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UNDERSTANDING SUPPLY CHAIN MANAGEMENT

An analysis supported by on-field experience

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Dedicated to my family and friends

*“Coming together is a beginning.
Keeping together is progress.
Working together is success.”*

- Henry Ford -

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Introduction

The following thesis aims to provide a description and analysis of the Supply Chain Management (SCM) discipline.

The structure of the dissertation will be divided into three main parts:

- a) The first chapter will provide a general overview of what Supply Chain and SCM are.

Here, all the core definitions that will be used in the next chapters will be explained, as well as a detailed description of the discipline and how it works. Useful frameworks and additional information to understand the discipline will be disclosed in this chapter

- b) The second part will start to analyze how SCM is implemented by companies.

The main traditional strategies, supply chain design decisions, and performance measures are the information this chapter will provide.

Through the section of this chapter, many recurrent topics such as responsiveness and efficiency will emerge and will be explained from different perspectives to give the readers a full in-depth understanding of the topics.

- c) The last chapter will focus on a critical analysis of SCM with a focus on the current and future relevant trends and technologies. The personal experience and observations gathered during the double degree internship at Ensign Energy Services (Adelaide, AU) will be a further tool for further analysis and critical dissertation about these topics.

Supply chain management is a very interesting discipline because it got increasingly important for firms since the early '80s the first studies and papers about it were disclosed.

Supply chain management has deep implications in the value creation for the firms, and that is the main reason why modern companies set reliable infrastructure to support the main flows of the supply chain. Supply chain

managers play a crucial role in the understanding of the most appropriate strategy and structure the firm should adopt.

It all starts by setting a supply chain strategy that can be integrated with the other strategic goals of the company. It is the result of the analysis of the demand and the competitive environment as well as the company's internal assets. The strategy might focus on achieving efficiency or responsiveness, but it is important to further design internal and external structures to enable the best performance of the supply chain. The overall goal is to implement a supply chain structure that exploits all the advantages planned with the strategy through the basic operations of the supply chain. More than that the strategy and structure implemented are needed to be constantly checked in order to measure the performance and manage possible issues that might arise.

Nowadays, it is important for managers to use technological tools that increase the competitiveness of the supply chain, enabling faster and more efficient flows. Following the current trend and future improvement is essential in SCM to build a reliable network and enabling increased performances. From the author's experience, it emerges how coordination and reliability are the key factors even in the traditional supply chain management related to the drilling industry.

Chapter 1

Key Concepts of the Supply Chain Management

Defining Supply Chain

Supply chain is a term that was first used in 1975 by Banbury¹ concerning the process of delivering electricity to the final consumer. This concept became then relevant in business when the processes of purchasing, manufacturing, sale, and distribution were put together in frameworks that reveal linkages between them.

Nowadays, the supply chain, in business, is a term referred to a complex system involving various entities who participate through specific tasks and activities to the transformation, transportation, and delivery of a specific good or service from the origin to the consumer.

Oftentimes, the supply chain can be assimilated at the value chain described by Michael Porter². Nevertheless, the value chain describes the processes that incur on the value creation, while the supply chain adds to that framework players, linkages, flows, and organizational networks that do not only create value but are crucial for the efficiency and sustainability of the processes.

The supply chain is a system that can have different grades of complexity and integration. Generally, a simple supply chain is a linear system: it starts with the supplier of raw materials, and it ends with the final user. The chain involves manufacturers, distributors, and retailers. The main objective of every supply chain is to create value and maximize it for all the players involved.

Any supply chain observed would include some fundamentals functions to reach the final goal. These functions are procurement, production, logistics, and sales³, which are commonly grouped into two stages.

The first one is generally called upstream activities. It includes procurement and production, and it is the stage in which raw materials suppliers, parts

¹ BANBURY, J. G.; 1975; Distribution – the final link in the electricity–supply chain; *Electrics and Power Journal of the Institution of Electrical Engineers*, pp. 773-775.

² PORTER, M. E.; 1985; *Competitive Advantage: Creating and Sustaining Superior Performance*; Free Press, New York

³ NAKANO, M.; 2020; *Supply Chain Management: Strategy and Organization*; Springer; pp. 3 - 11

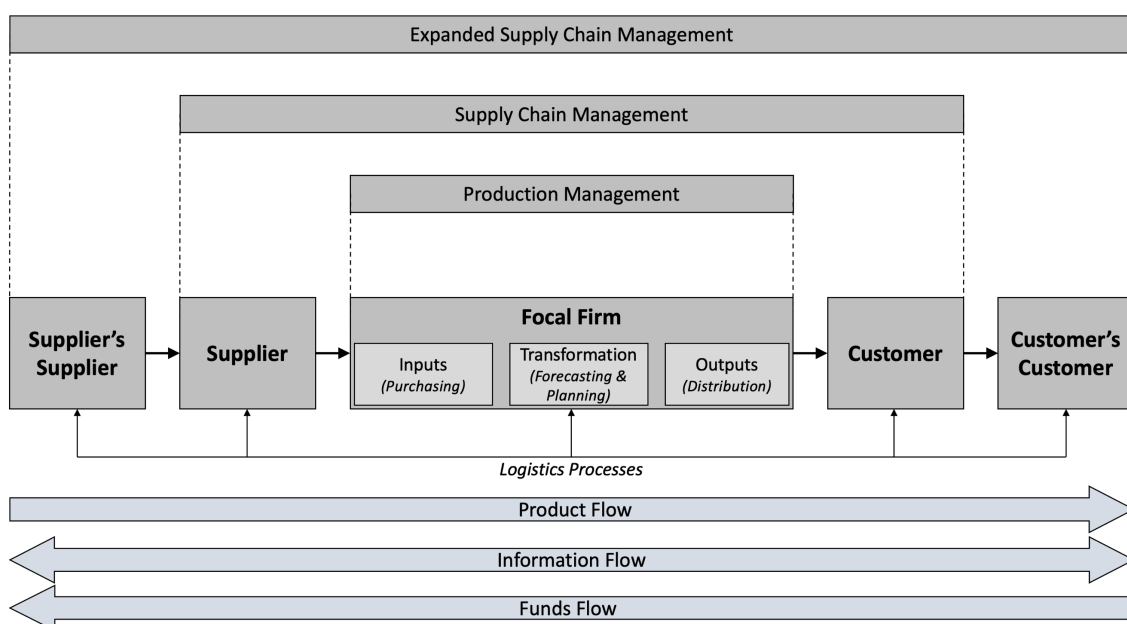
suppliers, and the manufacturer collaborate to ensure the flow of products and information through the chain.

The second stage is called downstream activities. Within this stage, the flow of products and information pass through the manufacturer, distribution services, and eventually reach the final customer. Production and sales are the key activities in this stage.

Within the two stages, logistics is always performed. Indeed, logistics is the fundamental function that supports each stage to ensure the flow of products and information and their effective distribution.

These activities are performed to ensure the operation of three fundamental flows along the chain (Fig. 1). The first one is the flow of materials, goods, and services within the entities that take part in the chain. The second one is cash flow, deriving from the selling activity. It generally starts from the end-user, and it goes back to the raw materials suppliers following the chain in the opposite direction. The third and last one is the flow of information. It is crucial for the correct operation of the chain. It flows back and forth, providing data about the previous flows, practices, rules, and demand occurring in the chain.

Figure 1. OVERALL SUPPLY CHAIN FRAMEWORK



Source: Adaptation of expanded supply chain. Crandall, R. E.; Crandall, W. R.; Chen, C. C.; 2014; Principles of Supply Chain Management; Second Edition; CRC Press; p. 218

From the previous definitions of flows and activities performed, it is finally clear that every supply chain is a mix of processes that every company needs to analyze to create value.

It can be very helpful in the analysis and decision making to group all the activities performed within a supply chain in three macro processes. These macro processes⁴ are:

1. Customer Relationship Management (CRM).

It includes all the activities that aim to increase the demand and deliver orders in the best way. Functions as marketing, customer care, pricing, and order management are part of this macro process.

2. Internal Supply Chain Management (ISCM).

It includes all the activities that aim to fulfill the demand. Functions as a production plan, inventory, and supply management are part of ISCM.

3. Supplier Relationship Management (SRM).

This process includes activities that aim to manage supply sources. The evaluation of suppliers, negotiation, and purchasing are functions related to SRM.

In conclusion, from the definitions above, it is clear how the supply chain is a crucial element for the business analysis and for companies to eventually achieve cost reductions through efficient processes and linkages. The discipline that works on this optimization is called Supply Chain Management.

⁴ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition; Pearson; pp. 12-13

Supply Chain Management

Supply Chain Management (SCM) has been defined for the first time in 1982 by Keith Oliver and Michael Webber in their paper “Supply Chain Management: logistics catches up with strategy.” There the authors state:

*“Through our study of firms in a variety of industries ... we found that the traditional approach of seeking trade-offs among the various conflicting objective of key functions – purchasing, production, distribution, and sales – along the supply chain no longer worked very well. We needed a new perspective and, following from it, a new approach: Supply-chain management.”*⁵

With these sentences, the authors introduced a new concept. The strategic plan of the supply chain was identified as a source of competitive advantage. The supply chain was no longer a mere relationship between a buyer and a seller; with the rise of SCM the focus was finally put on the coordination and cooperation of entities that work together to deliver efficiently a superior customer value.

A more accurate definition of supply chain management was developed in 2001 after a review of the different concepts raised by academic and professional papers. This definition states that:

*“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, to improve the long-term performance of the individual companies and the supply chain as a whole.”*⁶

Eventually, this definition underlines the relevance of strategic coordination and strategic planning. These concepts are the core of SCM since the final goal is to achieve a competitive advantage. Coordination becomes not only an internal function of each company, but it becomes crucial to manage

⁵ CHRISTOPHER, M.; Logistics & Supply Chain Management; Pearson Education Limited; p 16.

⁶ MENTZER, J. T.; DEWITT, W.; KEEBLER, J. S.; Min, S.; Nix, N. W.; Smith, C. D.; Zacharia, Z. G.; 2001; Defining Supply Chain Management; Journal of Business Logistics; Vol. 22; No. 2; p. 18.

relationships and networks along the entire supply chain. Evidently, the coordination must be assisted by a careful planning activity since SCM aims for sustainable long-term performance.

It is also important to note the difference between SCM and the traditional concept of logistics. There is a clear shift from a vision of activities performed by a single company such as procurement, distribution, and inventory; to a coordinated network that adds to these conventional activities also marketing, product development, strategy, and customer services.

The reason why SCM is the source of a superior performance lies in the conflicts of needs that occur on different supply chain requirements when a single company is observed. To be clear, imagine a company that runs a business based on fast customer service. In order to fulfill this requirement, the company needs to have high levels of inventory. The same company could also need to reduce costs related to inventory to have profits. These two needs apparently clash with each other, in fact, the single company by itself should choose between the two. SCM can solve this kind of conflict by coordinating external entities to the company business. In this example, a well-coordinated network of suppliers could allow the company to run a 'just-in-time' business, reducing inventory costs, and keeping the fast customer service.

In conclusion, SCM is so relevant nowadays because it is the logical evolution of internal company's management activities: the management of the whole chain is performed in order to reach superior performances that a single company could not achieve.

A Model to Understand Supply Chain Management

To represent what SCM is and what its functions are, in 2001 was developed a model to explain it.⁷ This model was then used as a reference in many academic textbooks.

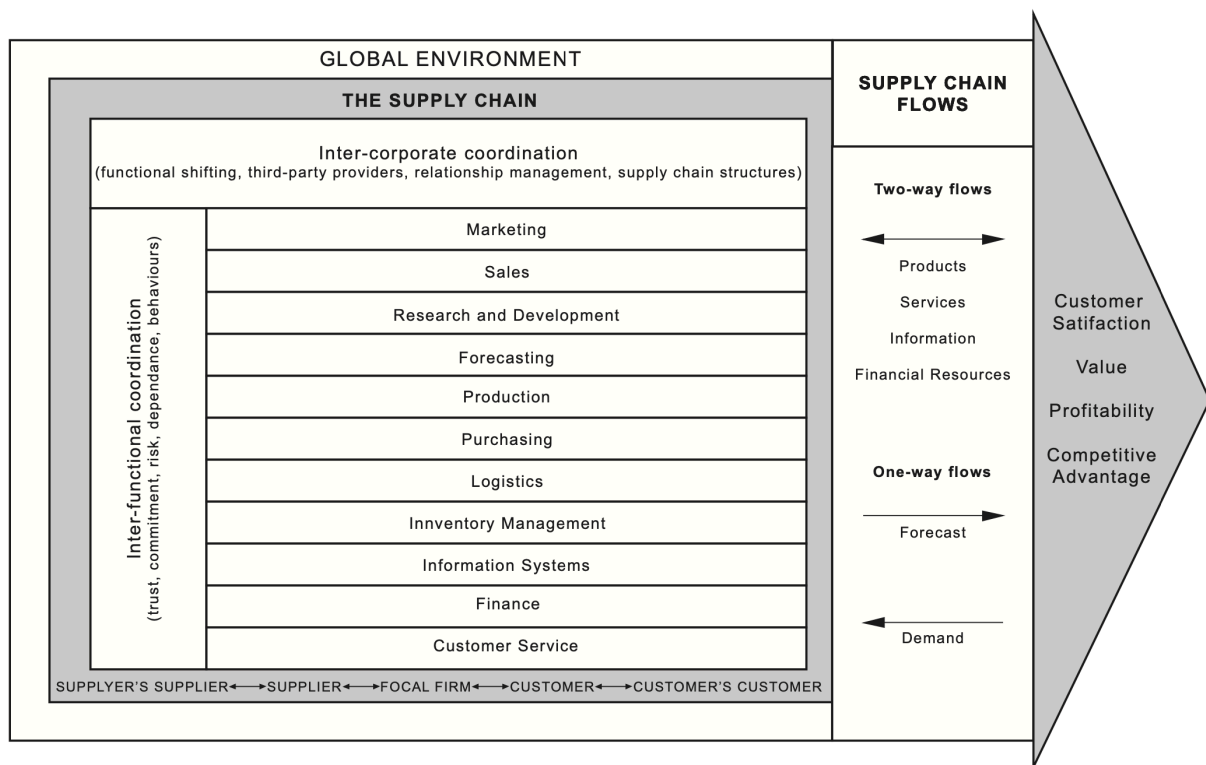
⁷ MENTZER, J. T.; DEWITT, W.; KEEBLER, J. S.; MIN, S.; NIX, N. W.; SMITH, C. D.; ZACHARIA, Z. G.; 2001; Defining Supply Chain Management; Journal of Business Logistics; Vol. 22; No. 2; p. 19.

In *fig. 2* it is possible to appreciate how this model presents some crucial differences from the traditional supply chain definition.

First of all, the model shows how the internal functions of a company needs to be coordinated both with inter-corporate activities and inter-functional procedures. The whole supply chain must incorporate these activities to reach the desired outcomes.

Also, the flows slightly change in this model. Most of them are two-ways flows, meaning that there is a cooperation of all the players who participate in the supply chain for the co-creation of value.

Figure 2. MODEL OF SUPPLY CHAIN MANAGEMENT



Source: Mentzer, J. T.; Dewitt, W.; Keebler, J. S.; Min, S.; Nix, N. W.; Smith, C. D.; Zacharia, Z. G.; 2001; Defining Supply Chain Management; Journal of Business Logistics; Adaptation.

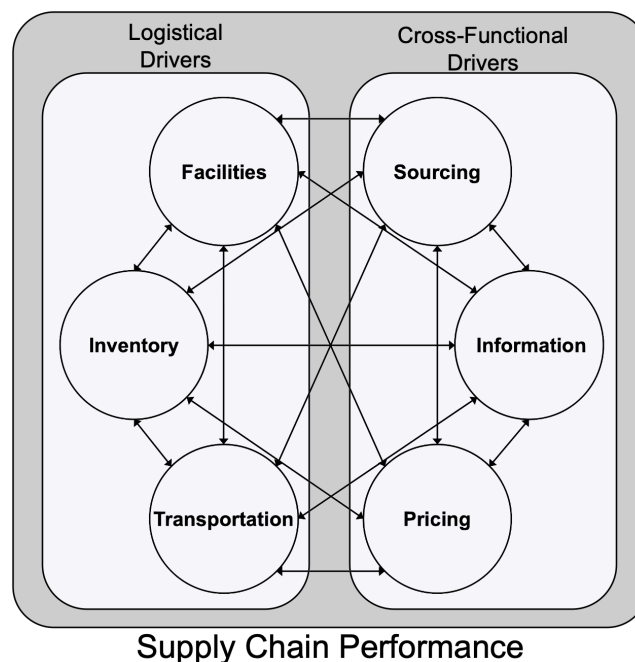
Key Drivers for Performance

SCM focus on some key drivers that affect the whole supply chain performance. For the purposes of this dissertation, the drivers selected are the ones first disclosed by Chopra and Meindl⁸ (2012).

These drivers are crucial on SMC to analyze the whole supply chain and achieve superior performances in terms of responsiveness and efficiency. Firstly, it is necessary to understand each driver and its area of influence; after that, it would be possible to approach the creation of a mix that would suit the business.

The drivers (*fig. 3*) are to divide into logistical ones (facilities, inventory, and transportation) and cross-functionals ones (information, sourcing, and pricing). While logistical are the most tangible and traditionally developed, nowadays, the cross-functional drivers are the ones that allow companies to achieve a major competitive advantage.

Figure 3. KEY DRIVERS OF PERFORMANCE FRAMEWORK



Personal visual adaptation of the Chopra and Meindl dissertation

⁸ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition; Pearson; pp. 41-59

It is essential to understand that even if each driver can be analyzed by itself, in reality they interact with each other within the supply chain. Because of that, SCM needs to evaluate the trade-offs of various mixes to reach a sustainable and efficient strategy.

The drivers for the supply chain performance are described as follow:

1. Facilities

They are *where* goods, materials, products, and services are located in the supply chain.

They influence the competitive performance because the location of them can make a huge difference in being responsive to customer demand or being cost-efficient.

To be clearer, the centralization of storage and production generates economies of scale for the company resulting in cost reduction. However, oftentimes it means the company cannot have facilities close to different groups of customers and suppliers, resulting in an increased distance and decreased responsiveness to the demand.

Because of this trade-off, companies need to make wise decisions regarding facilities. The components that need to be evaluated are the role of the facilities, their location, and their capacity.

The *role* is needed to understand if it is a storage facility or a production facility. The first one needs to focus on whether to be flexible (many goods, lower efficiency) or dedicated (one product, higher efficiency). On the other hand, the second one can be product-focused (performs all the processes to get the final product) or functional-focused (perform one function for many product lines).

As stated before, it is also crucial to evaluate the *location* of the facilities to follow a centralization strategy or a responsiveness strategy. The location decision is highly influenced by macroeconomics factors such as availability of workers and infrastructure, costs of facilities, taxes, and many others.

The third component is the capacity of the facility. It is clear that it depends on the demand, but it also can be influenced by the inventory strategy (whether to have excess capacity, lean system, high rotation, ...).

These components need to be analyzed by taking into consideration the company strategy and measured in order to create the best mix for the company business.

2. Inventory

It is *what* is stored along the supply chain.

Mismatches between supply and demand require companies to manage an inventory. It is vital in many industries because it enables the storage of goods that are efficiently produced in big lots (exploiting economies of scale) even if they exceed the demand. More than that, inventory enables the satisfaction of larger and future orders whenever it is required, meaning that higher responsiveness is achieved.

On the other hand, inventory generates higher costs of maintenance and storage for the company. Because of that, managers must create the best mix evaluating costs and responsiveness level needed.

The components that need to be evaluated in the process of decision making about inventory are the cycle of inventory, safety, if it is seasonal, and the level of product availability.

The cycle of inventory is how often and how much a company order from a supplier. There is a trade-off to be evaluated between the cost of holding a large inventory ordering big lots on few times, and the cost of ordering small lots very frequently to reduce the inventory size.

Safety inventory means how many goods a company holds more than the expected demand to respond to increasing orders and demand uncertainty. The safety inventory is needed mostly (but not only) by those companies with highly volatile demand. They need to have excess inventory to avoid losing sales if the demand increase.

Another vital component to evaluate is whether the company faces a seasonal demand. In this case, it is convenient to set up a seasonal inventory, meaning that the company store goods in a period of low demand in order to face a high level of sales when demand increase. The seasonal inventory allows having a relatively constant supply with variable costs of storage depending on the demand level.

Last but not least, it is crucial to evaluate the level of product availability. High levels mean the company will provide high responsiveness to customers, while low levels mean that the customer will face waiting time. The higher the level of product availability, the higher the cost of storage for finished goods.

3. Transportation

It is *how* goods are moved along the supply chain.

In the current global economy, transportation is a key driver for company performance. In particular, it affects time efficiency, cost levels, and responsiveness. A rapid and costly transportation mode (such as airplane transportation) might be the best choice for companies that need to have a high responsiveness level. On the other hand, companies that already have achieved responsiveness by setting facilities and inventory close to the end costumers might prefer to choose a cheaper transportation mode to deliver goods. The challenge of choosing the best transportation mode is faced by every player in the supply chain.

The choice of the best transportation strategy depends on mainly two components.

The design of the transportation network means that the company needs to evaluate the modes, routes, and locations along which each good will be transported. It is important to include intermediate stops within the shipment process or joint transportations for more types of goods at once.

The second component is the choice of transportation mode. Depending on the distance, costs, and time needs, a company has many modes for

delivering goods. The traditional ones are by air, sea, truck, rail, and pipelines, but nowadays some digital goods can be shipped via e-mail and the internet. Each mode has specific characteristics concerning speed, size allowed, costs, and flexibility, that must fit with the company needs.

4. Information

Information is crucial along the supply chain to increase efficiency and reduce risks. Companies that have a reliable information flow with their supply chain network are able to coordinate every process and logistic procedure in order to have a higher efficiency of their assets and a decrease uncertainty during supply chain flows.

Coordination is an essential activity to perform along the supply chain. Because of its importance, it is necessary for companies to share relevant information and put in place the best information technology system. Coordination and efficiency together also play an important role in reducing transactional costs and deliver better customer service.

Because of information relevance, there are many components to evaluate for managers to make the right decision.

Determining if supply chain processes are part of the *pull or push phase* in the supply chain. The push-system starts by forecasting and building a master production schedule. The information contained in that document is then transmitted to the suppliers to give them the right amount and type of goods, and a time schedule.

In the pull-system, managers wait for feedbacks from real demand to deliver information about requirements to suppliers. This system needs information to be delivered quickly and very precisely.

Another crucial component is *coordination through information sharing*. As stated before, coordination is one of the most important activities performed in a supply chain. Because of its importance, companies need to select the right information to share with partners in order to coordinate processes.

To make the right decision, it is also necessary for managers to plan, and more specifically, to build a sales and operation plan (S&OP). In this plan are contained all the information about the production, inventory, and sales. This information is vital whenever a manager wants to build a plan for supply chain needs.

Lastly, a very important component for information is the enabling technologies. Nowadays, companies can exploit technologies in order to store, share, and utilize information. The most important for the supply chain performances commonly used are:

- Electronic data interchange (EDI) and its more recent derivate. It is needed to place instant orders and create a common network of communication among the supply chain.
- Enterprise resource planning (ERP). It is needed to gather real-time information within the company and the whole supply chain. This information can be shared globally or used by other supply chain management software to increase efficiency.
- Radiofrequency identification (RFID) are tags used to track items whenever they move along the supply chain. The information contained in the tag and its location is shared with all the entities interested in that item.

5. Sourcing

It is essential to choose all the business processes needed to purchase a good or service. Managers select the sourcing strategy looking for a price advantage or a faster purchase depending on the business needs.

The components to evaluate in order to build a sustainable strategy are as follows.

Managers need to evaluate if it is more convenient to perform a task in-house or outsource the process. The choice is not only based on the lower price, but it needs to take into consideration also the degree of control the company wants on that specific task and the loss/gain of efficiency in outsourcing. The choice is not irreversible since reshoring is a feasible process. However, it is

important to have a solid business strategy through time, and every decision must be first evaluated wisely.

The second component is the supplier selection. This decision is very important in order to build a network based on trust and common goals. Having a joint vision and building a long-lasting relationship with suppliers is essential for SCM. As well as outsourcing, supplier substitution is also feasible; however, it is always a non-efficient process to replace a partner and engage a new one in the business and involve it in the business strategy and practices.

Lastly, managers need to evaluate *procurement* strategies. It means that a manager must decide on the structure of supply flows to ensure an efficient transition of goods and services between different stages of the supply chain.

6. Pricing

The process of pricing aims to decide how much to charge to the customer in order to create a supply chain surplus. Therefore, the main effects of pricing strategies affect the costumers. Despite that, pricing often plays a crucial role in the supply chain plan, and it depends on the responsiveness, storage, and transportation capacity of the whole supply chain.

Pricing strategy is very important because it aims to cover the supply chain costs, hopefully, generate a surplus, and it can also be used to control the demand level by rising prices, or making discounts.

As for the other key driver, a manager can try to increase the supply chain performance through pricing, which means he needs to evaluate the pricing components.

Each player in the supply chain could have *economies of scale* for some activities performed. In order to exploit these economies of scale, the company needs to set a price that incentivizes the buyer to purchase the more efficiently produced/delivered quantity. For example, a company could apply discounts for a certain amount of goods ordered. Another company could

increase prices if the transportation mode required by the buyer does not exploit the full transport capacity.

Moreover, the pricing strategist needs to choose whether to apply fixed pricing or menu pricing. Fixed prices do not change whether the buyer requests are. On the contrary, menu pricing tie price to another variable. This means that the price can vary depending on buyer needs. For example, when buyers request a fast delivery, additional services, or again remote location shipment, the company can apply additional cost for supply goods under buyer's requests.

Chapter 2

Build and Manage a Sustainable Supply Chain

Supply Chain Strategy

As it happens in other business areas, also for supply chain management is essential to set a strategy to follow in order to reach goals.

The following dissertation will explain how the supply chain strategy has to fit with the core business processes, what are the traditional strategies to evaluate and what are they based on, and finally, what are the strategic operations that a supply chain manager has to consider while setting the strategy.

Supply Chain Strategic Fit

The previous chapter explained how managers need to take into consideration all the drivers. Even if the manager analysis starts by evaluating drivers one by one, the final goal is to create the most appropriate mix. The activity aiming to find the right mix can be defined as the process of strategy making for what concerns the supply chain.

The supply chain strategy cannot be detached from the general business strategy of the company. This means that companies competing in their industry with strategies based on particular market orientations (such as low price, fast delivery, high quality, global demand exploitation, ...) must manage the supply chain so that it supports the business vision.

The supply chain strategy must focus on creating advantages for the company, both enabling the market strategy and creating value for customers. Trying to achieve lower costs along the supply chain is not always the best strategy since it could not enable the company to follow its set market strategy.

Accordingly, to that, the first step for a sustainable supply chain strategy is to find a *strategic fit* with other business areas. For SCM, the goal is to support the overall competitive objective with the best mix of the performance drivers

described in the previous chapter. To do that, the supply chain manager needs to proceed through three main steps.⁹

The first step is to **understand customer and supply chain uncertainty**. Customers are classified by the company on segments with similar attributes that drive their needs and behaviors. However, different customer segments have different degrees of uncertainty for what concerns the demand. Because of that, supply chain managers need to ensure flexibility along the supply chain based on the degree of uncertainty of the customer segment to satisfy.

At the same time, it is not enough to understand demand uncertainty for supply chain managers. In this area, supply uncertainty¹⁰ plays an important role. As for demand, the degree of supply uncertainty depends on goods to be supplied and suppliers selected. Innovative products, unreliable suppliers, goods vulnerable to breakdowns, scarce resources, and many other reasons could increase the supply uncertainty. Examples of products with relatively low demand and supply uncertainty are groceries, oil and gas, and basic apparel. On the other hand, products with a high level of demand and supply uncertainty are telecommunication, innovative technologies, and semiconductor.

Figure 4. SUPPLY CHAIN STRATEGIES FACING UNCERTAINTY

		Demand Uncertainty	
		Low	High
Supply Uncertainty	Low	Efficient Supply Chain	Responsive Supply Chain
	High	Risk-hedging Supply Chain	Agile Supply Chain

Source: Lee, H.; 2002; Aligning Supply Chain Strategies with Product Uncertainties

⁹ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition; Pearson; pp. 21-31.

¹⁰ LEE, H.; 2002; Aligning Supply Chain Strategies with Product Uncertainties; California Management Review; Volume 44, Number 3, pp. 105-119

After analyzing this first step, managers can already have an idea of what strategy could fit with their business.

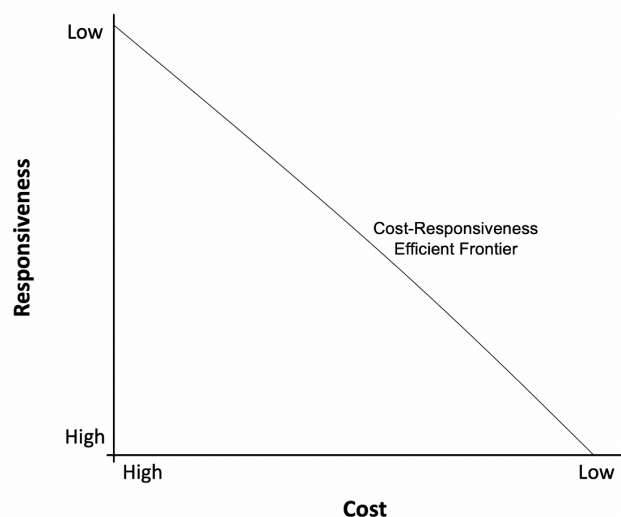
From the model in *fig. 4*, it is possible to notice that there are four different strategies available. The *efficient strategy* focuses on cost reduction and economies of scale, eliminating from the supply chain any activity and service that is not essential for the product delivery. *Risk-hedging* means that responsibilities and resources are shared along the supply chain. Because of that also risk is shared. The *responsive supply chain* is characterized by a high level of flexibility to satisfy any customer need and decrease the risk of losing sales. However, it still tries to cut costs whether it is possible. Lastly, the agile strategy is the one that focuses less on costs and more on flexibility and safety. This strategy calls for high inventory and high responsiveness.

The second step to find the strategic fit is to **understand the supply chain capabilities**.

This step is highly connected with the previous one because it aims to understand if the supply chain can effectively run one of the strategies identified before by analyzing the capabilities of the companies involved. For managers, it is often useful to build a *cost-responsiveness efficient frontier* (*fig. 5*) to understand if the activities performed are exploiting the best mix of efficiency and responsiveness.

Any capability mix that results out of the frontier can be improved to reach the most efficient mix.

Figure 5. *COST-RESPONSIVENESS EFFICIENT FRONTIER*



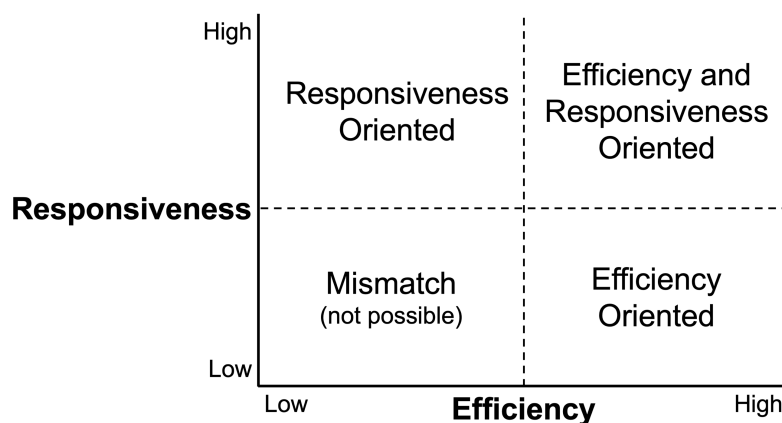
Source: Chopra, S.; Meindl, P.; 2012; *Supply Chain Management: strategy, planning, and operations*

The last step is to cross the results from the previous analyses and **understand the best strategy to follow**. This step is important since its goal is to ensure the best level of responsiveness for a given uncertainty identified.

The results provided in this step should disclose which is the best strategy to follow. Once the manager decides to undertake the strategy, it is necessary to assign to each player of the supply chain roles that match the responsiveness and efficiency required.

This process is quite straightforward when the manager focuses on a single customer segment, but it could be very complex when the company serves multiple segments and they are very different from each other. When this happens, the analysis is quite challenging, and it is necessary to design the supply chain in a way that different suppliers can ensure to the company both responsiveness to some product lines and efficiency on some others. For example, if there is a high demand uncertainty in some areas of the world while in some others there is a stable demand, the supply chain manager needs to create a network with delivery providers that are very responsive in the first case and very efficient in the other one.

Figure 6. TYPOLOGY OF SUPPLY CHAIN STRATEGIES



Source: Nakano, M.; 2020; Supply Chain Management: Strategy and Organization

From the previous dissertation, it becomes clear that the main trade-off that supply chain managers have to face is the one between the responsiveness and efficiency. The uncertainty described above enables the company to have efficient supply chain processes only when its level is low as it emerges by

the cost-responsiveness efficient frontier. Despite that, it is not true that uncertainty and efficiency are synonyms for what concerns this topic. Indeed, it has been explained that uncertainty depends on multiple factors, meaning that a company can set efficient processes even for different levels of uncertainty. In *fig. 6 (Nakano, 2020)*, it is possible to identify three different possible strategies to follow by analyzing the relation between responsiveness and efficiency.

The following paragraphs will describe in-depth the requirements needed to achieve the strategy chosen.

Efficiency Oriented Strategy¹¹

Companies that are willing to adopt this strategy should have in their portfolio a large volume of products characterized by stable demand, slow innovation (or else a long lifecycle), stability on price, and predictable fluctuations. Thanks to these factors, they can focus on increasing efficiency to reduce costs, increase margins, and become price competitive.

In this strategy, the company tries to eliminate overlapping and redundant activities by coordinating and joining processes. Achieving efficiency means that every task along the supply chain needs to be forecasted and planned. It is possible to predict and plan the whole supply chain because of the factors mentioned above and because supply chain procurement is based on these predictions and historical data. The plan is crucial to reduce inventory costs, transportation costs, and to achieve economies of scale.

There are different tools that can help managers in planning. The most common one nowadays is for sure ERP (enterprise resource planning). From historical data and manager inputs, it builds a plan for inventory, transportation, and production.

The activities of forecasting and planning cannot be performed without the support of both the internal structure of the company and the whole structure

¹¹ NAKANO, M.; 2020; Supply Chain Management: Strategy and Organization; Springer; pp. 79-98

of the supply chain. As it emerged analyzing the key driver “information”, the best way to create an efficient structure is to share information along with departments (internally) and the whole supply chain. This flow creates automatism, linkages, and time-saving procedures that enable the efficiency strategy.

For example, a “functional structure” (where internal departments are divided by the task performed: production, logistics, sales, ...) is very coherent with efficiency-oriented strategy. In this case, the supply chain manager needs to collect information from different departments. The sales unit often does market researches to forecast demand, logistics one usually plans inventory and transportation, while the production department set activities for the manufacturing. Supply chain managers should avoid to perform redundantly these activities. To do so, the manager should gather information from other departments and elaborate them into an efficient mix in order to allow the company to have efficient internal procedures.

This example is representative of internal processes, but it is not enough to aim at building an efficient structure. Supply chain managers have to create an efficient network with suppliers and customers too. In order to do so, supply uncertainty must be mitigated using standardized processes of delivering and transportation, as well as avoiding to depend on a single supplier. The objective is to create an automated network by integrating the primary suppliers to the information flow coming from the demand side. Sharing information and collaborating with upstream and downstream partners means they will be able to plan their processes too and follow the efficiency-oriented strategy.

Responsiveness Oriented Strategy¹²

Not many firms can have stable demand and a stable environment. Because of that, efficiency-oriented strategy cannot be undertaken by companies

¹² NAKANO, M.; 2020; Supply Chain Management: Strategy and Organization; Springer; pp. 109-150

involved in price competition, product differentiation, innovative environment, and uncertain demand.

For these companies, it is better to create structures based on responsiveness and flexibility. This kind of strategy is needed since the focus on forecasting and planning becomes complex. The prediction of demand and the plan of supply becomes a short-term challenge that needs to be performed repeatedly. This implies that it is not possible to set an information flow coming by different departments and build an overall plan for orders and sales. In this situation, it is better to have a department that performs all the activities of forecast and planning in the fastest way possible, even if the predictions will result to be less accurate. A quick response is the key. It will be the supply chain management department that will create the information flow and share it with other departments in order to work together to a common goal.

The activities performed by the supply chain management department will not be based on historical data as it happens in the efficiency-oriented strategy. They will be based on short-term predictions related to the fluctuation of the demand. The challenge in this situation is to set quick linkages between departments to change the whole ordering, production, and sales plans.

As well as the internal structure, the external network will change in this strategy.

It is important to have linkages with more responsive suppliers. However, in order to avoid risks, it is recommended to increase the inventory size to avoid losing sales and depending too much on the flexibility of suppliers.

On the other hand, the downstream side for these firms is usually buyer-driven. It means that the customer is the one looking for the best deal and customization. On the contrary to the standardization process explained for efficiency-oriented strategy, in this case, the supply chain manager has to ensure that the distribution, timing, and mix of products fit with the customer needs.

Hybrid Strategy¹³

This strategy aims to achieve both efficiency and responsiveness. Even if it sounds like the most appealing strategy, it is the most appropriate only for those companies that can directly decrease the demand uncertainty.

This strategy fits with companies that serve different customer segments but has low product diversification. Because of that, they can adopt a structure that allows them to have an efficient global structure divided into departments that can be responsive to their specific demand. It is the case of multinational where the production is centralized and aims to be the most efficient possible, while the other business units focus on the demand from a specific area of the world. Therefore, the units should be more or less responsive depending on the demand uncertainty in the area served.

In this kind of structure, it is possible to delegate to each department the activities of demand foresee and inventory planning as it happens for the responsiveness-oriented strategy. Following that, a centralized supply chain management department has the task of collecting the information for departments and then develop an efficient supply structure and transportation to different areas.

As previously stated, it is not possible to set an efficient process if the firm cannot decrease the demand uncertainty. To do so, firms usually use “postponements” of some processes. This practice can be applied when the firm produces standardized goods or components that will be differentiated and customized depending on the demand source. The global demand is fairly stable but at the same time, each customer could ask for personalized service. To be clear, let’s see some examples.

In the first example, a firm produces standardized goods for many customers. The products are precisely the same, but they need to be labeled according to each customer's needs. This example would drive the firm to set an efficient supply chain until the final good (not labeled) is ready. Following that moment,

¹³ NAKANO, M.; 2020; Supply Chain Management: Strategy and Organization; Springer; pp. 153-176

the processes of customization and transportation will be planned to be responsive to customer requests.

Another example could be a firm that has many products with the same components. In this case, efficient activities are performed until all the components are stored in a single factory. The assembly process of the final good will be performed in a second tie to be flexible to satisfy orders incoming. This last step is planned to be responsive to the demand needs and the transportation needs.¹⁴

Those examples clearly show that in this strategy the focal firm needs to have an efficient upstream structure with its network of suppliers, therefore based on collaboration and information share. Meanwhile, the downstream structure needs to be responsive to different sources of demand. The efficiency strategy can be implemented until processes and goods are standardized, while the final stages of customization and delivery need to be responsive.

Supply Chain Strategic Operations

From the analysis of the different strategies, it emerges that some operations are recurrent within supply chain management. Those activities are fundamental to develop a reliable and sustainable supply chain achieving long-term competitive advantages. The operations that can be observed and that supply chain managers need to take into considerations will be explained in this section.

An important activity performed is **forecasting**. The decisions that supply chain managers undertake are mainly based on demand forecasts.

Forecasts are by nature not accurate. Indeed, many errors can occur in the process of forecasting, and rarely the prevision is a perfect representation of the real demand. Because of that, short-term forecasts are more accurate than

¹⁴ TRENTIN, A.; FORZA, C.; 2010; Design for form postponement: Do not overlook organization design.; International Journal of Operations & Production Management; Vol. 30, No. 4.

long-term ones. In the forecasting activity, it is vital to be aware of the probability that errors could occur and what are the causes of them.

A firm with multiple sources of demand will be able to forecast more precisely than a firm with a very narrow customer segment. This happens because the errors coming from different sources are more inclined to have a lower standard deviation. Another factor increasing error probability on forecasting is the position of the firm along the supply chain. The upper the firm is positioned in the supply chain, the less accurate would be the end-customer demand foreseen. That is caused by the degree of approximation each company includes in the process of forecasting.

Once managers are aware of the probability of errors, they can proceed with forecasting the demand. The basic forecasting typologies are four¹⁵.

1. Qualitative.

Forecasting with qualitative methods relies on the ability of managers to understand the market. They are subjective methods that are appropriate when few historical data are available. The manager has to make a forecast basing the decisions on similar business observed and personal intuitions. The prime tool for managers undertaking those methods is the comparison with competitors and similar products and market surveys.

2. Time series.

The forecasting activity is based on historical data and patterns observed. It can be tricky for those firms that operate in a very uncertain industry with high fluctuations of the demand and a high degree of innovation. This typology is often used by management software since historical data are a huge source of information for calculating future needs.

3. Causal.

Causal forecasting methods try to find a correlation between demand and external factors. Observing the change in these factors, the manager can foresee if the demand will shrink or increase. External factors are usually

¹⁵ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition; Pearson; pp. 180-181

easy to observe and, most of the time, they are also measurable. Examples could be interest rates on real estate, country currency, GDP, environmental events, ...

4. Simulation.

Simulation forecasting methods are based on time series and causalities. The firm tries to answer a question (such as 'how costumers will react to a price promotion?') by analyzing outcomes of past similar operations and adding to the analysis the correlation between the price of the good and the willingness to pay of customers.

Companies usually implement more than one method of forecasting in order to have a different source for the plan of the processes to satisfy the future demand, and, at the same time, reduce the probability of errors by comparing the different outcomes.

Another strategic activity is **planning** the processes. The way managers try to match demand and production is called *aggregate planning*. This activity aims to create an overall plan for production, inventory, and distribution processes that are needed to satisfy the demand forecast.

Managers have to set a time horizon in which they have to plan all the activities that will be performed. Each activity must have a starting and finishing time, the materials needed, the inventory that will be used, and the set of tasks to perform.

In order to create a feasible aggregate plan related to the supply chain capabilities, the manager can proceed using three approaches based on a trade-off between the amount of production capacity, the level of utilization of that capacity, and the inventory to carry¹⁶.

The first approach uses production capacity to match demand. To plan a process where the demand forecasted is fully satisfied by the production capacity, the manager needs to be supported by a high level of flexibility on production volume and employees. It is crucial to avoid a massive loss of

¹⁶ HUGOS, M.; 2018; Essentials of Supply Chain Management; Fourth Edition; Wiley, pp 50-51

efficiency when demand shrinks and, at the same time, be able to increase production in the short term to satisfy high demand levels. In this approach, inventory should be empty to reduce costs.

The second approach tries to keep change the production rate maintaining the workforce constant and inventory low. Managers can make a plan based on this approach only when production capacity is not fully exploited. When there is this condition the manager can plan when to increase production in order to satisfy the demand forecasted.

The last approach is based on the utilization of the excess production to cover demand. The workforce and the production capacity, in this case, are quite stable. What varies in the plan is the inventory. The supply chain manager should foresee when demand will increase in order to satisfy the surplus with the inventory stored during low demand periods. If the plan is correct, this approach keeps production rate constant, and inventory will satisfy the demand.

The aggregate planning should always take into consideration the demand nature (whether the company can influence the demand by undertaking promotions or increasing the customer service) and the supply capacity comprehensive of the inventory capacity in order to have an overall vision of the resources available to match the demand forecasted.

The third strategic operation that emerged is **sourcing**¹⁷. This activity includes the procurement of materials and resources (both financial and physical). In the past, the common belief was that when a manager was looking for purchasing resources, the right choice was to select the supplier that offers the lowest price given the quality level needed. Nowadays, this belief slightly changed. The collaboration and the information share with long term supplier became as important as price to achieve efficiency and competitive advantages.

¹⁷ BLANCHARD, D.; 2010; Supply Chain Management Best Practices; Second Edition; John Wiley & Sons, pp. 55-66

Building a reliable and highly efficient network of suppliers became part of the organizational structure of the companies. The share of information in this activity is crucial. A supplier that can access a firm inventory and production schedule is way more efficient than another one that only satisfies the buyers' orders when they arrive. New technology and information systems are helpful in building a sustainable network with healthy information flow.

The next strategic activity is **producing**. This operation matters for supply chain management because the decision about inventory and facilities depends on the production schedules and practices.

The role of the supply chain manager concerning the production is to understand and support the needs of the product lines. A very important task performed is the support to the product design in order to understand the components and materials needed. It is crucial to have a general understanding of the suppliers needed by the firm and which degree of flexibility and efficiency is needed within the processes. Therefore, the supply chain needs to be coordinated, and often the manager has the task to engage suppliers in product design to get feedback on the feasibility of the supply of components and materials.

It is quite evident that the operation of production is tightly related to inventory and facility management. Those two key drivers, as it has been said in the first chapter, are essential to implement a sustainable production structure. In particular, the supply chain manager is interested in the location, type, and capacity of these to eventually set a network that allows production processes to flow in the most efficient way possible.

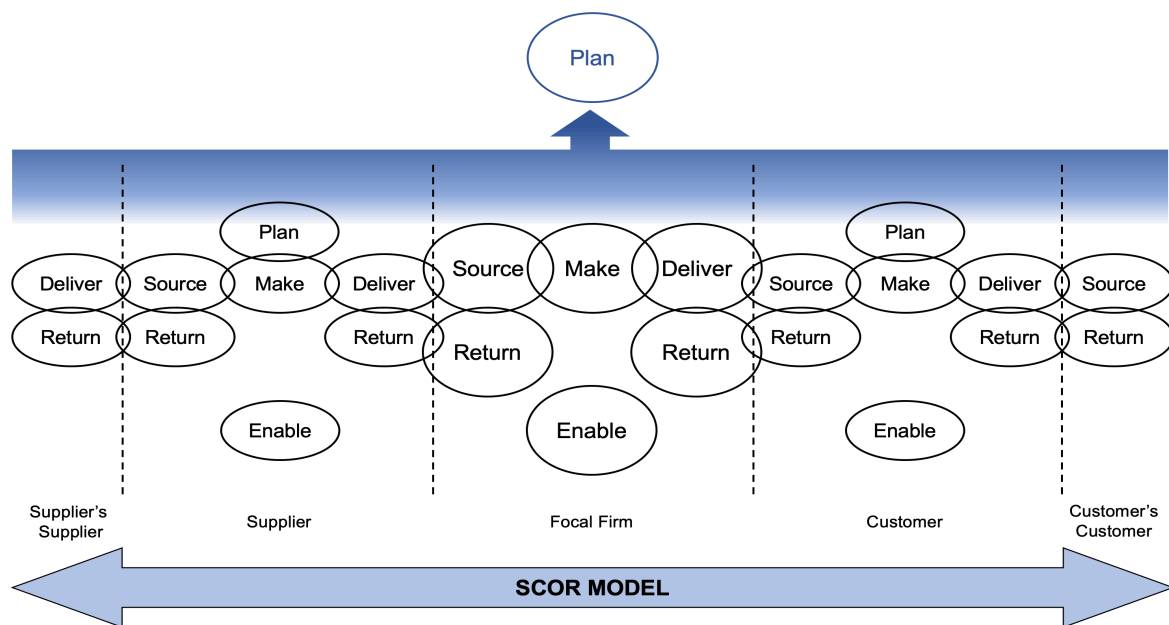
Lastly, it emerged from the strategies analyzed in the operation of **delivery**. It is very important for the supply chain in both the upstream and downstream structures. Delivery includes the transportation key driver, the process of scheduling orders, and the delivery of information to the right entities.

The supply chain manager is essential in this field because its role is to coordinate all the activities performed accordingly with the other operations that have been described above. The decision of the manager needs to take into consideration also external factors such as infrastructures available and socio-political factors (propensity on punctuality, contracts compliance, douanes...).

SCOR® Model: Operations Meet Performance

The supply chain operations (SCOR) model¹⁸ is a managerial tool implemented by the Supply Chain Council (then became the Association for Supply Chain Management) in 1999. This tool is highly related to the strategic operations of the previous section because it provides a framework that describes all the processes that occur from the supplier's supplier to the customer's customer. The SCOR model became a very useful framework for benchmarking the firm supply chain.

Figure 7. SCOR® MODEL



Source: Association for Supply Chain Management; 2017; Supply Chain Operations Reference Model: SCOR; Version 12.0; Personal Adaptation.

¹⁸ Association for Supply Chain Management; 2017; Supply Chain Operations Reference Model: SCOR; Version 12.0.

As shown in fig. 7, the model tries to represent the interaction between each player in the supply chain, their interconnected operations, and the overall plan made by the focal firm in order to coordinate and achieve an efficient supply chain.

From this popular framework often used in SCM, it emerges that each entity involved in the supply chain need to comply with basic operations described in the previous section. The SCOR model calls these operations plan, source, make, and deliver¹⁹. Besides, the last version of this framework integrates return and enable.

Plan, source, make, and deliver are operations that, even with a slightly different denomination, have been deeply analyzed in the previous section. Return and enables are two operations that have been identified because they are becoming increasingly important for firms nowadays.

Companies have to manage a reverse flow of goods that do not meet the customers' expectations and requirements (crucial on mass delivery such as e-commerce and warehouses). This operation, once incorporated on the 'make' ones, is called 'return' in the SCOR model. More than that, recent trends require companies to have departments dedicated to the repair, recycling, and remanufacturing to manage increasing returns on goods sold.

The 'enable' operation, as it happens for return, was once integrated into the others. They are now collected in a separate group because they play a crucial role in modern businesses. These activities are mainly related to the information flow and managing data that enable other activities.

From the SCOR model, it is clear how every entity participating in the supply chain performs all the operations. Moreover, a general plan adopted by the whole supply chain must be developed by the focal firm. That plan incorporates all the collaboration processes and coordination practices that a sustainable supply chain must have.

¹⁹ See appendix 1 for a visual framework of the 4 basic operations and their components that occur in the SCOR model.

The Association for Supply Chain Management embedded a method to measure the performances of the supply chain based on this model. They provided three basic steps to measure and evaluate supply chain performance.

The first step to follow is the identification of the performance attributes, which are all the sets of activities that the firm strategy is based on to be competitive. In this model, the attributes identified are reliability, responsiveness, agility, cost, and asset management efficiency. Each of those key characteristics is used by supply chain managers to evaluate the performance of a single process.

However, it is not enough to understand what the attributes are. The manager needs to have a reliable set of metrics to measure them. Therefore, the second step is using SCOR metrics. These are divided into three levels: the first one²⁰ provides a general measure of the overall health of the supply chain using key performance indicators (KPI). The second level is a further analysis of the relationship between the KPIs of an attribute in order to identify possible causes of a lack of performance. The third and last level is needed to further analyze the relationship between the level two metrics.

Lastly, the third step is to understand the level of maturity of the supply chain processes and practices compared to standards observed. In order to do so, it is often used a five-stage maturity scale deriving from a 1980 study by the U.S Department of Defense called Capability Maturity Model (CMM).

These five levels usually start with the so-called 'initial' stage which is characterized by low consistency and ad-hoc processes. It follows the 'managed' step that happens when the firm starts having some basic functional capabilities with a low degree of coordination. The third step is called 'Defined'. It is when basic integration between functions is in place even if the external network is still uncoordinated. The firm is in the fourth step ('Quantitatively Managed') when the supply chain is highly integrated both

²⁰ See appendix 2 for the general framework or SCOR performance attributes and their first level metrics.

internally and externally through an overall plan and IT sources that support the flow of information. The last step is called 'optimizing and it is the stage when the network is highly coordinated through a common strategy and a highly reliable flow of information.

Maintaining the Supply Chain Strategic Fit

Once a strategy has been adopted, tested through operation evaluation, and the strategic fit is achieved, the next big challenge for managers is to maintain that supply chain status and adapt to changes. The challenge derives from many business factors that companies face nowadays. They could be internal or external drivers that affect the overall strategy.

The first factor is something inherent to the natural product lifecycle. A growing business usually tries to increase product variety and, at the same time, reach a fast turnover of each product to increase market share and keep the path with innovations in the industry. This trend takes with it frequent changes in the product lines resulting in changes and uncertainty of the demand, and infrequent adjustments on the supply network. Clearly, those changes reduce the ability of managers to perform long-term plans and forecasts, resulting in a loss of efficiency.

An external factor that has been influencing the supply chain strategies is globalization. It plays a relevant role in the supply chain because firms that have foreign suppliers and customers occur in increased uncertainty. Demand and supply might be subjected to fluctuations related to financial status (for example, currency exchange) and social changes (especially in a developing country). Globalization also made technology innovations and industry competition increase. Nowadays, companies face competition from foreign firms across every industry. The challenge for supply chain managers is to set a strategy that enables the firm to keep the path with highly efficient multinational, technology innovation levels, and global prices.

Another recent trend is sustainability along the supply chain. The global standards provided by international organizations and the customer

perception impose on companies to put efforts on their code of conduct, social responsibility, and sustainability. While implementing internal practices might be a feasible process, the real challenge for many companies is to impose to its suppliers the adoption of the same standards. This trend calls for investments in implementing practices, innovate factories, and control the improvements. The result is a loss of efficiency while aligning the supply chain strategy to the firm marketing strategy aiming to reach international standards in corporate social responsibility and sustainability.

The challenges described in this section need the supply chain to adapt its strategy and create a sustainable network following the same vision. Despite that, there are many opportunities related to these challenges. Each of them, if correctly managed, can increase the supply chain surplus and the competitiveness of the firm.

This is the reason why the supply chain strategy cannot be detached from the other firm goals or else it will result in a loss of performance even though the supply chain strategy implemented achieve efficiency and responsiveness,

Supply Chain Design

In this dissertation, the choice of separating the concept of supply chain strategy from the concept of supply chain design has been made because, even if highly correlated, it will be used the term design to indicate the architecture of the whole supply chain that a manager has to develop after choosing the best strategy to follow.

It must be said that strategy and design cannot be detached: many operations analyzed in the previous chapters provide already the best structure that firms should implement to exploit efficiency and responsiveness. Therefore, the meaning of design that will be followed is 'the strategic outcome that a firm uses to develop, implement, and managing overtime all its resources, processes, and relationships'.²¹

The supply chain design is usually influenced by three factors.

1. Influencers. They are all the external drivers that impose rules and standard practices to the firms. There are many typologies of influencers. They can be political factors, economics ones, laws, technologies, market leaders, and many others.
2. Decisions. These are all the internal and external choices based on supply chain operations. They can be processes already in place, to be implemented, or the overall strategy that the firm implemented.
3. Building blocks. Once the design is planned by following the two previous factors, building blocks are all the investments needed to implement the selected design.

These three factors usually follow this order for a manager to develop the supply chain structure. Following this process is very useful because it first analyzes macro factors that cannot be influenced by the company, and then it proceeds with internal decision and supply chain department tasks.

²¹ MELNYK, S. A.; NARASIMHAN, R.; DECAMPOS, H. A.; 2013; Supply Chain Design: issues, frameworks, and solutions; International Journal of Production Research; Vol. 52, No. 7; pp. 1189

However, the supply chain is composed of many different operations (see previous chapters) and each of them must be supported by the most appropriate architecture for their performance. Supply chain managers need to follow the three steps above for each operation and create a sustainable structure that fits with the strategy of the firm.

Because of that, the decision step is fundamental because it goes through every internal and external operation the firm undertakes. From that, the real architecture of the company is quite straightforward because it need only to be supported by the right investments.

Key Decision Influencing Supply Chain Design

The decisions are tightly related to topics that have been described in the previous chapters, especially sourcing and performance drivers. However, these decisions are actually made when creating the supply chain structure, not only factors that are used for the supply chain analysis and evaluation.

When a firm is already operating in an industry, most of these decisions are driven by existing assets and external influencers. However, the supply chain manager has to evaluate the overall performance and provide the best structure possible, taking into consideration these variables. Key decisions influencing supply chain design that managers need to consider can be described as follows.

Make or Buy. ²²

This decision is crucial for the overall structure of both the supply chain and the internal facilities. The decision is based on whether to inshore key processes, or outsource them to third party collaborators.

Generally, the more complex a product is, the better it is to produce it internally to catch the complexity's benefits and competitive advantages.

²² INMAN, R. R.; BLUMENFELD, D. E.; 2013; Product Complexity and Supply Chain Design; International Journal of Production Research, Taylor and Francis

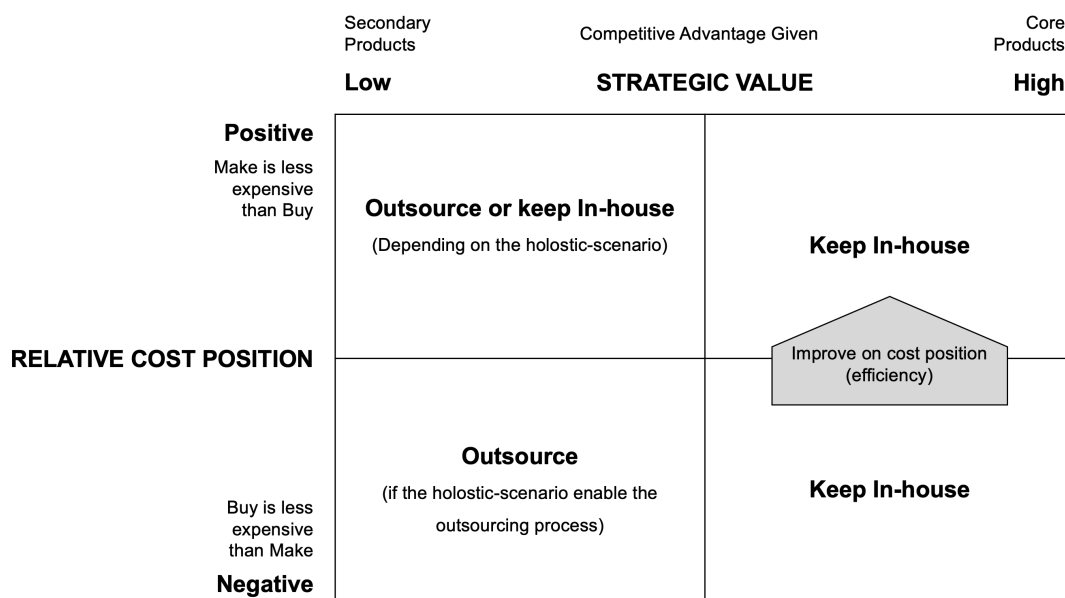
However, it is not a strict rule. The decision must be undertaken by evaluating different variables.

First of all, it is not obvious that a firm has all the competences and resources available to perform all the processes in-house. Because of that, a cost-benefit analysis must find if it is more convenient to outsource than invest in the acquisition of the capabilities needed. Secondly, even if they hold the whole competences, it is sometimes more convenient to outsource to a company with more efficient processes to cut costs and reduce times.

On the other hand, some variables might drive the supply chain manager to produce goods in-house even when the firm is less efficient than potential suppliers. This happens when the firm gets advantages from producing goods internally. (For example, advantages deriving by controlling a specific process, keeping a business secret, achieving 'made in' certifications, ...).

As shown in *fig. 8*, the decision of whether make or buy is not only a cost issue but also a strategic decision.

Figure 8. MAKE OR BUY DRIVERS FRAMEWORK



Source: BCG analysis; The Boston Consulting Group; adaptation

Once evaluated, if the process can be outsourced and if this decision will provide a competitive advantage, the supply chain manager needs to ensure

that the supplier selection is reliable creating inter-corporate synergies and coordinating the processes.

It is clear that make or buy decision influence the structure of the firm in term of facility capacity, product lines, and logistics infrastructures.

When managers chose to produce in-house resources and capabilities need to be acquired. The financial and time costs of that implementation can be very high if the firm does not hold the resources needed. On the other hand, the benefits are, as shown, high control of production activities and maintaining a competitive advantage if the firm holds scarce resources and highly strategic capabilities.

Outsourcing calls for investments in coordination structures and control procedures to lower supply risks. The benefits are the cost reduction for what concern labor and facilities, and more flexibility.

Facility Location.

In designing a supply chain facilities network, it is useful to follow some steps that take into consideration internal and external factors, as well as strategic decisions analyzed in the previous chapter. The process for the decision on the location of the facilities can be summarized into four phases (*fig. 9*).²³

Phase 1

It is the step in which the supply chain strategy that has been developed (see previous chapters) is put together. The main factors that play a crucial role in this phase are the overall competitive strategy, the current assets of the firm, and the forecast of the global competition.

Phase 2

In this phase, the supply chain manager needs to choose the configuration of the facilities regionally (whether to centralize production to achieve economies of scale, or decentralize them to have a strategic location related to customer

²³ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition, Pearson; pp 114-116.

delivery, taxation, availability of scarce resources, ...) depending on demand, competition level, and risks associated to each appealing location.

Phase 3

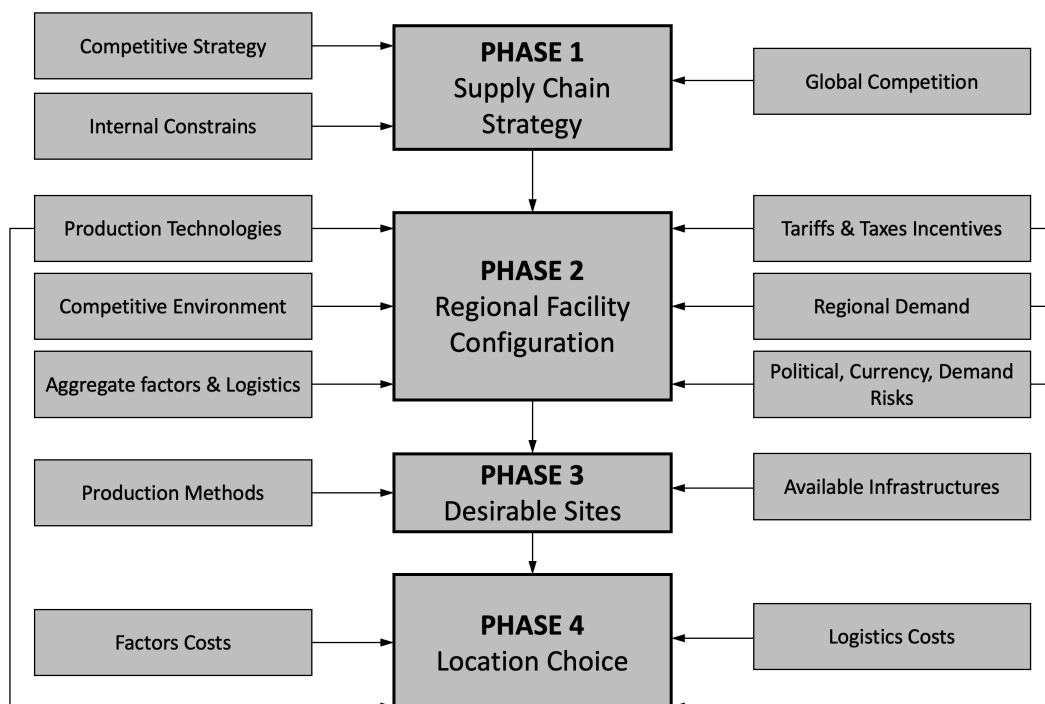
Based on the firm production method and available infrastructure, the third phase aims to identify specific sites where the production processes can be implemented, achieving the desirable efficiency. The availability of resources, suppliers, and closeness to the customers plays a crucial role in this phase.

The site is a narrower area compared to a regional location. (e.g. the regional location can be the European market, while the site could be Germany industrial areas).

Phase 4

In this phase, there will be the final location choice. This decision derives from all the analyses of the previous phases, and it can be a single location or more than one.

Figure 9. SUPPLY CHAIN FACILITIES NETWORK DESIGN DECISIONS



Source: Chopra, S.; Meindl, P.; 2012; *Supply Chain Management: strategy, planning, and operations; Fifth Edition, Pearson.*

The location choice includes capacity levels and facility network linkages needed for the optimization of the performances. For example, the choice to set two facilities close to the customer base in two different continents brings up the need for supply chain managers to allocate the demand to be satisfied and the supply of components for both the facilities.

Supplier Location

From the previously described 'sourcing' operation, it emerges that the selection of the suppliers takes into consideration reliability, integration to the network and processes, coordination, and cost advantages. These factors are highly influenced by the location of the supplier.

Some areas provide a lower risk of slow delivery and possible delays than others. Generally, creating a network of suppliers close to the focal firm (as it happens for industrial clusters) lower these supply risks²⁴, however, some other locations (even if geographically distant) could provide higher quality or lower prices than closer suppliers. Despite the distance, these suppliers could provide advantages influenced by an external factor such as lower labor cost, a higher level of specialization, or availability of scarce resources in their country.

For example, a firm from the United States selecting a Chinese supplier might achieve a higher efficiency level because of the low costs. At the same time, it needs to consider the political situation between the two countries, the currency exchange, the government intervention risk, the accessibility of resources and infrastructure in the supplier area, the possible taxation of imported goods, the sustainability standards the firm wants to meet, and many others.

Therefore, the location of suppliers becomes a key decision since managers need to design and adapt the firm structure to increase the overall

²⁴ CRANDALL, R. E.; CRANDALL, W. R.; CHEN, C. C.; 2014; Principles of Supply Chain Management; Second Edition; CRC Press.

performances of the firm even facing risks connected with the suppliers' location.

All the factors need to be evaluated and if risks are connected to them, the supply chain manager needs to ensure that the firm practices can reduce the risk level to the minimum. For example, if the location of the supplier provides great advantages in terms of costs, but it takes a high default risk, the supply chain manager needs to ensure that within the linkage between the firm and the supplier an external insurance provider is integrated into the process of ordering.

Shipping Mode and Route.

Within the description of the performance key driver 'transportation', it emerged how the modalities and routes are part of the decisions that a manager needs to take into consideration building a sustainable supply chain.

Different shipping modes (air, package carrier, truck, rail, water, pipeline, or intermodal) has pros and cons. The supply chain manager must decide so that the structure of the firm will enhance the pros and mitigate the cons.

For example, the negative side of air mode is the cost. But if the structure of the supply chain allows more suppliers from a similar location to exploit the same shipment, the cost will be divided into more players while the modality keeps being the fastest possible. Again, if the company ship by truck to buyers, joint transportation for more products and buyers at once would decrease the cost-per-unit, exploiting the maximum capacity of the modality selected.

It is not only a matter of the modality but also the route plays an important role.

Supply chain managers usually have to answer three questions to design the best shipping route.²⁵

²⁵ CHOPRA, S.; MEINDL, P.; 2012; Supply Chain Management: strategy, planning, and operations; Fifth Edition, Pearson; pp. 406-409

1. Transportation should be direct or indirect?
2. Intermediate sites should be product stocks or a cross-docking facility?
3. A delivery route should supply one location or multiple ones?

Direct and indirect shipment influence the time of delivery certainly, but the main evaluation that the supply chain manager needs to do is whether the shipment is efficient. Direct mode is undeniably faster but it could result in almost empty transportations if the demand is not enough. On the other hand, setting indirect shipments might cause a loss of responsiveness and increase coordination costs.

It is important to carefully design the role of the intermediate facilities in order to have considerable advantages over the costs of an indirect shipment. If the facility plays the role of a distribution center (product stocks) it means there will be a high level of inventory coming from different suppliers. It will then be shipped to the right buyer when demanded. This structure increases responsiveness to demand, even if it also increases inventory costs.

The other facility's role is to be a cross-docking location. This means that suppliers deliver goods to a unique facility. There will not be any storage, just a process of sorting goods out to the right buyer. This method provides a higher efficiency since suppliers can ship a high amount of goods that will be divided and shipped.

The decision about the nature of intermediate sites includes also the set of activities performed to achieve the best performance. Depending on them, managers chose whether they are consolidation or deconsolidation centers.

Consolidation centers are facilities where small freights coming from different suppliers are put together to reduce the shipping costs from that point on. In the same way, deconsolidation centers aim to divide bigger freights into smaller ones to enable a faster distribution to different buyers.

While the location of these centers can be both internal to the firm's facilities or in an external strategic location, inevitably, these processes add an intermediate step in the supply chain structure, slowing the shipping time.

The advantages given by consolidation centers are mainly the ones of lowering the transportation cost-per-unit, unify the goods to facilitate the shipping for the transportation provider, and finally to have better control over the shipment schedule.

On the other hand, the deconsolidation of freights is a process that takes different advantages. Firstly, faster shipment to the market (the freight to be shipped is divided into smaller ones that are easy to move and distribute), then better inventory management, since the firm ship the right items at the right time even in small lots; and finally if the center is used for customer delivery it decreases the cost of shipping to customers if placed in a strategic location.

Lastly, there is the selection of the actual route. It can be designed to connect a supplier to a buyer or follow the so-called 'milk run' structure. This term was developed to describe the process through which a single delivery route passes along different suppliers to get all the goods needed, and then it ends up with the final buyer. It could work also in the opposite way, where a single supplier ships goods for different customers in a single time, and the route will proceed from one customer to another.

Answering these questions is important for then structuring routes, facilities, and warehouses in strategic positions. For example, a centralized warehouse for different products placed near the customers served will increase both the efficiency and responsiveness of firms because it allows them to store different products in a single facility while using faster and cheaper shipment methods to satisfy orders.

Every time goods move along the supply chain it must be clear who is the supplier, the shipper, the buyer, the goods transported, and the route. This is clear only if the supply chain manager, collaborating with the supply chain partners, design a reliable flow of information.

Collaboration Design.

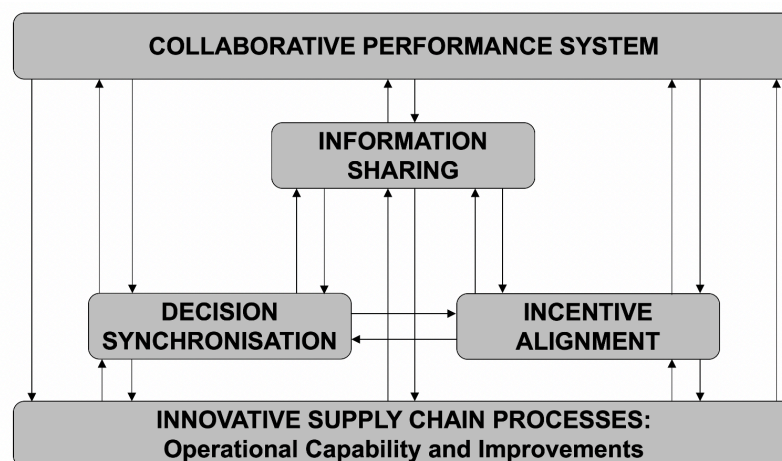
In the previous chapters, it emerged that a supply chain is effective when the proper collaboration strategies are achieved.

The term collaboration while designing the supply chain has the same meaning that the alignment of processes as well as the coordination of the strategy that has been described in the previous chapters. The structure implemented aims to improve the overall performances of the whole chain, creating automated linkages within the stages of the supply chain and enabling a reliable flow of information within it.

Coordination, nowadays, has a deep influence on the structure of the firms, especially for IT infrastructures such as ERP systems and supply chain databases. For the coordination of the supply chain is crucial to implement practices to follow that enables high efficiency and lower error risk along the chain.

In *fig. 10*, the five elements of the collaboration structure are represented. These are the elements that the different members of the supply chain must include in their structure to achieve increased performance. The five factors play specific roles during the operations of the whole supply chain.

Figure 10. THE ARCHITECTURE OF SUPPLY CHAIN COLLABORATION



Source: Simatupang, T. M.; Sridharan, R.; 2008; Design for Supply Chain Collaboration; Business Process Management Journal.

The collaborative performance system set the metrics and goals that must be attained. Information sharing is the flow of strategic decisions concerning planning, process, control, and current performance. Decision synchronization is needed to allow managers to make changes in the structure without destabilizing the overall collaboration in place. Incentive alignment is essential to reward the members who achieve a higher performance thanks to the alignment of the collaboration structure. And finally, innovative supply chain processes are necessary to enable practices and technologies that improve the overall performance.

Designing collaboration is crucial to enhance the supply chain coordination and set reliable linkages for the network of suppliers and customers.

Measuring Supply Chain Performance

Until now, chapter two described how supply chain managers proceed on developing a sustainable strategy and the decisions to undertaken when designing the supply chain network.

The last step once the supply chain is operating is to keep track of the performances in order to understand if there are possible areas of improvement and control the model developed is effectively working along the whole supply chain. The firm must have a clear structure of the processes performed along the supply chain in order to set a reliable way of measuring the performances.

The first way to measure the performance is an easy check on the strategic goals planned. It is necessary to observe if these goals are met, and the processes needed to achieve them. This measure is a mere check. Therefore, there is not an analysis of whether the goal is met most efficiently or not.

To further analyze the firm performance, managers have to focus on measuring costs and processes performed.

Concerning this need, the SCOR²⁶ model that has been described previously provides a metrics framework to measure performances. In particular, it emerged that level two and level three of the metrics are quite precise on measuring the performance source.

Level two (*Tab 1*) in particular, provides an explanation of the operational data that should be collected concerning the four main operations of the supply chain (plan, source, make, and delivery).

These metrics are very useful to compare a given benchmark with the actual performance of the firm. More than that, it provides a very useful framework that is reliable even if time passes.

²⁶ Association for Supply Chain Management; 2017; Supply Chain Operations Reference Model: SCOR; Version 12.0

Tab 1. SCOR METRICS LEVEL TWO

Supply Chain Operations	Level Two Metrics
Plan	Cost of Planning Activities
	Inventory Financing Costs
	Inventory Days of Supply on Hand
	Forecast Accuracy
Source	Material Acquisition Costs
	Sourcing Cycle Time
	Days of Supply
Make	Number of Defects/Complains
	Making Cycle Time
	Build-Order Attainment Rate
	Product Quality
Delivery	Fill Rates
	Order Management Costs
	Order Lead Time
	Items Return Rate

Source: Personal Elaboration from HUGOS, M.; 2018; *Essentials of Supply Chain Management; Fourth Edition; Wiley; p. 177*

The framework mixes financial data such as costs to non-financial information related to the responsiveness and efficiency of the processes. This framework recalls a popular reporting style called 'triple bottom line' accounting. As it happens in these kinds of reports, also for the supply chain, it is essential to mix financial and non-financial information in order to achieve optimized coordination and flow of goods along the supply chain.

Therefore, in practice, managers use two kinds of measurements: qualitative and quantitative.²⁷

Quantitative measures are the ones related to costs and resource utilization. Costs can be divided depending on the department that originated them to understand which business unit is absorbing more financial resources.

²⁷ CHEN, F. T. S.; 2003; Performance Measurement in a Supply Chain, *International Journal of Advanced Manufacturing Technology*, No. 21, pp. 536-542

Usually, the division of the costs concerning SCM is made by following supply chain operations and the nature of the cost itself. For example, a division could be made by costs related to sourcing, manufacturing, inventory, warehouses, and distribution. Whatever the division would be, it must be useful to comprehend the source of the costs and whether expenses are proportioned to the processes performed or they could be reviewed.

About resource utilization, the quantitative measure aims to keep track of the number of labor hours, materials, machine utilization, and energy consumed. This measure is crucial when compared with costs in order to understand if the firm is achieving economies of scale/scope and efficient consumptions.

Together with quantitative, firms have to take into consideration qualitative measures. These could be related to quality level, flexibility, visibility, trust, and innovativeness. Qualitative data can be measured by comparing the error rate to the firm total processes performed, or else they can be measured by setting a target to reach and observe if the firm performs worse or better.

Quality is the measure that expresses how the firm operations are reliable and their position compared with the average of the industry. Several factors influence the quality level. Firstly, customer satisfaction can be measured on the number of complaints received and the amount of time that pass from the order received to the production and delivery of the good. Then managers can set target goals on the expected delivery time, the number of orders that can be immediately satisfied, the probability to be out of stock before satisfying the whole demand, and the rate of accurate products delivered (with the right specifications).

Another relevant qualitative measure is flexibility. It can be correlated to different operations of the firm.

- The flexibility of its input, such as the number of tasks a worker can perform or the number of activities a machine is used for.
- The flexibility of processes depends on how strict is the assembling sequence for each product and how many routes connect processing

centers with all the raw materials needed as well as how many centers use the same raw materials.

- The flexibility of outputs is measured by the volume that the company can fulfill without higher costs when demand level change and the product portfolio that can be produced with the firm assets.
- The flexibility of improvements means how much the firm can change existing products, add new lines, and expand its production without the need for new assets.

The third qualitative measure is visibility. It is measured by observing the time and resources wasted when a new design is implemented by the firm.

In order to measure trust, the firm has to measure late deliveries by setting an optimal delivery time and compare the rate of the product that exceed that target, and wrong deliveries that are usually measured through the number of returns the company receives.

The last qualitative measure is innovativeness. It represents the number of new products a company launch and the percentage of time saved whenever a new technology or process is introduced.

The measures described above, whether they are qualitative or quantitative, cannot have the same weight when analyzing the overall performance of the supply chain structure. The weight of each measure can change depending on the firm's industry and the business model adopted. Because of that, the supply chain manager must implement a hierarchy structure for those measures to understand the priority to give to each one. By doing this operation, a manager performs the so-called analytic hierarchy process (AHP). For example, if the supply chain strategy says that flexibility is more important than efficiency, the overall performance is positive if the firm is performing well on flexibility at the expense of efficiency.

Chapter 3
Critical Analysis of Supply Chain Management
Trends

SCM Trends and Technologies

The previous chapters explained what supply chain management is and the activities that managers usually perform when implementing the supply chain network. However, all those activities nowadays are not performed in the same way as before.

Recent trends and technologies changed the approach of managers to the activities they have to perform. The following sections will analyze how these trends changed supply chain managers' work, and it will be explained whether the changes take advantages and challenges to firms nowadays.

Global Supply Chain Management

Globalization is a process ongoing for many years already. It is unquestionably bringing deep changes in the industries. SCM is not an exception. As it emerges from the previous chapters, the internationalization of supply chain operations (especially global sourcing and delivering) provides access to new technologies, materials, and customers, but it also increases uncertainty, complexity, and risks related to supply chain processes

Because of that, and because most of the firms are nowadays into the internationalization of their supply chain, it is necessary to change the classical management adapting to a global environment.²⁸

First of all, it is necessary to manage the uncertainty and risks that globalization brings. This issue is increased from the internationalization of the supply chain since firms have to face different markets characterized by different socio-cultural, political, and legal environments. Companies try to implement risk management department or consultation in order to reduce the issue.

Risk analysis can provide reliable data to plan and forecast the future evolution of both the external environment and internal assets. While some risks are quite simple to analyze, specific cultural, political, and structural

²⁸ POPE, J. A.; 2011; Supply Chain Survival in the Age of Globalization; Business Expert Press; pp. 39-56

risks need further attention. Nowadays, risk analysts do not stop on observable data, but they try to predict uncertain and disruptive events (such as black swans²⁹ and future technologies) to build alternative strategies whether the events happen or not.

Uncertainty is undoubtedly a supply chain issue nowadays. Risk management helps in reducing it to the minimum, giving to the firm possible strategies to face risks. However, even if the international uncertainty described above calls for a flexible structure that adapt to future changes. Nowadays, it is also vital to build a reliable system that enables the fast flow of information and goods as well as automated procedure supporting speed along the supply chain.

The international environment increases the challenge of setting stable and standardized operations because of many factors influencing negatively the stability, such as the increased uncertainty described above and because of the complexity of laws and procedures when moving goods around the world. This means that managers have to implement (also thanks to modern technologies) a network that works independently in the global environment.

The needs of stable supply chain operations and firm flexibility are achieved by setting agreements on standard procedures within the supply chain members, decreasing the hierarchy chain to rapidly approve operative decisions, and implementing a system that connects in real-time the firm inventory and distribution departments with the rest of the supply chain. The standardization and reliability of operations are crucial for the efficiency of the supply chain as well as reducing risks through flexibility is relevant for future sustainability.

Therefore, security nowadays becomes a key driver for the performances. Supply chains characterized by a high degree of operations stability and structural flexibility are the ones with the higher supply chain value.

²⁹ TALEB, N. N.; 2007; *The Black Swan: The Impact of the Highly Improbable*; Random House

Supply Chain Technologies

As it emerges from the above dissertation, technologies are fundamental to the sustainability of modern supply chains.

In the last decade, many companies undertook a process of digitization of internal operations as well as supply chain ones. This trend is vital nowadays because it provides substantial advantages to competitors with traditional business models.

Technologies are implemented to improve the performance on activities such as the collection of information, access to data, analysis (planning and forecasting support), and linkages with other supply chain members.³⁰

Therefore, technology is nowadays a fundamental part of the enabling operations. Thanks to that, companies achieve higher efficiency and reliable flow of information along the supply chain.

Because of that, several Information Technology (IT) systems have been developed on different levels of the supply chain from the '90s to increase the efficiency of the supply chain and support SCM decisions. For example, IT systems that have been used for a long time already are Electronic Data Interchange (EDI), Virtual Private Networks (VPN), Enterprise Resource Planning (ERP), Executive Information System (EIS), and online ordering software.

All those systems are, nowadays, common practices for firms with a structured supply chain. Some of them are nowadays fundamental to set high efficiency and security. Therefore, many external companies and firms' managers work on developing those systems more than focus on the classical operation described in the previous chapters. For example, a huge focus was put on developing ERP, that is needed to calculate the volume and time of orders depending on the resource's consumption and inventories, and VPNs, that are useful to have closed networks where supply chain members can access to data online maintaining high privacy.

³⁰ PRATER, E.; WHITEHEAD, K.; 2012; An Introduction to Supply Chain Management: A Global Supply Chain Support Perspective; Business Expert Press; pp. 99-111

The systems cited above are now commonly implemented by firms around the world because they are quite simple to integrate into traditional internal databases and processes. However, many developers work on the optimization of these technologies to eventually fully automate SCM operations.

In this section, the focus will be put on new trends more than the ones that are nowadays becoming standards (e.g. SAP ERP). This choice is made to have a more critical view of how the SCM is changing more than giving a snapshot of the current situation. However, the functions of some of the leading current technologies, are listed in appendix 3.

According to a McKinsey & Co. study³¹, the supply chain is highly impacted by industry 4.0. This impact is disrupting traditional SCM activities because, thanks to automatization and digitization, all the operations will be affected. In *fig. 11*, McKinsey & Co. developed a compass infographic to show which areas of SCM will be influenced and how it will happen.

Figure 11: MCKINSEY DIGITAL SUPPLY CHAIN COMPASS



Source: McKinsey & Company Insight

³¹ McKinsey&Co Insight; 2016; Supply Chain 4.0 – the next-generation digital supply chain; McKinsey&Co.

From that compass, it emerges that the key drivers of new technologies are the automation of business processes and the power of data analysis.

It is supported also by the trend of supply chain managers on investing resources in artificial intelligence (AI) and automated facilities aiming to reduce human error risks and, at the same time, improve the capability of analyzing data in support of the decision process.³²

Internet of Things (IoT), robotics, AI, and big data are the recent trends for what concerns supply chain management.

The process of digitization of the supply chain operations is highly impacting on its performance and in the competitive advantages that companies gain from these technologies. However, there is the risk of a highly disruptive process eliminating many firms from the market. Technologies are expensive and often they increase costs more than cut them since they require investment in new infrastructures and structural changes in the short-term.

It is evident the risk of the failure of small and medium enterprises (especially in developed countries with high fixed costs) that do not have resources to implement technologies and keep a competitive position in their industries.

This change might result in the rise of external providers that allow those firms to access to the digitization as it happens for the logistic providers in the past.

Future of SCM

It is very challenging to predict whether SCM will have the same role in future businesses. For sure, it emerged that globalization and new technologies are reshaping the traditional processes.

Since global supply chains are not yet robust and reliable, and the digitization process is the main source of risk reduction, it is likely to happen that the core operations of SCM will be integrated with technologies.

IoT and big data analysis could be the new and most powerful tools for managers to foresee, plan, and measure the supply chain performances. In the era in which companies owning data are the most influential in the market,

³² KHUAN, L. S.; RAMAN, S. R.; 2018; Emerging Technologies for Supply Chain Management; Wou Press

it is clear that also SCM can gain a huge advantage by gathering a high volume of information. However, it is not enough: managers with access to these data need to focus on security and, consequently, on the flow of them to the right partner at the right time.

The high risk of human errors led to the implementation of IoT based procedures.³³ This happens because, once two partners set a connection based on network-connected hardware, the activities are automated and the flow of information is constant and reliable.

The role of people might change from analysts and managers to engineers and technicians that are capable of managing digital connections. They will provide the skills to ensure the reliability of the new technologies, lowering the risks of globalization and uncertainty.

The 2020 global pandemic of the Covid-19 brought out that many global supply chains, even highly technological and innovative ones, need to be managed in a very flexible way to respond to unpredictable events.³⁴ This topic is necessary because digital tools themselves cannot easily predict those events, and they cannot actively intervene when a tier of the supply chain breaks down.

That's the reason why digitalization will be integrated into traditional operations, but it is not likely to fully replace human activities. Flexibility is given by the capability to adapt and to take timely decisions, even facing disruptive events.

The process of digitization cannot be denied, and the ability of firms to integrate these new technologies into traditional operations can be the key to achieve the best performance.

³³ BIRKELAND, H. S.; HARTMANN, H.; 2020; Internet of Things—the future of managing supply chain risks; Supply chain management, Vol.25; Emerald

³⁴ AZEEM AZHAR; 2020; Exponential View: The Digital Future of the Supply Chain; Harvard Business Review Podcast; Season 4, Episode 25

Analysis based on Ensign Energy Services Experience

This section will contain personal observations and critiques deriving from the internship experience of the author at Ensign Energy Services, located in Adelaide, Australia. Because of that, contrary to the rest of the dissertation, some parts will be explained using the first-person subject to better explain the tasks and observation made.

Ensign Energy Service is a public traded company founded in 1987 providing oilfield services. The headquarter is in Calgary, Canada, and the core of its operations in the territory of North America. In 2002 Ensign acquired the Australian drilling company “Oil Drilling & Exploration Limited” based in Adelaide, which had part of its operations in Huston, Texas. The Australian firm became Ensign subsidiary for the international expansion in south-east Asia and middle-east countries. In 2019 the company had revenues of 1.59 billion dollars with a net loss of 163 million dollars, mainly deriving from the ongoing construction of a new rig and shares distribution. (Appendix 4 shows the consolidated statement of income)

Thanks to the University of Adelaide, I was employed for the internship position of project manager in the Adelaide office of the Australian subsidiary, under the supervision of the supply chain manager. The project goal was to upgrade the internal material request (MR) database so the managers could integrate the order status into each MR. The other requirements were: the database should be integrated into the international ERP system, and the status update won't need more workload for the purchasing officers.

In this position, I had the opportunity to work on the databases while gathering information from the purchase officers, IT engineers, and the supply chain manager. Because of that, I had an insight view of how the local supply chain is integrated into global operations.

The internal MR databases were run on Microsoft Access software that was then integrated into the global database to be the data source for the ERP system.

In the drilling industry, there are very few items they could set for recurrent orders. The only ones were related to office materials and security tools that field workers need to use. All the other materials needed for the operations of rigs were directly requested from the rig manager to the purchasing office. The orders were transmitted in a standard format paper that needed to be approved by the purchase officer and supply chain manager and then processed to order materials.

This practice was quite time-consuming because the approbation procedure had to go through the hierarchical levels. Even after the order, the method of updating the local and global database was quite long, and the purchase officer often waits many days before updating the Access sheet.

This long and strict procedure might look old and complex, but it was necessary to increase the reliability of the data and orders. The key outcome was to deliver the materials effectively when requested, and have high control and reliability on the orders. Because of these goals, suppliers were selected accurately, and they had to be certified by the managers of the Australian subsidiary and to be inserted on the international system checked by the headquarters.

The whole process is implemented thanks to networks internal to the company and long-lasting relationships with suppliers. In the Australian subsidiary, the strategy has been developed focusing on responsiveness more than efficiency. The central offices were placed near suppliers where urban infrastructures were highly reliable to be more efficient. This choice was made at the expense of the distance to the rigs, that were mainly in the central Australian desert.

This represents a responsiveness-oriented strategy since it has to be very flexible depending on the order request and the supplier's availability. To increase efficiency, the central offices also plays the inventory function structured with the role of consolidation center since one order could have different materials needed for the rig. Once all of them were delivered to the

inventory manager, he proceeded to prepare a truck loaded with the full order and, following managers' approbation, it was delivered to the rig.

The part of the chain I observed was the upstream side, and it is short since it includes only suppliers and the rig that takes the position of an internal customer.

From my project management position, I experienced the IT side of the supply chain related to databases and internal data management. The company had a huge volume of material requests coming every day to be processed, and each purchase officer was busy with the approbation procedure and the ordering process. Supply chain managers, instead, were busy with supplier management and planning of the distribution. Moreover, they needed to meet rigs managers on-site to understand the infrastructure status and check the plant with engineers.

For the nature of my tasks, I had to collaborate with both sides, understanding the challenge for purchase officers to keep the database updated accordingly with the headquarter requirements, and, at the same time, I understood the importance that those data plays in the decisional and control processes performed by the supply chain manager. From that, it is understandable that coordination in the office was the real key driver for the performance. Coordinate the flow of information during the approbation process, and at the same time, have real-time data to support supply chain managers' decisions were crucial to exploit the responsiveness needed in this industry.

Within this project, I had the opportunity to talk with a supply chain manager coming from Huston, Texas, who explained to me the importance of having a reliable database design and helped me on understanding how the American office implemented a similar function for the status check. It was very useful for both understanding the different ways to face the same challenge and the way a multinational company needs to be flexible to allow each office to develop the best systems for their local workflow.

Overall, I believe that the three key drivers for Ensign supply chain performance are responsiveness, coordination, and flexibility.

Responsiveness is vital on the satisfaction of material requests arriving at the purchasing officers. Coordination is necessary in the office's internal procedures in order to manage both the ordering and the decisional processes. And finally, flexibility of the global operation is essential to adapt to the local workflow and environment while following a common goal.

From this experience, I brought up a useful experience in IT and SCM. Comparing it to the thesis dissertation, it is clear that the drilling industry has an entirely traditional supply chain even if the management is supported by technologies such as ERP, internal databases, and supplier management systems. However, the critical stages remain for sure the sourcing and the delivering operations. Sourcing is necessary to provide the responsiveness and reliability needed both locally and internationally. Delivering is essential to ensure the efficacy of the distribution to the far rigs, and because of that, it is needed to manage the inventory with the role of consolidation center.

I believe that the coordination and the flow of information are crucial for the sustainable performance of Ensign's supply chain. This makes me think that due to globalization and the efficiency needs, also in such traditional supply chains as the drilling ones, it is becoming increasingly important to implement processes and automatizations that reduce the time consumption and enables managers to be more responsive. This happens by enabling a fast flow of information internally and with the supplier's network.

Conclusion

The thesis dissertation has provided a general explanation of the core definitions and basic processes related to the supply chain management (SCM) discipline. The primary purpose was to develop an overview to explain how from a traditional view, which takes into consideration few sourcing and distribution processes, today supply chains became a complex set of operations aiming to create a sustainable and effective network.

The supply chain has always been a sequence of vendors and buyers connected to each other to create a product or deliver a service. The basic structure of the chain has not changed much except for the fact that firms nowadays trend to build a network of suppliers and customers instead of managing single relationships. This slight shift from direct connection to networking takes huge advantages in terms of risk reduction, availability of resources, and reliability of supply chain flows, meaning that firms can exploit higher performances and sales.

However, this is not an automatic shift. Companies invested years in creating a sustainable network through implementing SCM departments focused on this challenge. Supply chain managers became crucial for the value creation and for the sustainability of the firm's business because they started to perform analyses that connect external operations such as sourcing and delivering, with internal departments that focus on the production process and internal efficiency.

The second chapter in particular, explained how supply chain managers perform activities that cannot be ignored today. First of all, setting a supply chain strategy means to forecast and plan all the processes that enable firms to achieve the most general business goals being supported by both the upstream and downstream structures.

While setting the best strategy for enabling supply chain flows, the main trade-off that managers face is the one between efficiency and responsiveness. It

emerged that this dualism depends on many factors that might be related to the external competitive environment or internal assets of the firm itself. To create the best strategy, managers need to focus on set recurrent activities such as plan, source, make, deliver, return, and enable. These are identified by the SCOR model as the supply chain operations, which every member of the supply chain network has to perform.

Following strategic decisions, a sustainable structure for the supply chain must be built by supply chain managers. Outsourcing decisions, location decisions, facilities role, distribution structure, and collaboration linkages need to be evaluated and designed. Evidently, it is not possible to perform this decisional process and expect performances to be sustainable and stable in the long term. It is essential to monitor all the activities measuring performances related to them and evaluating whether the supply chain can perform better.

Lastly, for the thesis purposes, it is necessary to understand how the general overview provided has real implications in the SCM trends and technologies nowadays. Globalization of the supply chain is taking several challenges related to risk management and coordination because of the increased distances and the cultural framework of the different countries.

Companies nowadays need to undertake a process of internationalization to be competitive even in the local markets, and the only way to mitigate the uncertainty and risks related to globalization and increasing industry complexity is to set reliable structures. This is achieved through technological development and implementations that enable firms to set infrastructures supporting supply chain flows. Technologies themselves provide competitive advantages to firms, but it is not always easy (especially for SME) to implement the most modern ones, that is why external providers are thriving today.

In the dissertation, it is provided an overview of the core concepts that can be observed in every modern company's SCM department. However, there are

some limitations related to specific company issues and industry dynamics that can be investigated only through case studies.

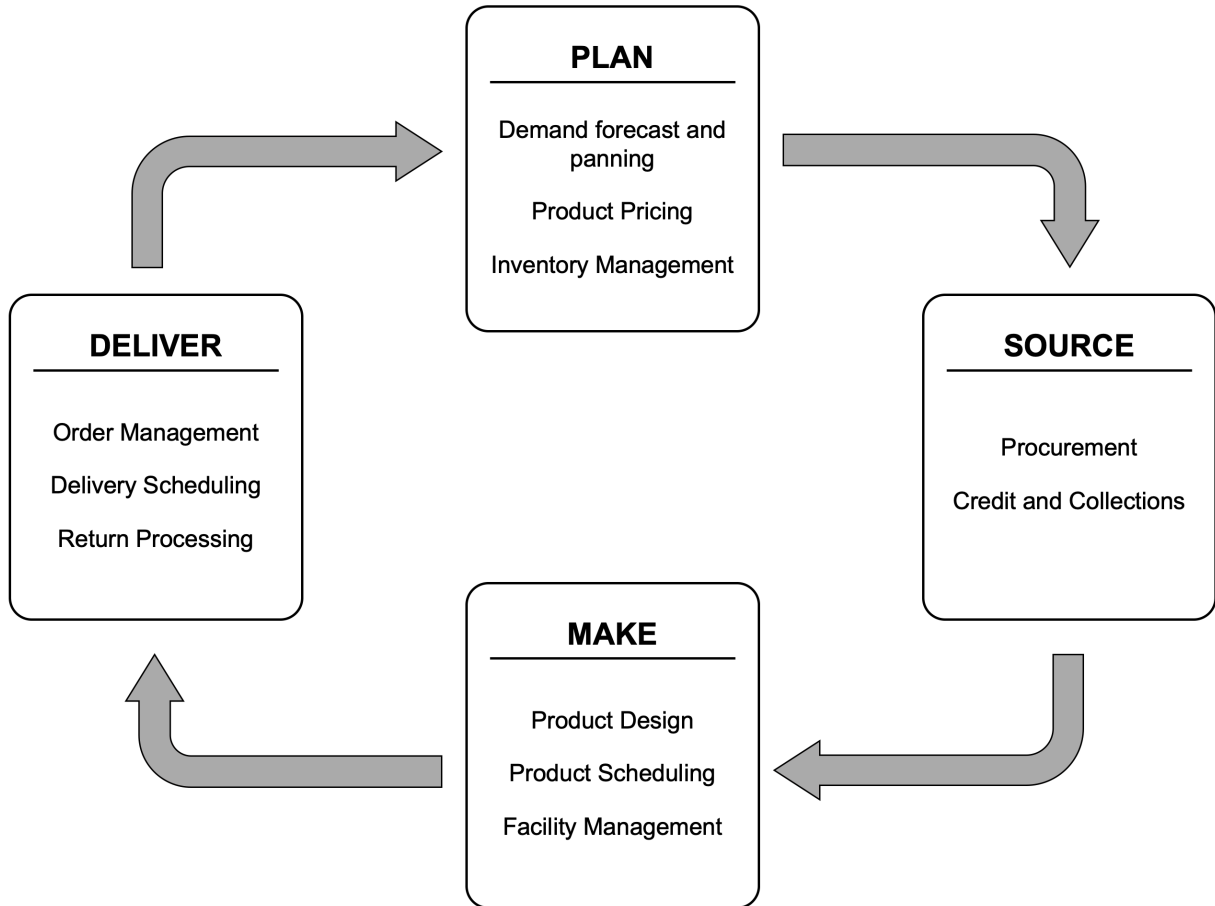
This is the reason why the last section is dedicated to the author project management internship experience at Ensign Energy Service, a multinational company with an office based in Adelaide (AU). This company operates on oilfield services and drilling, meaning that the industry is characterized by a very traditional supply chain structure and strict hierarchical processes.

This experience outlines how core concepts observed in the thesis dissertation are integrated with a global network and internal IT infrastructures to achieve higher efficiency and reliability even in an industry characterized by a responsiveness-oriented strategy.

Overall the thesis can be useful to have a general understanding of the supply chain management, supported by data that outline the importance of some operations and trends characterizing this discipline. Nevertheless, the main limitation of the thesis is its general view. Further researches might find out specific trends enriching the contents of this thesis.

Appendices

Appendix 1. Michael Hugos visual representation of the SCOR model key operations



Source: Hugos, M.; 2018; Essentials of Supply Chain Management; Fourth Edition; Wiley; p. 43.

Appendix 2. SCOR Performance Attributes and Their First Level Metrics

ATTRIBUTE	LEVEL 1 METRICS
Reliability	RL 1.1 – Perfect Order Fulfillment
Responsiveness	RS 1.1 – Order Fulfillment Cycle Time
Agility	AG 1.1 – Upside Supply Chain Adaptability
	AG 1.2 - Downside Supply Chain Adaptability
	AG 1.3 – Overall Value-at-Risk (VaR)
Cost	CO 1.1 - Total SCM Cost
	CO 1.2 - Cost of Goods Sold (COGS)
Asset Management	AM 1.1 - Cash to Cash Cycle Time
	AM 1.2 - Return on Fixed Assets
	AM 1.3 - Return on Working Capital

Source: Association for Supply Chain Management; 2017; Supply Chain Operations Reference Model: SCOR; Version 2.0; 1-3

Appendix 3. Current Leading Technologies in SCM

Technology Name	Function
<p>EDI and XML <i>(Electronic Data Interchange and eXtensible Markup Language)</i></p>	<p>They are an automatization of the back-office procedures. They are needed for the transmission of standard data among partners. While EDI is very rigid on the format of data transmittable, XML is more flexible and with a higher potential.</p>
<p>VPN <i>(Virtual Private Network)</i></p>	<p>It is a closed network server to which only authorized people can access. It is useful for privacy issues and multinationals that need a unique server to collect global data. It enables data to be encrypted and shared only into the VPN safely, even if connected to an open internet access point.</p>
<p>ERP <i>(Enterprise Resource Planning)</i></p>	<p>It is a system that gathers data from different departments of the firm and processes them to monitor orders, production schedules, purchases, resources allocation, costs, and inventories.</p>
<p>EIS <i>(Executive Information System)</i></p>	<p>It is a tool that gathers information from different firm's departments to support manager on the forecasting and planning processes. It processes a high volume of data to provide a simplified analysis of the performances.</p>
<p>Cloud Computing</p>	<p>It is defined as the combination of different technologies that enable a higher power for data processing and calculation. Companies pay a provider to have those technologies on centralized servers. It is also convenient because firms do not have to invest in infrastructure and they pay as they consume.</p>
<p>CRM Systems <i>(Customer Relationship Management)</i></p>	<p>They are systems used to track customers' behaviors and predict future and analyze the supply chain downstream performance. They gather data from sales, returns, and customization to turn them in statistical distributions and patterns.</p>

Source: HUGOS, M.; 2018; *Essentials of Supply Chain Management; Fourth Edition; Wiley; pp. 115 -157*

Appendix 4. Ensign Energy Services Consolidated Statement of Incomes (2019)

For the years ended December 31	2019	2018
<i>(in thousands of Canadian dollars, except per share data)</i>		
Revenue (Note 17)	\$ 1,592,247	\$ 1,156,357
Expenses		
Oilfield services	1,140,939	855,824
Depreciation (Note 8)	363,144	415,036
General and administrative	55,064	44,945
Restructuring	12,644	1,492
Share-based compensation (Note 11)	4,047	707
Foreign exchange and other loss (gain)	25,426	(19,001)
Total expenses	1,601,264	1,299,003
Loss before interest, other (gains) losses and income taxes	(9,017)	(142,646)
Loss (gain) from investment in joint ventures (Note 9)	39,892	(874)
Gain on bargain purchase (Note 5)	—	(200,672)
Gain on asset sale (Note 7)	(9,824)	—
Gain on purchase of unsecured Senior Notes (Note 12)	(4,647)	—
Interest expense	149,159	52,416
(Loss) income before income taxes	(183,597)	6,484
Income tax (recovery) (Note 14)		
Current tax	3,416	1,044
Deferred tax recovery	(23,559)	(53,224)
Total income tax recovery	(20,143)	(52,180)
Net (loss) income	\$ (163,454)	\$ 58,664
Net (loss) income attributable to:		
Shareholders	(162,905)	58,302
Non-controlling interests	(549)	362
	(163,454)	58,664
Net (loss) income per common share (Note 16)		
Basic	\$ (1.02)	\$ 0.37
Diluted	\$ (1.02)	\$ 0.37

Source: Ensign Energy Services Annual Report 2019

References

BANBURY, J. G.; 1975; Distribution – the final link in the electricity supply chain; *Electrics and Power Journal of the Institution of Electrical Engineers*, pp. 773-775.

BIRKELAND, H. S.; HARTMANN, H.; 2020; Internet of Things–the future of managing supply chain risks; *Supply chain management*, Vol.25; Emerald

BLANCHARD, D.; 2010; *Supply Chain Management Best Practices; Second Edition*; Jhon Wiley & Sons

CHEN, F. T. S.; 2003; Performance Measurement in a Supply Chain, *International Journal of Advanced Manufacturing Technology*, No. 21

CHOPRA, S.; MEINDL, P.; 2012; *Supply Chain Management: strategy, planning, and operations; Fifth Edition*, Pearson

CHRISTOPHER, M.; 2016; *Logistics & Supply Chain Management; Fifth Edition*; Financial Times Publishing; Pearson.

CRANDALL, R. E.; CRANDALL, W. R.; CHEN, C. C.; 2014; *Principles of Supply Chain Management; Second Edition*; CRC Press.

DOU, Y.; SARKIS, J.; 2009; A joint location and outsourcing sustainability analysis for a strategic offshoring decision; *International Journal of Production Research*; Vol. 48, No. 2; Taylor and Francis.

DRAKE, M.; 2011; *Global Supply Chain Management*; Business Expert Press.

FAROOQUI, S. U.; 2010, *Encyclopedia of Supply Chain Management*; Himalaya Publishing House; Vol 1.

FISHER, M. L.; 1997; What is the Right Supply Chain for Your Product; *Harvard Business Review* 75.

GUNASEKARAN, A.; PATEL, C.; McGAUGHEY, R. E.; 2004; A Framework for Supply Chain Performance Measurement; *International Journal of Production Economics*; No. 87.

HUAN, S. S., WANG, S. G.; 2004; A research and analysis of supply chain operations reference (SCOR) model; Supply Chain Management: An International Journal; Vol. 9, No. 1.

HUGOS, M.; 2018; Essentials of Supply Chain Management; Fourth Edition; Wiley.

INMAN, R. R.; BLUMENFELD, D. E.; 2013; Product Complexity and Supply Chain Design; International Journal of Production Research, Taylor and Francis

KHUAN, L. S.; RAMAN, S. R.; 2018; Emerging Technologies for Supply Chain Management; Wou Press

KÜPPER, D.; KNIZEK, C.; SPINDELNDREIER, D; ZINSER, M.; 2015; Maximizing the Make-or-Buy Advantage; The Boston Consulting Group Publishing

LEE, H.; 2002; Aligning Supply Chain Strategies with Product Uncertainties; California Management Review; Vol. 44, No. 3

MELNYK, S. A.; NARASIMHAN, R.; DECAMPOS, H. A.; 2013; Supply Chain Design: issues, frameworks, and solutions; International Journal of Production Research; Vol. 52, No. 7.

MENTZER, J. T.; DEWITT, W.; KEEBLER, J. S.; Min, S.; Nix, N. W.; Smith, C. D.; Zacharia, Z. G.; 2001; Defining Supply Chain Management; Journal of Business Logistics; Vol. 22; No. 2.

MURILLO; X. C.; 2020; Advanced Strategies in Supply Chain; First Edition, Independently Published.

NAKANO, M.; 2020; Supply Chain Management: Strategy and Organization; Springer.

POPE, J. A.; 2011; Supply Chain Survival in the Age of Globalization; Business Expert Press.

PORTER, M. E.; 1985; Competitive Advantage: Creating and Sustaining Superior Performance; Free Press, New York

PRATER, E.; WHITEHEAD, K.; 2012; An Introduction to Supply Chain Management: A Global Supply Chain Support Perspective; Business Expert Press.

ROSS, D. F.; 2010; Introduction to Supply Chain Management Technologies; Second Edition, CRC Press.

SCHNIEDERJANS, M. J.; SCHNIEDERJANS, A. M., SCHNIEDERJANS, D. G.; 2005; Outsourcing and Insourcing in an International Context; Taylor and Francis Group.

SHILLING, M. A.; 2019; Strategic Management of Technological innovation; Fifth Edition; McGraw-Hill International Edition.

SIMATUPANG, T. M.; SRIDHARAN, R.; 2008; Design for Supply Chain Collaboration; Business Process Management Journal, Vol. 14, No. 3.

TALEB, N. N.; 2007; The Black Swan: The Impact of the Highly Improbable; Random House

TRENTIN, A.; FORZA, C.; 2010; Design for form postponement: Do not overlook organization design; International Journal of Operations & Production Management; Vol. 30, No. 4.

Online References

Association for Supply Chain Management; 2017; Supply Chain Operations Reference Model: SCOR; Version 12.0.

Available via free digital download to all APICS members at www.apics.org/myapics.

AZEEM AZHAR; 2020; Exponential View: The Digital Future of the Supply Chain; Harvard Business Review Podcast; Season 4, Episode 25

Available at: <https://hbr.org/podcast/2020/04/the-digital-future-of-the-supply-chain>

Ensign Energy Services; 2019; Annual Report.

Available at: <https://www.ensignenergy.com/company-reports>

HIPPOLD, S.; 2020; Gartner Top 8 Supply Chain Technology Trends for 2020.

Available at: <https://www.gartner.com/smarterwithgartner/gartner-top-8-supply-chain-technology-trends-for-2020/>

McKinsey&Co Insight; 2016; Supply Chain 4.0 – the next-generation digital supply chain; McKinsey & Company.

Available at: <https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain>

Select Business Solution; What is the Capability Maturity Model; Review.

Available at: <http://www.selectbs.com/process-maturity/what-is-the-capability-maturity-model>