1: Dimensions and variables for SCI evaluation (Alfalla-Luque et al., 2012)

4.1.2. Methods used through my internship at Sonaca

Prior to being able to assess Sonaca's supply chain, I had to gather sufficient relevant information regarding the way the organization operates and its integration efforts. In order to do so, I conducted two projects in the company that allowed me to learn more about the organization and to build my opinion on its supply chain activities. Both projects will be explained in the following chapter.

As it proved to be efficient, I used the same methodology for both my projects within Sonaca. Both were expected to deliver flowcharts summarizing all processes and practices related to the specific projects. To do so, I first gathered information by myself. It would allow me to get a first idea of how I should proceed for the design of the flowcharts. This first step mainly consisted in document lookups and office discussions with Sonaca's employees. I would then conduct interviews with the main protagonists or responsible for these projects in order to confirm my primary findings. Those interviews also proved to be relevant for new information lookout.

Having all necessary information to kick-off the flowchart designing, I started sketching first drafts. As I was moving forward on the designing of each process, I would have recurrent and frequent meetings with my supervisors or main processes' accountable for them to approve the current state of the flowchart. In case of disapprobation, I would refine the flowchart up until I got the confirmation of the rightness of my designs. Working this way, I was able to meet Sonaca's expectations regarding my projects.

Thanks to both my projects at Sonaca, I have been able to get detailed information from insiders. Nevertheless, I was still lacking information to be able to assess the company's supply chain. In order to get this crucial information, I conducted interviews with Michel Fievet (Supply Chain Manager for Sonaca Group) and Bernard De Bournonville (Operational Planning & Scheduling Manager for Sonaca Group) which have allowed me to refine my knowledge about the company and better understand the purposes of my projects at Sonaca. This information I gained has then been used as groundwork information for the comparison between my research and real-life situations.

Empirical analysis

Chapter 5: My project at Sonaca Group

5.1. Presentation of Sonaca Group

Foregoing diving into the analysis and of Sonaca case, I deem imperative to set the frame by explaining what Sonaca Group is. I also judge important to expand on the purpose of my projects at Sonaca and the results I delivered.

5.1.1. Sonaca Group

Sonaca Group has been created years ago with Sonaca's extension abroad. Yet, the group took a different turn in 2017 with the gathering of two major players in the aerospace industry: Sonaca and LMI Aerospace. The group was set up following Sonaca's takeover bid that was initially launched in February 2017. This takeover would allegedly have costed Sonaca \$ 432 million (€ 405,5 million) which represents the value of LMI's debt plus its 13,6 million shares evaluated at \$ 14 each (RTBF, 2017). In this acquisition, LMI Aerospace retained its name while being 100% integrated to Sonaca Group.

LMI Aerospace is an American company founded in 1948 which is now headquartered in St. Louis, Missouri, USA. LMI operates around 19 locations across the United States, Mexico and Sri Lanka and tallies approximately 2000 employees (LMI-Aerospace, 2020). The company's core business is the fabrication, machining and assembly of aluminum, specialty alloy and composite components. LMI also supports aircraft product lifecycles from design to fleet support via engineering and program management services. They supply structural assemblies, kits and components and provide design engineering services to the commercial, business and defense aerospace markets (LMI-Aerospace, 2020). Their customer portfolio consists of the main aircraft manufacturers: Boeing, Airbus, Gulfstream, Bombardier, or even the F22 military aircraft.

The other constitutive party of this group is none other than Sonaca. The Belgian company was initially founded as a flight school in Gosselies, Wallonia, Belgium in 1920 (Sonaca, 2020a). To this day, the company's headquarters are still located in Gosselies. With the recent events of June 2017, the city even turned out to become a major pole in the aerospace industry since Sonaca Group's headquarters also remained unchanged and are still located in Gosselies. The company has evolved over the years and deviated from its initial flight school business. Nowadays, Sonaca is responsible for the development, manufacturing and assembly of advanced structures for the civil, military and space markets. The company is especially known for its capability to design and produce advanced structures such as wing movables and complex fuselages.

Starting off on a purely national scale, Sonaca grew over time and gradually developed its strategic presence on a global scale. In the early 2000s, the company set a foot in Brazil with the creation of a subsidiary in order to get closer to their Brazilian customer Embraer. The subsidiary called Sobraer was later completed with the setting up of two manufacturing plants on the same location: Pesola and Sopecaero. Over time, the Brazilian subsidiaries took over more important workloads and developed capabilities to answer to other aircraft manufacturers' needs such as Airbus or Boeing. In 2003, Sonaca also acquired NMF, which further became Sonaca Montréal. A few years later, the company extended its international footprint with the opening of an assembly line in Tianjin, China and the creation of Sonaca Transylvania, the Romanian subsidiary of the company.

As a worldwide leader operating in the aerospace industry, Sonaca Group employs now over 4600 peoples and operates around many sites all over the globe: Belgium, Brazil, Canada, China, Germany, Mexico, Romania, Sri Lanka, and the USA. An overview of the group's worldwide footprint is given in Figure 5.1.1 while Figure 5.1.2 highlights the group's subsidiaries network.

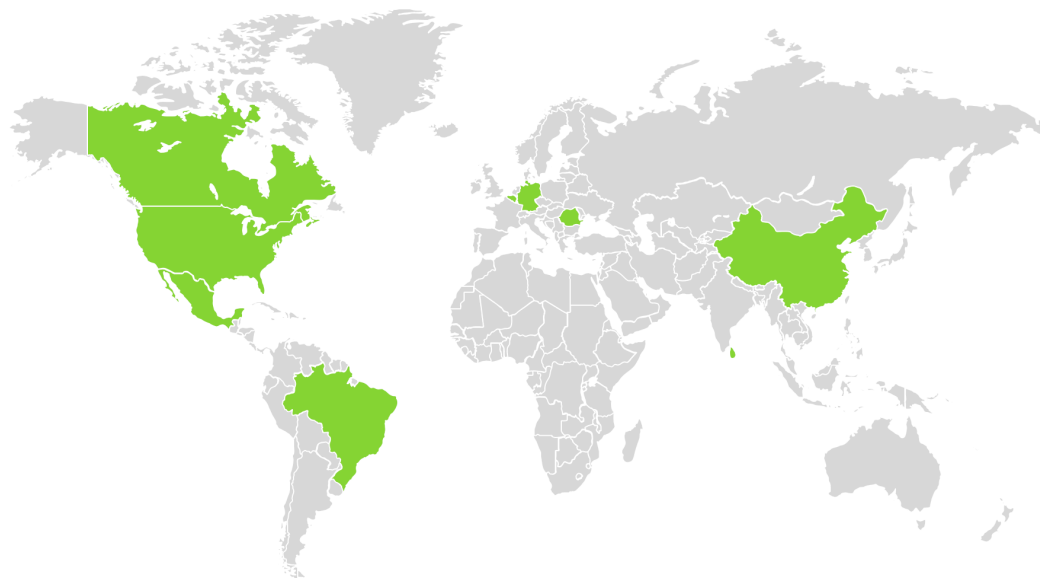


Figure 5.1.1: Overview of Sonaca Group's global footprint

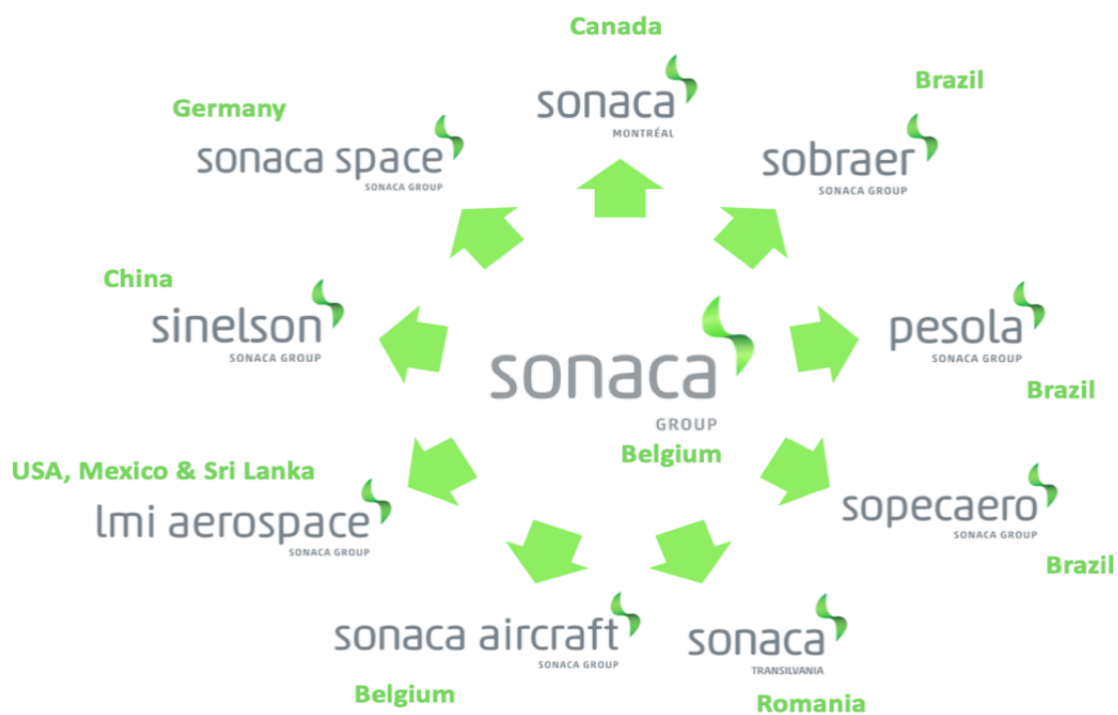


Figure 5.1.2: Sonaca's subsidiaries

Operating in a high-capital market, Sonaca Group's operations allow them to enjoy revenues of around € 750 million (*Sonaca Group Annual Report, 2018*). As of today, the group draws its revenues from 5 business lines (see Figure 5.1.3). For the purpose of this thesis, the projects I conducted at Sonaca Group have been exclusively focused on the Aerostructure business line. Hence, I will not develop the other strategic lines in this thesis. In this Aerostructure line, thanks to its know-how and best-in-class capabilities, Sonaca Group serves a large customer portfolio and became the main partner of the most important aircraft manufacturers: Airbus, Boeing, Bombardier, Embraer, Dassault, Gulfstream.

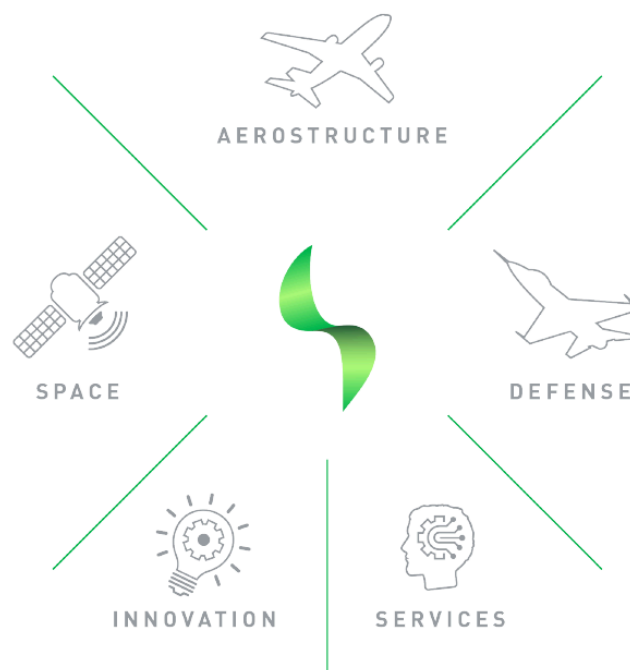


Figure 5.1.3: The 5 business lines at Sonaca Group

5.1.2. Sonaca Group supply chain activities

Sonaca Group is also known for its best-in-class supply chain activities and delivery capabilities. In order to reach its corporate target of 98% on-time delivery, the Belgian aircraft product manufacturer relies on several teams within its supply chain department: a Planning Development team; a Planning & Scheduling team; a Procurement team; and a Logistics team.

At the very center of the supply chain department lies the Planning & Scheduling team. Their work and efforts will lay the ground for the other teams within this department. At Sonaca, a distinction is drawn between the activities of central planning and scheduling, related to existing programs, and the planning and scheduling activities related to new contracts or projects under development done by the Planning Development team. On one hand, the central planning team's role is to acknowledge customer demand and inputting it in SAP, which is the ERP system used at Sonaca Group. In order to do so, customer data first needs to be translated into production needs and production time requirements before being uploaded in SAP. Once this information is made available in the ERP, it will be used as a central repository for all teams within the supply chain department. The central planning team is also responsible for the creation of production forecasts. On the other hand, when planning and scheduling activities are related to new contracts or developing projects, they have a much broader scope. The team working on these activities will not only be involved with production planning but will be concerned with the entire end-to-end process planning. They will plan and schedule product's design, stress tests, raw materials and tooling sourcing, fabrication and ultimately, delivery. This information can then further be used as an order-winner for Sonaca or as a lever for customer negotiations.

The other supply chain teams intervene at different steps in the production process. The procurement team's input is required before actually starting production. Their role is to collaborate narrowly with the Purchase department and with suppliers in order to ensure all necessary materials and tools sourcing in due times. This happens through an SAP-integrated Materials Requirement Planning System. The MRP will receive as input the production needs and production time requirements that were uploaded in SAP by the central planning team, as above-mentioned. As the MRP has built-in information regarding the assembly process and Bill of Materials (BoM) for each required component, it will transform the production needs into purchase needs for raw materials, tooling or subcontracted parts. This will result in the creation of an order book for the procurement team which will be communicated to suppliers. The procurement team is also in charge of collaborating with suppliers through the sharing of production forecasts, delivery horizons and backorders. This collaboration is in line with the objective of avoiding any procurement shortage that would greatly hamper Sonaca's production activities and hence on-time delivery objective.

Intervening all along the production process, the logistics team at Sonaca is further divided into an internal logistics and an external logistics team. The internal logistics team is responsible for inventory management, stock entries and exit as well as punctual materials handling between the different production plants or production lines. The external logistics team is rather outward-facing. Their duties are related to the crating, shipping, customs and documentation dealing.

Ultimately, hovering around all these teams in the supply chain department at Sonaca is also a team that is striving for continuous process and material flows improvement. Whether it is regarding the delivery of the different components to the assembly, the sourcing from the suppliers or even the production process in itself, this team collaborates with all other teams in order to continuously reduce cycle time and internal costs.

5.2. The initial projects

For the purposes of this thesis, I conducted two projects within the Aerostructure business line in Sonaca Group. More specifically, I worked as part of the supply chain department, alongside the Planning & Scheduling teams at Sonaca. Both projects were chronologically and content-wise different. The first one was very specific and related to a single program within Sonaca (A350 TEDSS) while the second one had a broader scope and was not linked to any particular program in the group. Although time-different and varying in their finalities, both projects were aligned in terms of purpose: synchronizing and standardizing processes across Sonaca Group. For the sake of this section, I will explain both projects chronologically before expanding on their results.

5.2.1. *Flowchart for the A350 TEDSS*

The first project was related to the internship I carried out at Sonaca between April and July 2019. During this internship, I spent 2 weeks working in Sonaca's headquarters before leaving for the Brazilian subsidiaries for 3 months. The reason for me to analyze the situation directly on-site in Brazil was related to the specificities of the program I was working on. This program, namely the A350 TEDSS, is a tripartite agreement between Sonaca's headquarters, GE Aviation located in the UK, and the production facilities located in Brazil. GE Aviation was a subcontractor for Airbus on the production of A350 aircraft. Sonaca's role in this agreement

was to supply Airbus, through the subcontractor GE, with wing slats (front part of the wings), de-icing systems, fuselage and wing detail parts (Sonaca, 2020b). The denomination TEDSS actually refers to the specific parts that were to be supplied (Trailing Edge & Detail parts of Secondary Structure) whereas the A350 stands for the type of aircraft the parts would be used for. In order to do so, Sonaca leveraged its Brazilian production facilities who were in charge of 95% of the total workload. The remainder of the workload was assigned to the Belgian plants, located in Gosselies.

My project within this framework consisted in analyzing the end-to-end process, understanding it, assessing it and being a force of recommendation for further refinement. In this sense, I modeled the entire process in a sequential way using a flowchart. My main supervisors for this project were Arnaud Deblandre (Planning & Production Control Manager for Sobraer), Bernard De Bournonville (Operational Planning & Scheduling Manager for Sonaca Group), and Michel Fievet (Supply Chain Manager for Sonaca Group). The purpose of this project was double. Firstly, it would enable internal synchronization on the A350 TEDSS program. Thanks to this flowchart, every person involved on the program would know its responsibilities, duties, inputs and outputs. Secondly, when refined and assured the entire process can flow seamlessly, it could be used as a standard roadmap on how to proceed for both existing or future similar programs within Sonaca Group. I will elaborate on the projects' results in the sections 5.3.1 and 5.3.2.

5.2.2. Standardizing the Planning & Scheduling processes

This second project was related to an extracurricular internship within the Planning & Scheduling teams of Sonaca Group and lasted for 3 months, going from February to April 2020. This project's scope was broader than the one I conducted on the A350 TEDSS. Indeed, it was not related to any specific current or future program at Sonaca and was actually carried out in collaboration with both constituting parties of Sonaca Group: LMI Aerospace and Sonaca. On this project, I worked under the supervision of Bernard De Bournonville (Operational Planning & Scheduling Manager for Sonaca Group) and Gregory Dewil (Director of Materials Planning for LMI Aerospace). The support I brought to the Planning & Scheduling teams of both the Belgian and American counterparts was actually following the line of a longer-term project for the group. The timeframe for these joint activities was set to run on a two-year period.

The punctual help I brought on this longer-scoped project incorporated a two-step objective. The primary objective was to gather most knowledge around the Planning & Scheduling practices and processes at a group level. In order to do so, I worked closely with the leaders of the Planning & Scheduling teams of both LMI Aerospace and Sonaca. As the knowledge was gathered, the second step was to agree upon good practices and standard processes for this specific function within Sonaca Group's supply chain activities. Processes would then be mapped in a flowchart that would be used as a "how-to" booklet for all Planning & Scheduling teams within the group's extended subsidiaries network. The ultimate goal of this project was to strive towards the standardization of processes across Sonaca Group.

5.3. Results

5.3.1. *Flowchart for the A350 TEDSS*

For this project, the flowchart was detailed on three distinct levels. The rationale for this was that people could go to a deeper level of detail for the processes they were in charge of or for the one they were interested in. The guiding line throughout the entire project was to produce a flowchart that would be both easy enough to understand for newcomers and sufficiently detailed and complete to avoid ignoring whose responsibilities it is to perform specific tasks. In order to fulfill this double aim, the flowchart has been divided into pools or horizontal lanes to distinguish between every team or department's roles. The different tasks that needed to be performed, the required input and output documents, who these documents needed to come from and go to are all the information that were represented in the flowchart. The visuals of this project's end results are available in the appendices, on p.- 94 -.

5.3.2. *Standardizing the Planning & Scheduling processes*

In the same sense as for the flowchart I produced for the A350 TEDSS agreement, this project was intended to be shared throughout several plants, if not throughout the entire group. Hence, it was paramount to deliver standardized processes that would leave no room for hesitation as to one's responsibilities and yet be easily understandable for all people who were not involved in the early development stage of this flowchart. Drawing on my previous experience at Sonaca, I decided to build my project upon the same model as the one I previously used. The flowchart thus incorporates pools to highlights one's responsibilities and duties and

is detailed on two distinct levels to facilitate navigation through the chart. Tasks, input and output documents were also represented using the same framework. The end results of this project can be found in the appendices, on p.- 112 -.

Chapter 6: Comparison between theoretical and empirical analysis

Prior to deep diving into the core of the empirical analysis and comparing Sonaca's experience regarding supply chain integration, their motives for it and the micro-level practices they implemented, I deem paramount to understand the aerospace company's take on SCI.

6.1. Sonaca's vision on supply chain integration

In accordance with what the literature review has revealed, Sonaca considers the essence of supply chain management lies in the structure and architecture of the company's supply chain. They consider prior to actively managing its supply chain, a company must understand the boundaries of it. It is paramount to first adopt an inward-looking perspective and acknowledge what operations will be englobed by the company's supply chain activities. Organizations should understand if their focus need to be geared towards purchasing, sourcing, planning, or logistics activities. Most of the time however, and as illustrated by Sonaca's example⁴, companies include these four activities in their supply chain activities. Once the content of the supply chain has been defined, companies can then face outward and define the scope of their supply chains. As identified by Mentzer et al. (2001) companies can consider the management of a supply chain in its direct, extended or ultimate scope. As for Sonaca, I would argue they are positioned as managing an extended supply chain.

I would like to evidence this statement with reference to the A350 TEDSS agreement signed between Sonaca Group and GE Aviation UK. As abovementioned, on this agreement GE Aviation was a subcontractor for Airbus which is Sonaca's end-customer. In this sense, the Belgian company was not only concerned with its direct stakeholder but went further and also considered Airbus. Looking at the supply side, part of the workload was assigned to Sonaca's Brazilian subsidiaries which in this contract were considered as suppliers. Sonaca's headquarters were in charge of producing and delivering parts to GE Aviation and in this agreement, part of the workload was delegated to external suppliers which are none other than Sonaca's Brazilian plants. In this specific configuration, Sonaca also kept an eye on their suppliers' suppliers in order to ensure smooth process flows. The way Sonaca's headquarters considered its supply chain in this agreement corresponds to the description of an extended

⁴ Cf. 5.1.2. Sonaca Group supply chain activities

supply chain Mentzer et al. (2001) gave us. An illustration of Sonaca's extended supply chain management can be seen in Figure 6.1.1.



Figure 6.1.1: Sonaca's extended supply chain

Sonaca further considers SCM as a system englobing the different supply chain activities and supply chain partners. They consider this system requires various functionalities to enable the management of the supply chain. Nevertheless, Sonaca insists on the importance of having minimal levels of customization in order to facilitate the transition with external supply chain partners and foster a transversal supply chain management. In doing so, Sonaca unconsciously joins several authors such as (Gunasekaran & Ngai, 2003; Richey et al., 2010; Yu et al., 2013) whose definitions of SCM encompass the notion of supply chain integration.

In their understanding of the concept of supply chain integration, Sonaca stresses the importance of collaboration and coordination with both upstream and downstream partners in the supply chain. They deem integration will deliver added-value to the focal firm as well as to the chain as a whole and deliver superior performance which resonates with my conception of supply chain integration⁵. Sonaca goes even further and reveals a gap in the literature review. At Sonaca, the added-value criterium is considered as an absolute requirement for SCI. Integration will not be pursued if it doesn't bring sufficient value to the organization. This may seem pretty straightforward but has yet to be identified as a SCI requirement in the literature review.

Regarding the way of considering SCI, Sonaca abides by mine and thinks of it as a two-axis integration. Supply chain integration can happen at the internal level, breaking down the functional silos and allowing for swift information flow across the organization but can also take place with external partners along the chain such as customers and suppliers through information sharing and enhanced collaboration. Sonaca even thinks of SCI as being mandatory

⁵ Cf. 1.2. Supply chain integration

for companies in the aerospace industry. The global positioning of both the suppliers and customers induces pressure on the Belgian Group to react in a flexible and agile way to its environment. Without integration efforts, the group considers it would barely survive on such an international and competitive market. The pressures globalization comes with have also been identified in the literature review. More precisely, El-Sakty and Osama (2015); Mentzer et al. (2001) noted that companies evolve in a VUCA (Volatile, Uncertain, Complex, Ambiguous) world and that this environment imposes greater flexibility from companies in their supply chains.

In this sense, even if Sonaca agrees with the RBV and considers that the right talent and the adequate financial resources can help gain competitive advantage, they nuance Barney (2012) standpoint. They do not consider SCI as an internal resource that can deliver sustainable competitive advantage but rather see it as a necessity to reach competitive parity. Sonaca agrees however with the overall performance improvement integration efforts yield.

6.2. Micro-level practices of supply chain integration at Sonaca

This section will linger on the micro-level practices Sonaca has implemented in its supply chain in order to facilitate both internal and external integration. I will then position the company using the concept of arcs of integration, as developed by Frohlich and Westbrook (2001). Despite the criticisms that were brought to this model by Schoenherr and Swink (2012), I deem this model is still relevant and can thus be applied to the case of Sonaca.

In terms of internal integration, the group remains splintered as LMI's operations and Sonaca's remains separated. Each constituent operates with its own material and information flows, as if both organizations were distinct. Additionally, LMI does not rely on the same ERP system as Sonaca and manages its subsidiaries on its own. Hence, I will not expand on LMI's integration efforts. For its part, Sonaca considers its subsidiary network is nowadays almost entirely integrated in SAP which is the ERP system they rely on. However, of all the plants operating under the governance of Sonaca Group around the world, only one of the manufacturing plants in Brazil, Pesola, is not integrated in SAP and is still using its own system. Even though the system in place at Pesola delivers some of the same functionalities as SAP, it is less powerful. Most importantly, because of this missing link, the integration chain in the Group is broken and Sonaca loses the benefits of having a fully integrated organization.

Concretely, this might result in the incapacity of bulk-loading SAP data in this lone stander system and hence drives to the necessity of data translation which can be time-consuming. Moreover, as one of the most depicted benefits of having all internal stakeholders relying on the same system is to enable information to flow swiftly and more easily across the entire group, this use of an independent system heavily complicates the information flow towards this isolated plant.

Even though one plant is standing out in the group integration scheme, making the benefits a full integration less apparent at the group level, organizations that actually make use of SAP can still leverage the benefits of such a system internally, at the individual company level. As often highlighted in the SC literature (Baymout, 2014; Boon-itt & Wong, 2011; Gunasekaran & Ngai, 2003; Su & Yang, 2010), systems such as SAP will break down the functional silos in organizations. An illustration of this benefit can be made through the example of Sonaca's headquarters. Before switching to an ERP system in 1998, and as revealed by the interview with Michel Fievet who has over 20 years of experience with Sonaca's supply chain, each department at the headquarters was dealing with its own system. Almost everything went through Excel spreadsheets that were journeying from department to department. Additionally, to the time loss this induced, it also led to many approximations and hindered swift information flow across the organization. Now that the headquarters rely on SAP, all departments rely on a central information repository. This ensures every person in the organization has access to the updated information which suppresses the approximation risks.

Besides, Sonaca is also trying to foster internal integration through process standardization across the group. Operating with similar processes around the group makes in-group collaboration easier. People sharing the same processes can help each other in case of trouble, no matter which subsidiary they come from. Standardizing processes also breaks down the organizational silos at the group level. Via sharing the same processes, the group is working as an integrated entity and not as multiple constituencies. As identified by many authors (Alfalla-Luque et al., 2012; Flynn et al., 2010; Gimenez & Ventura, 2005; Power, 2005; Yu et al., 2013; Zhao et al., 2011), this can supposedly further facilitate external integration with suppliers and/or customers. At Sonaca, this process standardization can be illustrated by the flowcharts that were created for the A350 TEDSS⁶ and for the Planning & Scheduling

⁶ Cf. 5.2.1. Flowchart for the A350 TEDSS

activities⁷. The purpose of both these projects was to provide all involved plants with a common work base and ensure alignment across the group on those specific processes.

In terms of external integration, Sonaca seems to have reached advanced supplier integration. They make use of Supplier Relationship Management (SRM) and operate in Just-in-Time (JIT). This inventory management technique greatly helps Sonaca improve efficiency since goods are only received when they are needed for the production process. This method also allows important inventory costs decreases for the Belgian company. The core of this system is that it requires accurate demand forecast and lead time management on the manufacturer side. Most importantly, JIT cannot be attained without reliable information transfer along the supply chain. I can thus easily assume this demands narrow collaboration between Sonaca and its supplier base. Hence, I consider JIT inventory management as a form of supplier integration even though it has been unidentified in the literature review.

On the importance of having seamless and reliable information flows, as stated by Gunasekaran and Ngai (2003), the complexity of supply chain models nowadays has forced companies to share information through integrated Information System (IS). Sonaca's supply chain network being highly complex and extended across the globe, it was paramount for them to go online for communication tools. More precisely, information is shared with suppliers through SAP and through an EDI. As identified by Gunasekaran and Ngai (2003) in their IT-enabled SCM framework⁸, an EDI will not only enhance communication and collaboration between a focal firm and its suppliers but will also ensure the reliability and quality of the exchanged information.

The EDI at Sonaca grants suppliers a straightforward access to large amounts of real-time data which, as highlighted by (Su & Yang, 2010), greatly enhances collaboration between supply chain partners. Specifically, the EDI at Sonaca comes under the form of a portal suppliers can connect to. This portal is directly linked to Sonaca's SAP which allows the sharing of real-time and reliable information. When signing in on this portal, suppliers can access information regarding customer demand forecasts, order books, lagging or urgent parts. Moreover, in a wish of continuous improvement and improved collaboration with its suppliers,

⁷ Cf. 5.2.2. Standardizing the Planning & Scheduling processes

⁸ Cf. 2.1. IT and supply chain management

Sonaca also provides its suppliers with indicators regarding their performance. The monthly evaluation is represented as a scorecard on the portal that suppliers can access anytime.

The Belgian company even went further in its collaboration with its supplier base. Some suppliers work under a Vendor-Managed Inventory (VMI) regime. As developed by Boon-itt and Wong (2011), those suppliers specifically have access to additional information through the EDI. At Sonaca; this information is mainly related to inventory levels. Suppliers have thus access to order books, demand forecasts and inventory levels. With such information in their hands, they are trusted to self-manage Sonaca's inventory and make sure the company will never have to face a supply shortage. This pushes the collaboration and trust emplaced in suppliers to a further level. Sonaca also expanded the concept of VMI to its tooling inventories. Along the production lines are cupboards filled with necessary tools such as drill bits. Those cupboards are directly related to SAP and the EDI which allows corresponding suppliers to constantly have access to the inventory levels in these cupboards. Sonaca then trusts those suppliers to organize themselves the replenishment of these cupboards.

Looking at the other side of the supply chain, Sonaca also integrates with its customers. The collaboration is here specific to each client Sonaca is working with. In the case of Airbus for instance, Sonaca is being given access to a portal through which it can receive information regarding customer demand and demand forecasts. This allows the customer to operate changes in its orders while letting Sonaca know of it in real-time. This collaborative tool can also be used as a safe watching tool for on-time delivery KPI's. Customers can upload the date of order reception which can then immediately be cascaded down to Sonaca's performance indicators related to the corporate target of 98% on-time delivery.

Going deeper in the customer integration, Sonaca is implementing the concept of shuttle boxes for its deliveries. Those boxes are filled with captors and will travel along a two-way journey between Sonaca and its customer. The finished products will be put in the shuttle-boxes. Captors will then detect the presence of the goods and will identify that the box is not empty. The boxes are also filled with temperature/humidity captors, GPS trackers and shock detectors. All the information the captors will detect is transmitted in-real time to a platform Sonaca uses to manage its deliveries. Once the box has been sent, the customer will store it and collect the finished goods. The captors will detect the box has been emptied, the information will be transmitted to Sonaca's platform and the box is then ready to be shipped back to Sonaca.

These shuttle-boxes can be considered as a VMI tool for Sonaca with its customers. This push-pull system is intended to ease the logistic flows and to reduce WIP management at Sonaca. This project has been launched very recently at Sonaca and is only in its premises. However, the ultimate objective for Sonaca is to start the production process over only if the customer has effectively consumed the part.

Having all this information regarding the integration practices at Sonaca, I would like to illustrate their situation using Frohlich and Westbrook (2001) concept of arcs of integration. As I have not conducted a study across several enterprises in the aerospace industry, I am unable to position Sonaca on this framework using the quartile method favored by the authors. Nevertheless, I deem it does not make the framework any less valid and suited for this analysis. On one hand, with all the practices Sonaca has implemented to collaborate and better share information with its suppliers, I consider Sonaca as having reached extensive integration with its suppliers. On the other hand, integration efforts towards customers have been present at Sonaca yet to a lesser extent up to now. The shuttle-boxes project is only at its beginning and is not yet fully operational. In this sense, I cannot consider Sonaca as enjoying extensive customer integration. Hence, due to Sonaca's more developed integration on the supplier side than on the customer side, I consider it as experiencing a supplier-facing arc of integration, as depicted in Figure 6.2.1.

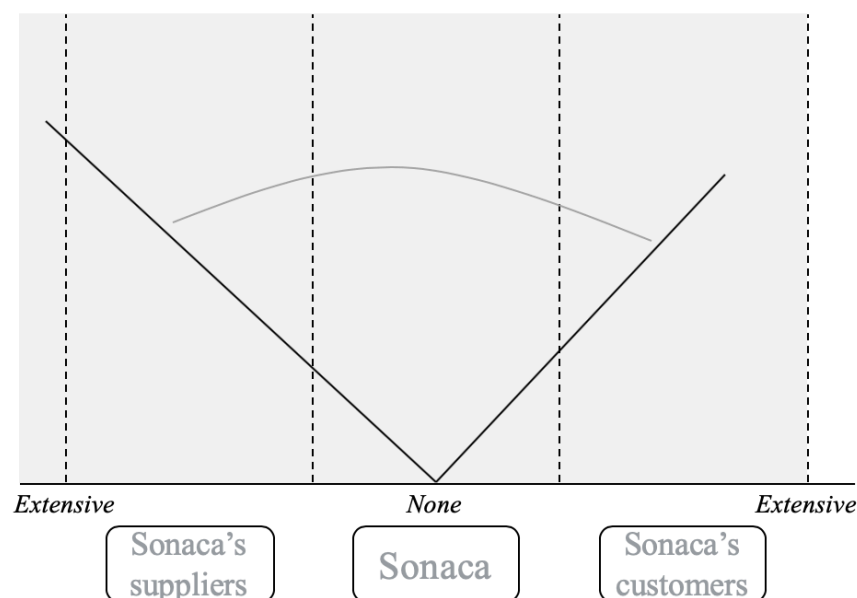


Figure 6.2.1: Sonaca's supplier-facing arc of integration

6.3. Components of supply chain integration at Sonaca

6.3.1. Implications of supply chain integration at Sonaca

As stated in the literature review, Sonaca perceives the many benefits integrating its supply chain has yielded. As Chang et al. (2016) or Flynn et al. (2010) have identified in their researches, integrating at an internal level or with external supply chain partners is considered as a performance enhancer. Sonaca considers its supply chain integration efforts as one of the bottom lines that enabled to improve its operational and financial performance. Sonaca even goes further and states that SCI has become mandatory for them to remain competitive on the aeronautic market. Considering supply chain integration as an indispensable condition for market survival is a trait that has, to my knowledge, not been identified in the supply chain literature.

Sonaca states developing closer relationships with its external partners has enabled them to enhance collaboration and coordination along the supply chain. Especially, as exemplified by Flynn et al. (2010), developing closer relationships with their customers has allowed them to get more accurate information regarding customer demand and demand forecasts. This participates in a reduction of time spent on customer demand forecasts. With more accurate and reliable information gained from customers through collaborative behaviors, it can be cascaded down to the other side of the supply chain and translates in better information for Sonaca's suppliers. This, in turn, has allowed for a reduction of inventory obsolescence, as identified in Flynn et al. (2010) study.

Similarly, Boon-itt and Wong (2011) came to the conclusion in their researches that better information sharing with external partners can avoid inefficiencies in the supply chain and hence allow swift flow of materials. Sonaca mentioned having experienced similar implications related to the integration with their customers and suppliers. The company reveals SCI has helped them reduce to a minimal level the risk of bullwhip effect. According to both interviewees, better information also translates at Sonaca in a reduction of total inventory and Work-In-Progress (WIP) which has turned to benefit the company's treasury.

Furthermore, Sonaca considers the Planning & Scheduling activities must consider the entire industrial process. As such, it must incorporate the lead time necessary for delivering the

end products to the customer, the time needed to assemble the different parts together, the amount of time the manufacturing of these primary parts actually requires depending on if they are subcontracted or not and the amount of time needed to order and reception all necessary supplies. In this sense, supplier integration has allowed Sonaca to share better information with suppliers regarding the planification of their end-to-end process. Suppliers were then able to cover an enlarged time horizon and better comply with Sonaca's planning. In the end, supplier integration allowed Sonaca to stabilize its supply chain and ensure schedule attainment and OTD (On-Time Delivery).

Before initiating the infancy of supplier integration, the group was struggling to reach its corporate target of 98% OTD. The amount of parts that were indeed received on-time by the customer was ranging from 80% to 90%. This specific performance improvement at Sonaca can be linked back to the literature. Indeed, Boon-itt and Wong (2011) found SCI was likely to improve customer delivery performance. By the same token, Sun et al. (2013) identified that supplier integration was specifically related to better schedule attainment.

Overall, supply chain integration has allowed Sonaca to enjoy performance improvement, as identified by many authors (Caniato & Größler, 2015; Chang et al., 2016; Yu et al., 2013). Yet, some of these authors have identified in their researches mediating factors to the positive implications of SCI. Chang et al. (2016) posited that internal integration was more of a long-term process and that supplier integration will strengthen as relationship quality does so. On this extent, Sonaca's experience with integration has led them to similar conclusions. Chang et al. (2016) further stated that all three types of integration were stronger in Asian cultures than in Western's. Sonaca's internal integration with its Chinese subsidiary did not bring the same conclusion, leading us to doubt this finding.

Nevertheless, Sonaca's integration has not been an easy path. The company stated that the complexity of its products was hindering integration, especially with suppliers. This experience had already been identified by Caniato and Größler (2015) who stated high product complexity would entail high supply chain complexity which makes integrative efforts towards external partners more demanding.

6.3.2. *Requirements for supply chain integration at Sonaca*

As often identified in the literature (Alfalla-Luque et al., 2012; Gimenez & Ventura, 2005; Yu et al., 2013), Sonaca considers internal integration as the ultimate requirement for further external integration. Sonaca's standpoint on the necessity of considering internal integration first is actually best summed up in Sun et al. (2013) findings. They established empirically that the development of an integrated system will allow for more reliable data and information flows which they consider as a prerequisite for integration with external partners. In this sense, Sonaca considers ensuring data standardization, information quality and reliability across the entire group is the primary requirement for supply chain integration. They believe unreliable data cannot lead to successful external integration. All subsidiaries and departments within the group first need to be aligned and consider the same data before looking outside the company's boundaries for integration. Sonaca's way of considering internal integration resonates with Tarifa-Fernandez and Burgos-Jiménez (2017) who mentioned that external integration, when carried out before internal integration can be detrimental to a firm's performance.

Further, Sonaca considers process standardization as a requirement for supply chain integration. By this token, the organization's view on process standardization matches the ones of Fawcett and Magnan (2002) and Alfalla-Luque et al. (2012). Both studies identified the adoption of a process approach geared towards standardization and collaboration as a success factor for SCI. They consider the successful integration of the supply chain depends on the capacity of all organizations within the same SC to overcome their functional silos and adopt a standardized approach that will further lead to integration. Sonaca even joins Mentzer (2004) who has developed it in his researches that the internal management system of each individual firm within the supply chain should be aligned to permit integration. Sonaca concedes working with a counterpart that operates with the same system makes it easier for them to share information in a rapid and trustful way.

Yet, Sonaca warns against heavy process standardization. Even if they perceive the benefits of it, they claim excessive standardization will bring rigidity in the company's processes which will detriment the agility. As supply chain agility is an important factor in Sonaca's success in its competitive environment, the company militates for avoiding complete process standardization. Indeed, as identified in Eckstein et al. (2015) and Blome et al. (2013)

studies, supply chain agility and adaptability can help organizations sense short-term changes or supply chain disruptions and react to it in a cost-efficient way.

6.3.3. Facilitators and barriers of supply chain integration at Sonaca

Unlike Eckstein et al. (2015), who considered supply chain agility as being a facilitator for supply chain integration, Sonaca views it the other way around. The Belgian aeronautic group understands its integration activities as being the enabler for better agility along the supply chain. However, as Sonaca has long been stressing the importance of being agile in all its processes I believe the company started off its integration efforts with a solid base of supply chain agility. Hence, I firmly believe this has facilitated further supply chain integration which has allowed them to reach even higher levels of agility along the chain.

As many who went in the same direction (Chang et al., 2016; Power, 2005; Rai et al., 2006; Zhao et al., 2011), Sonaca considers the improvement of communication flow as facilitating the integration both internally and externally. As abovementioned, sharing better information with its suppliers through the use of SAP, or even an EDI has helped Sonaca develop enhanced collaborative relationships.

Regarding the framework of organizational culture developed by Cao et al. (2015)⁹, Sonaca does not consider development, group or rational culture as having a facilitating effect in supply chain integration. Yet, they conceive strong hierarchical culture hinders collaboration and integration efforts. Sonaca actually considers the main barrier to supply chain integration is the lack of senior management involvement. Hence, the stronger the hierarchical culture, the more difficult it will be to overcome the top management's reluctance to dive into internal or external integration. Sonaca also agrees with Cao et al. (2015) to the extent that strong hierarchical culture can lead to fear of losing power and privilege and might thus also negatively impact SCI.

On the other potential barriers to supply chain integration, Sonaca defends a position that can be partly found back in both Tarifa-Fernandez and Burgos-Jiménez (2017) and Richey et al. (2009) studies. Sonaca claims that SCI can sometimes lead to higher costs. As Tarifa-

⁹ Cf. Figure 3.3.1

Fernandez and Burgos-Jiménez (2017), they claim building collaborative relationships with customers or suppliers is a long-term process that requires training which might generate high costs. As investing in supply chain integration is often only likely to deliver results on the long run, companies often prefer to maintain short-term results. Sonaca deems the reason behind this refusal of SCI is often due to a lack of understanding of the benefits it could deliver. Similarly, Richey et al. (2009) had identified the prevalence of short-term over long-term focus and insufficient understanding of the importance of SCI as barriers to it.

Similarly to Power (2005) who identified implementation issues as barriers to supply chain integration, Sonaca considers the quality with which the integration project is carried out greatly impacts its outcome. According to the company, the absence of an implementation plan or a roadmap is an almost insuperable barrier to an effective integration of the supply chain. Moreover, as Sun et al. (2013) have noted it in their research, Sonaca thinks of supply delivery risks as hinderers for SCI. The fear of endangering the sought 98% OTD can engender reluctance towards process modification.

6.4. SAP as integration vector for Sonaca

As stated in the previous sections, Sonaca relies on SAP's ERP system as central data repository for its operations. As identified in the literature review, the aerospace-active organization understands the numerous advantages such systems bring in today's competitive environment. As expected by Gunasekaran and Ngai (2003) and Rai et al. (2006), Sonaca's world-spread supplier base greatly complexifies its supply chain model. This complexity has forced the company to go online for communication systems such as SAP. Sonaca even goes further and thinks of SAP as Mabert et al. (2001) did: an indispensable tool for integration, whether it is inward- or outward-looking.

From an internal integration perspective, the use of SAP has allowed Sonaca to build its operations around a network of computers that are all connected to the same system and that constantly communicate with it. This has allowed the company to ensure data instantaneity and quality throughout the entire group, as noted by Adaileh and Abu-Alganam (2010) in their researches. Moreover, SAP turned out to be the only system the company could use to deal with its vast amount of data. Before the setting-up of the ERP system at Sonaca, the company's operations were managed almost exclusively through Excel spreadsheets. Each department was

working on its own spreadsheets which hindered internal communication and data transmission. Most importantly, as spreadsheets were flowing from one person to another in the same department, there was a lot of room for data misinterpretations and approximations. The use of SAP as central database has allowed Sonaca to ensure data standardization and access throughout the whole group. As Su and Yang (2010) have identified it, this has helped Sonaca link the entire organization together and break down its functional silos by avoiding having specific information enclosed to specific departments.

Among the other benefits ERP systems yield, Sonaca perceives its added-value as a tool for external integration. SAP has allowed the company to share important amounts of data with its suppliers and customers. Sonaca leverages its ERP system as a collaboration tool with its external supply chain partners. As Su and Yang (2010) mentioned, such systems greatly enhance external supply chain integration. As explained in the previous sections, Sonaca is collaborating with its suppliers through the use of an EDI and VMI techniques. In this sense, Sonaca's experience confirms Baymout (2014) thoughts that ERP systems can be considered as the backbone in organizations for supply chain integration.

Yet, despite the SAP's indispensability in Sonaca's integration efforts, the development of an IT-enabled supply chain has not been seamless for the aerospace company. More precisely, a barrier to the extensive SAP-integration of the entire supply chain has been the lack of top management support, as identified by Gunasekaran and Ngai (2003). Integrating such a large-scaled group in the same ERP system requires time, efforts and above all financial capital. As developed earlier, the fear of changing an as-is situation that is working properly and the fear of changes that could generate high delivery risks might be reasons for the top management reluctance to support the project of a fully-integrated supply chain. Another problem Sonaca has experienced in the development of its IT-enabled supply chain, in accordance with Gunasekaran and Ngai (2003) findings, is the lack of proper strategic planning. The implementation of each subsidiary in SAP has been thought at the local level, not at the corporate level. Each plant desire more autonomy and prefers to self-handle its IT-requirement. This leads to system differences in the group supply chain which, even if slightest, can detriment the benefits of operating with a fully-integrated supply chain. Ultimately, Sonaca supports that insufficient knowledge within the organization of the benefits of an ERP system and of SCI made people reluctant to change and to adopt SAP as primary working tool.

6.5. Evaluation of Sonaca's supply chain integration

This section will linger on analyzing Sonaca's supply chain and its integration efforts in light of Alfalla-Luque et al. (2012) framework¹⁰. Since I don't want to get lost in too fine a granularity, I assigned each variable a score on a 1-5 scale. All scores are based on the experiences and information I gathered at Sonaca through my internship, the discussions I had with the company's employees and the interviews I conducted with Michel Fievet and Bernard De Bournonville. The scores only reflect my opinion and only engage my subjectivity. All variables, scores and explanations of my decisions are found in Table 6.5.1.

Variable	Score	Explanation
II1 ¹¹	4	Sonaca is almost fully integrated in SAP which allows the company to easily share information and real-time data within the group and with external partners through online platforms and EDI/VMI that are connected to SAP. Yet, there is one subsidiary that is missing in this integration scheme. One of Sonaca's Brazilian plants is still using its own IT system which is very similar to an ERP but nevertheless lessens the benefits of having a full integration across the entire group.
II2	3	To my knowledge, Sonaca has not put any particular effort in aligning its IT system with the ones of its external partners. Yet, efforts have well been made to allow data transfer and information exchange with those partners through the use of online platforms, EDI or VMI. Internally, the group is almost entirely integrated in SAP (irrespective of LMI) which eases the access to information throughout the group.
II3	5	Sonaca's effort in implementing an EDI allows its suppliers to constantly have access to instant information which greatly helps them plan their operations. Better planning on the supplier side benefits Sonaca in return as it helps aligning planning activities across the entire supply chain. On the customer side, Sonaca is constantly communicating with its customers and updating them with delivery expectations and information regarding where production stands at. Doing so, Sonaca, its suppliers and its customers work together as one

¹⁰ Cf. 4.1.1. Model to evaluate the integration of the supply chain

¹¹ II stands here for Information Integration.

		comprehensive supply chain rather than separate enclosed entities operating for their own benefits.
II4	5	The use of SAP allows Sonaca to share real-time information throughout the entire group while EDI and VMI techniques allow the company to cascade the information down to its suppliers in real-time as well. Information instantly flows from one end of the supply chain to the other end.
II5	4	Through the use of SAP, Sonaca has access to information regarding each of its subsidiaries. It can easily share the workload and understand what supplies are needed thanks to the integrated MRP. Yet, the one Brazilian plant that is not integrated in SAP is not directly visible at the group level. Hence, all information coming from this plant has to come from an external source to SAP which does not allow the ERP system to deliver its full benefits.
CRS1	3	I feel Sonaca has put a lot of time and effort in improving the communication and information sharing with its external supply chain partners but still has to improve their involvement in the decision-making. My opinion can be exemplified through the product design activities at Sonaca. The organization is operating around two processes: design-and-build, where Sonaca is in charge of both the design and the manufacturing, and build-to-print, where the customer sends in the products blueprints and Sonaca is responsible for manufacturing. When operating around design-and-build, Sonaca collaborates with its customers and shares its expertise and know-how by jointly designing the product with them. However, when Sonaca's operations are organized around a build-to-print model, there is limited collaboration with customers regarding product design.
CRS2	3	Even though joint activities in the design stage are not systematic and depends upon the type of contract, I consider the VMI techniques implemented at Sonaca as a joint inventory management process.
CRS3	5	The sole experience I can draw on is the one I acquired during my internship working on the A350 TEDSS ¹² . The workload was balanced

¹² 5.2.1. Flowchart for the A350 TEDSS

		between Sonaca's headquarters and the Brazilian subsidiaries given each plants capacities and knowledge. In this sense, I feel Sonaca leverages perfectly its global subsidiary network and supplier base.
CRS4	5	Sonaca has recourse to subcontracting wherever it feels it will benefit the efficiency of its overall processes. The organization also makes use of third-party logistics providers for all its deliveries.
CRS5	5	On some of its work packages with Airbus, Sonaca is developing the concept of shuttle boxes in narrow collaboration with its customer.
CRS6	5	The implementation of the EDI and VMI techniques highlight Sonaca's strive for continuous improvement in its procurement processes. The corporate objective of 98% OTD also translates the search for optimization in the procurement and distribution processes since reaching this target requires swift and seamless flow of materials across the entire supply chain.
CRS7	5	Sonaca is using containers and packaging for all its material transports. On the A350 TEDSS specifically, the company mainly relies on air and sea freight mainly. Truck freight is also used for inland transport. Overall, Sonaca has long been looking for the optimal way of transporting its products and has reached an efficient process. The proof of this lies in the current overall 98% OTD Sonaca has reached and maintained for a couple of years already.
CRS8	4	Sonaca has managed to break its functional silos internally thanks to the use of SAP. The organization's processes now involve all departments' collaboration. Furthermore, the company involves its external partners in its processes. On the A350 TEDSS for instance, Sonaca is operating around a build-to-print process which means Sonaca's customer GE sends in the blueprints and Sonaca manufactures the products. Yet, the link between both organizations extends throughout the entire production process. If Sonaca's teams encounter any technical issue, they can issue a technical query that will directly be addressed to GE through a shared platform. This reveals the interconnectedness Sonaca built with its external partners. However, Sonaca does not push to the

		interconnectedness at its peak. Product design for instance, is not systematically a joint activity between Sonaca and its customers.
ORL1	4	Sonaca has implemented an EDI and various communication platforms both within and beyond its boundaries. Yet, emails remain the predominant communication tool in the organization which I do not consider as an active communication channel.
ORL2	5	Thanks to SAP, the performance indicators for plant workers are displayed on screen. Sonaca also shares scorecards with its suppliers to inform them about their own performance appreciation and their position versus their objectives.
ORL3	3	When Sonaca's subsidiaries want to update or add a module to SAP, they are often given the autonomy to do it on their own. Doing so, it is most of the time the subsidiary itself that is the risk-bearer. In this specific situation, risks are not equally shared between the headquarters and the subsidiaries.
ORL4	4	Sonaca relies on SAP for all its operations and the ERP system is being used at different stages of the supply chain as an integration vector. However, the lack of top management support vis-à-vis those integration efforts sometimes hinders the "tone at the top" effect and does not promote integration efforts.
ORL5	4	Even though joint product development is conditional to the type of contract at Sonaca, the organization is constantly communicating with its subsidiaries, its customers and its suppliers to ensure smooth processes and end-customer satisfaction. The company also strives for continuous improvement. The flowcharts I developed were created to help improve the processes related to the A350 TEDSS and to the Planning & Scheduling activities and highlight this continuous improvement search.
ORL6	5	The best practices at Sonaca are often materialized through flowcharts or process description that are then further shared within the group. The mapping of the Planning & Scheduling activities is an example of it. Sonaca also extends its best practices to its customers and suppliers, such as the development of shuttle boxes with Airbus.

ORL7	5	Sonaca insists on staying agile in all its processes and trying to avoid heavy standardization as they consider it leads to inflexibility.
ORL8	5	Sonaca tries to bring in trust and transparency in its relationships with its external partners, as shown by the development of scorecards or VMI techniques on the supplier side or shuttle boxes on the customer side.
ORL9	5	During my internship in Brazil, I had a lot of opportunities to build team relationships. Whether it is the links between the Belgian headquarters and the Brazilian subsidiaries or the relationships with the customers, the suppliers or even with the American counterpart LMI, Sonaca insists on maintaining excellent relationships with its supply chain partners.

Table 6.5.1: Evaluation of Sonaca's supply chain integration

Taking all these scores into consideration, I consider Sonaca's supply chain integration as being advanced. It has allowed them to reach high performance levels and to be considered as best-in-class for supply chain capabilities. Nevertheless, some aspects still demand improvement.

Chapter 7: Recommendations

Having analyzed Sonaca's supply chain integration and compared it against the literature on the matter, I now have a better understanding of the next steps regarding the organization's integration could be. Even if I consider the supply chain integration at Sonaca as being already extended and high-level, I believe there is still room for further improvement. As suggested by many authors, I believe the more thorough the integration, the better the performance improvements for the organization. As Sonaca is evolving in a highly competitive environment, I am convinced more advanced integration could benefit its position on the market. In this chapter, I will thus advise the company on how to improve its market position using further supply chain integration.

7.1. Evaluation framework as a roadmap for improvement

Tying back to the evaluation of Sonaca's supply chain integration I made using Alfalla-Luque et al. (2012) framework, I would suggest the company to focus on two distinct areas: customer integration and internal integration. I consider Sonaca's integration as advanced already, as highlighted by the high scores assigned to each variable in the framework. Actually, by averaging out these values, an average score of 4,36 is retrieved. Rounding this number down, I consider a score of 4 as being the threshold above which the company does not have to primarily focus its efforts. Hence, I would recommend Sonaca working on the four variables that were assigned a lower score than 4. These variables are found in Table 7.1.1.

Variable	Assigned score	Description
II2	3	“To make compatible the information systems so as to allow access to information concerning the activity of the company from different departments and companies that make up the SC”.
CRS1	3	“To involve to the SC members in decision making and to delegate to the member with the best negotiating position to lead the relevant decision making.”
CRS2	3	“To realize of joint actions to achieve the same end.”
ORL3	3	“To share risks, costs and rewards (operational and strategic collaboration).”

Table 7.1.1: Variables to leverage for enhanced SCI at Sonaca

Variables CRS1 and CRS2 are both related to the involvement of supply chain members in decision-making. Even if Sonaca collaborates and shares information with its external partners, I do not consider this as including them in the decision process. Nevertheless, when working in design-and-build, products are designed jointly and the company does involve its customers in the decision making. Yet, when operating around a build-to-print model, joint activities and customer involvement in the decision-making are more limited. Hence, I recommend the company to strive for more joint activities and especially for joint product development under build-to-print. I am thoroughly convinced this will enhance the company's efficiency.

Variable II2 relates to the compatibility of information systems across the supply chain. As mentioned, even if Sonaca does not consider this as selection criterium for either its suppliers or customers, efforts have been made to allow overlapping and interconnectedness of entities' systems. Yet, at an internal level, the group is not fully aligned in terms of systems since a one plant remains independent of the SAP ecosystem at Sonaca. Once again, Sonaca loses the benefits of data reliability, quality and instantaneity across the entire group if only a single plant stands out with its own system. Hence, I heavily recommend the company to integrate its last plant in SAP as soon as can be. Nevertheless, to improve variable ORL3, the subsidiary must not be given full autonomy in managing its own SAP implementation. Planning, risk sharing

and implementation must result of a collaboration between both the subsidiary and the headquarters. Additionally, I would also recommend Sonaca to deploy a Manufacturing Execution System (MES)/Quality Management System (QMS) in order to enhance real time operations and quality monitoring throughout the group. The recommendations I made for future SCI improvement at Sonaca are summarized in Figure 7.3.1.

7.2. Better leverage of customer integration

As previously described¹³, Sonaca has intensively geared its integration efforts towards its suppliers which has allowed the organization to reach extensive supplier integration on the framework developed by Frohlich and Westbrook (2001). The group has also developed its supply chain in an integrative way by better collaborating with its customers, although to a lesser extent. As I can perceive how more extensive customer integration could benefit Sonaca, I would advise them to work towards that direction. Hence, my primary recommendation would be to broaden the arcs of integration and to collaborate more narrowly with customers. In accordance with Frohlich and Westbrook (2001) findings, broader arcs of integration will improve the organization's performance.

More precisely, I would advise Sonaca to develop more joint processes with its customers. Oftentimes, both entities are working separately and only pool resources or information once one's separate processes have been completed. This way of working results in redundancies and loss of time therefore affecting the overall process efficiency. As Sonaca is striving for a 98% OTD, any time loss or inefficient process can potentially endanger this corporate target.

Practically speaking, I recommend to Sonaca to include its customer in the product design stage and to strive for joint product development. The group is known across the entire aerospace industry for the expertise of its design office. Sonaca currently operates around 2 models: design-and-build, where Sonaca fully provides the product blueprints and manufactures it, and build-to-print, in which the customer provides the blueprints and Sonaca applies them and manufactures the products. Build-to-print represents 10% of Sonaca's agreements whereas design-and-build dominates and accounts for 90% of the programs the

¹³ Figure 6.2.1: Sonaca's supplier-facing arc of integration

company is working on. As LMI is almost exclusively operating in build-to-print, this ratio plateaus around 50/50 at the group level. Sonaca already involves its customers at the design stage when working under design-and-build. Nevertheless, when activities are operated around a build-to-print model, the interactions and collaboration between both partners at the product development stage is limited which leads to inefficiencies further down the manufacturing process.

This can be exemplified through an example I experienced when working on the A350 TEDSS program during my internship. On this contract, Sonaca and GE Aviation were operating around a build-to-print which meant that GE was designing the products and Sonaca was responsible for producing them. As Sonaca's team were not in charge of product design, incomprehension vis-à-vis the blueprints might arise on the production side. Hence, a shared platform was created for Sonaca's team members to communicate directly with GE regarding design matters. A technical query had to be introduced on the platform by Sonaca's employees. GE's teams would be notified new queries had been raised and would answer it in the shortest term possible. Sometimes, GE's answers to the initial query would not result in better understanding on Sonaca's side which would lead to subsequent technical queries related to the same topic. This led to time-consuming back-and-forth messages between both entities. Moreover, as Sonaca's teams were not involved in the design stage, these technical queries were countless. As production could not go on until Sonaca's teams were fully certain having thoroughly understood the blueprints, this heavy process had a negative impact on the company's productivity and hence on its overall efficiency.

Even if I am not doubting the usefulness of such process given the state of situation at that time, I am convinced these time-consuming tasks could have been avoided. Hence, I would recommend Sonaca to collaborate more narrowly with its customers as early as of the product design when working around a build-to-print model. I truly believe this would result in better understanding from both entities of the material requirements and the production specifications. This would in turn reduce, if not suppress, the number of technical queries flowing from one end of the manufacturer-customer relationship to the other. Acting so, Sonaca would save a great deal of time in its production process and as such, improve its overall performance.

It can be argued this recommendation is specific to build-to-print contracts at Sonaca. Additionally, some could think as build-to-print only accounts for 10% of Sonaca's agreements,

it is unnecessary to invest time and money in enhanced collaboration with customers at the design stage. It could even be argued that LMI has developed swift processes around its build-to-print model and that the 50/50 ratio at the group level does not demand further improvement. Yet, I am convinced improved collaboration with customers at the early stage of product development may turn out to be a value-adding criterium for the group. The aerospace company could bring its expertise in product design to its upward supply chain partners and jointly develop the products' design. Doing so, Sonaca Group would ensure its products will be tailor-made and will fully fit customer's expectations. Moreover, customers might feel more included and trusted which I believe would result in the building of trustful long-term relationships between Sonaca and its customers. Most importantly, the group is restraining itself by not offering its design expertise to its customers. As such, Sonaca has the capabilities to create even more added-value for its customers but does not fully leverage it at the moment.

7.3. Strive for full internal integration

The other improvement point Sonaca should gear its efforts towards is related to internal integration. Sonaca Group, excluding LMI Aerospace, is at the moment almost fully integrated in SAP. The one single plant that remains out of this SAP-connected subsidiary network is Pesola, one of Sonaca's Brazilian plants. Pesola is still relying on its own system which resembles an MRP but integrates less modules and less functionalities than SAP does. This implies that data and information need to be downloaded from SAP and translated into Pesola's system before being usable by the Brazilian plant. This creates a dependency relationship for Pesola which is both unnecessary and avoidable.

Integrating Pesola in SAP would benefit Sonaca in various ways. It would ensure swift flow of information and data across the entire group. It would also bring instantaneity in the information flows across the group which Sonaca does not enjoy since data going to and from Pesola first demands a translation step. Most importantly, it would ensure the reliability of data across the entire group as it will create a central data repository.

It could easily be argued that Pesola being one of Sonaca Group smallest plant in terms of size, integrating the plant in SAP is unnecessary and is far too costly and time-consuming compared to the benefits it could deliver. I believe leaving the situation as it is equivalent to falling into the standstill trap. This reluctance to change can be linked back to Gunasekaran and

Ngai (2003) findings. The authors claimed insufficient knowledge of the benefits of IT tools and most especially ERPs can lead to unwillingness to use them.

As such, I would like to build upon their framework to advise Sonaca on how to integrate Pesola in SAP. As previously stated, Sonaca experienced the lack of top management support in SAP integration. As Gunasekaran and Ngai (2003) highlighted it, top management support is paramount to bring support, financial and technical resources to the development of IT tools in the supply chain. I believe the reason for such hesitation from top management to adopt SAP across the group can be explained through the imperception of the benefits a fully integrated supply chain delivers. This touches back to the potential reluctance of people to use SAP because of the lacking knowledge of it. Missing that knowledge myself, I cannot pretend to bring it here. However, I would suggest Sonaca to teach its employees about the benefits of SAP. Practically speaking, Sonaca would have to lever internet resources in order to educate the entirety of its subsidiary network. The company could for instance use E-learning platforms for people to learn more about ERPs' benefits. Sonaca could also create a communication channel on its intranet and post videos of people explaining how their processes have changed since the use of SAP. This would prove to be even more effective as I believe the incentive might be more impactful if it comes from peers rather than from top management.

Then, I would suggest Sonaca to train its teams in the use of SAP. Many still only use the basic functionalities of SAP and do not leverage the full potential of such a system. This training could be provided by internal or external IT experts. I am convinced of the beneficial impact of using ERP systems in world-spread organizations. Hence, I am convinced better training regarding SAP functionalities can also help people realize the powerfulness of it and ultimately, people from Pesola might end up asking the corporate headquarters to integrate the SAP network which is likely to foster integration. If Sonaca decides to integrate its last subsidiary in SAP, it will be paramount to develop proper strategic planning for it. This project must be developed in collaboration with both entities as risks need to be thoroughly evaluated and shared between both the Brazilian plant and the headquarters. Moreover, collaboration turns out to be paramount in this case as Pesola lacks the experience in SAP use and implementation. This experience can be brought by Sonaca's headquarters which has been relying on SAP for years and has already experience the integration in SAP.

Additionally, I would advise Sonaca to consider the use of an MES/QMS. Such systems are used to bridge the ERP and the production lines. It allows for production information such as machine parameters, defaults or product quality to be instantly linked back to SAP. It allows for deepened and instant production follow-up which SAP cannot offer. This will help Sonaca break down its functional silos even more by easing the communication and information flows between the production lines and the other departments within the organization.

Ultimately, I would recommend Sonaca to foster internal integration with LMI. Within Sonaca Group, LMI and Sonaca work as two distinct entities. Both parties use different ERP systems which accentuates the separation between both organizations. They also operate with different processes as Sonaca mainly works under design-and-build whereas LMI draws most of its revenues from build-to-print contracts. Obviously, Sonaca's takeover of LMI is recent and an adaptation period is still needed. Yet, I believe Sonaca should strongly consider better internal integration with LMI in the near future.

In order to help Sonaca in its future integration efforts, represents a roadmap summarizing the above-mentioned recommendations.

Recommendations for further SCI integration

Roadmap for Sonaca Group

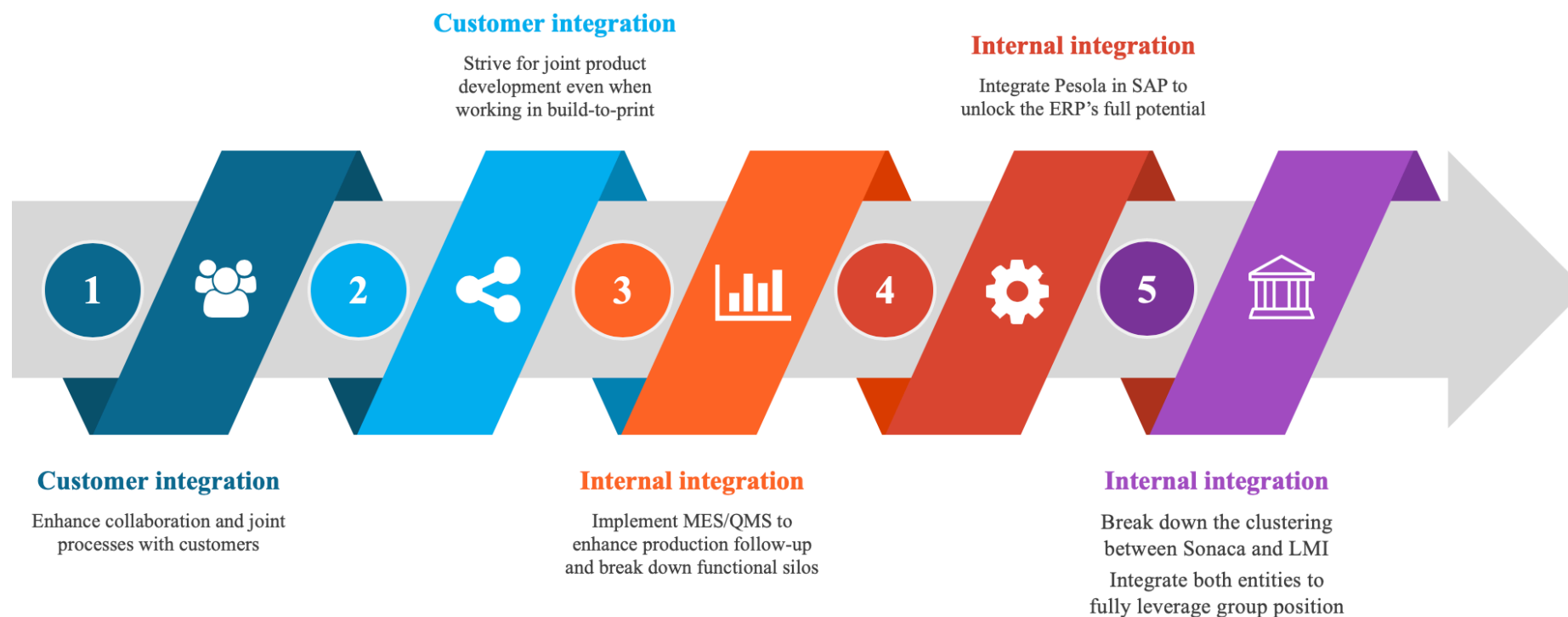


Figure 7.3.1: Roadmap for future SCI efforts at Sonaca Group

Conclusion

In this thesis, I have compared an empirical example of supply chain integration with theoretical knowledge I gathered. At first, a literature review was conducted. I focused my literature review on three main aspects: the definition and the ways of considering supply chain integration; the relevance of IT tools and most especially ERP systems in the development of an integrated supply chain; and the rationale behind supply chain integration and its implications. Reviewing the literature also helped me identify several frameworks that revealed their usefulness in the comparison with an empirical situation. I tied my analysis back to projects I conducted at Sonaca, an aerospace active company that has operations all around the world. Those projects, along with the interviews I conducted with Michel Fievet and Bernard De Bournonville have allowed me to get of Sonaca's motives for supply chain integration. Most importantly, it brought me knowledge regarding the company's micro-level practices of supply chain integration. Lastly, I evaluated Sonaca's supply chain integration using Alfalla-Luque et al. (2012) framework. The framework also highlighted the gaps in Sonaca's integration and turned out to be the base upon which I developed my recommendations for further SCI improvement.

Overall, it can be concluded that Sonaca has already reached an advanced level of integration both internally and with its external supply chain partners. As identified in the literature review, Sonaca has experienced a performance improvement since it started its integration process. The company has managed to leverage SAP to break down its functional silos and to connect all its subsidiaries to a single interconnected network. Yet, there is still a subsidiary that remains out of this loop and keeps using its own IT system which prevents Sonaca from exploiting the full potential and benefits of ERP systems. On its relationships with its external partners, Sonaca has been narrowly collaborating with its suppliers to achieve high levels of supplier integration through the development of collaborative platforms such as an EDI or by building trust in supplier relationship through VMI techniques. On the opposite side of the supply chain, the company is also collaborating with its customers, although to a lesser extent. The company has for instance developed the concept of shuttle boxes for its deliveries. Yet, the collaboration with its customers does not go as far as with its suppliers since they are not included in the product design stage for instance.

In light of the analysis I conducted using Alfalla-Luque et al. (2012) framework, I recommended Sonaca to first achieve full internal integration across the entire group by integrating the isolated plant in SAP. This would allow Sonaca Group to fully leverage the potential of ERP systems at an internal level. Then, I advised to enhance collaboration with customers in order to improve the overall efficiency of the organization. Especially, I recommended to operate around joint product development to ensure greater customer satisfaction and hence overall firm performance.

Nevertheless, the results of this work need to be balanced by a major limitation. Even though I tried to adopt the most neutral position possible, the analysis and its recommendations might lack objectivity. Indeed, being as critical and self-thinking as possible, my neutrality might have been influenced by unconscious biases. At a broader level, the framework for evaluating Sonaca's integration is also debatable. Other frameworks would potentially have delivered different results.

Given these limitations, I believe additional studies need to be conducted internally at Sonaca before actually applying the recommendations made. As such, following studies could focus on the financial or strategic impact of supply chain integration.

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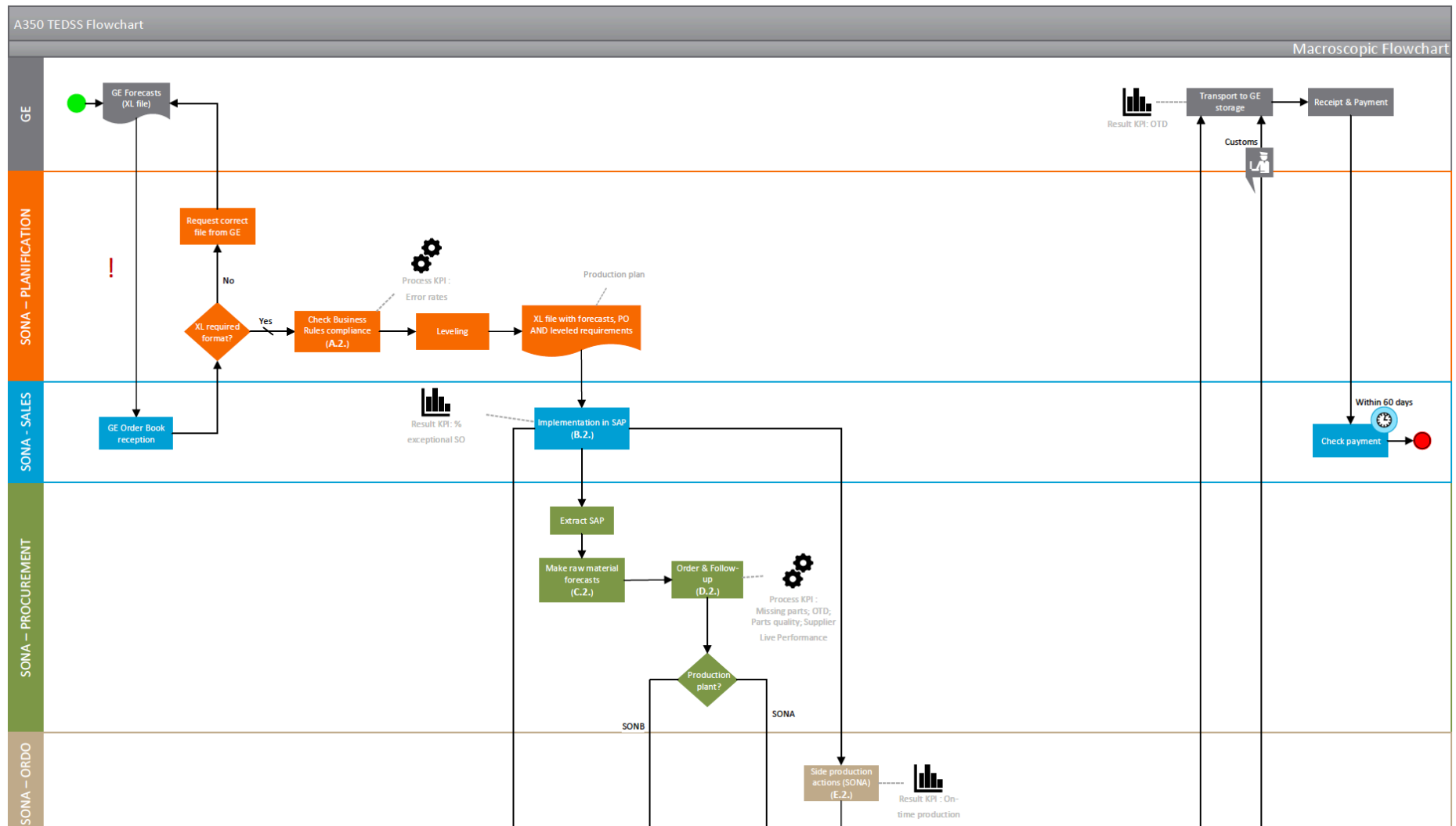
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Sonaca Group Annual Report. (2018). Retrieved from https://www.sonaca.com/wp-content/uploads/2019/06/annual_report_2018.pdf

Appendices

A. Flowchart for the A350 TEDSS

A.1. Results



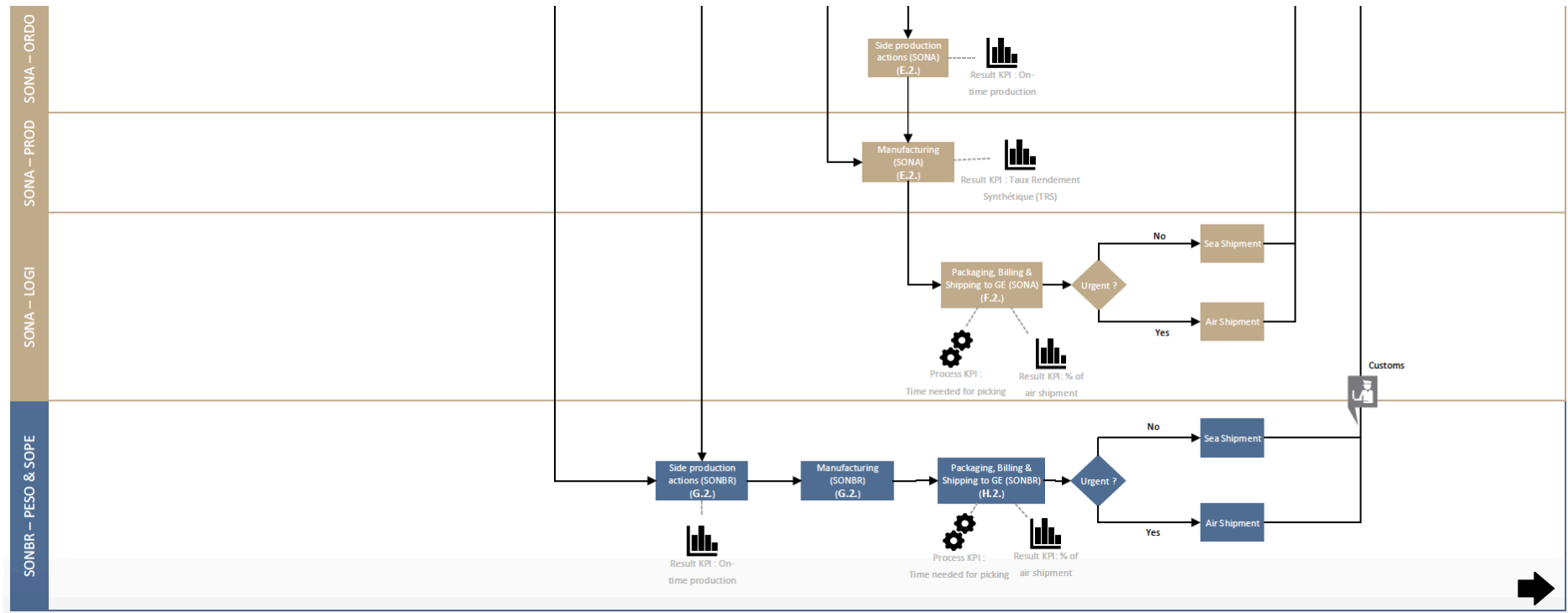
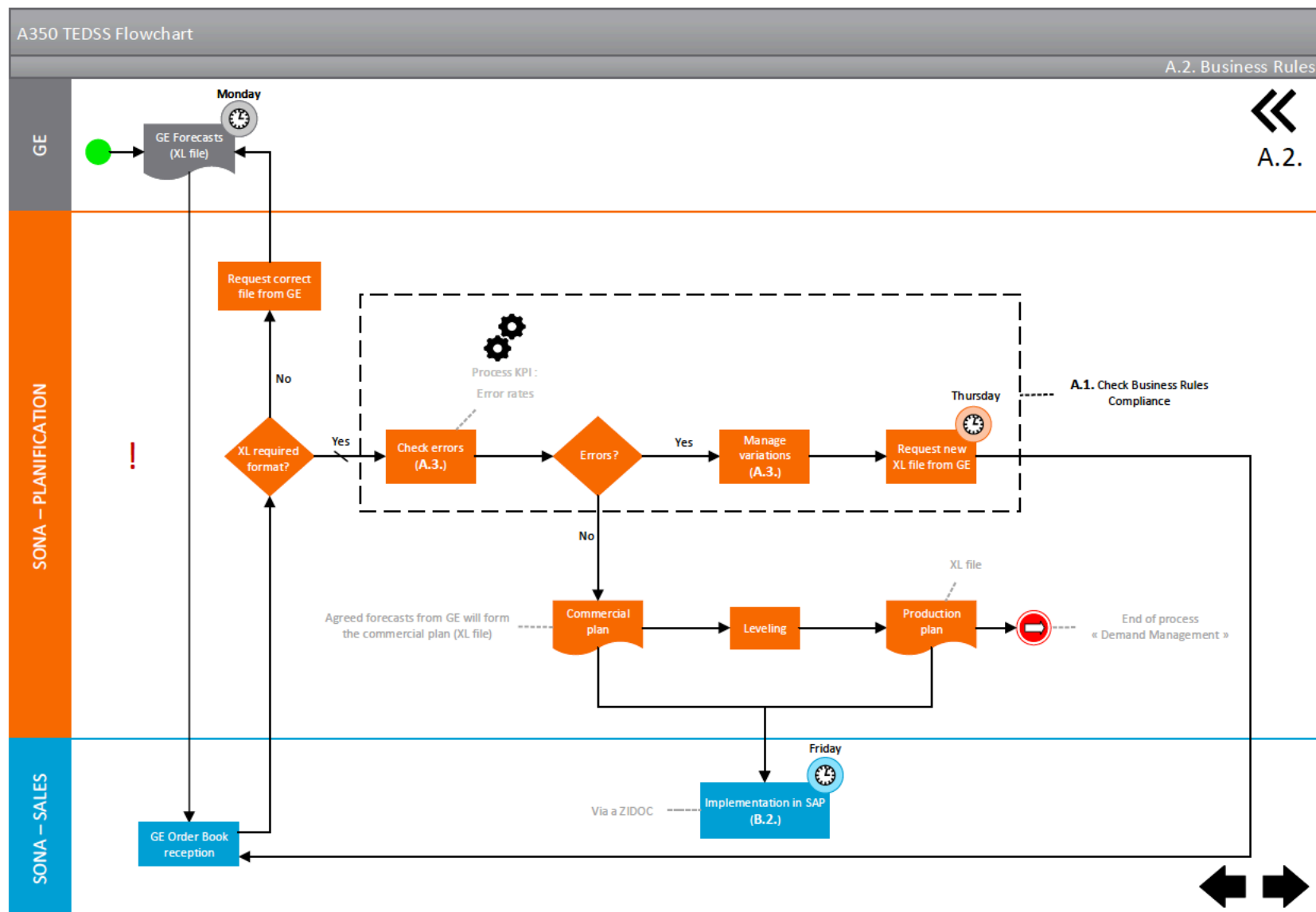
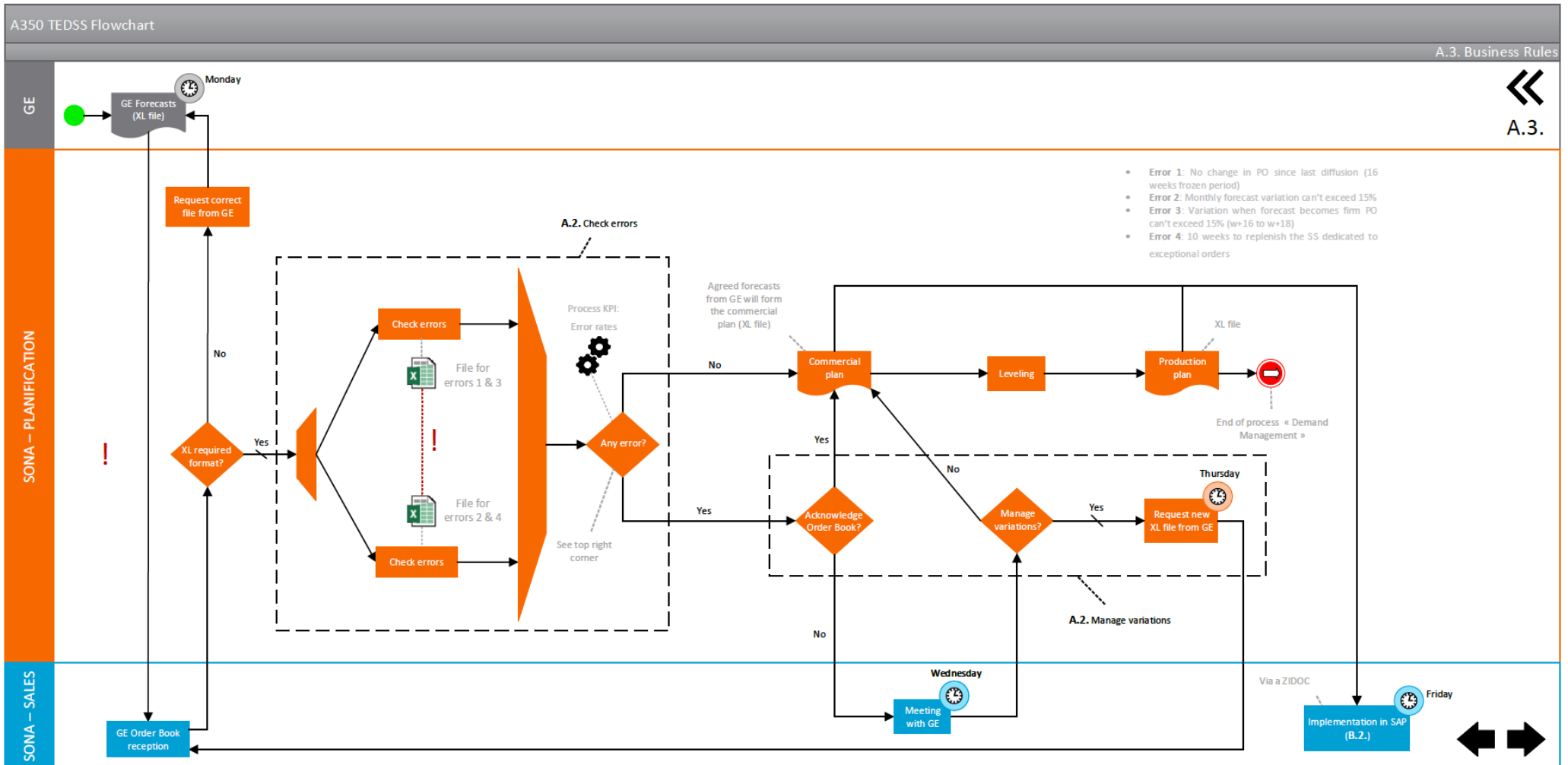
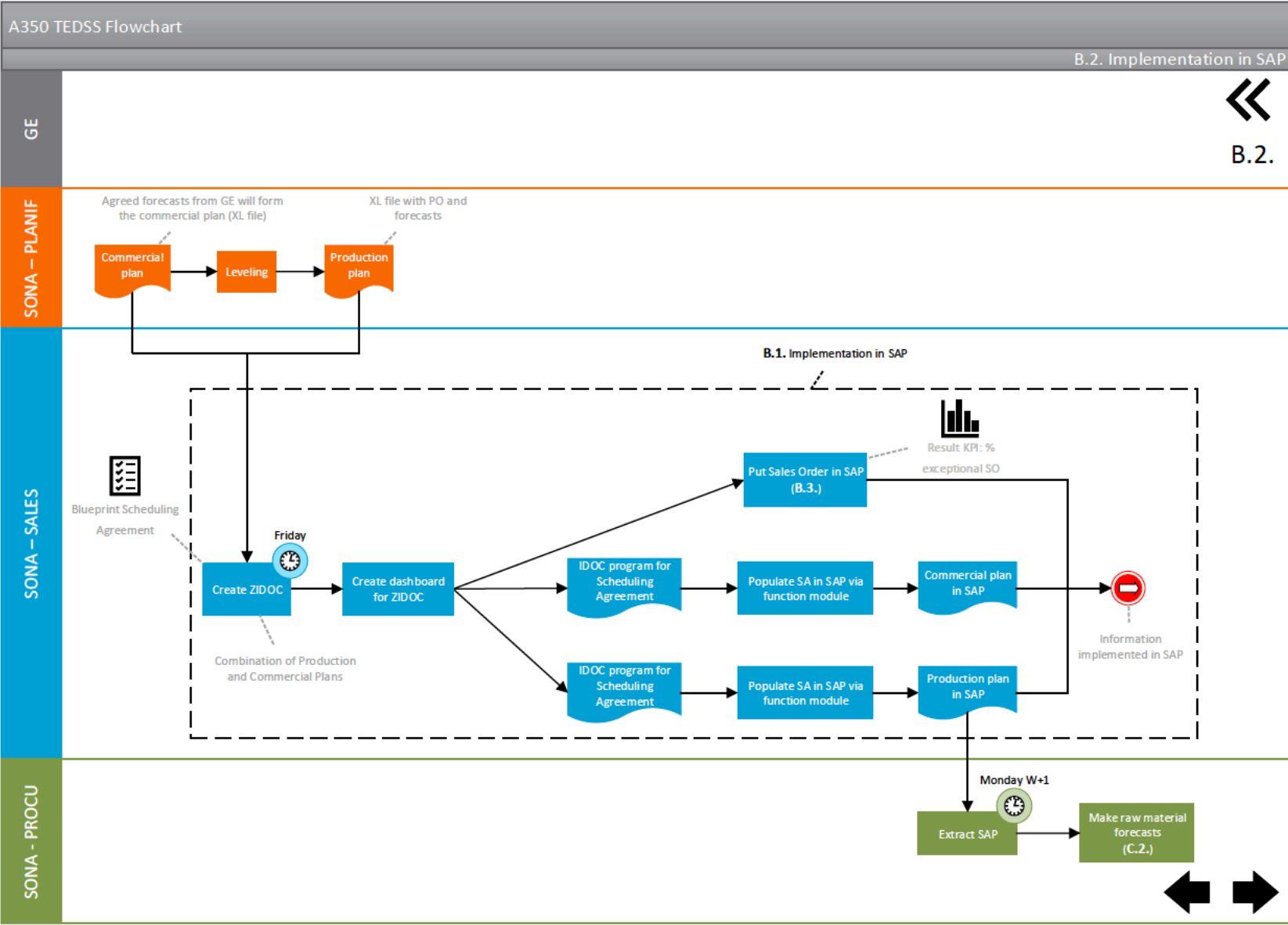
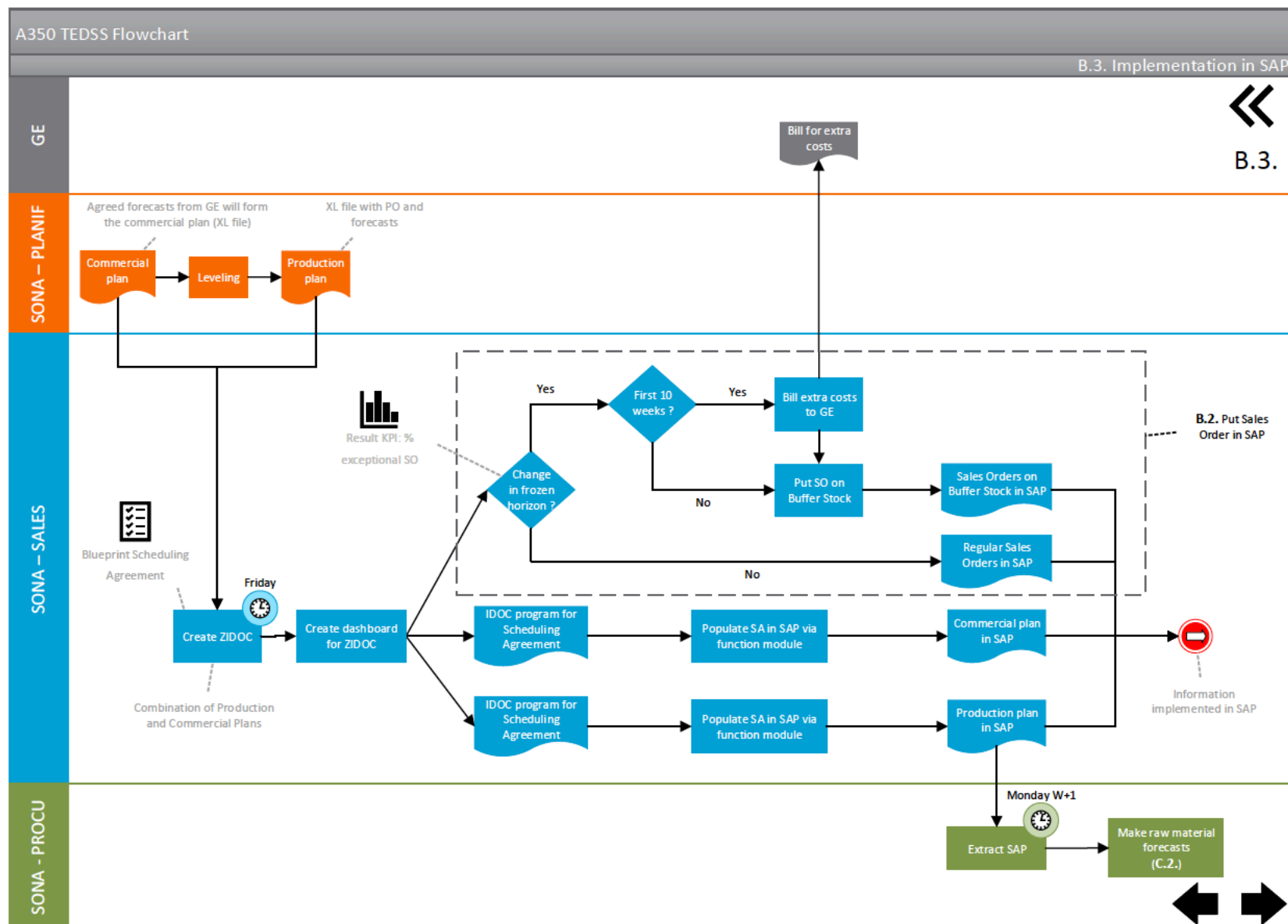


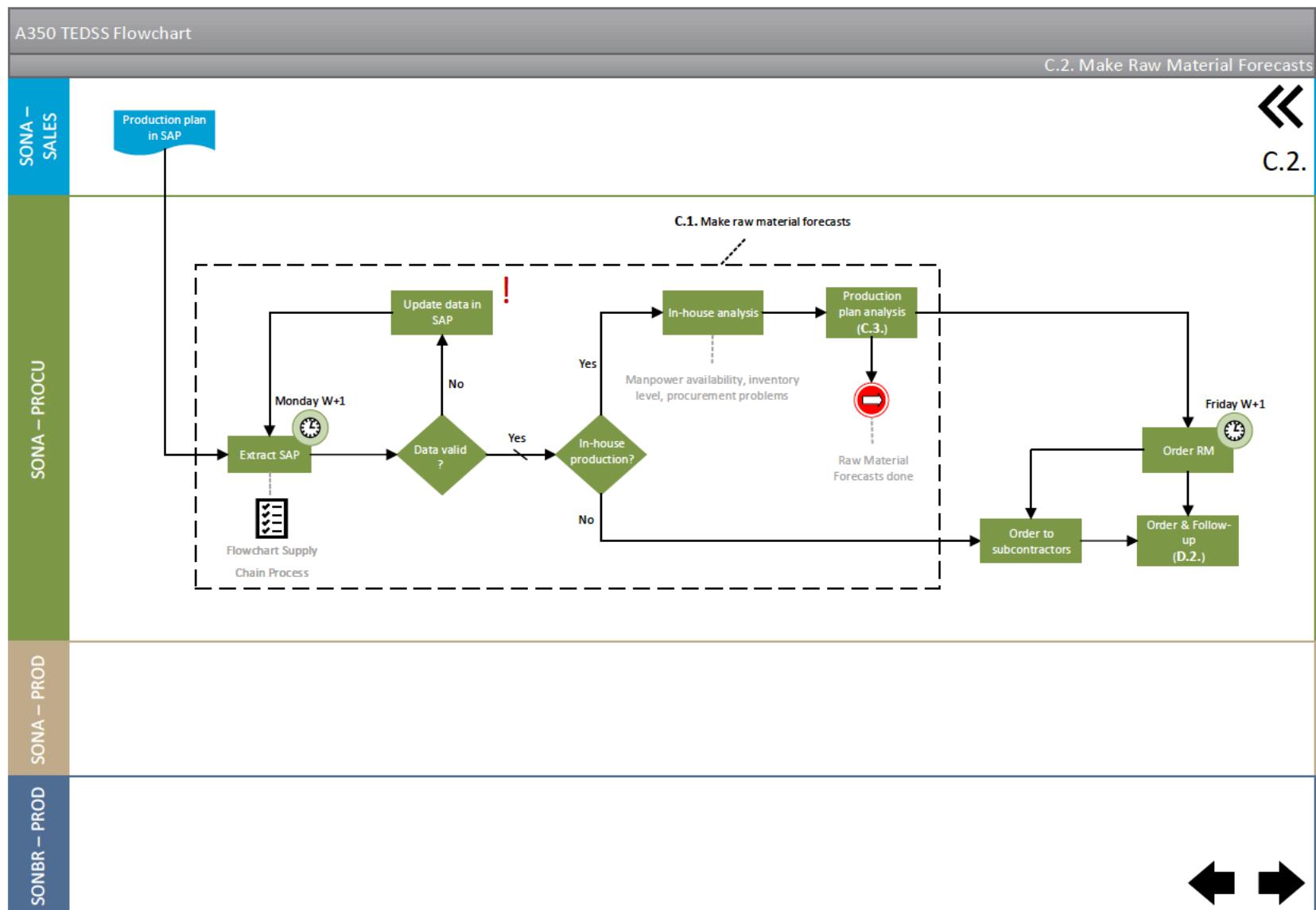
Figure A.1.1: Flowchart for the A350 TEDSS at Sonaca

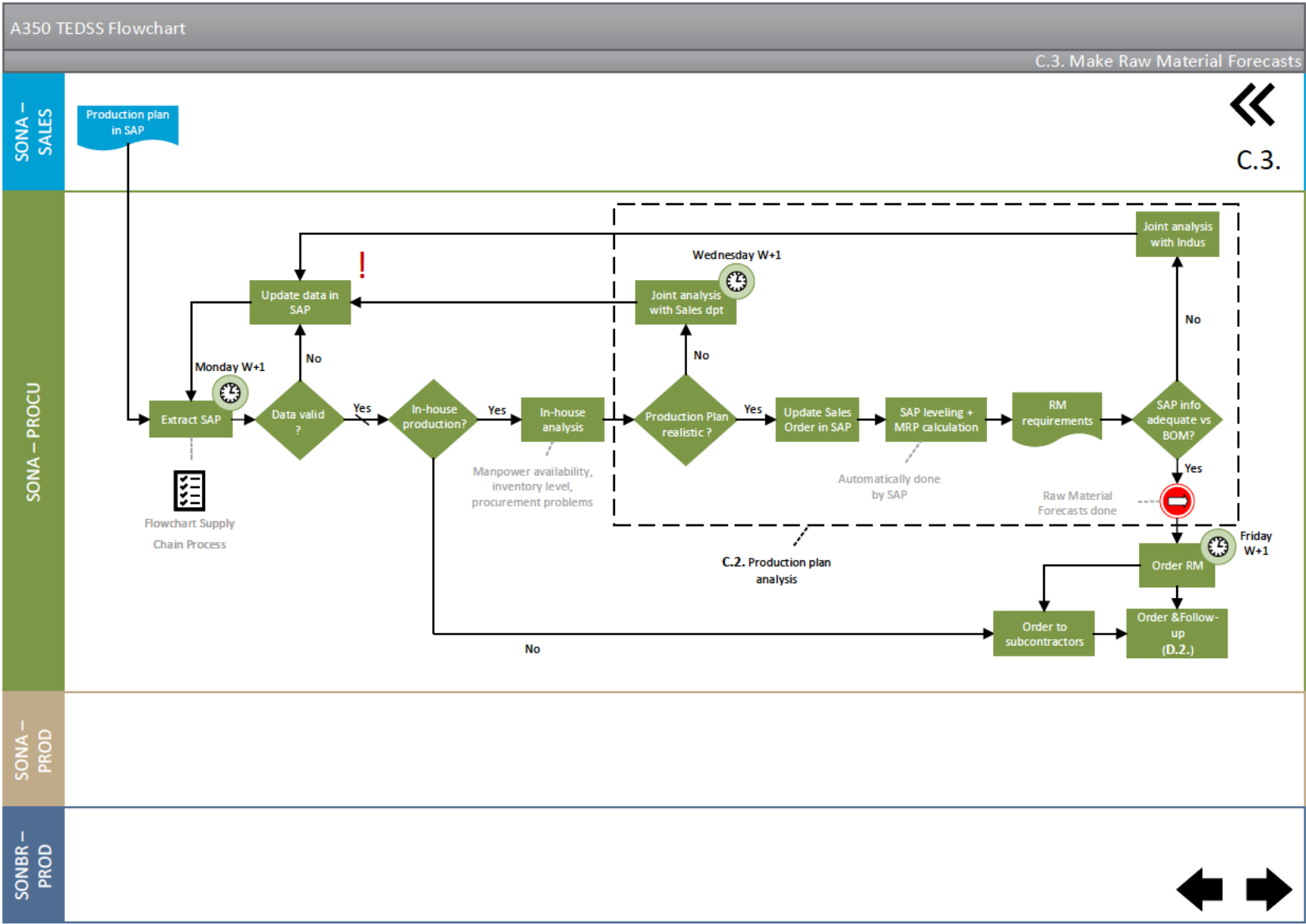


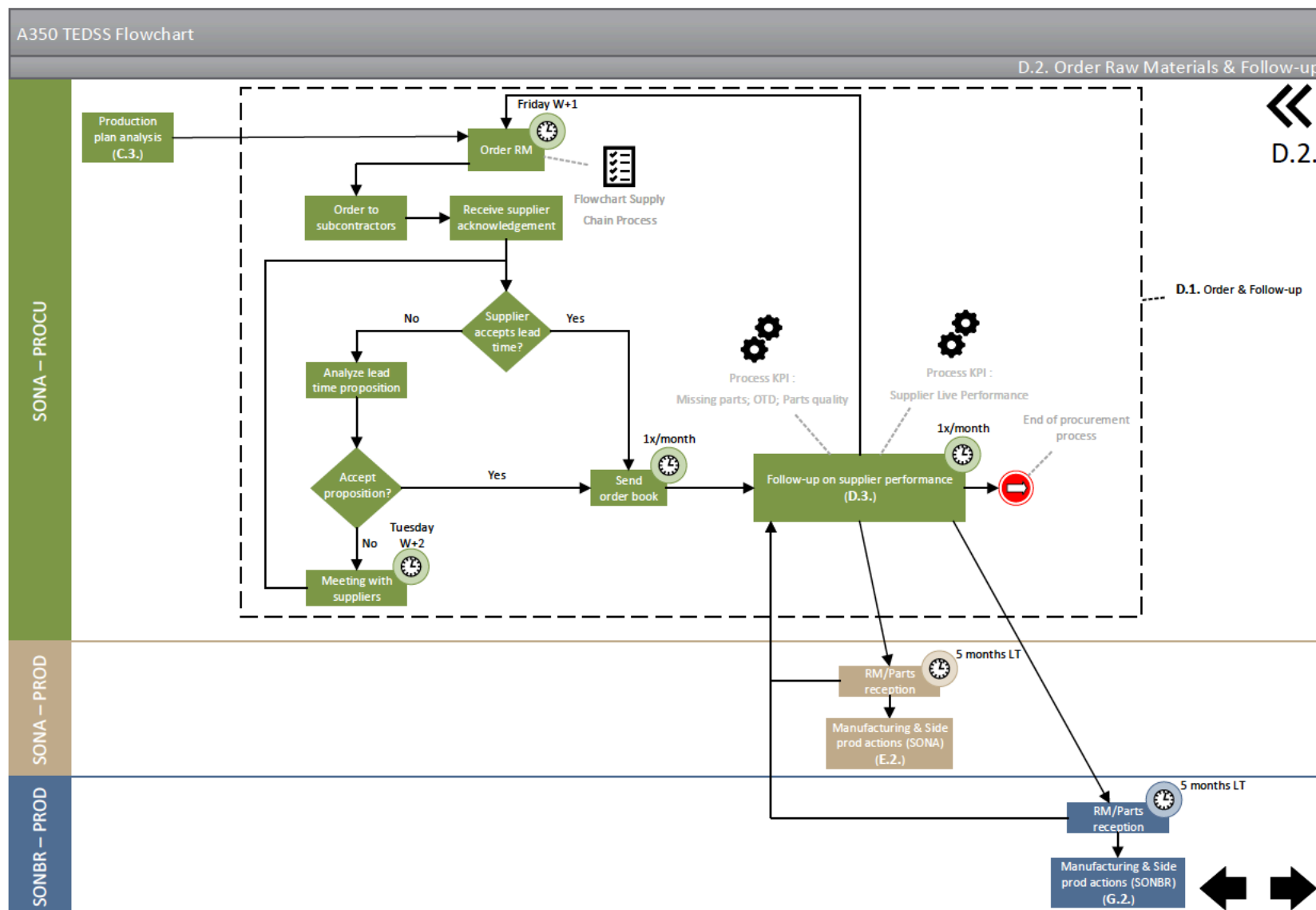


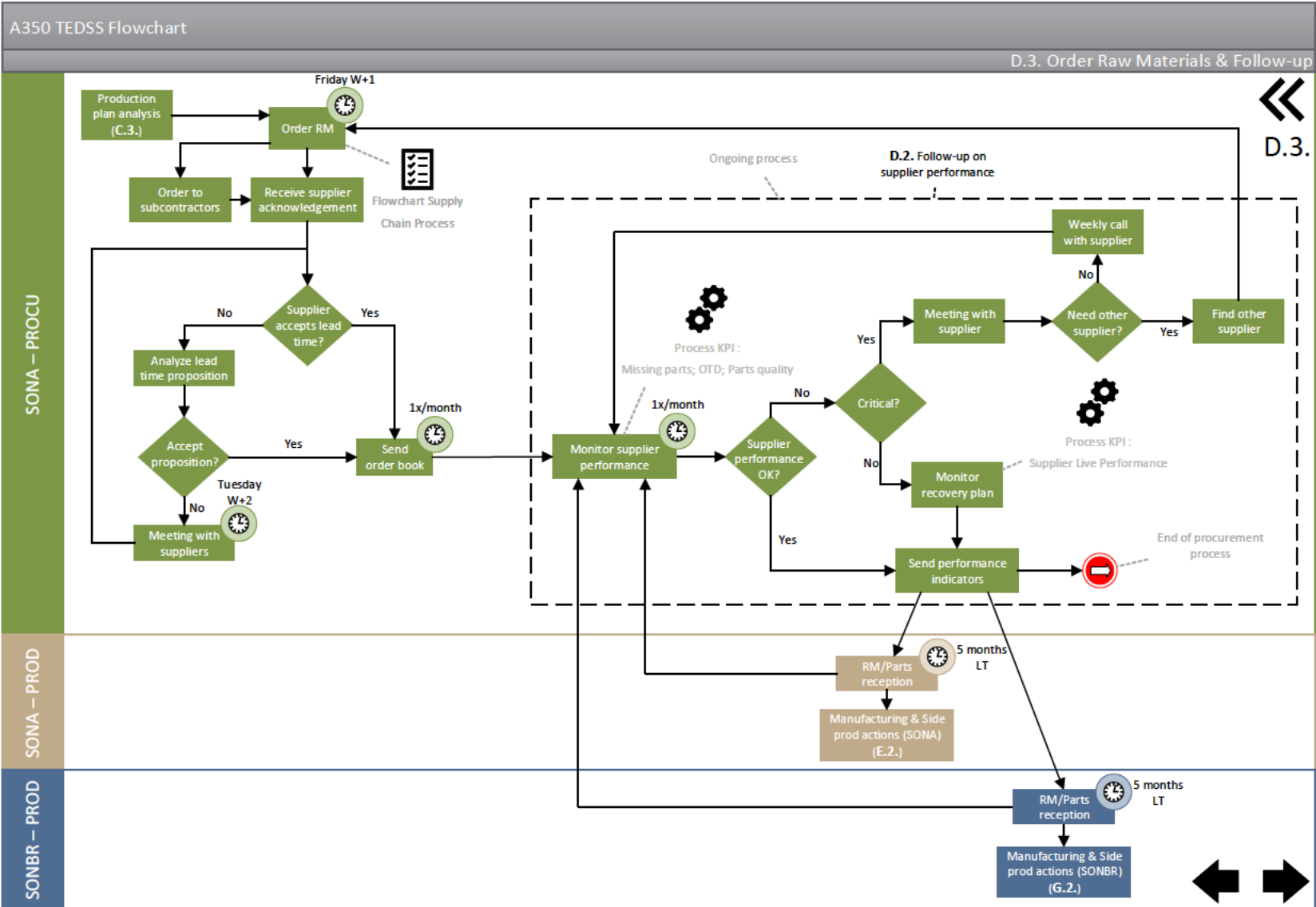


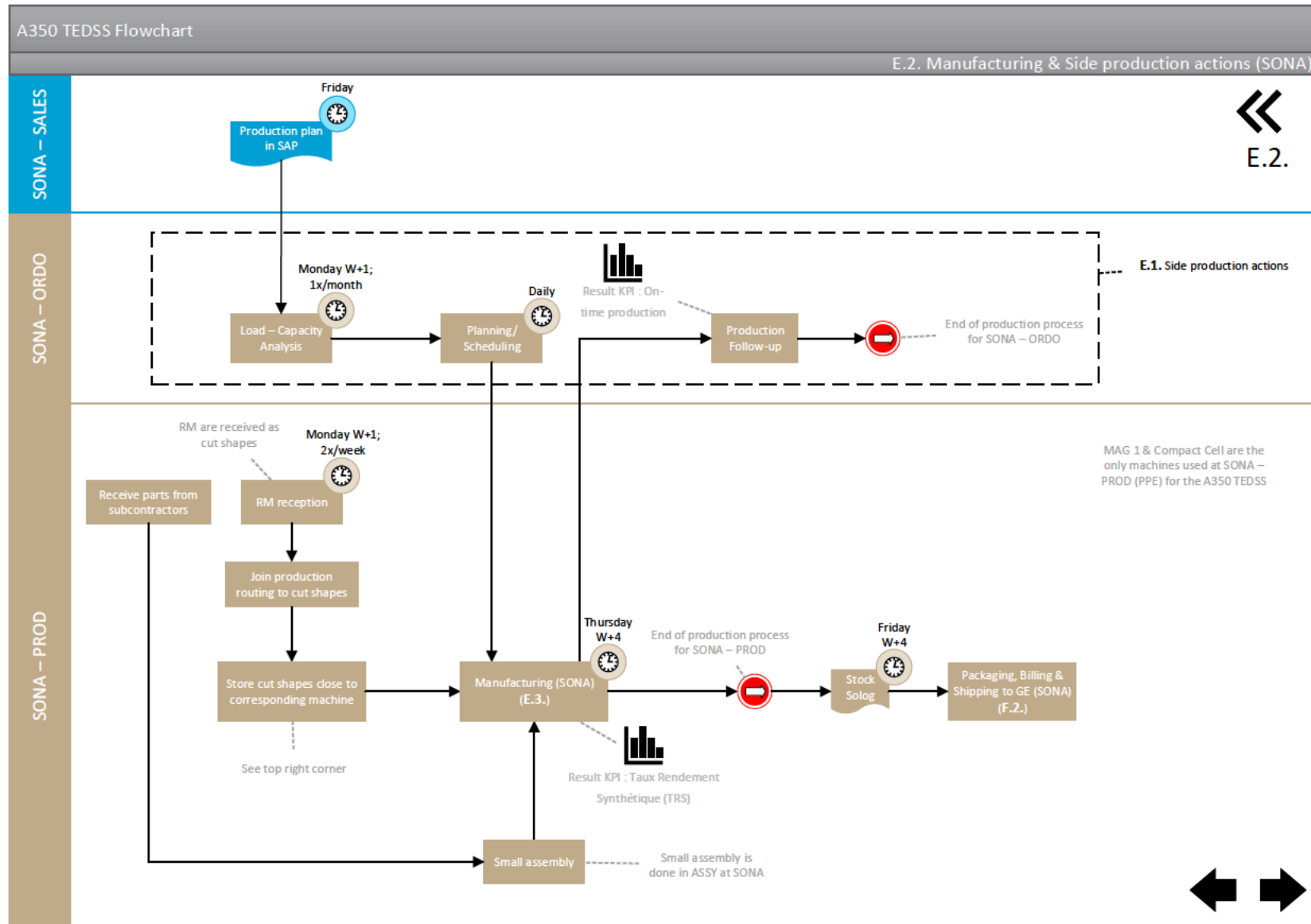


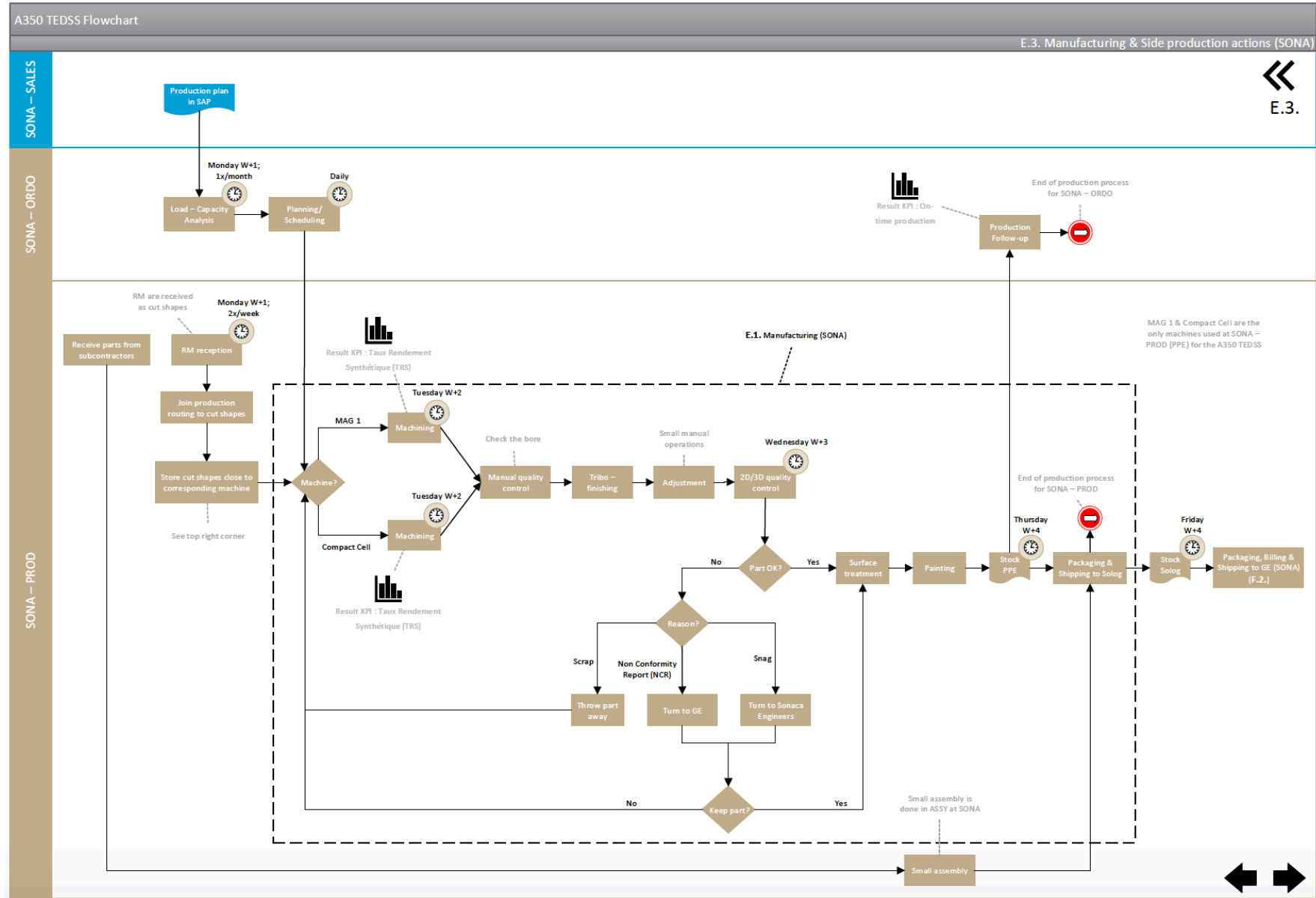


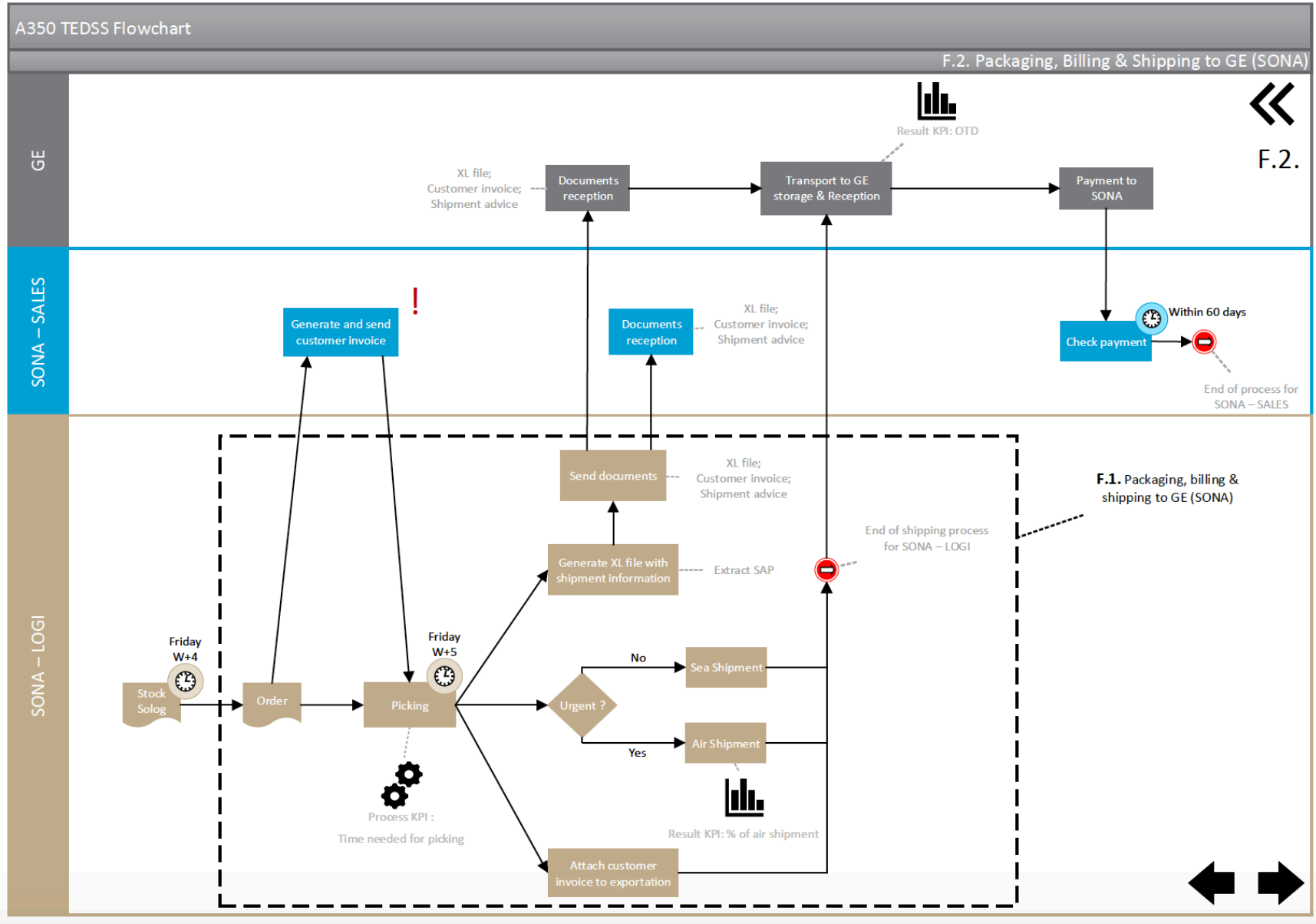


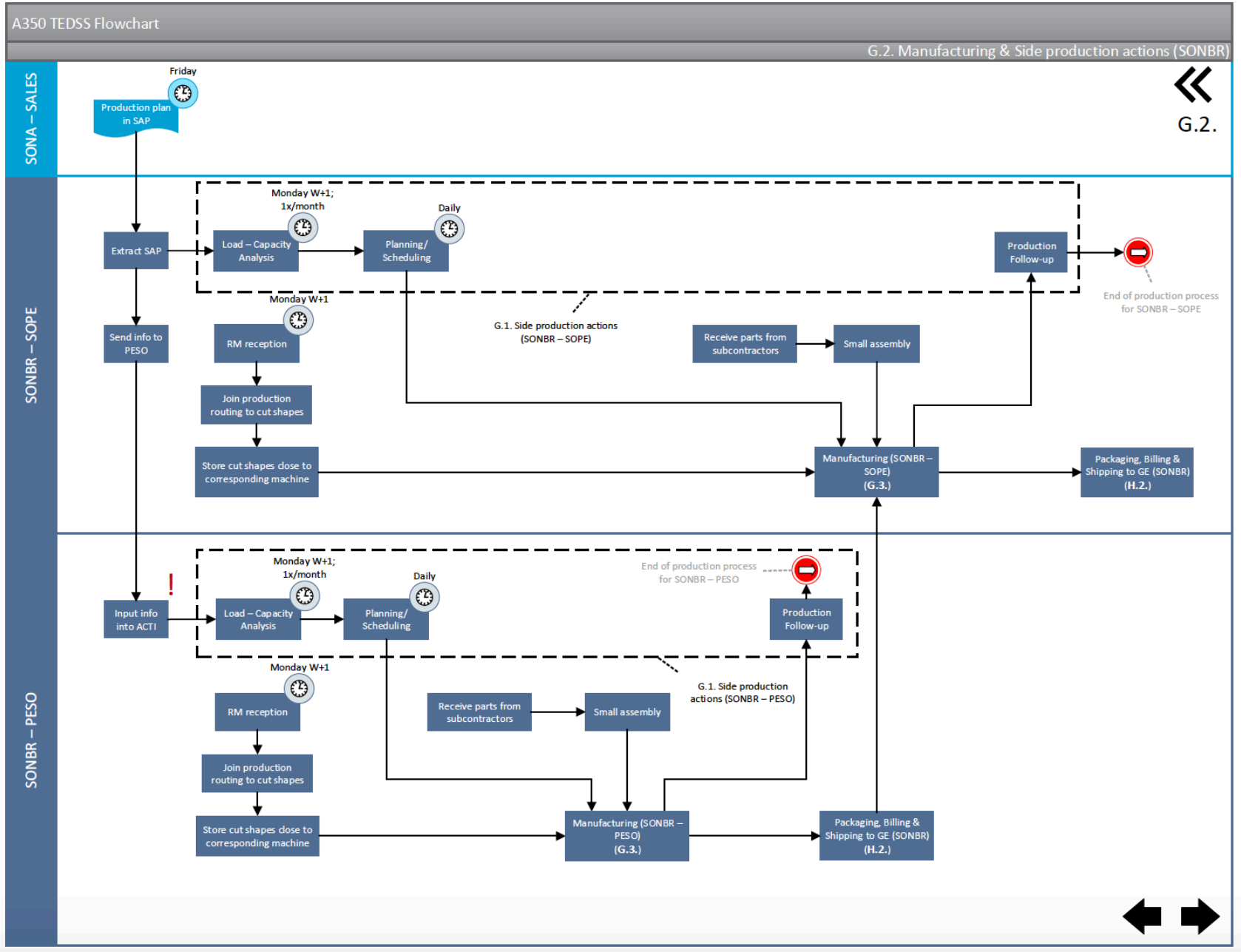


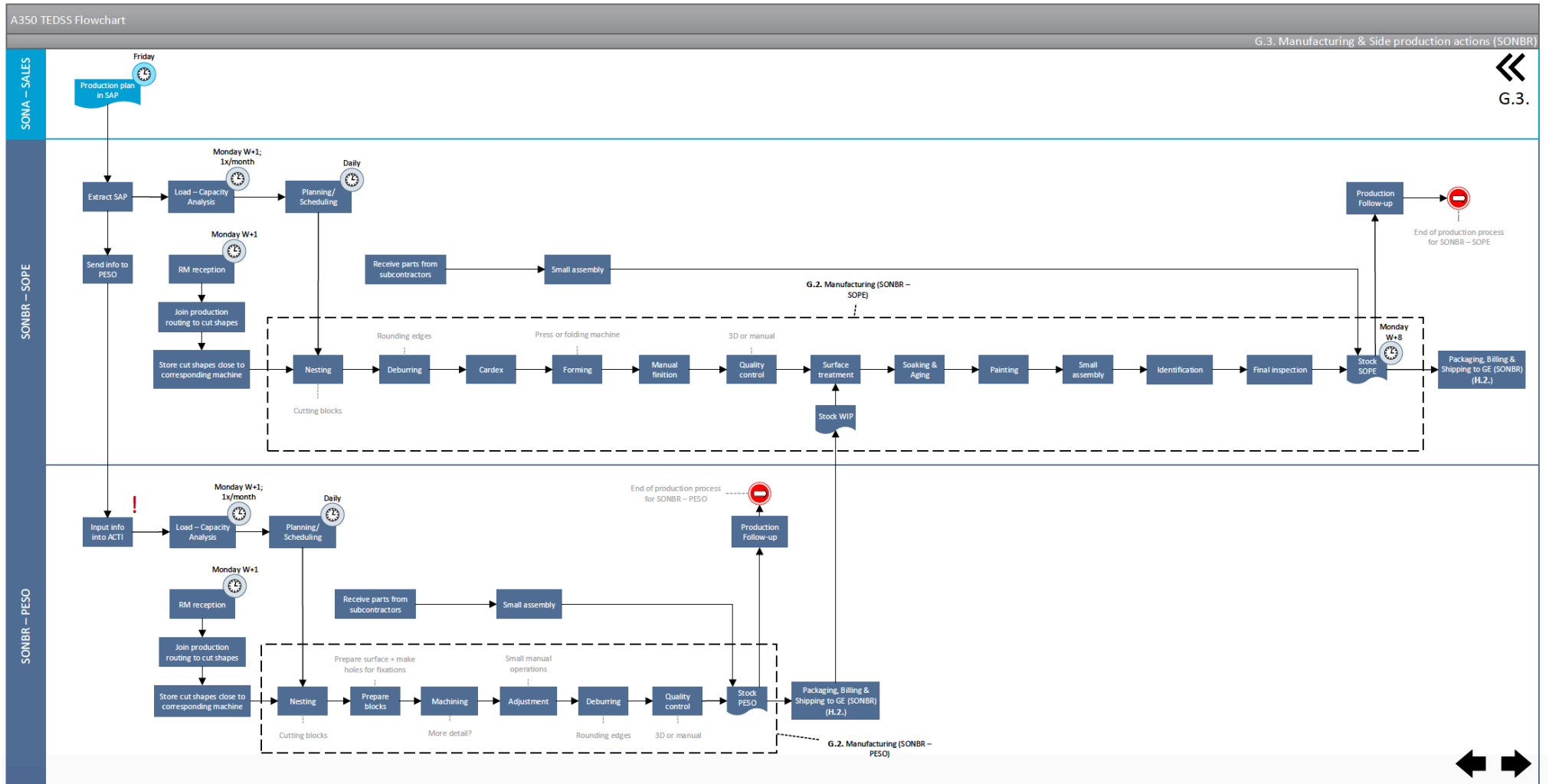


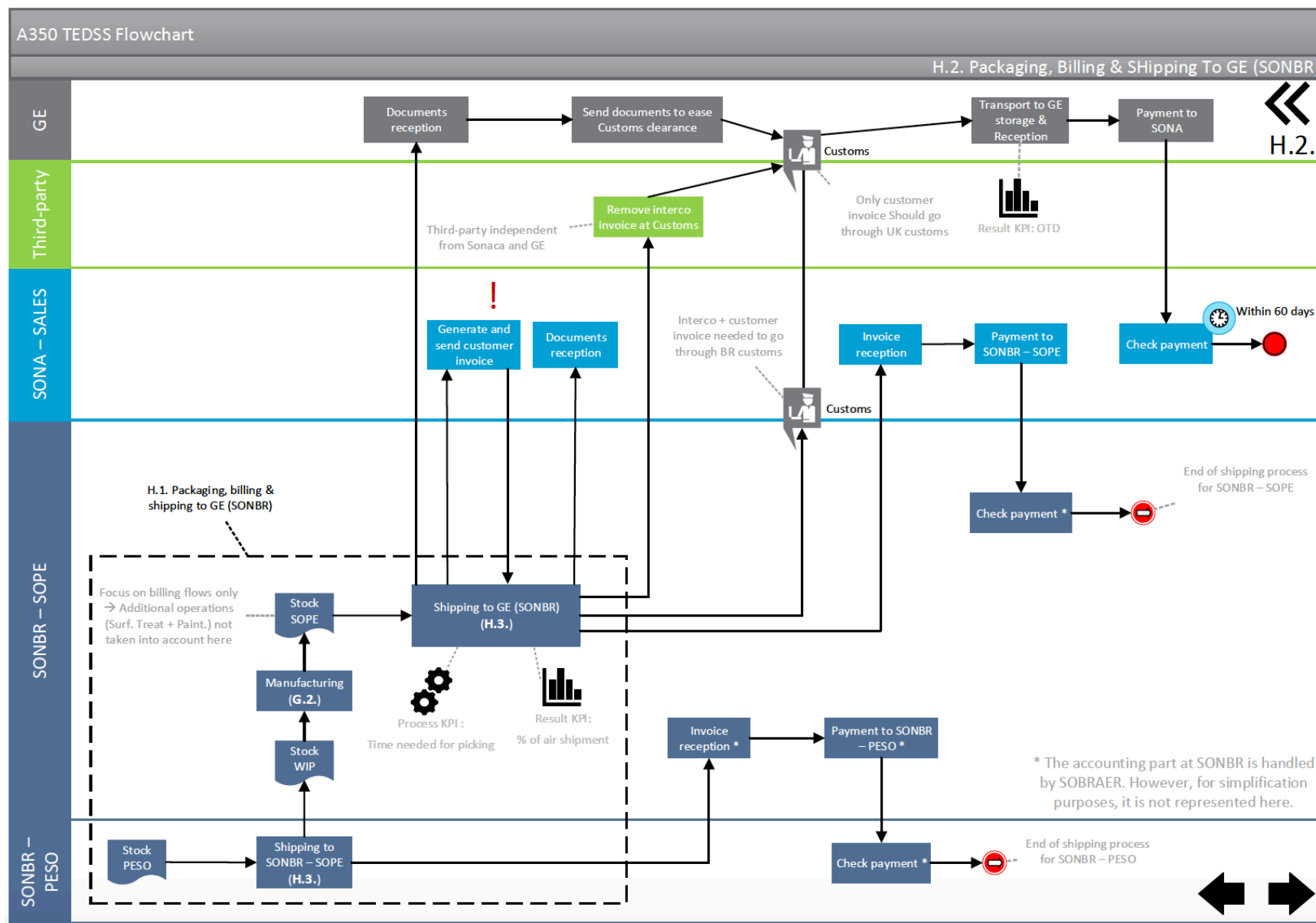


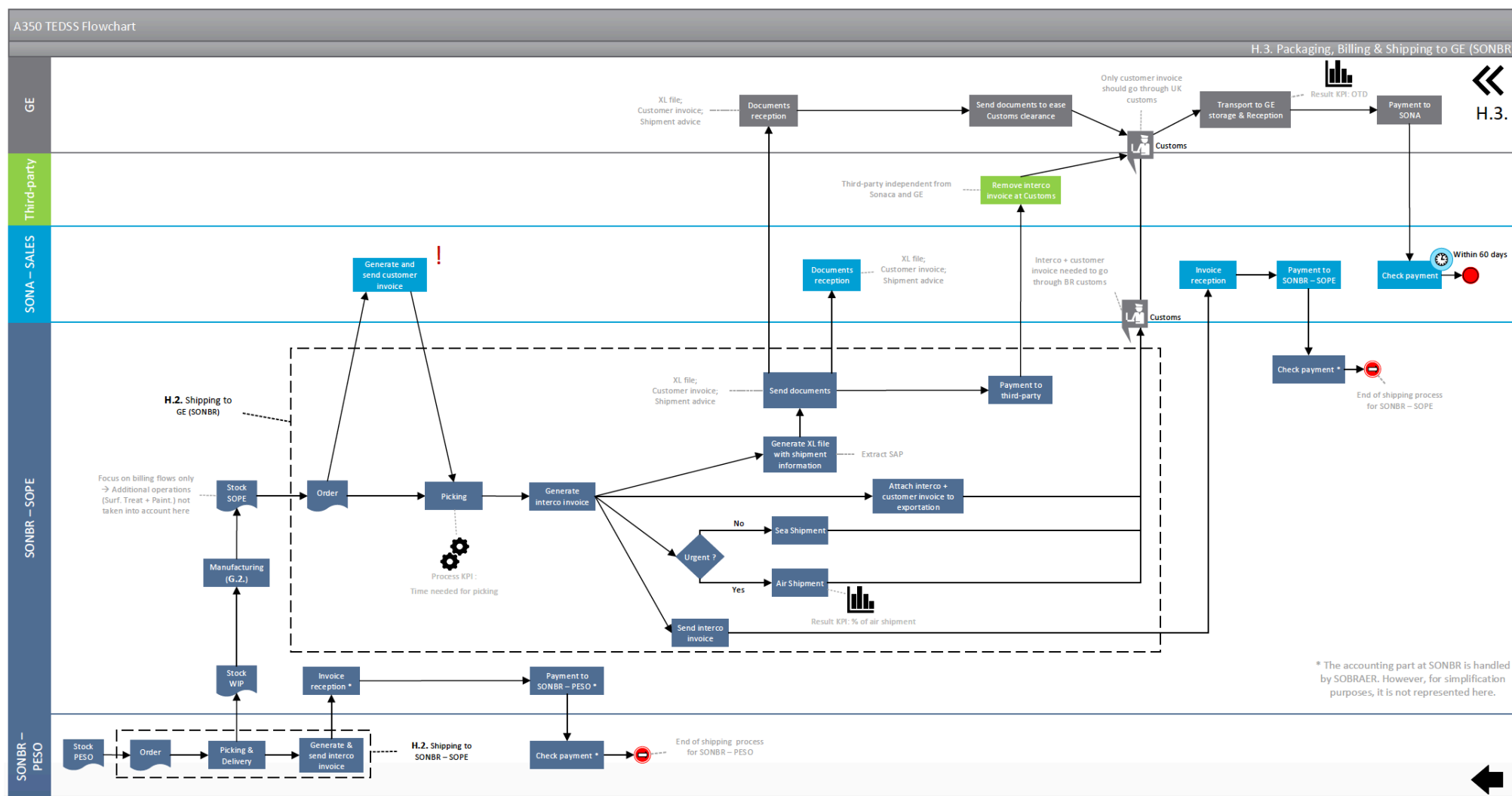












B. Standardizing the Planning & Scheduling processes

B.1. Results

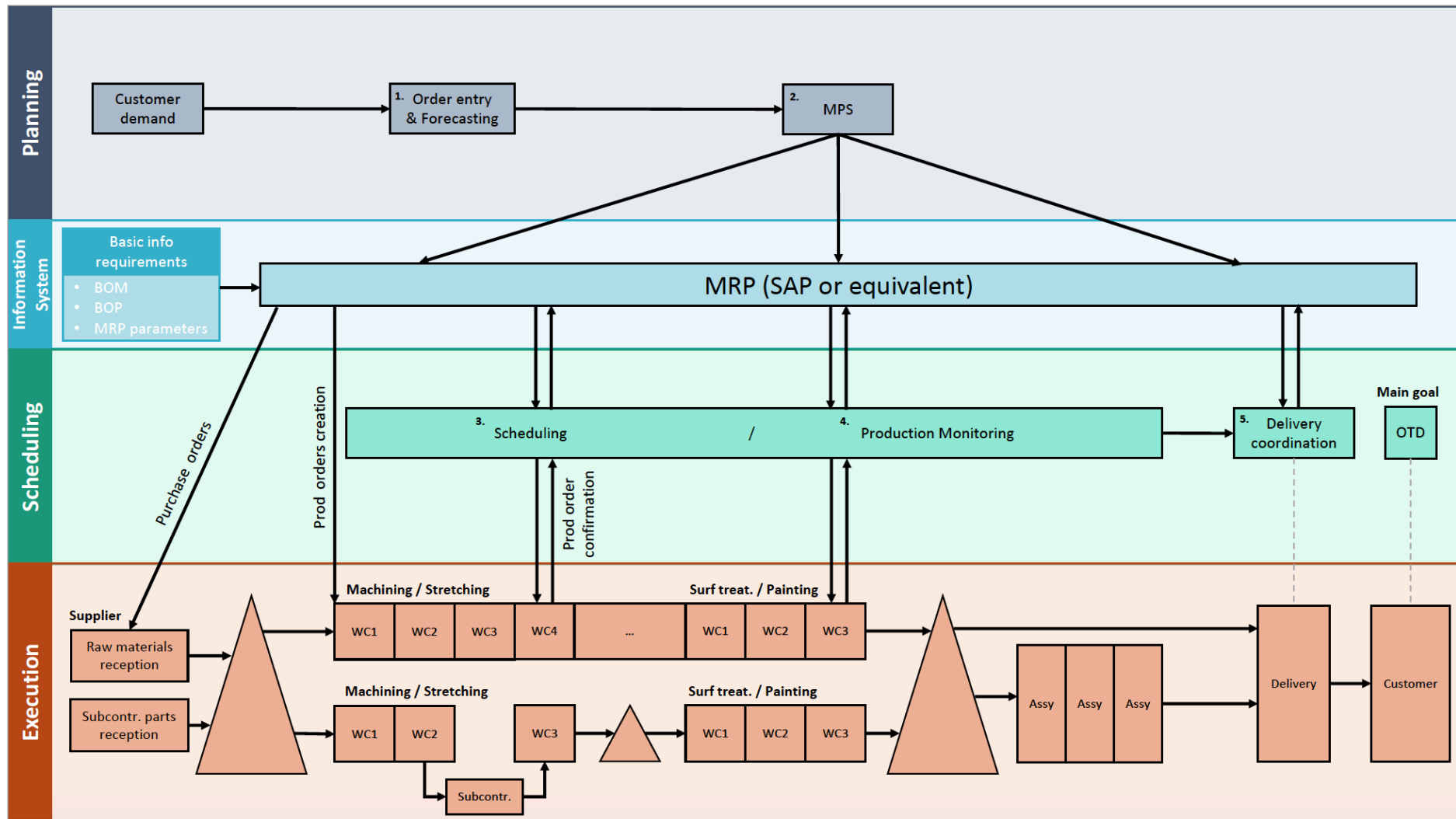


Figure B.1.1: Flowchart for the Planning & Scheduling processes at Sonaca

