POLITECNICO DI TORINO

Master's thesis in Engineering and Management

Implementing agility in the logistics flows to achieve competitiveness in a turbulent external environment

Thesis realised within Argon&Co Consulting

122 Rue Edouard Vaillant, 92300 Levallois-Perret

7/02/2022 – 5/08/2022

Supervisors:

Prof. Arianna ALFIERI

Prof. Erica PASTORE

Candidate:

Letizia ALLIONE

October 2O22

Acknowledgements

Abstract

This thesis discusses how companies are now required to review their supply chains in order to be competitive in today's marketplace. Indeed, sudden external events that disrupt the smooth operation of corporate supply chains have been found to be increasingly common, leading the concept of agility, the ability to respond promptly to unexpected circumstances, to be incrementally popular. Agility translates into the concepts of process integrations, market sensitivity, virtual supply chain and network. In fact, today's challenges of companies no longer focus only on achieving a lean supply chain, through cost efficiency and the elimination of all unproductive processes, but also on the concepts of durability, robustness and scalability of all operations involved.

What is said here above will be analysed through a project consisting in the optimization of the logistics network in the USA of a French company operating in the food sector following the acquisition of one of its main 3PL distributors.

The project starts with the modelling of the current network by collecting the data of all flows during 2021 of the two entities, the French company and the acquired distributor. Once these have been cleaned, reordered and restructured, the flows going to the same customers were assembled, as the two entities merged following the acquisition.

In order to get a complete view of the as-is situation which can then be compared with future scenarios, it is interesting to take into account parameters such as transportation and warehouse costs as well as the lead time of orders shipment to the final customers. However, companies' databases are often incomplete and disorganised, which is why it was necessary to estimate functions that could represent such parameters.

Once obtained a final vision of the as-is, the modelling of future scenarios was conducted. As a first step, insights of the U.S. market impacting the company's logistics activities were analysed. Given these findings, possible alternative locations for current warehouses were then defined to restructure the logistic network. Next, a three-step approach was followed for the modelling of future scenarios. Beginning with the integration of sales forecasts up to 2027, the criteria for dividing the flows of purchased and manufactured products according to

distribution centres' locations were defined, concluding with the modelling of scenarios in terms of costs and lead time.

The model created is simple, intuitive and dynamic. Nowadays, in fact, it is necessary to have in hand tools that even if they do not bring the highest precision in results, are able to provide an immediate global vision that can best guide business decision-making correspondingly to the continuous changes of external parameters.

Table of contents

List of tables

List of figures

1 Introduction

If in the early 90s the concepts of mass and lean production, in which a certain product is produced in large quantities by considering the cost and quantity parameters, were leading supply chain management; today, the demand for more customized, affordable, and timely business and supply chain has notably increased. Therefore, the need to implement agile supply chains, which are able to quickly sense and respond to internal and external changes, through flexible and fast production systems, has affected organizations and the industry environment. Competition between businesses has turned into competition between supply chains. An agile supply chain primarily contributes greatly to customer satisfaction, profitability and overall organizational performance. It is considered that it is an important issue for enterprises to review their current organizational philosophies and supply chain models in today's organizational environments where customer expectations and product diversity are increasing day by day. It can be said that moving from the current production systems to the agile supply chain model is important in establishing a sustainable competitive advantage. Moreover, it is considered that the handling of the agile supply chain issue by businesses and future manager will provide a serious proactive risk management advantage in preparation for organizational environments with more uncertain future and more personalized customer expectations.

In the following chapters, it can be found a brief description of the company where I developed my thesis. Consequently, will be presented the concept of agility: its definition, its main characteristics, how it differs from the lean supply chain, its impact on business performance, and an overview of the main operational areas where agility could bring broad improvements. In addition, will be briefly introduced other key challenges for future supply chains such as technological developments and the management of its environmental impact.

Secondly, the concept of agility related to companies' logistics will be described in more detail and why it has become fundamental, given the changes in the industrial strategy that have affected most companies in recent times. Indeed, firms have begun to move away from the strategy of offshoring to third world countries for ethical and environmental reasons, but also for having closer and more controlled supply chains. They also began to try to be as close

as possible to customers to offer the best possible service, given the rise of competition in many business sectors.

Consequently, simple explanations are presented on the main topics that are involved when talking about concrete restructuring of a company's logistics system: warehouses, transports and distribution network in general.

To conclude, the concepts presented here above will be concretely applied to a project carried out at the consulting firm Argon&Co, consisting in the optimization of the logistics system in the USA of a French company operating in the food sector following the acquisition of one of its main 3PL distributors.

2 Company presentation: Argon & Co

2.1 Company activities

Created in 2001, Argon&Co is a consulting firm specialized in operation strategy and business transformation.

Today, Argon is considered a leading firm in the field of operations thanks to the two areas that compose it: on one hand, the consulting branch that supports clients on operational transformation's missions through the exploitation of data analysis, on the other hand, the digital branch known as "IRIS" where data scientists cooperate for the development of tools using technologies such as IoT and machine learning, in partnership with other companies such as Sigfox or Microsoft.

Thus, Argon&Co supports clients of very different sizes, from SMEs up to CAC40 groups and in various sectors whether automotive, luxury, consumer goods, industrial & chemicals, transport & logistics or public.
The company helps its clients to face challenges such as:

- Achieving a competitiveness plan
- Optimize cash flow
- Develop operational agility
- Manage/reduce complexity
- Reduce the carbon footprint
- Optimize Selling, General and Administrative expenses (SG&A)
- Decline the strategic plan & Manage performance
- Making transformation happen

To do so, the firm supports its clients' operations transformation, whether across their entire value chain or in a specific functional area of expertise, such as one of those reported in the figure 1.

Figure 1. Argon&Co functional areas

2.2 Global presence and growth

To establish its position as a leader in business transformation Argon merged with a second consulting firm named Crimson&Co in 2018. The objective of this merger was above all to expand internationally and to gain in competitiveness by supporting customers on a more global scope. Since then, the company faced, year by year, an intensive growth around the entire world. London, Abu Dhabi, Chicago, Atlanta, Melbourne, Sydney, Mumbai and Singapore are just some examples of where Argon&Co is now operating.

The company today has more than 400 consultants and recorded around €50 million in revenues in 2019. In addition, Argon was voted in 2018 by Gartner as one of the top two digital operations improvement consulting firms and ranked 14th in Best Workplaces France 2020 (50 to 250 employees' category) distinguishing as one of the best companies in France to work for.

2.3 Argon's vision

Argon&Co's vision consists in the creation of an intime and trustful relationship with its clients which will lead to the establishment of a successful collaboration for an efficient improvement of the clients' operational performance.

As a consulting firm, Argon's goal is to identify companies' potential and turn it into a source of sustainable value.

The firm's approach is based on 3 main dimensions:

- **Strategy:** Identify high-impact strategic levers by combining a cross-functional vision with in-depth expertise in areas of operations
- **Consulting:** Take advantage of the firm's experiences in multiple sectors to design pragmatic solutions that will lead to achieve the strategic ambitions
- **Implementation:** Lead and support processes', tools', organization's and skills' transformation in order to achieve the strategic goals.

2.4 Internal organization of the company

2.4.1 The structure of the company

For each mission carried out by Argon&Co Consulting, a team of 4/5 people with different grades of expertise is composed. The hierarchy related to experience within the company can be represented by the diagram below:

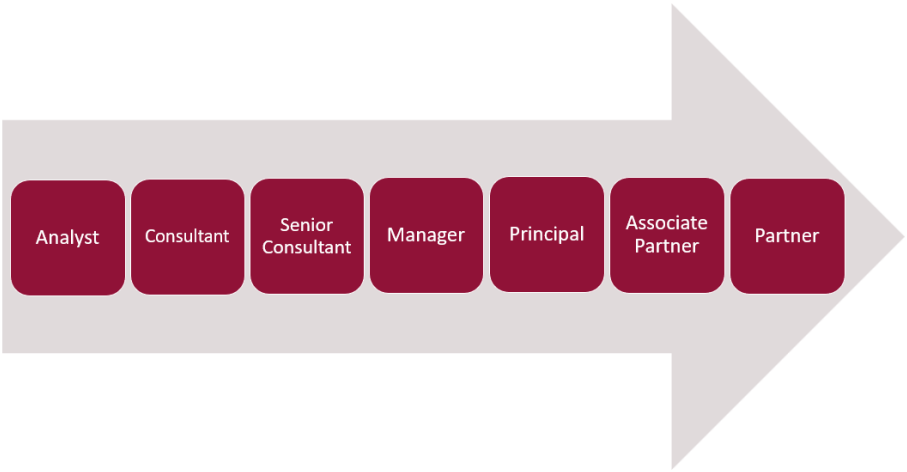

Figure 2. Hierarchy related to experiance within Argon&Co company

In general, the organization within Argon ensures prospects for a rapid evolution and improvement. As illustrated in Figure 2, when a master student is hired for an internship s/he

is classed as an analyst, when instead a young worker is hired with no prior experiences s/he is categorized as a consultant, degree who is generally held between 2 and 3 years. Once consultant, senior consultant, manager or principal, the transition to the higher grade can be done in 4 years maximum. This rapid role progression plays an important role in the motivation of consultants and their willingness to improve.

Normally the work's coordination is most of the time organized as follows:

- A partner or associate partner supervises the progress of the mission and gives expert advice on subjects of which s/he is a specialist.
- A principal or manager organizes the day-to-day work done by the consultant(s) on the mission and manages the good progress of it.
- The consultant(s) and analyst(s) carry out the background work, the analyses and participate in the workshops with the client.

Thanks to the firm's "human" size, working at Argon&Co has two particularities which deserve to be pointed out. The first one is that consultants are not affiliated with "Practices" or "Business Units" as in most of consulting firms. A consultant can, indeed, work on a Logistics project and then on a Sustainable operations project. This approach allows workers to acquire competences in varied fields of supply-chain operations. Secondly, the intern is always considered as a consultant on a permanent contract. Therefore, s/he is always personally involved during meetings with clients and the expectations are the same as for a young consultant who has just joined the company. This allows interns to immerse themself into a real working environment.

2.4.2 Objectives of a consultant

The overall internship objective is to discover the world of consulting and more precisely of the role of a consultant during a mission for a given client.

The work of a consultant is judged on 4 distinct criteria:

- Mission ownership: Ability to understand the context and objectives of the project.

- Skills development: Ability to quickly assimilate or not the subject of the mission, to look for information in the right place and to be autonomous.

- Adaptation to the project: Ability to acclimatize to the work environment, from a relational but also methodological point of view.

- Risk management: Ability to anticipate the workload and difficulties of the project.

After each project and every 6 months the work of all consultants is evaluated in order to truck their progression path.

3 Definition of Agile Supply-Chain Management

The project I was involved in while working at Argon&Co Consulting was concerning the reshaping of a French company logistic network. The reason of the project is linked to the company's strong growth ambitions who can be achieved through the review of its supply chain operations. The main driver of this transformation is represented by the concept of agility. The latter will be, therefore, presented in the following chapters through the explanation of its meaning, the highlighting of the difference of this term with the concept of lean supply chain, the presentation of its main characteristics and a brief introduction of the impacts of the agility on supply chains' business performances. Later, the main areas of supply chain will be listed with some insights on the benefits that agility apports in order to have subsequently a focus on the domain of logistics, who will be the main topic of the following chapters.

3.1 Origin of Agile Supply chain

Much like a flexible foundation is essential for making a building less vulnerable to earthquakes, agility is considered today to be one of the fundamental characteristics needed for a supply chain to survive and thrive in an environment of turbulent and volatile markets.

In the late 90s, as conditions of incertitude started becoming the norm due to reduced product life cycles, increased demand for customized products and services, and reduced visibility of demand, organizations have acknowledged that agility is a key element for their endurance and for acting as market leaders while their competitors struggle to realign more rigid supply chains.

In this context, we can define Supply Chain Agility (SCA) as follows:

SCA is the strategic capability of a supply chain to quickly sense and respond to internal and external changes, either proactively or reactively, leveraging intra and inter-organizational capabilities believe effective manner that ensures profitability[1].

[1] Sharma et al.; 2017

Briefly, an agile supply chain emphasizes flexibility, responsiveness, and resiliency to sudden changes in supply and demand in order to prevent risks with proactive and reactive methods. The proactive attitude aims at reducing the risk with a set of precautions and practices before problems occur. On the other hand, the reactive attitude represents the process of generating a quick solution to the problem that comes up. Proactive and reactive solutions that can be implemented in an organization within the scope of risk management are summarized in Table 1.

The SCA topic is certainly not new in the field of Supply Chain, however, due to the recent disruptions caused by Covid-19 pandemic and wars, its importance became more evident and prioritized than ever before. SCA concept is, indeed, now widely taken into account when talking about Supply Chain Management (SCM), who aims to a supply chain wide reorganization who turns around a new set of principles that emphasise the need for new structures, new value chain configurations, new communication and information systems and a whole new mindset in terms of how a supply chain should operate.

Table 1: Proactive and reactive applications in prevention of risks

Strategy	**Implementation**
Proactive	Multiple sources of supply Inventory Make-and-buy decisions Product design Logistical network design
Reactive	Supplier/buyer communication Business continuity planning Visibility

	Assortment planning Make-to-order/postponement

3.2 Agile vs Lean Supply Chain

There is a fair amount of crossover between lean and agile supply chain management, but there are a few main differences between the two that needs to be pointed out.

- An agile supply chain, as previously mentioned, focuses on flexibility and responsiveness and the ability to handle changes in demand and sudden crises.

- A lean supply chain focuses on maximising savings by continuous improvement coupled with minimal redundancies through the elimination of all nonvalue-additing activities such as overproduction, lengthy processing tiles, defective products or hoarding unsold inventory. Lean embodies, indeed, the concept of "doing more with less", of "zero inventory" and of the "just-in-time" approach.

The applicability of a lean rather than an agile supply chain can be driven by two main factors:

1. Volumes and Variety: Lean supply chains work best in high volumes, low variety and predictable environments, whereas an agile supply chain is needed in less predictable environments where the variety of demand is high.

2. Strategic Inventory: Lean supply chains aim to maximise efficiencies by exploiting the Economic Order Quantity (EOQ). On the other hand, an agile supply chain aims to maximize its effectiveness thanks to a more demand driven approach and the choice of more localised configurations.

As shown, the "lean" and "agile" concepts are clearly different, but there is no reason why both can't be applied to the same supply chain. Agile and Lean supply chains both aim, as matter of fact, to increase productivity, increase the quality, empower the people, and respond as better as possible to customer's demand.

The flexibility and applicability offered by agile methodologies often acts as an enabler for the constant improvements and low redundancies needed in a lean supply chain. For example,

a manufacturer might keep large amounts of raw materials on hand to prevent to run out of them. This would make his supply chain more agile, but less lean, as it would increase inventory carrying costs. Nevertheless, by using the greater visibility enabled by an agile supply chain, the same manufacturer would be able to more accurately predict both demand and delivery time frames, removing the need for the redundant materials and making the supply chain both agile and lean.

3.3 Fundamental characteristics of an Agile Supply Chain

The modern Agile Supply Chain is based around four major characteristics: "market sensitive, virtual, process integration, network" (Christopher; 2000).

1. **Market sensitive:**

It refers to the capacity of the business to read the market regarding what the real demand is and its trends. The data gathered from real-time point of sale systems allows companies to adopt demand-driven decision-making.

2. **Process integration:**

It refers to the integration of business processes in order to enable the stakeholders in the supply chain to work together effectively and to share information in this process. An example might be collaborative product design and development, in which design departments collaborate with suppliers at all levels of product development to ensure that the end-product is as easy to manufacture as possible. The overriding principal is that supply chains are far more efficient, agile, and resilient when all stakeholders are pulling in the same direction.

3. **Virtual supply chain**:

It refers to the establishment of an effective network between buyers and sellers and between relevant departments through information technologies. A free flow of information and an open and clear communication is vital for today's companies.

4. **Network**:

It feeds into the same idea as process integration, but at a conceptual, rather than technical level. In an agile supply chain, the greater visibility and coordination afforded by process alignment allows all stakeholders in the supply chain to share the overall responsibility for the successful operation of that supply chain. Therefore, the network features represent the close relationship between the members of the network, and, additionally, the awareness of being in the network who allows to tackle at best the problem during changes and unpredictable processes. It aims at ensuring integrity and efficiency in resources and capabilities. Thus, the speed and flexibility required is provided within the supply chain.

3.4 Agile Supply Chain and Business performances

As explained above, supply chain agility is considered nowadays by companies an essential element for them to survive in the market. Of course, this is the result of the clear impacts that agility has on business performances.

Although business performance is handled in different criteria, many studies conclude that there is for sure a positive effect between SCA and companies' performance.

In the study of Al Humdan et al. (2019), a comprehensive literature review was conducted on the relationship between SCA and business performance, this relationship was tried to be revealed, but not concretely quantified. Some of the studies collected in Al Humdam article based on supply chain performance are compiled in Table 2.

Table 2. Summary of main studies in Al Humdan et al. (2019) literature review

Author	Sample	Result
Dwayne Whitten et al. (2012)	A national sample of 132 supply chain professionals collected in partnership with APICS.	Triple-A (agile, adaptable, and aligned) supply chain strategy has positive impact on supply chain performance and supply chain performance impacts the marketing

		performance.
Qrunfleh and Tarafdar (2014)	Senior and executive management in the purchase/materials management/logistics/supply chain functions, from 205 firms.	There is direct impact of the SCA on the firm performance and supply chain performance has a mediatory effect on this relationship.
Sangari and Razmi (2015)	3129 executives working in a randomly selected sample of manufacturing firms in the United States having more than 200 employees.	The Agile SC strategy is associated with higher levels of Supply Chain Performance.
Tarafdar and Qrunfleh (2016)	Members of senior and executive management in the logistics/supply chain functions of 205 firm.	A positive effect is supported.

In another comprehensive research on agile supply chain, McKinsey (2015) conducted a study on employees as managers in the operations department of more than 250 global companies. Within the scope of this study, analyses were carried out to cover 10 important supply chain capabilities such as "portfolio and complexity, order and demand, forecasting, and risk". In this paper it can be found some kind of impact quantification of agility on business performance.

Indeed, companies with more agile supply-chain practices (as shown in figure 3) had service levels that were seven percentage points higher and inventory levels that were 23 days lower than their less agile peers did.

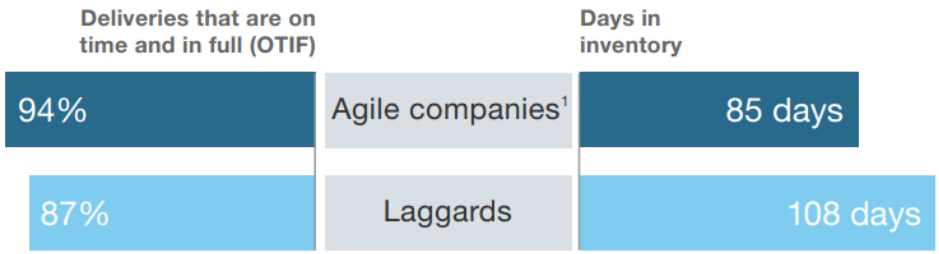

Figure 3: Service Level and Inventory comparison between agile companies.
McKinsey study 2015

3.5 Agility as key elements of demand-driven supply chains

Since now the concept of agility has been illustrated. Is important to highlight how this concept is embodied into the concept of demand-driven Supply Chain. The latter can be represented through 5 "rules"[8]:

1. Align the supply chain with the business
2. Improve supply chain visibility
3. Instilling flexibility and agility
4. Organize for success establishing cross-functional governance
5. Address customers segments

In a demand-driven supply chain 2.0, companies know precisely what the clients value is, and organize their entire operations around satisfying their needs, to create a consistent, excellent customer experience. Sophisticated demand planning, inventory management and distribution enable customers to select, receive and return products/ services when and where they wish, with an ever-shortening time between order and delivery. The supply chain flow starts with the buyer, with purchases — and an expressed desire to purchase — providing the demand 'signal' that triggers production and replenishment.

Today for the clients it is indeed not only important to receive the product at the right place at the right time, but also there is all a structured cost-to-serve model. That also means that a networked supply chain must lead the path to customer satisfaction. Therefore, to understand the cost-to-serve linked with different service or customization options, such as the 800+ journeys, is a key driver for companies.

Along with this consumer centric view, the demand driven supply chain also aims to respond at best to the increasing shortages affecting the manufacturing world, in terms of raw materials, personnel, transports mode, in order to be able to offer anyway the best service possible. As said before, demand-driven Supply Chain must be not only agile but also flexible. When a supply chain is flexible, managers must look ahead and plan for an unpredictable but nevertheless potential development. These are events that are relatively unlikely but place big demands on the inventory. For example, a car manufacturer may order additional parts if it fears that trade embargoes could block off certain sources. In anticipation of wider industry upheaval, they may also have built relationships and external capabilities with a wider range of suppliers and partners, or forged strong partnerships with manufacturers and research bodies, enabling them to produce new, cutting-edge products ahead of the competition. While agility refers to an ability to respond/ adapt to a completely unplanned or unscheduled external circumstance.

3.6 Application of agility in different supply chain areas

Just as a reminder, a supply chain is a network between a company and its suppliers built to produce and distribute a specific product or service to the final buyer. This network includes different activities, people, entities, information, and resources.

Generally, supply chains can be rendered down into six areas in which agile methodologies can be easily applied. These areas are: demand planning, procurement, manufacturing, inventory management, warehousing and distribution.

1. Demand planning

   It represents the process of forecasting customers' demand. As we have mentioned, the vast majority of companies focus on using information taken from previous cycles to make decisions on future production and to improve their inventory ordering and

shipping schedules. However, this assumes that similar patterns will be the only market drivers in the future, which is obviously not true. Companies for being truly agile and market reactive need to combine demand-driven planning and insights drawn from previous cycles.

2. Procurement

It represents the activity of acquiring all resources needed to accomplish the goals of an organization. As the economy becomes more global, the opportunities become even more exciting. An agile supply chain also includes the ability to quickly and efficiently onboard new suppliers to avoid delays or to take advantage of new demand-driven opportunities. Using the current pandemic as an example, the organizations that survived the economic and logistical fallout of the pandemic were those who were able to transition away from traditional overseas manufacturing operations and near-shore new manufacturing parameters with a quick and simple onboarding process.

3. Manufacturing

Manufacturing is the creation or production of goods with the help of equipment, labour, machines, tools, and chemical or biological processing or formulation.

The topic is very relevant in term of supply chain agility. The concept of agility originated indeed, linked to manufacturing and was popularized in 1991 by a group of scholars at the Iaccoca Institute of Lehigh University. The group defined agility as:

"A manufacturing system with extraordinary capabilities (Internal capabilities: hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness). A system that shifts quickly (speed, and responsiveness) among product models or between product lines (flexibility), ideally in real-time response to customer demand (customer needs and wants)."

Agile manufacturing was posited as the means to rapidly respond to changes in demand and to meet widely varied customer requirements in terms of price, specification, quality, quantity and delivery. Synchronizing production and scheduling with demand-driven sales figures is vital to avoiding overstocking and out stocking.

4. Inventory management

It represents all the activities employed in maintaining the optimum number or amount of each inventory item. The objective of inventory management is to provide uninterrupted production, sales, and/or customer-service levels at the minimum cost. Because of seasonal changes and cyclical sales cycles, inventory can simply sit in warehouses doing nothing for large parts of the year, just so that it is in place for a certain period of time. Agile supply chain management can help to combat this problem by simply allowing companies to take on local manufacturing and logistics partners who can provide the goods and services in response to demand.

5. Warehousing

It represents the activities of proper handling, storing and managing of the products within warehouses or distribution centres. The latter are essential for enabling the fulfilment of customer orders with the right product at the right time.

Figure 4. Schematic representation of logistics

6. Distribution

It represents the activity of delivering the end-products. As companies are trying to globalize and extend their markets, deliveries are becoming always more complex. Therefore,

new cost-effective alternatives started to develop in the recent years for managing logistical efforts such as transportation and distribution. An example of this are the third-party logistics (3PL) services. 3PL providers offer outsourced logistics services, which include anything that involves management of one or more facets of procurement and fulfilment activities.

The good functioning of the entities presented here above is the objective of supply chain management. On the other hand, it is important in order to dot leave any room for confusion to differentiate the term of supply chain management from business logistics management (or simply logistics), who are often wrongly used interchangeably. As represented in figure 4, logistics can be defined as the management of the link of all steps, or entities, involved in the supply chain. It deals with the planning and control of the movement and storage of goods and services from their point of origin to their final destination.

Successful logistics management ensures that there is no delay in delivery at any point in the chain and that products and services are delivered in good condition. This, in turn, helps keep the company's costs down.

The application of the concept of agility, not only to each area who constitute a company's supply chain, but also to all the logistics, represent an essential driver for firms to respond to changing business conditions in an efficient and effective manner.

Consequently, in the next chapter we will focus on the concept agility applied to logistics.

4 Other insights on the future of the Supply Chain

The restructuring of the Supply Chain for the achievement of agility to meet the challenges of the future has been discussed so far, but it is necessary to consider other key concepts that complement the concept of agility.
The two aspects that will be presented in this thesis are the integration and technological development involving today's supply chains and the need to transform the Supply Chains into Green Supply Chains, i.e., supply chains that take into account the environmental and social aspects that today, more than ever, we are trying to protect.

4.1 Meeting the needs of the future: logistics adoption of digital innovation

The global economy is characterized by extreme uncertainty, disruptions, extended lead time, and dynamic demand. Organizations seek to move toward technological innovation to improve the efficiency of operations and maximize resource utilization. Further, inter-organizational integration becomes essential to sustain the operations and persist in the stretched competition (Queiroz et al., 2019).

Legacy software such as Enterprise Requirement Planning, Advanced Planning and Scheduling systems, Warehouse Management Systems or Transport Management Systems still serve as the backbone of Supply Chain Management processes. The relevance of these software to manage both master data and transactional data under Supply Chain Management best practices is not under debate, with decades of experience baked into each solution’s functionalities. Now, to achieve the required agility over time, these monolithic solutions need to be augmented with targeted business tools. Benefits arise when such tools:

- Effectively improve the efficiency of the Supply Chain processes (example use-case: improved forecast accuracy thanks to a custom forecasting algorithm)
- Or provide a competitive advantage (ex. new service of vendor-managed inventory enabled by a shortage prediction at SKU level).
- Can be quickly developed and deployed (in under a few weeks or months).
- Are continuously updated to fit the latest requirements dictated by the Supply Chain reality

These circumstances have compelled organizations to adopt advanced digital technologies in their supply chains (Agrawal & Narain, 2018). Embracing various technologies (such as blockchain, Artificial Intelligence (AI), cloud computing, Internet of Things (IoT), Cognitive automation) has facilitated the supply chain to process extensive information, execute smart decisions, receive feedback, create new opportunities and improve continuous monitoring. This transition toward digital transformation is termed the digital supply chain (DSC) (Ageron et al., 2020). DSCs can be defined as the integration of advanced digital technologies in the traditional supply chain to improve the decision-making activity grounded on a knowledge-based system and to facilitate coordination and collaboration across the stakeholders (Di Vaio & Varriale, 2020). The potential digital technology sought by supply chain managers are IoT, augmented reality, nanotechnology, big data, predictive analytics, social media, internet of value, blockchains, AI, and social media. Ivanov and Dolgui (2020) highlights that DSC enhances the agility, adaptability and alignment among the supply chain stakeholders. Organizations are required to transform digitally, but also embed the circular economy (CE) principles. The CE principles are considered as the enablers and motivating elements behind waste reduction and life-cycle extension for the material and products. The transition to CE requires system redesigning and business process modifications (Kouhizadeh et al., 2020).
The transformation toward DSC has been reported as inevitable and necessary but the impact of this transformation on operation and environment has been less understood. A study by Ashish Dwivedi,Sanjoy Kumar Paul, (2022) tried to analyse this aspect. They highlighted the main barriers to for the integration of digital supply chains to a circular economy environment. Their study suggests that the "lack of digital skills and facilities" is the most influential barrier. Given this finding, it is critical to develop the knowledge and know-how of digitization on a global scale. Both industry and academia must work together to develop a digitally-skilled workforce that contributes to a sustainable business environment.

4.2 Meeting the need of the future: green transformation

Since the recent terrible environmental events of bush fires, floods, and earthquakes throughout the world, there has been a marked increase in concerns among governments and scientists on climate change and global warming. High levels of air pollution, the most severe type of pollution because it quickly seeps into the ecosystem and travels great distances to inflict worldwide environmental harm, have been brought on by ever-increasing CO_2

emissions. In emerging nations, two sources—vehicles and industries—are mostly responsible for air pollution.

4.2.1 Analysing the industries to manage environmental problems

The “dirty” Industries are able to survive in the developing world due to the inefficient environmental protection plans, poor environmental standards and underdeveloped pollution control techniques in developing countries.

However, several improvements have been made recently. Due to a heightened worldwide awareness of environmental issues, the area of Green Supply Chain Management (GSCM) has become increasingly researched.

Organizational performance has been operationalised using the "Triple Bottom Line (TBL): people, planet, profit” concept proposed by Elkington in order to rationalize the new reality of operating in systems that must deal with lowering costs, improving quality, and increasing flexibility and agility in an environment that also honors environmental and social aspects of sustainability. As a result, sustainable supply chain management emphasizes "the management of material, information, and capital flows as well as cooperation among companies along the supply chain while taking into account goals from all three dimensions of sustainable development, namely, economic, environmental, and social, which are derived from customer and stakeholder requirements." As a consequence, it is critical that each firm consider how its sustainability initiatives will affect the several partners in its multi-tiered supply chain, particularly its direct suppliers and customers.

As a demonstration of the increasing world awareness of environmental problems, in September 2015, the 193 member states of the United Nations adopted the 2030 Agenda for Sustainable Development, which is an action plan aiming to protect the humanity, the planet and people’s prosperity. It includes 17 Sustainable Development Goals (SDGs) and 169 targets (or sub-targets) and draws a detailed roadmap covering virtually all societal issues.

Additionally, 195 countries at the United Nations climate-change summitted in December 2015 the Paris Agreement, who aims for reducing global greenhouse-gas emissions enough to prevent the planet from warming by more than two degrees Celsius. To cut their emissions in line with the Paris target while increasing sales at the projected rate of 5.3 percent a year, CPG companies would have to lower their carbon intensity—the amount of greenhouse gas emitted per unit of output—by more than 90 percent between 2015 and 2050 (figure 5).

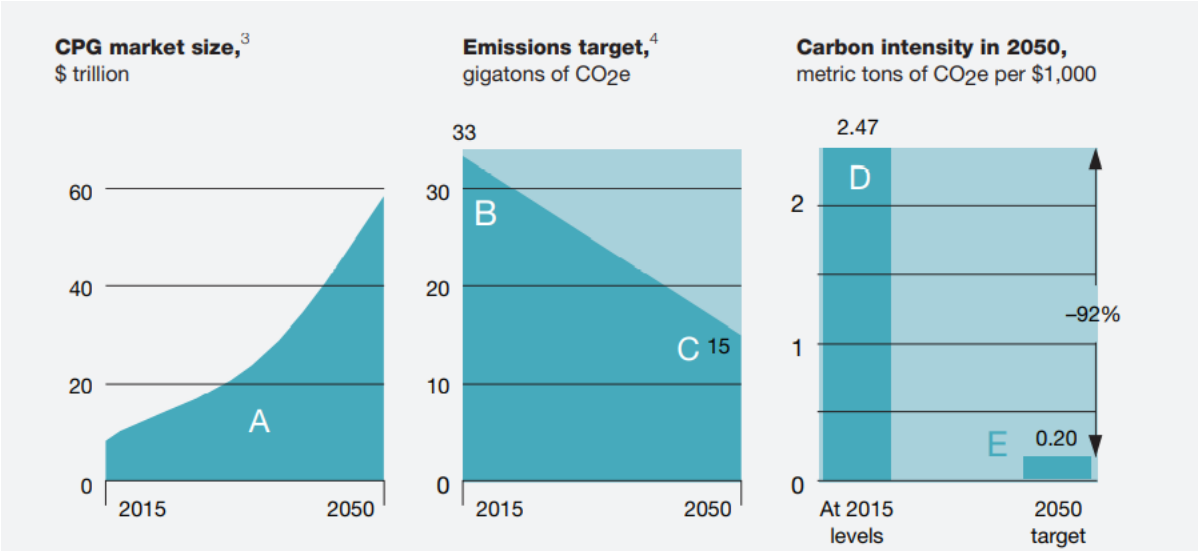

Figure 5. To achieve global climate goals while meeting growing demand, consumer-packaged-goods companies would have to significantly cut their greenhouse-gas emissions.

Also, investors nowadays take the pursuit of sustainability as an important prerequisite for investment in an organization. Furthermore, they appear to be more willing to invest in an organization whose sustainability indicators have strategic relevance. The authors of "The Economist" in a report intitled "The missing link", stated that 85% of consumers are more likely to buy from a company with a reputation for sustainability than from a neutral company if their prices were equal. And a recent study from Unilever says 33% of consumers purchase products with sustainability in mind.

A report done by the consultancy firm McKinsey shows that companies betting on sustainability improve processes, have higher growth rates and help to create value. The worth of a company can be expressed in fact as the sum of two values: the present value of the company's current cash flows extended into the future, and the present value of the expected growth in its cash flows (figure 6). Because of this, factors that alter these companies' growth projections will also have a major effect on their total returns to shareholders.

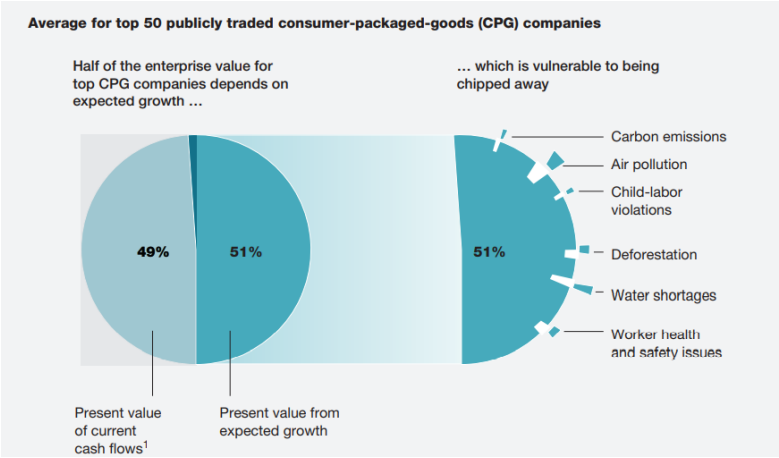

Figure 6. Sustainability factors could alter the growth projections for CPG companies, seriously affecting their total returns to shareholders.

Moreover, McKinsey says 90% of companies' impact on the environment comes from supply chains.

Accordingly, GSCM practices should be implemented across a company's supply-chain which regard internal and external processes (Gimenez et al., 2012; Wolf, 2014):

- Internal GSCM practices concern the reduction of consumption of raw resources, production of waste, use of toxic materials, and toxic emissions in internal operational processes (i.e., product development and production).
- External GSCM practices concern the reduction of the volume of purchased items and the use of hazardous materials, minimization of unnecessary packaging and increased use of recycled/recyclable materials in external operational processes (i.e., supplier selection and collaboration)

Notwithstanding the sustainability risks that lie in supply chains, relatively few companies are working with their suppliers to manage these risks. Of the companies that report their greenhouse-gas emissions to CDP, a non-profit organization that promotes the disclosure of environmental impact data, only 25% say they engage their suppliers in efforts to reduce emissions. Even when companies attempt to influence their suppliers, they are likely to run into challenges. The biggest one may be that consumer companies do not deal directly with all the firms in their supply chains. Primary suppliers routinely subcontract portions of large orders to other firms, or they rely on purchasing agents to place orders with other firms.

Subcontracting is especially common in the apparel industry; the fast-fashion business in particular requires large volumes of garments to be made in short time frames. Subcontractors can be managed loosely, with little oversight regarding workers' health and safety. In a recent survey by The Sustainability Consortium (TSC), a non-profit organization dedicated to improving the sustainability of consumer products, less than one-fifth of the 1,700 respondents said they have a comprehensive view of their supply chains' sustainability performance. More than half reported being unable to determine sustainability issues in their supply chains. Until consumer companies identify the sustainability problems in their supply chains, they cannot begin to work with their suppliers on solving those problems.

It is believed that three approaches can help consumer companies make their supply chains more sustainable. These include:

1. Identifying critical issues across the whole supply chain.

   Critical issues can be studied through life-cycle assessments or through conducting surveys to find out companies' main practices. It is important to say that not only environmental issues have to be considered but also social aspects. It is crucial in fact to evaluate social impacts and consequences of companies' supply chain operations/activities on human well-being (including worker health and safety, working conditions, human right practices, etc.). The Social-Life Cycle Assessment can be considered a useful methodology in this aspect, which assesses the organization's social aspects and sustainability performance and the positive and negative impact of its products and services on people well-being along the lifecycle.

2. Linking the company's supply-chain sustainability goals to the global sustainability agenda.

   Concretely, GSCM practices should be introduced to answer stakeholder needs and improve environmental performance, such as:

   - Transform digitally and embed the circular economy (CE) principles. The CE principles are considered as the enablers and motivating elements behind waste reduction and life-cycle extension for the material and products. Circular economy is based on 7 pillars who can be grouped in three macro-families:
     - Supply from economic stakeholders:
       1) Extraction/Manufacturing and sustainable supply chain
       2) Eco-design
       3) Industrial and territorial ecology

4) Functional economy

- Consumer demand and behaviour
  5) Extension of product life span: reuse, repair, recycle
  6) Responsible purchasing: e.g., sale or donation of second-hand goods
- Waste management
  7) Recycling e.g., use of raw materials from waste

- Implementation of a series of environmental KPI's to monitor, report and manage the environmental performance across sites.
- Tracking key measures such as: energy consumption, carbon emissions, waste production, water usage and environmental compliance status, all of which are monitored and reviewed monthly.

3. Helping suppliers manage their impact.

   This objective can be reached through the disclosure of the company's goals to the suppliers. Sensibilization and awareness among the stakeholders can be seen indeed as an essential strategy for improving the implementation of Green Supply Chain principles.

   Environmental disclosures practices concern information sharing with a variety of stakeholders about environmental pollution and natural resource consumption performance (Plumlee et al., 2015).

   To have a more global as possible view on its overall supply chain, companies should try to establish a close relationship with its suppliers through industry collaboration, advising or reverse logistics (consisting in encouraging them to receive the packaging they have previously supplied and ask them to reuse it or recycle it)

   Before to control supplier's sustainable situation there were used methods such as:

   - Third-party certifications management systems: Party Certificates, such as SA8000 and ISO 45001, are widely used across organizations. They are issued by external entities and attest that suppliers have met a list of practices that merit the relevant accreditation.
   - Physical audits and assessment.
   - Supplier codes of conduct. The latter is a method that is more likely to be used by large corporations. The CoC is prepared by the buying organization and contains

guidelines and principles underlying the values and cultural norms of the organization and any principle covered by international and national conventions. The buyer shares its CoC with all relevant suppliers as a means of creating a background for common expectations and to eliminate any potential areas of misunderstanding

In recent years, instead, consumer companies and others have adopted more sophisticated and effective methods for changing their suppliers' practices.
They started to help suppliers design and implement sustainability programs that directly support the companies' own goals. Campbell Soup Company, in collaboration with the Environmental Defense Fund, offers farmers technologies, guidelines, and products to help them optimize their fertilizer use and improve soil conservation. Digital technology has also increased companies' ability to assist large numbers of suppliers. In 2014, Walmart launched a program to help thousands of its Chinese suppliers make their factories more energy efficient through the use of an online tool. The program has enabled the average supplier to reduce its energy consumption by an average of 10%. Consumer companies can also offer their suppliers incentives for improving sustainability performance.

On the other hand, the existing literature indicates that there are considerable challenges facing organizations in achieving sustainability objectives across their supply chains. One of the strongest barriers is the difficulty to monitor complex supply chains and find the expertise to assess suppliers' sustainability despite the methodologies listed above. This situation can be due to:

- the geographical dispersion of suppliers.
- whether or not suppliers or buyers are located in developing or developed countries.
- the size and influential power, as measured by volume of supplier sales to buyers or volume of purchases from suppliers.
- the pressure exerted by different stakeholder groups.

Another reason is that there's a lack of support from either the top management or government. Turning companies' supply chain more sustainable as possible, is synonymous with higher costs (even if they mean costs saving on the long term) and the promise of

increased reputation and growth opportunities it is not always the key to unlock the funds needed.

4.2.2 Changing transportation modes to manage environmental issues

Transportation is the second highlighted aspect who mainly impacts world's pollution. Therefore, for the past few decades, the theme of sustainable transportation has been very researched. Apart from providing services and infrastructure for the mobility of people and goods, sustainable transport is a cross-cutting accelerator, that can fast-track progress towards other crucial goals such as eradicating poverty in all its dimensions, reducing inequality, empowering women, and combatting climate change. As such, it is vital for achieving the 2030 Agenda for Sustainable Development, and the Paris Climate Change Agreement.

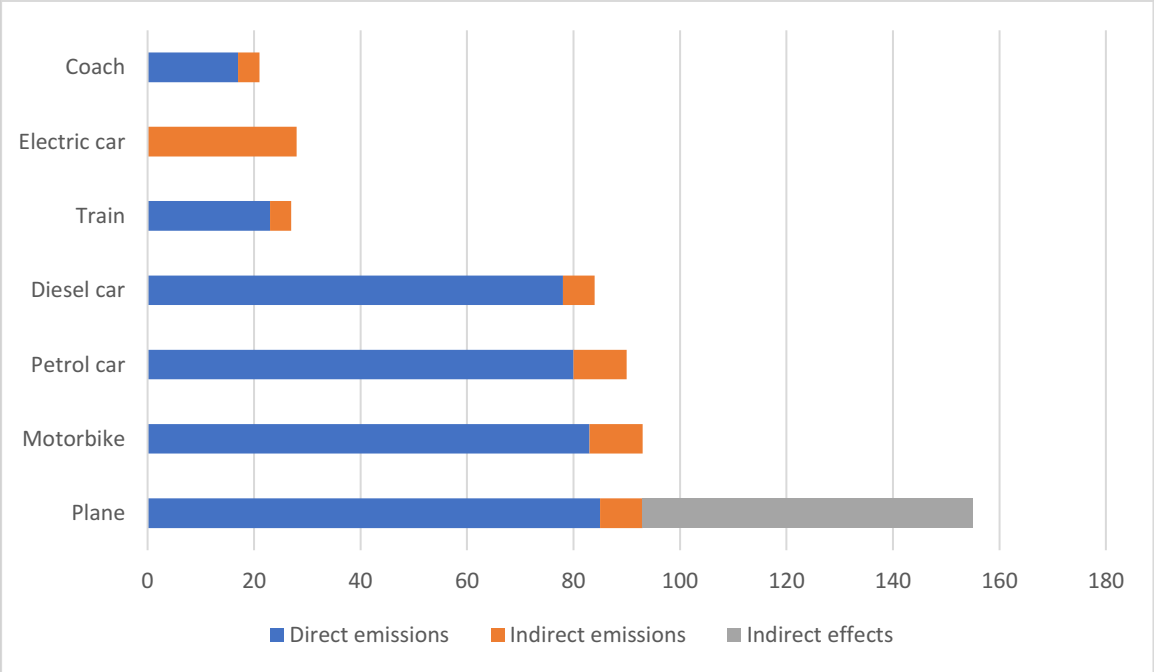

Figure 7. Indicative GHG emissions (KG CO2) for a single passenger, 2021

Figure n.7 shows indicatives Green House Gasses (GHG) emissions ($KGCO_2$) for a single passenger who travels from London to Glasgow. Indirect effects refer to the climatic effects of non-CO_2 pollutants, such as water vapour, aerosols or nitrogen oxides. This chart represents a central estimate of non-CO_2 effects, which is however highly uncertain.

Flying as environmentally friendly transportation mode is at the bottom of the list.

Aviation is the fastest-growing source of greenhouse gases in the world and yet less than 20% of the world's population has ever flown. If it could be represented by a country, aviation would be the 7th largest emitter of CO_2 in the world and it independently makes up 12% of all transport emissions.

According to the Department of Transport's most recent Official Statistics, issued in October 2021, the average greenhouse gas emissions for a single passenger flying from Glasgow to London were 155 $KgCO_2e$ (carbon emission equivalent). In comparison, a single person traveling by bus created just 21 $KgCO_2e$. These data demonstrate the massive amounts of CO2 emitted by the aviation sector.

Moreover, cars account for 12% of total greenhouse gas emissions in Europe. As a result, there has been a significant push toward a future of electric automobiles that are free of fossil fuels. However, are electric vehicles are not as environmentally friendly as we believe.

Electric vehicle manufacture, like that of fossil fuel automobiles, begins with the extraction and refining of raw materials to make components required for the car to function, most notably the battery. Because they are constructed of rare earth elements (REE) such as lithium, cobalt, nickel, and graphite, the batteries used in electric vehicles have significant environmental repercussions.

Because these elements lie under the earth's surface, they can be accessible only by mining. Each tonne of REE generates 75 tonnes of acidic waste and one tonne of radioactive residues. Furthermore, not only does the energy used to manufacture these car batteries account for nearly half of their environmental impact, but there are also few effective ways to reuse or recycle the batteries, which means that the majority are incinerated or thrown into landfills, both of which have additional environmental consequences.

Therefore, electric automobiles are not zero-emission vehicles. While the post-production of electric vehicles is more ecologically friendly, the manufacture and production of electric vehicles is not. However, suggestions for improving the sustainability and eco-friendliness of electric vehicles are being explored, and the fact that we have constructed a vehicle that creates no CO2 after manufacture is certainly a significant step forward.

Whereas, in terms of speed, efficiency and environmentally friendliness, trains probably come out on top. They are one of the most energy-efficient modes of transport and while they carry 8% of the world's passengers and 7% of global freight transport, they represent only 2% of transport energy.

In conclusion, even if nowadays are developed always more strategies which focus on customers, who want to see their products delivered as faster as possible, companies need absolutely to consider the environmental impacts of their activities and search for the best solution in term of overall supply chain performances and transportation modalities.

5 Agile Logistics

After having presented an overview off all areas of a supply chain in which agility today plays an important role, we will now focus on the relevance of agility in the logistics services.

Results of the Agarwal et al. (2007) study indicate that supply chain agility is, in fact, mainly contingent upon seven factors including: customer satisfaction, quality improvement, cost minimization, delivery speed, new product introduction, service level improvement, and lead time reduction. These can be directly or indirectly linked to logistics capabilities making the latter a major "ingredient" for the achievement of supply chain agility.

To be more agile in term of logistics two main aspect have to be taken into account:

1. Precise estimation of clients' needs through fast and reliable sales forecasts.

2. Agile management of transport flows who can be achieved through several major levers: reducing cycles, optimizing batch sizes, making fast and reliable operational and tactical management processes, and even reviewing its industrial strategy.

The review of company's industrial strategy has been incredibly relevant in the last years; therefore, it deserves a dedicated in-depth analysis.

5.1 Companies' industrial strategy then and now

Nowadays we are in the middle of a clear transformation in term of industrial strategy related to firm's logistics network. In the past decades the main drivers for supply chain optimization were defined by:

1. Delocalization given the globalization trend
2. Centralization in term of inventory model

Globalization has been a prevailing trend in nearly every industry for the past several decades as manufacturers and other businesses attempt to take advantage of the abundant raw materials and low-cost manufacturing available in developing countries around the world (global sourcing). This phenomenon led to the birth of "Global Supply Chains": sophisticated

networks of manufacturing, logistics, transportation, and communication firms that move products and material through worldwide production and distribution channels.

Although the use of foreign suppliers can be traced back several decades, it was not until the late 1980s that the outsourcing of production processes started to characterize business models. Initially limited to only a few sectors such as textiles, clothing and electronics, by the early 1990s the process of globalization was rapidly expanding to various industries and engaging firms in a number of developing countries.

In the 1990s, in fact, the declines in the costs of cross-border transactions – due to trade liberalization, technological progress and improvements in transport logistics and management, and to increases in the industrial capacity in developing countries – have allowed supply chains to further segment, and to gradually integrate developing countries into production networks.

By relocating production processes (i.e. R&D, design, manufacturing, packaging, marketing, distribution and retailing) in different countries, as said, companies could take advantage of the best-available human or physical resources in different countries, with a view to maintaining their competitiveness by augmenting productivity and minimizing costs. In one of the first comprehensive studies of new scenarios in global production, Gereffi and Korzeniewicz (1994) stated that: "In today's global factory, the production of a single commodity often spans many countries, with each nation performing tasks in which it has a cost advantage."

Secondly, inventory centralization was the other trend of the industrial strategies of the past years. The inventory centralization is linked to the concept of uncertainty. Uncertainty in supply chains is usually classified as either demand uncertainty or supply uncertainty. A simple model concerning demand uncertainty is the newsvendor problem, which determines the optimal order quantity or inventory level to minimize the expected cost under stochastic demand in a single period for a single location. The problem was then extended to a multiple-location model and it has been proven that under demand uncertainty, a centralized inventory strategy provides the *risk-pooling effect* (it diminishes the impact of demand uncertainty on supply chain performance) and reduces expected costs versus a decentralized strategy. The

risk pooling effect, in fact, allows to combine the demand variance at each retailer, resulting in a lower expected cost.

Supply uncertainty has also been considered in several settings in the literature. The two most commonly considered forms of supply uncertainty are supply disruptions (in which supply is halted entirely for a stochastic amount of time) and yield uncertainty (in which the quantity delivered from the supplier is random). In case of supply disruption, it has been proven that expected costs are equals in case of a centralize or decentralize systems, but the variance of the cost is higher in centralized systems. This effect is called the *risk-diversification effect* and concretely it occurs because a disruption in a centralized system affects every retailer and causes more drastic cost variability. In conclusion, risk diversification increases the appeal of inventory decentralization in a system with disruptions. In the context of multi-location inventory management, decentralization or diversification is leveraged to achieve lower cost variance instead of the expected cost. In the research paper regarding decentralization analysis of Schmitt et all. it is shown that under a risk-averse objective function, the benefits of risk diversification typically surpass those of risk pooling and therefore decentralization is the optimal network configuration.

Today we are exactly under the conditions of a risk-averse system, caused by the fear of unexpected supply disruption as it happened during the Covid pandemic or the war in Ukraine, who has, for example, strongly invalidated the flour market. This leads companies to choose lately for more decentralized networks.

Furthermore, today's world has been changing and many aspects that weren't relevant yesterday, are now companies' business priorities, such as ethical and environmental topics.

Companies are today evaluated also in term of their Environmental, Social and Corporate Governance (ESG) compliance. Therefore, companies work on goals that go beyond the role of a corporation to maximize profits on behalf of the corporation's shareholders.

Key ESG factors are summarized in table 3.

Table 3: Key ESG factors

Environmental	• Climate change and carbon emissions • Air and water pollution • Biodiversity • Deforestation • Energy efficiency • Waste management • Water scarcity
Social	• Human rights • Labour standards • Customer satisfaction • Data protection and privacy • Gender and diversity • Employee engagement • Community relations
Governance	• Board composition • Audit committee structure • Bribery and corruption • Executive compensation • Lobbying • Political contributions • Whistle-blower schemes

In addition, competition in every market started to increase and the reactivity to clients need started to become essential.

In conclusion, due to higher supply uncertainty, to environmental and social reasons and increase in competition, companies are consequently changing their sourcing strategy, choosing for more local suppliers and more decentralized inventory configurations (figure 8).

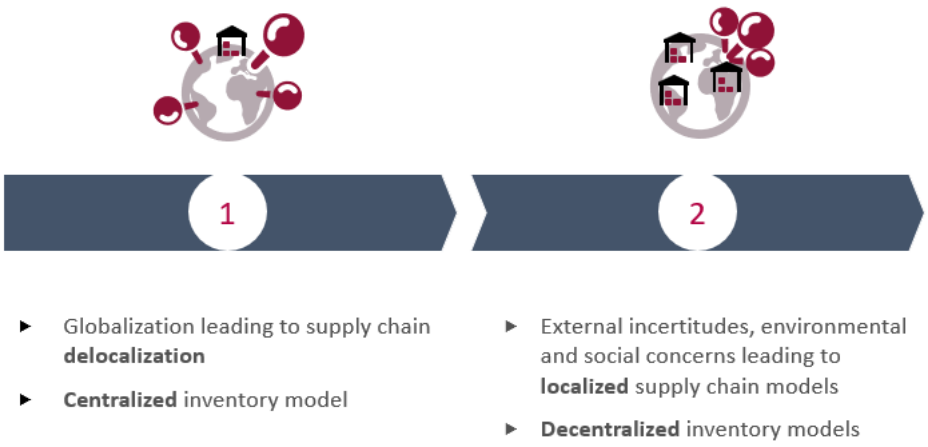

Figure 8. Industrial strategy now and then

5.2 Mergers and Acquisition for logistics performance optimization

Until now, we have explained the concept of agility and how firms are converting it into a priority given the extreme situation of uncertainty which is leading today's word. We have then explained how the latter has also generated a change in term of companies' industrial strategies. Companies prefer to be more local and decentralized in order to be able to better face risks and also to be closer to its clients, gaining, therefore, in term of lead time and service level, along with the consumer centric view of the demand-driven Supply Chains (paragraph 3.5).

As a side effect, this situation invites company to increase visibility on their supply chain and consequently to increase Mergers and Acquisitions (M&A) with the aim of expanding their international presence and to better control their supply chain.

A study done by A.T. Kearney consultancy firm has analysed the trend of Mergers and Acquisitions in the food and beverage sector.

The article focuses on two main information:

1. It emphasizes that M&A activity in the market of consumer-packaged goods has skyrocket in the past years as well as the values of M&A, as shown in figure 9.

2. It remarks that most of the M&A lead acquiring companies to lose money during the post-merger phase. According to the A.T. Kearney Global Post-Merger Integration

(PMI) survey, 57% of companies declined in aggregate profitability, while 14% reported no change after an M&A. Problems with the supply chain spurred this underperformance, including a new organizational structure with too many compromises, lack of an integrated master plan, failure to capitalize on the merger's momentum to integrate, and addressing IT issues too late in the process.

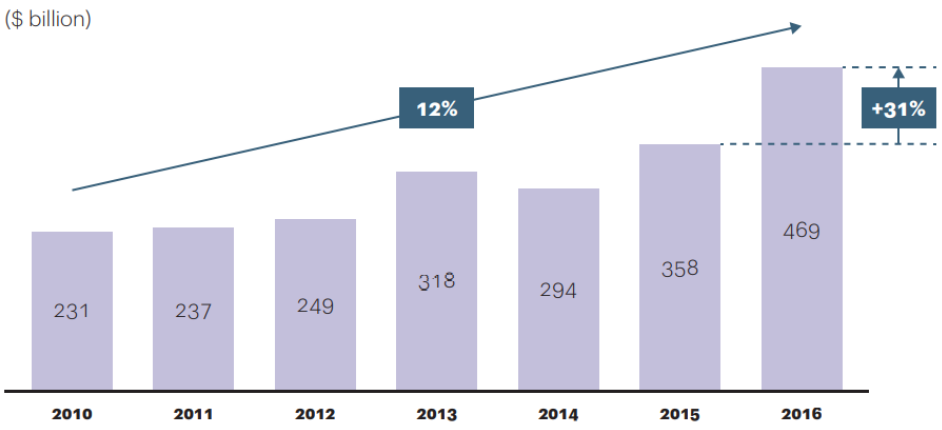

Figure 9. The value of consumer-packaged goods M&A deals increased 103% 2010-2016

Most companies give in to the pressure of today's fast M&A pace and high stakes by hurrying through the supply chain assessment, doing it piecemeal, or even ignoring it completely. It has been found that speed is far more profitable when a company integrates merged supply chain organizations quickly but carefully in order to maximize the benefits of synergies with a focus on end-to-end supply chain integration.

Consequently, the article identifies four major areas who, if taken into consideration, can help to ensure an M&A success story. The latter will be described in the following paragraph.

5.2.1 The four key areas to faster logistics synergies savings

The four top logistics challenges identified in M&A are (figure 10):

a) External collaboration
b) Systems integration

c) Organizational structure

d) Network design

We will now deep dive each of these challenges to highlight why the good treatment of this subjects is essential for a successful M&A.

Figure 10. Problems identified in merger integration

Companies if they decide to go through a M&A should:

a) Rapidly adapt the organizational structure to the new post-merger situation

Smart acquirers seize the day by using a merger as an opportunity to integrate and improve upon existing business processes. They move fast to adapt a new organizational structure that meets the post-merger situation because they know that delays will exacerbate differences and slow down buy-in.

Insightful companies design the desired end-state of the combined organizations as early in the deal process as possible. They also directly address differences in the current structures to reduce opposition and speed up buy-in.

To have a successful review of the organizational structure there are some key considerations who should be considered:

- Involve the leadership teams from both organizations to improve the efficiency of the buy-in.
- Transparent communication.

- Do not assume that the acquiring company's structure is optimal and the other company should be force-fit into that structure. Rather, take the best elements from both organizations to create a new one that best serves new needs.
- Clearly define the roles and responsibilities of the future organization.
- Define the needs during the transactional versus stable state (end of acquisition process).
- Account for the different organizational structures (matrix, centralized, or decentralized) of the merging entities.
- Asses the degree of outsourcing of both organizations.

b) Define a system integration strategy and a future technology landscape early in the game

To determine which systems will best support the merged organization, it should be first understood how the supply chain will run going forward. Otherwise, the decision of which systems to keep and which to retire could be driven more by internal politics than by tangible business reasons. To implement a successful system integration, companies should:

- Define an integrated systems landscape that incorporates best practices from other organizations and industries.
- Focus on process improvement for the future operating model. If aspects of the acquired company are broken, invest resources in better processes instead.
- Seize the opportunity to standardize. Use the integration to improve, optimize, and standardize globally across the organization, which could entail making changes to the core system infrastructure of the acquiring company as well.
- Institute change management when implementing new or revised enterprise software. Among the challenges that post-merger companies encounter with ERP

implementations are unique stressors that arise among employees at combined entities, such as resistance to new roles and responsibilities.

c) Reset relationships with customers and vendors for increased integration and collaboration

Too much change too quickly can be devastating from a customer standpoint. Instead, define the merger's goal and plan its rationalization schedule accordingly:

- Engage vendors and customers in process improvements. Doing so during fit-gap workshops and as the company defines the core model will help identify and address issues early and gives these important entities the opportunity to provide input on the best future state.

- Harmonize policies and contract terms. Contractual obligations and policies will certainly be different between merging organizations. However, define and transition to the future operating model before harmonizing policies to minimize changes, avoid scaring off vendors, and allow for more holistic decisions. Leverage the combined scale for another benefit— improved terms.

- Consolidate 3PL providers. Initially focus on the seamless transition of operations with minimal business risk. Then undertake an exhaustive review and request-for-proposal process to consolidate providers and lock in savings by leveraging the larger spend

d) Redesign the network early

Two aspects of network design—site selection for distribution centres (DCs), along with asset rationalization decisions—can save or cost a merged company tens or hundreds of millions of dollars. Revisit the networks as early as possible and build an updated one that supports the new organization's long-term needs. The company should determine the best way to merge the networks after an initial optimization of the individual supply chains. Companies should:

- Design and plan for the future. Align on network design parameters and future growth requirements. Focus on a long time-horizon that includes long-term strategy, developing industry trends, and the desired capabilities of the combined organization in the years to come.

- Build in flexibility. Develop a platform that easily adapts to evolving markets, consumer trends, technology, expansions, policies, and requirements.

- Reach the best compromise on cost, complexity, and service for each customer channel. Focus on how to best serve those channels at the lowest possible cost from the combined entity.

- Accommodate various product and activity types. Coordinate with sales and marketing to determine which products will be retained or emphasized in the future and require network support. Work with manufacturing to clarify where products will be produced and how that will affect the network, including accommodation of different product types and activities supported at various factories.

- Be realistic and avoid excessive risk. Evaluate the plan's feasibility and ambitions. For instance, think twice about building multiple DCs all at once. Instead, use pilot programs to test recommendations before rolling them out to the rest of the network.

5.2.1.1 3PL acquisition

Among all the different kinds of M&A, it can happen that companies decide to acquire their 3PL providers.

Which are the benefits?

1. Expand geographic reach: While the world becomes more globalized, the process of shipping, sourcing, and selling goods complicates as well. 3PLs and freight forwarders can provide additional international expertise and help to globalize more the industry.

2. Acquire coverage of specific industries: Many 3PLs specialize in multiple and specific areas of industry, providing exclusive expertise that can help you to expand your reach.

3. Achieve scale: Merging with a 3PL can allow you to focus on growth, however big or small.

4. Systems integration in order to create the ideal business process

To conclude, combining 3PL providers' final mile expertise with the company's global freight capabilities enables to better serve the customers by managing the movement of product from the factory floor to consumers' homes.

6 Modelling an agile logistics system

As said, companies often decide to restructure their logistics. Business logistics are organised in flows of goods and information. Information and data generally flow downstream, i.e. from the consumer to the manufacturer's suppliers, while the transport of products is upstream to downstream (from suppliers to consumers).

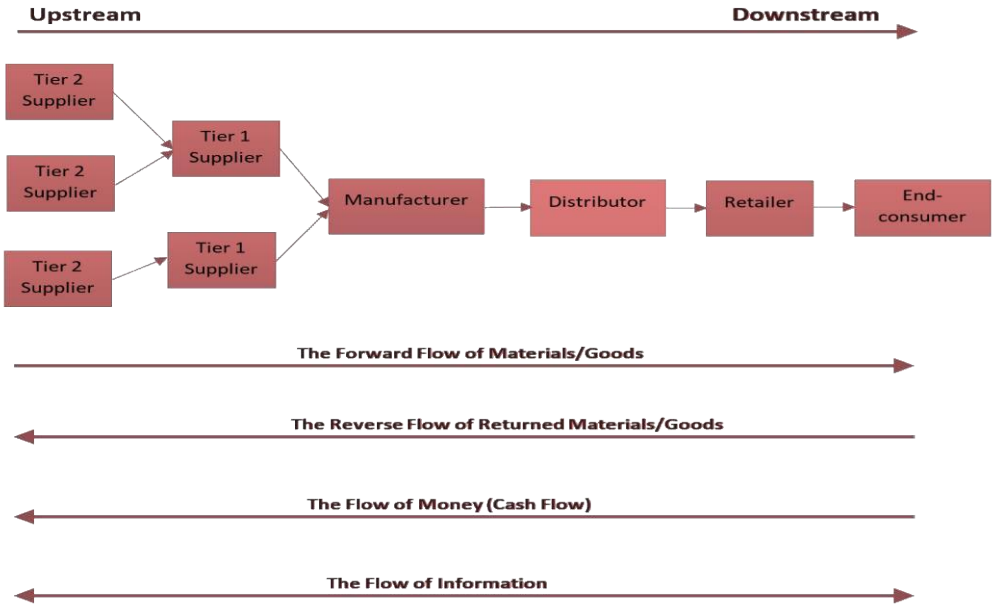

Figure 11. Standard supply chain organisation

The figure 11 shows the standard organisation of a company's global logistics:

The restructuring of companies' logistic system is not an easy task. There are many parameters that must be taken into consideration as well as the associated costs. Therefore, when doing so, a strict analysis and comparison of the AS-IS scenario vs the TO-Be scenario should be implemented to highlight all gains and costs that could be faced.

A company's logistics definition is related to three fundamental aspects:

1. Warehousing

2. Transport
3. Distribution network

In the following chapters, the presented topics will be analysed through the explanation and definition of each as well as the presentation of the related cost modelling.

6.1 Warehousing

To begin we will give a global presentation of warehouses: what are they needed for and how can they be classified, later on a schematic cost modelling will be illustrated.

6.1.1 Warehouses presentation and classification

Warehouses have several functions in the supply chain, which can be summed up as follows:

- Storage: This is the most evident function. Warehouses in fact are used to store product either coming from different suppliers either having been produced from different factories.

- Reduction of delivery time: Given the warehouse location, the seller can get closer to the consumption areas reducing its delivery time.

- Order picking: It is the function representing the preparation of clients' orders.

- Differentiation: The structure, the location, the way in which products are stored are just some of the factors who influence the way in which orders are prepared and delivered to the clients, leading to different services in respect to other competitors.

It is important to remark that warehouses are not all the same. Its characteristics are different depending on its positioning in the network and its functions. We can distinguish them in two main categories:

1. Warehouse post-production

   These warehouses are intended used to store products. They act as a buffer between production-driven and demand-driven flows. They can be supplied by one or more factories, served by complete trucks with complete mono-reference pallets. This type of warehouses are named in the literature also as industrial warehouse or factory store.

2. Distribution warehouse or distribution centre

   These warehouses are intended to prepare orders for customers. They are located in strategic points such as catchment areas (close to all company's delivery points) in order to guarantee compliance with delivery times. If the goal is to have zero stock in the warehouses, we are talking about just-in-time flows.

A basic logistics scheme can be seen in the figure 12:

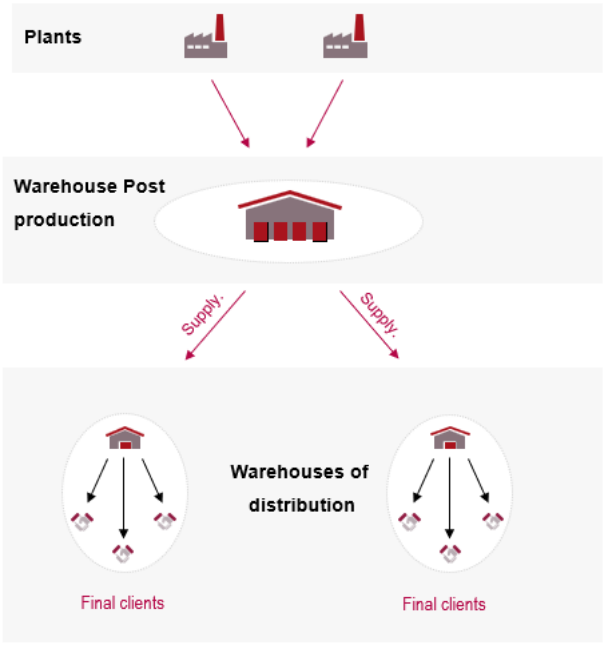

Figure 12. Supply Chain basic logistic network representation

Given the product specification and necessities, a warehouse can be also classified as (figure 13):

- Stocking warehouse: In these warehouses products are stocked on shelf for a certain period of time before being picked and delivered to final clients.

- X-dock: These warehouses are made for managing product flows. Cross-docking is the practice of unloading goods from inbound delivery vehicles and loading them directly into outbound vehicles. In a system with incoming trucking docks and outgoing trucking docks, a cross-docking warehouse may move product directly from receivables to outgoing shipping without long-term storage.

Sometimes stocking is necessary, but in other cases it can be avoided, leading to reduced warehouse costs and faster deliveries, leading the x-dock warehouse an optimal option.

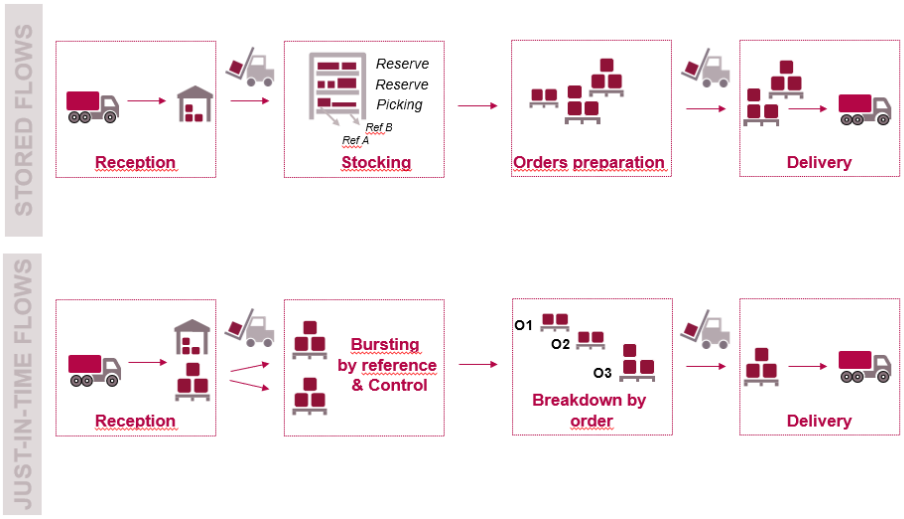

Figure 13. Stored vs. Just-in-time flows

In addition, the type of product stocked in the warehouse will influence the operating conditions and the costs of the warehouse. Storage temperature, product dangerousness and value, product's weight and dimension are just some of the parameters who has to be taken into account when defining a warehouse.

6.1.2 Warehouse cost modelling

Warehouse cost modelling consists in sizing a warehouse and its costs based on volumes, processes, and parameters. The analysis will be done considering stored flows.

Of course, when sizing a warehouse, companies must have in mind primarily the volumes they will have to manage: the incoming and outgoing flows, the number of references, the

number of possible stock levels etc…. Secondly, the processes that will be performed in the warehouse such as the activity of picking, stocking, controlling, etc… Thirdly, some necessary parameters such as productivity ratios, surface usage assumptions, unit cost data associated to stuff, areas and resources exploitation.

Once collected all the stated information, the warehouse modelling can start.

In term of warehousing costs, we can divide them into two categories:

- Variable costs: direct and indirect labour costs
- Fixed costs: surface costs and other costs such as building costs, storage equipment, handling equipment, IS, management and taxes

In the figure 14, we can see a cost repartition overview related to different types of industries:

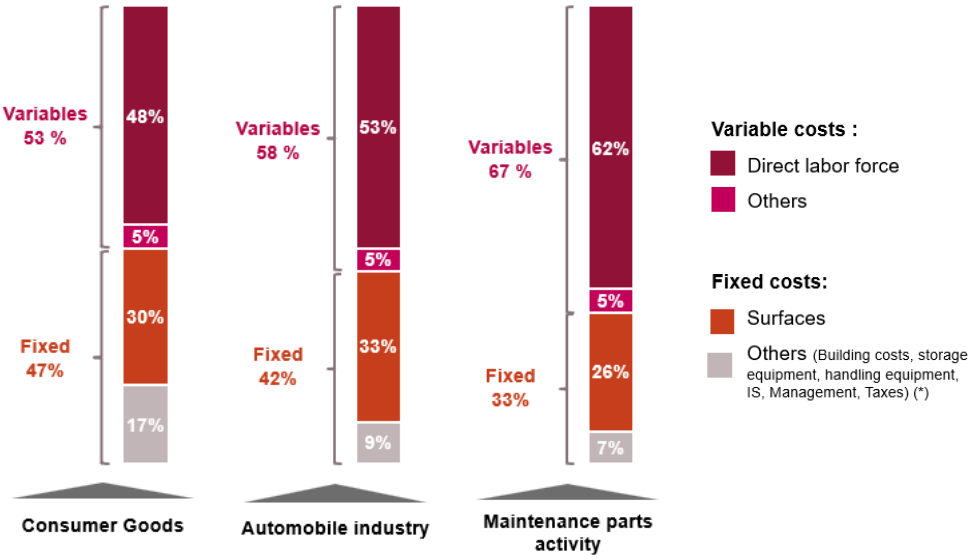

Figure 14. Warehousing cost repartition

Therefore, the main drivers of warehouse modelling are:

1. Direct labour modelling
2. Management modelling
3. Surface modelling
4. Operating equipment modelling

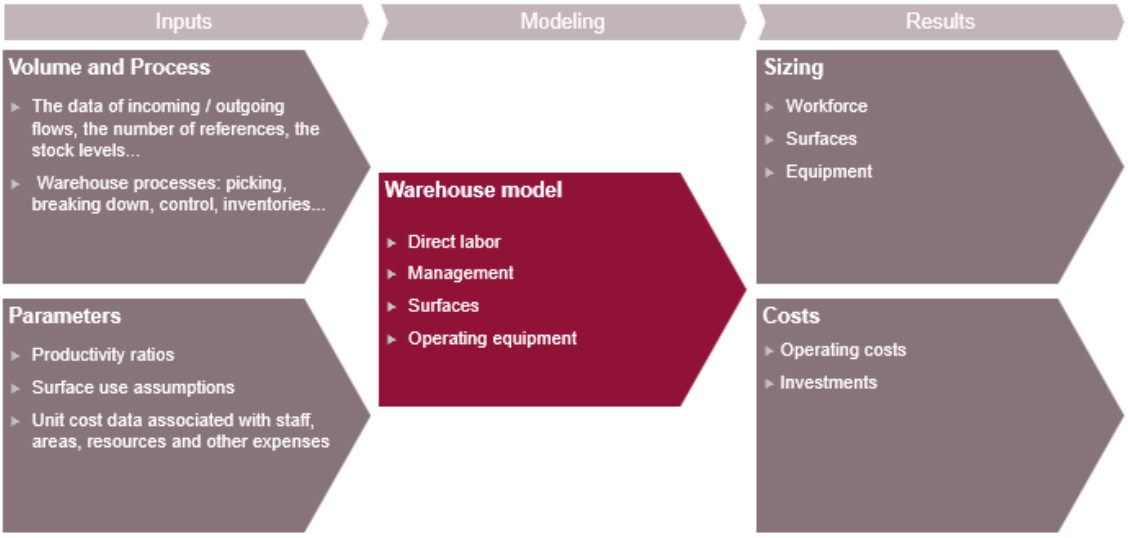

Figure 15. Warehouse modelling approach

Through the dimensioning of these four variables, we will obtain the sizing of a warehouse's needed workforce, surface, and amount of equipment with the associated costs.

Therefore, as shown in the figure 15, after the parameters collection and the process definition, the warehouse modelling can be implemented, leading to the sizing a warehouse's workforce, surface and equipment as well as to the definition of all related costs.

6.1.2.1 Focus on workforce sizing and labour costs estimation

For the definition of how many employees are needed in order to carry on efficiently all the activities into a warehouse and to estimate the related costs, a set of parameters must be known:

- The number of productive hours necessary to carry out a certain logistic activity. The higher the productivity the smaller the number of productive hours is needed.

- The number of productive hours per person per year: from a standard work shift the following must be taken into account: training, vacation, absenteeism hours, and all non-productive hours of attendance. Therefore, to calculate the number of productive hours per person, it is necessary to know the number of paid hours per employee and an estimate of the rate of paid hours not worked.

- The rate of labour efficiency

- Salary cost per person per year: it represents the employee remuneration. Sometimes to economize and to be more efficient, companies prefer to outsource some labour force. It can be less expensive and it allows to avoid the cost of training and forming the new employees.

As an example, we can assume that a random logistic activity requires 15000 hours/year. Employees work 8 hours/day and a year is composed by 220 working days. The rate of paid hours not worked can be assumed equal to 25%. Therefore, if an employee is paid for working 8 hours, its effectives productive hours are: 8*(1-0,25) = 6 hours.

Finally, the rate of labour efficiency is 80% and the hourly wage per employee is 18 €/h. Given the presented parameters we can now compute the number of direct workers needed and the related cost.

$$Nb\ of\ direct\ workers = \frac{Productive\ hours\ for\ logistic\ activity}{Productive\ hours\ per\ person \cdot Efficiency\ rate}$$

$$= \frac{15000}{6 \cdot 220 \cdot 80\%} = 14{,}2 \sim 15\ employees$$

$$Direct\ labour\ cost = Nb\ employees \cdot Yearly\ wage\ per\ employee = 15 \cdot 18 \cdot 8 \cdot 220 = 475200\ €$$

The sizing of the indirect workforce (managers) is deduced from the direct workforce. We will not go into this topic in this thesis.

6.1.2.2 Focus on surface sizing and costs and operating equipment costs

To begin, the main areas who constitute the surface of a warehouse will be presented:

1. Dock

   Is an entrance or exit point for goods that are being loaded or unloaded from trucks and vans. It is one of the most important areas of the warehouse to keep efficient, as it manages the inflow and outflow of goods.

   Its modelling depends on the entry flows and by the number of dock rotation allowed. Docks rotation represents the number of times the docks can be used during a day. Additionally, the incoming and outgoing flows are not regular along the year, therefore, it is taken into account the fluctuation coefficient who allows to size the dock area taking into account eventual externalities through the sizing of it given the max received or shipped volume respect to an average day. Empirically, thanks to numerous flows analysis, the fluctuation coefficient has shown to be often close to 1,2.

$$Dock\ area = \frac{\frac{Annual\ flow\ in\ pallet}{Nb\ of\ days\ reception/shipping} \cdot fluctuation\ coefficient}{Nb\ of\ rotation} \cdot Area\ needed\ per\ pallet$$

2. Reserve area: It is proportional to the max volume stored as it has to be able to absorb the peak stock.

$$Reserve\ area = \frac{\frac{Max\ pallets\ stocked}{Number\ of\ pallets\ per\ location}}{Target\ fill\ rate} \cdot \frac{Floor\ pallet\ area}{Nb\ of\ levels}$$

3. Picking/preparation area: it is normally the lower level of products stock (figure 16). The products on the picking shelf are the ones who will be used for the preparation of clients' orders. To make an example, when going to Ikea the same reference is stocked on different levels. The buyers, once in the warehouse, can take by them self the product from the shelf. That shelf, in this case, represents the reference's picking area. This

warehouse structure was conventional when the activity of picking was done mainly manually. Therefore, the picking shelf were the ones that could be reached easily by humans. Today, the picking is performed also by different automated solutions, who make the here above-described warehouse configuration obsolete.

$$Picking\ area = Nb\ of\ references\ \cdot Nb\ of\ locations/reference \cdot \frac{Floor\ pallet\ area}{Nb\ of\ levels}$$

The total storage area corresponds to the maximum between the reserve area required and the preparation area required.

$$Storage\ area = \max(Reserve\ area, Picking\ area \cdot Nb\ of\ levels)$$

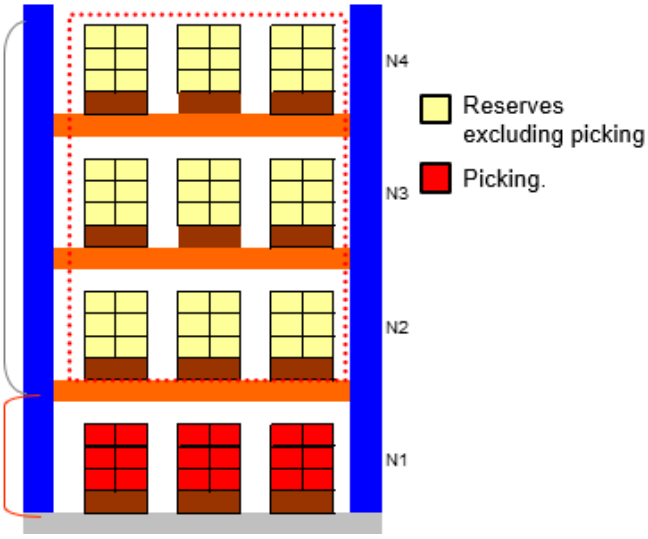

Figure 16. Illustration of the picking and reserve area

4. Other ancillary surfaces influence of course the sizing of a warehouse such as: offices, pallet room, technical rooms, waste room, exterior surfaces, guard post. They are sized depending on the number of employees, the number of machines and other company-specific data.

To conclude, the costs linked to warehouse management include also operating equipment costs. This category of costs is proportional to the number of the equipment on site. The cost is related to the maintenance of storage structures and operating equipment and the cost of rental of the latter.

6.2 Transport - Road transport overview

When modelling a logistic network, the transport is a predominant voice of costs. Many different types of transports are existing: maritime transport, river transport, air transport, railway transport and road transport. From the purchasing of raw materials to the delivery of the final product to the client, many different transportation modalities can be used. In this thesis we will focus on road transportation only.

The road transport costs are not only related to the fuel price and the driven distance. In fact, this sector of activity is concentrated around three central "businesses": FTL, LTL, express. Each of these professions corresponds to different characteristics and service type, and cost constraints.

- FTL: Full Truck Load. In this case the truck is basically all full. If considering EU pallets (80 x 120 cm) a truck can contain max 33 pallets. If considering US pallets (100 x 120 cm) a truck can contain max 26 pallets.

- LTL: Less than Truck Load. In this case the truck is travelling with no more than 4/5 pallets.

- Express: This type of road transport is characterised by very fast deliveries and very low volumes.

6.2.1 Transport costs modelling

When computing the transport costs 3 main factors are taken into consideration:

- The cost per kilometre (oil, tyres, tolls): C_k

- The vehicle and structure cost: C_v and C_s

- Hourly driver wage: C_h

$$Transport\ cost = C_k \cdot (Nb\ of\ Km) + C_h \cdot (Nb\ of\ hours) + (C_v + C_s) \cdot (Nb\ of\ days)$$

On the other hand, only these "technical" parameters are not the only drivers for transport costs. Also, the driven distance and the camion filling rate are essential for the estimation of the transport costs.

6.2.1.1 Impact on transport costs of the truck load

As we mentioned earlier, the price of a load per loading unit (Kg, pallets, m^3, floor meter etc) depends on the quantity loaded. For this reason, shippers use regression curves to level out the price per loading unit. The figure 17 shows the regression curve for a pallet load (Euro-pallet 80x120 cm: classic for road freight transport).

According to this curve, the regression coefficient characterises the price per pallet. Thus, the fewer pallets are loaded (the distance being the same, of course), the higher the price per pallet. With this regression curve, if the buyer wants to send one pallet from A to B, the unit price will be 5 times higher than if he had sent a full truckload with 33 pallets from A to B.

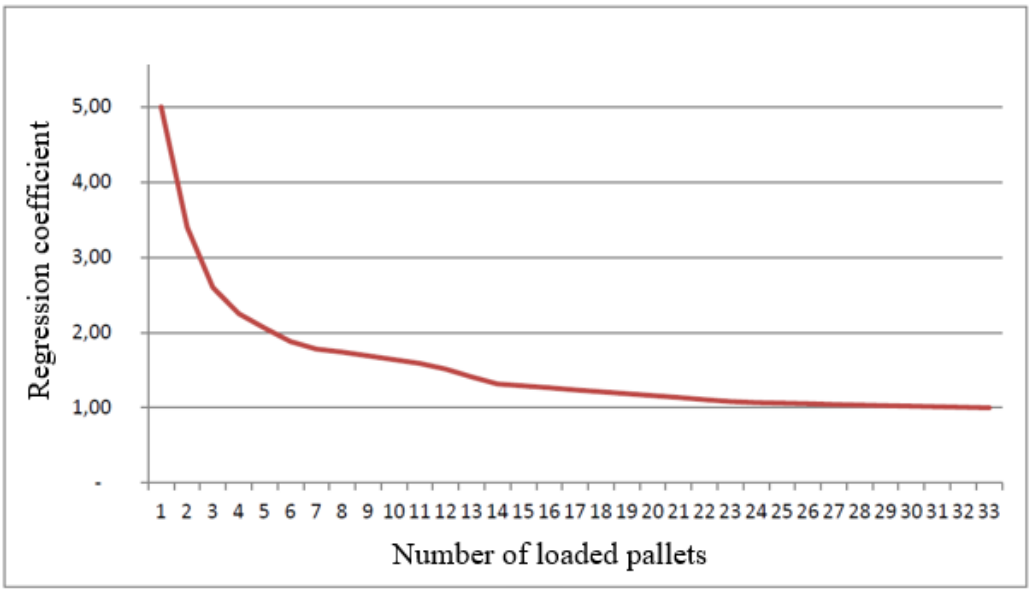

Figure 17. Regression curve representing the cost per pallet in function of the number of loaded pallets in the truck

6.2.1.2 Impact on transport costs of the travelled distance

Distance also influences the cost of a transport, as does the load. Distance cost is one of the factors that is usually attributed to variable costs, since it depends on the travelled distance. Indeed, when the driver's vehicle covers a greater distance, the costs of fuel, depreciation, vehicle maintenance, labour (driving hours) and port or customs charges increase.

The driver is in fact not paid on the actual distance of a journey, but on a calculated distance depending on the actual distance and a variable factor depending on the distance requested. This distance, which is added to the actual distance, is called the repositioning distance. This is the distance that a driver has to travel in addition to the actual distance before he can pick up a load. The figure 18 shows the evolution of the repositioning distance as a function of the distance travelled first for a given transport:

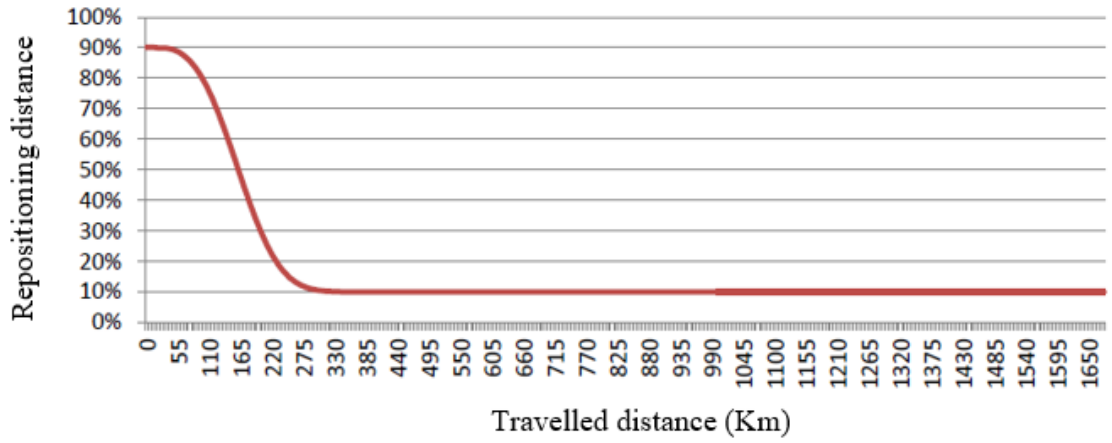

Figure 18. Repositioning distance cost

The repositioning distance represented in the figure 18 is classically expressed as a percentage of the distance travelled. Thus, if the driver transports goods from point A to point B over a distance of 50 km, s/he will have to search within a radius of 40 km around point B to renew his load. The objective is for the service provider to reduce the number of km driven empty and therefore without a load (in this case the fixed costs and personnel costs are not amortized by a customer). If the service provider does not find a load, s/he will of course invoice the customer who ordered the link A to B for all the costs (in this case fixed) associated with the

empty run of the vehicle. This characteristic partly explains the high cost of logistics services far from the major centres of activity.

This repositioning component is, therefore, less important if the provider's customer network is high or dense in the region served as he can afford to find a load over short distances. Consequently, it is generally advisable, from a strictly financial point of view, if using external companies to manage the deliveries, to choose local companies for deliveries to or within a certain country, as they normally should have a large number of customers located in the various regions of this country and, therefore, they are more likely to offer attractive rates for certain routes where their repositioning distance will be very weak or non-existent.

6.2.2 Levers for optimising transport costs

A 1992 study highlighted two important characteristics of logistics costs in companies:

- Downstream logistics account for a larger share than upstream logistics. This trend can also be seen from the employment point of view, where there are more vacancies in distribution than in supply.

- Transport represents the most important cost item: upstream supply transport (12% of the total cost) and downstream distribution transport (33% of the total cost), i.e. almost half of the logistics cost generated.

Companies must therefore know how to identify their transport needs through a careful analysis of their supply chain.

The development of a transport strategy makes it possible to identify possible improvements to the current organisation. The definition of the service is essential because it sets the basis for a pricing system tailored to the company's needs. Then, the optimisation of the use of transport means can be a determining factor. In addition, there are synergies to be activated between upstream and downstream in order to ensure optimal use of its resources. Finally, the choice of service providers and their control is another essential point for reducing the transport bill.

1. The definition of the right level of service

Today, as we mentioned earlier, the company's activity is focused on customer satisfaction. As a result, the entire supply chain of the company is driven by the downstream and therefore by this customer demand.

The company can be considered as a producer of goods, which it delivers according to a delivery plan adapted to its customers. To best meet the expectations of the market, the company can optimise its supply chain considering the following elements:

- The adequacy between the customer's demand (and therefore order) and the products sent by the company
- The punctuality of deliveries to its customers
- The quality and integrity of the products delivered
- The appropriate time interval between two deliveries

These needs, which are dear to every customer, can be satisfied by acting correctly on three central elements of a transport service:

1. Lead-time: delivery time
2. The minimum order quantity (EOQ)
3. The frequency of delivery

Lead-time is essential in transport, as it defines the level of service expected in terms of speed of execution. The shorter it is, the more flexibility it offers to customers and the company in establishing their production plans. However, it is very expensive if it is badly evaluated.

The minimum order quantity is the other element of service quality since it defines the relative ease with which a customer can order products from the company. As we have seen, the cost decreases with volume. Thus, the greater the volume ordered, the cheaper it is per unit. The imposition of a minimum order to customers also protects against prohibitive costs charged by transporters for small volumes.

The frequency of delivery makes it possible to significantly reduce these transport costs. It is also a question of proposing a delivery plan that is appropriate to the customer's needs, while

reducing the frequency of delivery rounds. It is also necessary to take into account the possible delivery times in order to optimise the tour plan in line with the activity of its customers.

2. Optimising the use of resources

The use of transport and loading equipment can be optimised. On average, only half the volume of trucks and trailers is used during a transport operation. There are two main reasons for this under-utilisation of means of transport:

- Volumetric heterogeneity of customer preparations

- Poor organisation of batches

Sometimes in the warehouse, customer preparations (boxes or pallets) are of completely different sizes and volumes, which makes it difficult to optimise the loading. If the pallets are too different in height, there is a significant risk of losing volume in the truck or trailer.

In addition, the preparation of batches is not always optimal. It can happen that products destined for the same customer and prepared on the same day are distributed on two different pallets. This multiplication of transport media also leads to a reduction in the useful capacity of the transport vehicle.

In order to increase the use of truck volume during delivery or supply rounds, it is preferable to

- Increase the size of the batches
- Avoiding preparation breaks (one customer = one batch)
- Increase the stackability of products and pallets

3. Flow synergies to be activated

The organisation of the supply chain itself can be used to develop a new transport strategy. Synergies within the supply chain aim to reduce the number of empty kilometres (i.e. without a load) and the number of vehicles on the road while providing the same services.

To achieve this, companies can opt for different types of synergies depending on their industrial strategy:

- Upstream/downstream synergies
- Inter-site synergies
- Reverse logistics synergies
- Inter-company synergies

Upstream/downstream synergies are often the ones most frequently requested by companies. This involves recovering products from suppliers during the delivery rounds of their own customers. These synergies make it possible to considerably reduce transport costs. This is known as backhauling.

The figure 19 shows the advantages of integrating suppliers into the routes:

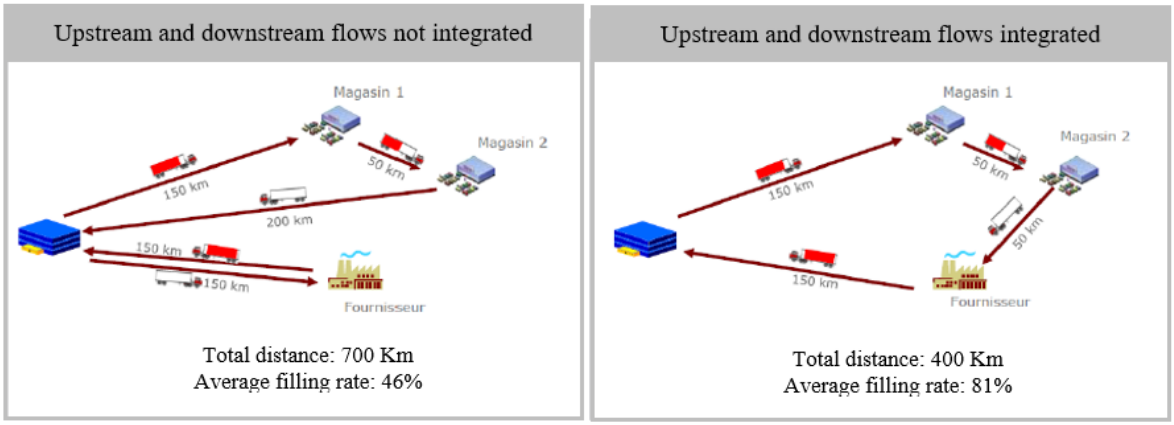

Figure 19. Upstream and downstream flows integration[2]

[2] Argon&Co internal data

This method reduces the number of kilometres travelled but also optimises the fill rate of the trucks on the return journey by recovering products from the supplier. This integration is essential for any transport strategy today.

Similarly, it is also possible to develop transport synergies between the various sites of a company. This involves organising coherent routes between sites and suppliers, or sites and distribution points if there are several types of products intended for the same customer on different sites.

Reverse Logistics is also subject to optimisation. Environmental concerns have pushed manufacturers to deal with the waste and scrap of their products. They can collect their waste from distributors when delivering their products, or organise specific rounds dedicated to collecting end-of-life or defective products.

Inter-company synergies are rarer because they do not depend solely on a company's strategy, but they are an important lever for optimisation. This is particularly true for companies with low or specific transport volumes. Groupings between companies in the same sector of activity are then possible in order to organise rounds with common suppliers or distribution rounds with distributors. Grouping also allows buyers to be more competitive with transporters, with potentially lower transport rates and services. However, these synergies are more difficult to activate, as it requires the alignment and coordination of different actors with different capacities, needs, expectations and strategies. Investment funds sometimes use these synergies to obtain competitive rates by playing on the volume effect of the companies involved.

6.3 Distribution network

The third and last essential element we will discuss when talking about agile logistics modelling is the definition of the distribution network.

A logistic network is the combination of transport, handling and storage facilities, usually organised around one or more nodes.

When talking about distribution network we generally refer to an interconnected group of storage facilities and transportation systems that receive inventories of goods and then deliver them to customers. The definition of this network is essential for companies' performances.

Therefore, to be competitive companies reshape their networks for:

- Improving their economic performances: reshaping efficiently a logistic network can lead to improve transport costs as well as warehouses costs and the working capital requirements.

- Supporting the development of their business: sometime is essential to reinforce the competitive company's positioning vs. competitors in order to outperform in term of clients service through the improvement of the reactivity to clients demand, as we said to thanks to lower LT and higher delivery frequencies, or through the re-designing of the service offer.

- Adapting the logistic network to the evolution of the external context: increasing or decreasing flows because of new trends in demand or new industrial or sourcing schemas.

- Reduce the risk of business interruption: it refers exactly to what it has been said at the beginning of this thesis. In the last years it became always more evident the need to implement an agile supply chain and logistic network in order to respond to sudden external events.

- Improve the company's ecological footprint through the reduction of travelled distances and by and favouring the use of sustainable means of transport

6.3.1 The development of the logistic strategy through the reshaping of the distribution network

Now that we have explained why companies want or need to reshape their logistic/distribution network, it is now necessary to explain how they can define it, in order to choose the best solution for their needs.

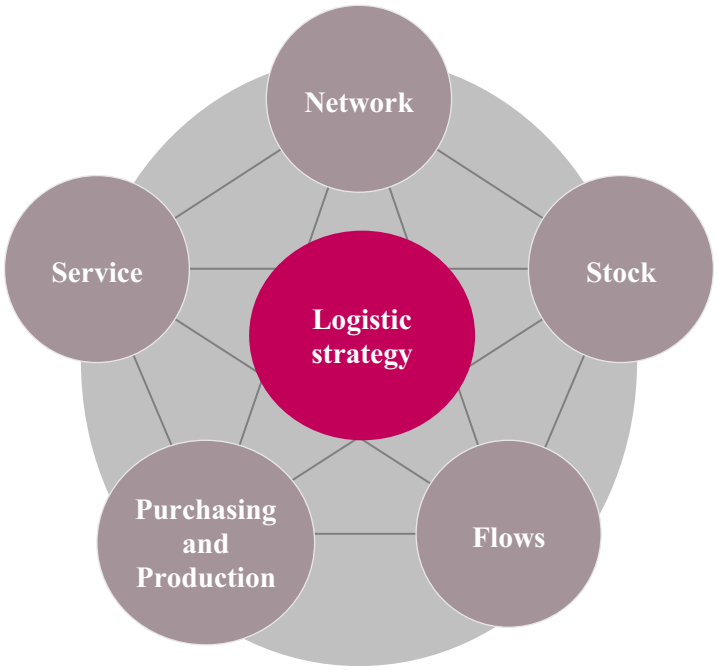

Figure 20. Topics to be discussed for the definition of a successful logistic strategy

As shown in figure n.20, companies should firstly ask them self how their distribution network should be physically structured. This translates into: how many distribution centres (DC) are needed? Where should they be localized? Should the DC be specialized for type of product or per client?

Secondly, it should be defined the inventory management modalities. Companies should ask them self if it is convenient for them to centralize the stock of products with low rotation[3] whereas if should the stock of some products be defined with a single echelon strategy or a multi echelon strategy[4].

In addition, questions about the optimal flows management should be answered. Is it optimal to deliver directly from factories to clients? Or should warehouses be used to enhance the flows consolidations? Should the warehouse work as stocking warehouse or a cross-dock or a hub?

Furthermore, the topic of mergers and acquisition should be treated. Which level of vertical integration of the supply chain is it optimal? Which strategy of M&A and Make or Buy for logistics operation should be put in place?

To conclude, it also important to define the specification of the service level which we want to deliver to the clients. Some companies might in fact prefer to offer the best LT possible, other

[3] The rotation of goods is the speed at which goods are sold. Depending on the industry, this is charged per year, month, week or day. The higher the sales of a product, the higher the rotation of goods.
[4] Single-echelon inventory control problems focus on determining the appropriate level of inventory for an individual unit within the supply chain network, while multi-echelon inventory optimisation takes a holistic approach by focusing on the correct levels of inventory across the entire network

focus on products availability, products tracking or other specific logistics performances. Should the service level strategy be defined in relation to the type of client or products? Many companies in fact prefer to offer an impeccable service to their best customers. Or, on the other hand, there are some products who might necessitate to be pe prioritized in term of delivery performance in respect to others.

6.4 Overall evaluation synthesis of a company's supply chain

To conclude the presented study on logistics modelling, it is logical to ask the question of how the performance of a supply chain be assessed. The performances of a firm's supply chain can be evaluated through 4 key parameters (figure 21):

1. Costs: purchase costs, logistic costs, transport costs, etc.
2. Stocks: Stock of raw materials (RM), work in progress (WIP) and finished products (FP)
3. Service Level: Respect of the given delivery date, availability, frequency, lead time (LT)
4. Sustainability: Impact CO_2, wastes, water and energy consumption, etc.

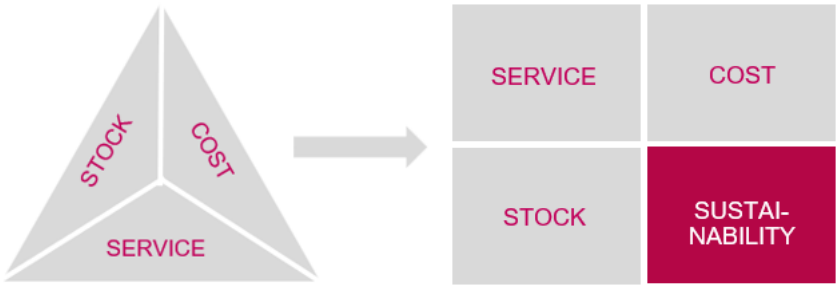

Figure 21. Parameters considered when measuring companies' performances

Since not much time ago, only the first 3 concepts were taken into account, today, instead, also the environmental aspects, as previously said, have an important influence on companies' performances.

Of course, companies would love to outperform in each of this aspect, unfortunately this is not possible. Companies are obliged to choose the best trade-offs possible, for example:

1. Transport speed vs. transport cost
2. Far away suppliers vs. local production
3. Transport overseas by boat vs. by plane
4. PF availability vs. High stock costs of PF

To conclude, the definition of a logistic strategy is a very complex exercise which depends on a high number of different parameters and key decisions as explained above. In addition, there are significative constraints and costs linked to the reshaping of the network such as potential site closures/openings to be financed, transfers of activities that must be done without disrupting the business activity and the need to build a precise transfer plan minimizing costs and risks. Therefore, all these dimensions must be taken into account in order to define the most appropriate logistic strategy.

7 Logistic project in a French food-company

7.1 Introduction

After having presented the external factors that have strong influence for the prioritization of companies' supply-chain agility, after having explained more in detail the concept of agility applied to the domain of logistics and after having reviewed the different elements that need to be considered to reshape the logistics of a company, we will implement the concepts and ideas presented earlier to a concreate case-study concerning the reshaping of a the logistics network of a French company acting in the food sector. We will first explain the context of the project, its planning and the associated approach. We will then discuss the formalisation and recovery of the data (AS-IS analysis). Afterwards, we will present the different scenarios that will be analysed for the definition of the optimal future logistic scenario (TO-BE analysis). Finally, we will explain the model created in order to analyse the data and compare the different scenarios.

7.2 Project context

7.2.1 Description of the project

7.2.1.1 Company's growth strategy

What has been explained so far can be applied to the project I have developed at Argon&Co consulting firm.

The project concerns a well-known agri-food French company. The company has strong growth ambitions and, in all its different business units around the world, the company started in 2018 to implement a global "change" program aiming on a horizon of 7 years (until 2025) at: becoming the world leading company in making and delivering fruit-based products, developing new markets and recipes and setting as the 1st European company for dairy products and desserts.

To reach these ambitious objectives the company needed to put in place an attentive restructuring of its supply chain in order to be the more competitive as possible on the market improving its performances in term of:

1. Visibility on its supply chain,
2. Agility and flexibility of factories based on demand variation,
3. Customer service by optimizing cost, margin and inventory,
4. Industrial capacity to ensure growth ambitions.

These four company's objectives translate operationally into:

1. The formalization of Sales and Operation Planning (S&OP) collaborations between all Industrial Business Units to anticipate needs and ensure good quality and customer service
2. Reviewing its product lifecycle management
3. Reviewing its demand management system to improve the reliability of sales forecasting
4. Reviewing its inventory management consisting into finding the optimal stock level and making the best deployment choices
5. The prioritization of customers on commercial and financial criteria
6. Reviewing the logistics: set up a cost-to-serve logic
7. Reviewing its production planning system consisting into finding the optimal production plan while taking into account the S&OP plan
8. Reviewing its production management strategy through the optimization of costs and processes traceability
9. Reviewing of the purchasing and sourcing strategies

At this aim, the company decided to reshape the logistics network in the USA

The specific context of the latter will be now presented.

7.2.1.2 Description of the logistic project

The project concerns the company north America's market. In 2021 the company had in the USA one own factory with a raw material (RM) and a finished goods (FG) warehouse located in Edinburg, Virginia.

In 2021, the firm's products were delivered to its client, in addition to its internal distribution network, thanks to 3PL providers, mainly by one of the biggest food wholesalers in the US who imports goods worldwide and locally in the US and distributes them from the East coast through the whole country, and another frozen food distributor.

In 2021, the food company has increased its participation into the first mentioned distributor and decided to acquire it. This decision led to the need to reshape its logistic network in the USA as the physical and administrative flows became complex and not optimal.

In 2021 the company existing logistics capabilities were represented by:

- 1 plant located in Edinburg
- 1 RM warehouse in Edinburg
- 1 FG warehouse located in Edinburg, storing only the company's own final products
- 1 distributor's warehouse located in Jamesburg, New Jersey
- 1 distributor's minor warehouse located in Taylor, Pennsylvania

Therefore, after the acquisition of the new sister company, the French firm has increased its logistics footprint on the East coast, it became evident that there were products stored in the distributor's warehouses and in Edinburg who were sent to the same retailers/distributors in the US as well as potential sources (factories/ port of entries) were evolving. Moreover, the offered service and the related costs were not optimal. Therefore, the company's North America BU decided to look for external expertise to review and challenge its current

network and thus propose evolutions to improve the overall service/inventory and cost balance of the 2 entities.

In addition, it is important to highlight that the project perimeter doesn't consider all products managed by the company who can be mainly divided into two categories: ambient products and frozen products. The projects focuses only on ambient products, who, in turn, can be further classified into four different "families" (figure 22):

1. Company's products produced in the US in Edinburg (represented by the large red circle in North America).

2. Company's products imported from its headquarter located in France (represented by the green circle located in Europe).

3. Other products that were delivered by the acquired distributor coming from the US (represented by all light blue circles)

4. Other products that were delivered by the acquired distributor but imported from other countries except North America (represented by all yellow, black, dark blue circles).

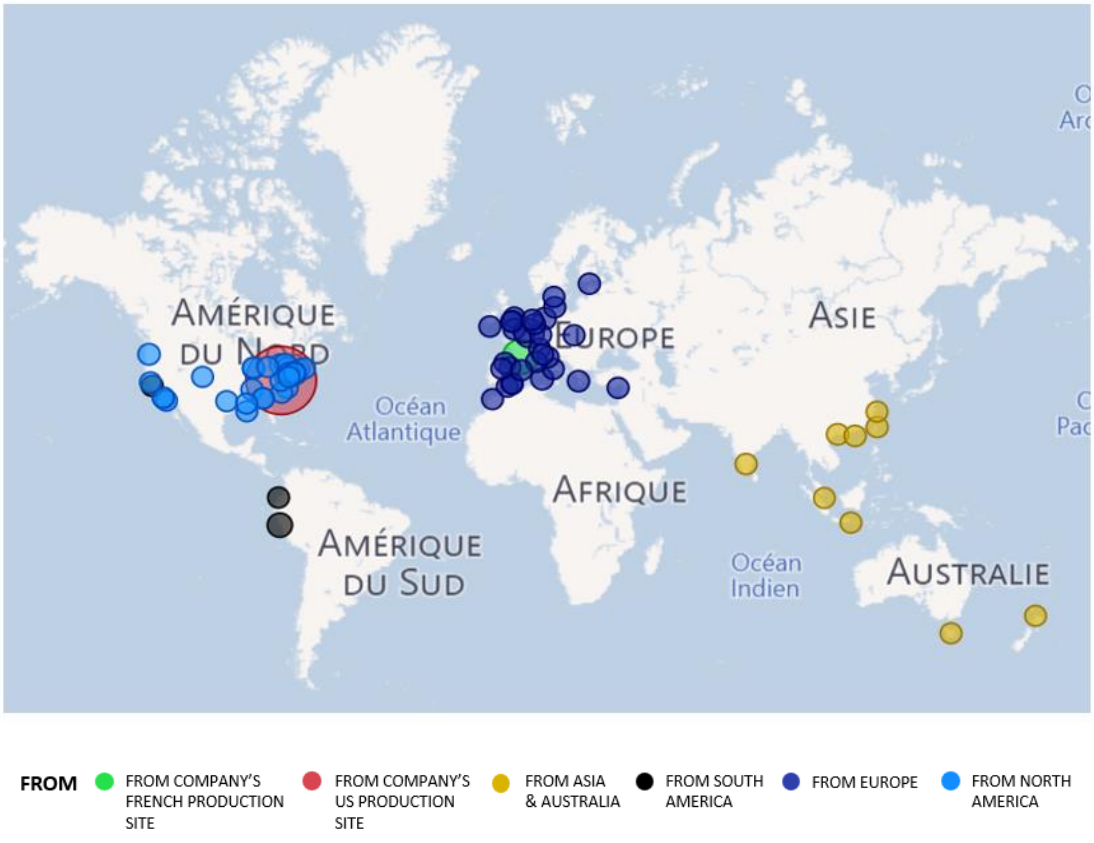

Figure 22. Representation of company's products sources (the ray of each circle is different, as it is proportional to the volumes supplied by each producer).

7.2.2 Objectives

Given the presented project context, the related objectives and stakes were to:

1. Assess the current logistics network and actual logistics costs for both entities
2. Refine the future business projection and related hypothesis (west coast ambitions, time-to-market reduction with inventory building etc.)
3. Identify potential logistics scenarios for the To-be
4. Model the identified scenarios (costs, stock, service) and recommend the best one regarding sensitivity analysis of upstream flows (e.g., factories/port of entry localization) or new acquisitions.

7.2.3 Approach and project planning

The project was scheduled to begin the second week of April. During the Kick-off all the people involved in the project, consequently the Argon team and the company's internal stakeholders, came together in an online meeting. The Argon team was not only constituted by the Paris-based team, but also by a team of consultants from Argon's office located in America. The latter would not be involved for helping at data analysis, but rather for providing insights about the American food-market and future business sales projection. After the Kick-off, regularly meetings called Steering Committees (SteerCo) have been planned to monitor the progress of the project.

The figure 23 shows the latest updated project schedule:

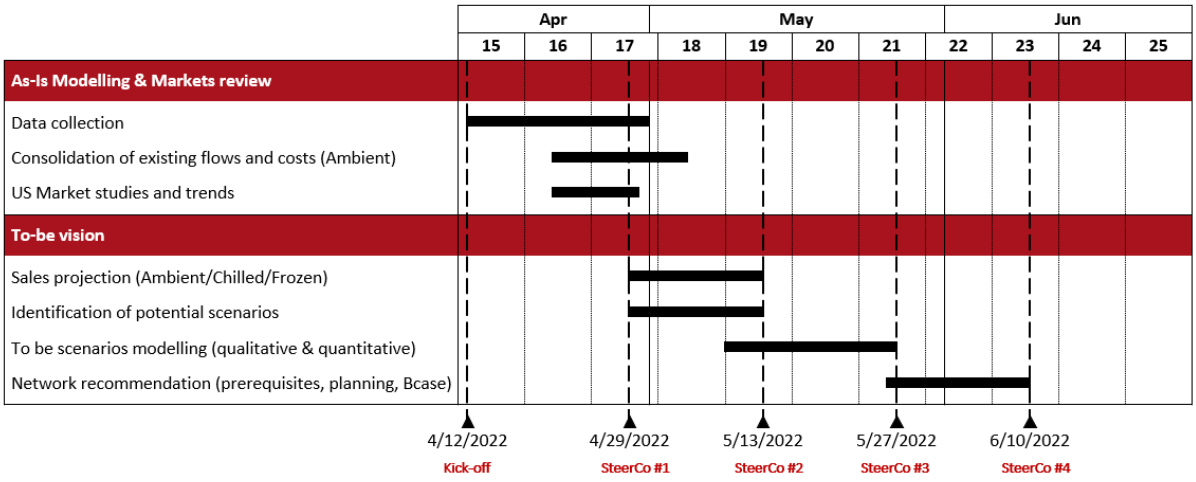

Figure 23. Project planning

The development of the project was planned over about two months and a half. The planning was composed by three macro phases of almost similar duration. The details of the project planning can be found in figure n. 24.

The collection phase consisted in the gathering of useful data for the reconstruction of the AS-IS logistic situation as well as the organisation of interviews and calls with internal company interlocutors in order to understand all the dynamics involved. This step is normally the hardest one when the project is taken on by a consulting company as data are not always all in the hands of one single person. Therefore, the data collection, the more complete as possible, takes time. In our specific case, was even harder because of the need to collect the data not only from the company the project was developed for but also from the acquired entity.

The second phase of the project consisted of processing the data received in such a way as to be able to analyse and map the current flows in America and consequently extrapolate the key values representing the current flows. In addition, this phase was also characterised by meetings to define the assumptions to be taken into account to calculate and evaluate the future scenarios.

Finally, to finalise the project, a model was structured to evaluate possible alternative logistics scenarios on the basis of the as-is data and through the relocation of warehouses and the reorganisation of flows for improving the current network.

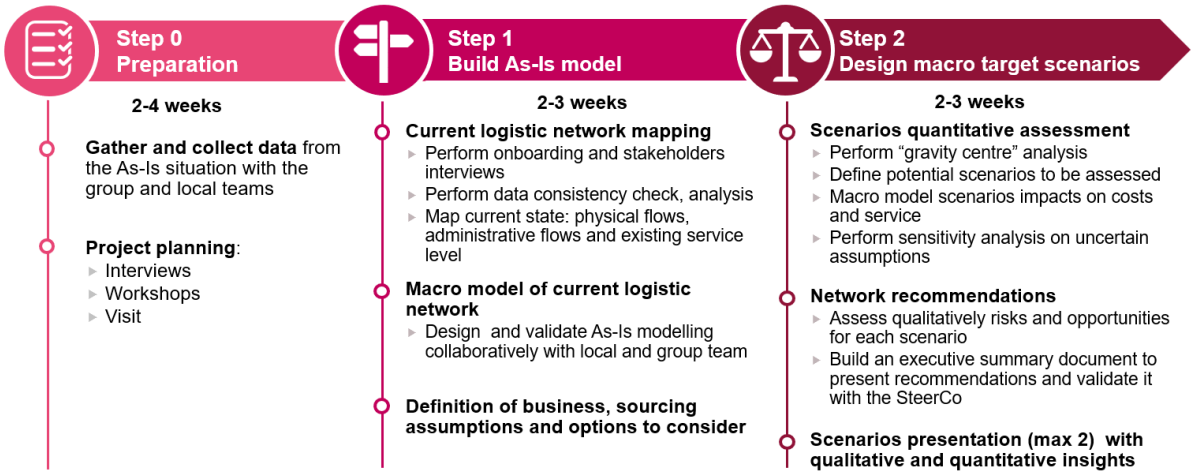

Figure 24. Project's development phases

7.3 Recovery and formalisation of the AS-IS scenario

As previously said, the first weeks of the project were dedicated to the definition of the planning, its scope, its perimeter and the results attended.

The crucial starting point for a project is the reception of the data from the company. Once received the latter, we dedicated our time to the analysis, the cleaning and the reorganization of them in order to be able to have a clear vision of the AS-IS company's logistic situation.
The data sheets received were concerning all the shipments orders and some warehousing data from the two entities in our perimeter of analysis.
The work of data consolidation took some weeks as the data were often massy, incomplete, and not very clear.

For our analysis we focused only on the outbound flows. This means that we analysed only the flows departing from the distribution centres located in the US and reaching the finals customers. All the antecedent flaws were not considered as well as all direct flows (around 50% of all total distributor's flows are delivered directly to its clients) as they wouldn't influence the dimensioning of the warehouses.

7.3.1 As-Is scenario

The actual clients' portfolio is represented in the figure 25 by circles of three different colours. The yellow circles represent the clients supplied by Edinburg warehouse. Secondly, the blue circles and the purple circles picture respectively the clients served by the WHs of the acquired distributor located in Jamesburg and in Taylor.

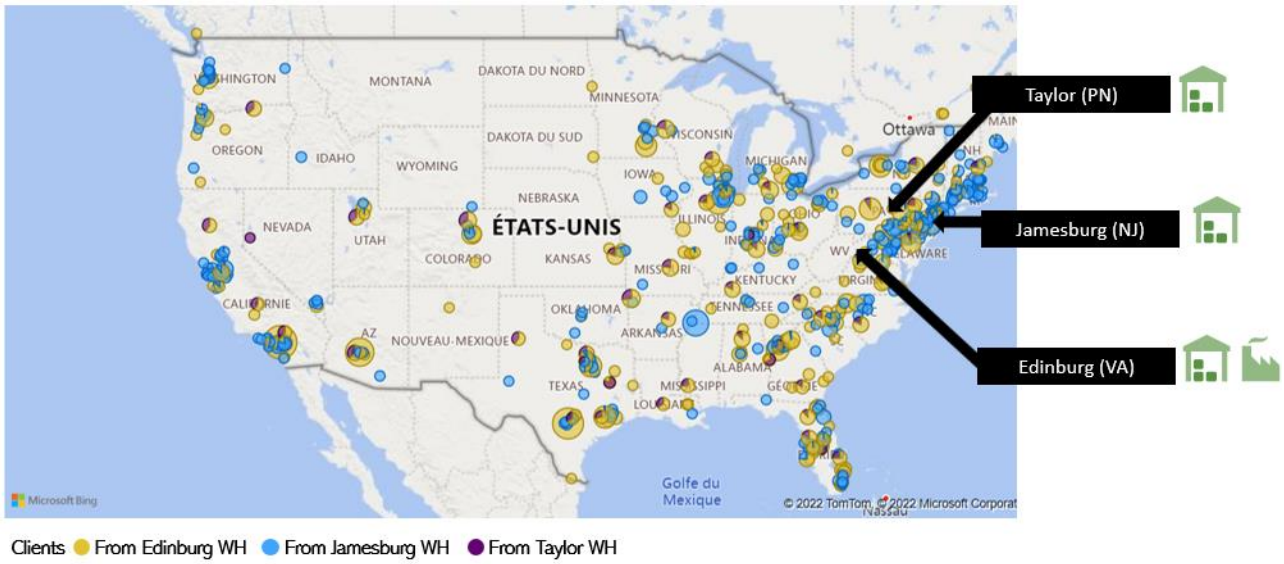

Figure 25. As-Is clients and warehouse configuration

The circles have different dimensions as the ray is proportional to the volumes delivered to each client on a 12 months horizon (in our case December 2020 - November 2022) by each entity.

As we can realize, the clients are mainly distributed on the east costs and the customers' distribution of the two entities is very close.

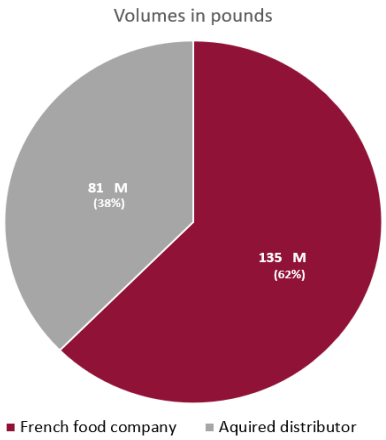

Figure 26. Volume split per entity

Furthermore, when analysing a distribution network, there should be clear information about the warehouse such as: fixed spends, variable spends, the actual workforce and its related costs, the percentage of picking per case etc… as well as all the transport information: the flows that the company managed along a 12 months horizon, the cost

per delivery, the percentage of delivered products vs picked-up (when a final product is picked-up the customer comes directly at the warehouse to get the product, not paying consequently any delivery fee).

In our case not all these data were accessible. The available information is presented below.

As shown in figure 26, the total delivered volume to clients is 216 lbs along the 12 months period December 2020 – November 2021. The volume managed by the French-food company is about 135 million lbs (~61 mln Kg) whereas the volumes managed by acquired distributor is 81 million lbs (~ 37 mln Kg), of which 38M (47% of total) are delivered directly.

Table 4 summarizes other information such as the volumes managed in pallets, the downstream transportation costs, the average delivery distance and size, and the percentage of the deliveries made vs. the percentage of pick-up.

Table 4. Logistic activities and transport costs

	French food company	Acquired distributor		TOT
DC location	*Edinburg*	*Jamesburg*	*Taylor*	-
	East	East	East	-
Number of pallets outbound	100 k	28 k	7 k	135 k
Downstream computed transport costs[5]	14 M$	5 M$	2 M$	21 M$
Average downstream distance (miles)	973	1 100	1 146	1073
Average downstream delivery size	10 pallets	5 pallets	3 pallets	6 pallets
% Delivery (Vs Pick-Up)	17%	6%	100%	19%[6]

7.4 Transport cost computation

An aspect that needs to be further deep dived is related to the transport costs. In fact, we only received the company's transportation costs for the deliveries of products produced in Edinburg who amounted totally for 2,6 M$ (considering only the flows whose delivery was in charge of the company).

[5] These costs consider all flows: delivered and picked-up. These are esteemed costs: see paragraph 6.4
[6] Weighted average w/ volumes in pallets

In addition, we collected from the company's data sheets a table showing the cost of a Full Truck Load (FTL) delivery depending on the driven distance. Therefore, we decided to use this table as starting point to estimate the missing transportation costs related to the picked-up own company's products[7] and to all the acquired distributor's flows).

Firstly, we plotted the points mapping the cost per distance on a graph and, subsequently, we tried to interpolate the points using a linear regression function. As we can see from figure 27, using a linear regression function we can well represent the cost per distance until a distance of about 1300 miles. After this threshold the linear function doesn't work anymore that well. The points are very dispersed.

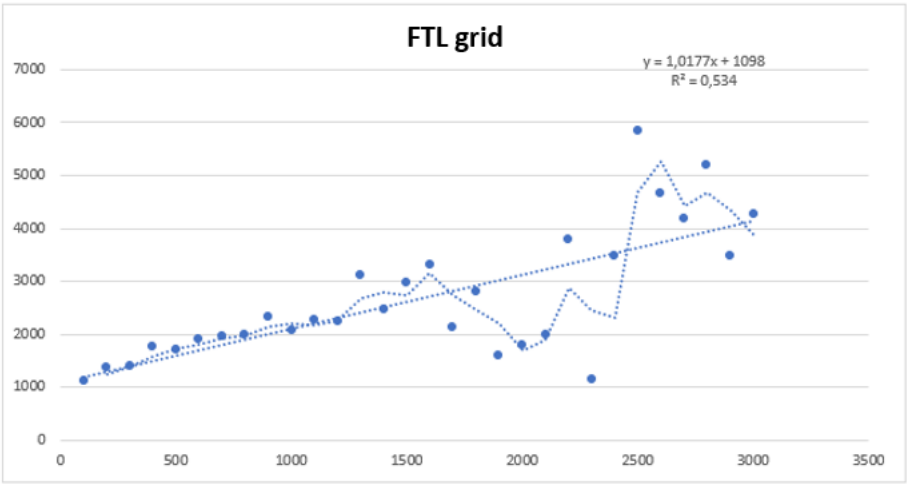

Figure 27. Representation of the FTL grid and its linear regression function

Therefore, thanks to the American Argon team we received a new function able to estimate the transportation costs.

Consequently, we decided to use two different functions for computing transport costs:

$$\begin{cases} y = 1098 + 1{,}0177x & if\ \ x \leq 1300\ miles \quad (1) \\ y = 37{,}375 + 0{,}0742x & if\ \ x > 1300\ miles \quad (2) \end{cases}$$

[7] Picked up costs were also esteemed as the company aims at decreasing the rate of picked-up deliveries. It has been considered interesting to see the transport cost amount if all deliveries were in charge of the company.

It has to be noted that the first function is representing the cost per distance of a FTL truck. Therefore, in case of US pallets, a truck is considered full when 26 pallets are transported.

The second function estimates the cost of a truck containing 22 pallets.

Consequently, given these functions it was easy to compute the cost of delivering 26 pallets for distances shorter than 1600 miles and the cost of delivering a truck containing 22 pallets for longer distances than 1600 miles. But, of course, shipments are different, and each truck can hold in a number of pallets from 1 to 26. How can be then esteemed the cost related to the driven distance of delivering *x* pallets?

In the light of Argon consulting cabinet's experience thanks to all of the logistics project that have been developed along the years, a regressivity coefficient function has been esteemed. The latter represent the increase of the cost/pallet of a truck not completely full (chapter 5.2.1.1).

The Argon function has been evaluated considering European transportations examples, who, of course, use European pallets. The European pallets' dimensions are: 80x120 cm. On the other hand, US pallets are 100x120 cm.

Hence, one EU pallet covers a 80*120 = 9600 cm² surface whereas one US pallet covers 100*120 = 12000 cm² surface.

To readapt the regressivity coefficients to the US model, considering US pallets, it has been extrapolated the exponential function who links the EU regressivity coefficients to the truck filling rate: $y = 374{,}063 \cdot x^{-0{,}467}$, where *y* is the regressivity coefficient and *x* is the truck's surface covered (figure 28).

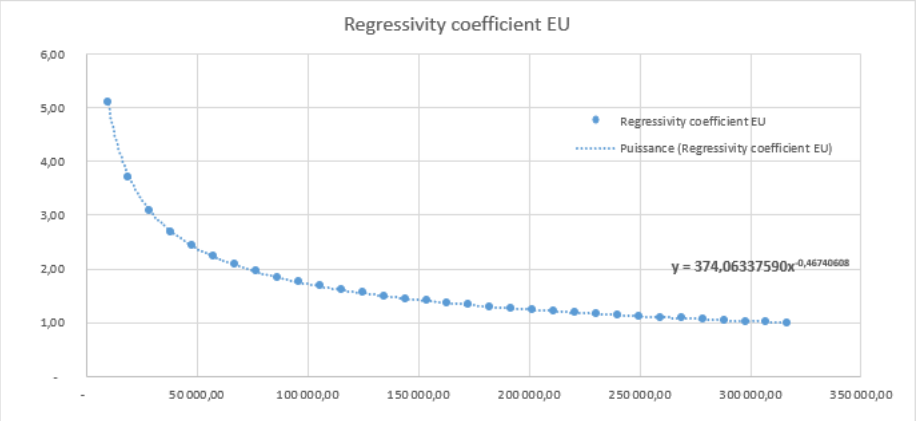

Figure 28. EU regressivity coefficient function

The new US regressivity coefficient are available for consultation in the annex n.1

Finally, through the combination of the functions (1) & (2) and the US regressivity coefficient computed, we were able to evaluate a grid estimating the cost per delivery in the USA taking into account the driven distance and the number of pallets (annex n. 2).

7.5 Project development

After having presented the collection of the AS-IS data, before going into the description of the modelling of new logistic network scenarios, it is interesting to list some key information who need to be taken into consideration when talking about the distribution market in the USA.

7.5.1 Key drivers of distribution strategy in the US

The main aspects that emerged tanks to the market analysis taken on by the Argon US consulting team were:

1. The US population is not homogenously distributed across the country's surface. The population is, indeed, very dense on the east coast and along the pacific coast, but it is registered a very limited population density in the middle of the country. Therefore, even if logistically it would be interesting to have one central warehouse in order to minimize the delivery distances between the clients located on the east and the west coast, this is not possible due to the absence of structures, and sometimes even roads in the middle of the country. It is well known, indeed, that the centre north America is a very desert area.
2. Service Level ambitions. To shorten the lead times, it would be optimal to set-up a regional distribution centre in the east and one in the west, only if the business volumes are sufficient. In case the volumes are not enough, another strategy to consider to be the more reactive as possible is to exploit third party distributors, even if this would lead to higher costs.

3. Industrial footprint. It is optimal to locate the national DC quite close to the factories to limit upstream transportation costs, whereas the number of regional DC(s) should be influenced by the location and specialization level of each factory.
4. US logistics constraints. When reshaping the logistic network in the US it has to be taken into account that on average there are higher logistic costs in the west.

   Since the French-food company is considering reshaping its logistic network, and, as it has already one DC close to its own factory in Edinburg on the east side of north America, it would be logic to consider as second possible DC location, the west side of the country to be closer to the customers located there.

   Therefore, the price of renting and managing a DC in the west has been researched.

   The results are shown in figure 29.

Region	Candidate Location	Labor rate/hr	Rent psf/yr
	National Average	$14.92	
East	North/Central NJ	$17.00	$11.00
East	Memphis TN	$14.74	$3.47
East	Louisville KY	$15.13	$4.25
East	Cincinnati OH	$15.53	$4.26
East	Atlanta GA	$14.62	$4.00
East	Kansas City MO	$15.25	$4.25
East	Dallas TX	$15.03	$4.50
East	Columbus OH	$15.26	$3.97
East	Indianapolis IN	$15.06	$4.00
East	Chicago IL	$16.61	$5.50
East	Saint Louis MO	$15.38	$3.48
East	South NJ / East PA	$14.97	$7.07
East	Baltimore MD	$16.08	$5.25
East	Central FL	$14.20	$5.60
East	Houston TX	$15.09	$5.00
West	Seattle WA	$19.17	$7.87
West	Phoenix AZ	$15.53	$6.00
West	Inland Empire CA	$16.65	$9.04
West	Central Valley CA	$17.31	$7.20
West	Los Angeles CA	$17.36	$14.92

Source: CBRE Research March 2022

Figure 29. Rent and labour cost per North America location

As we can see, the prices related to west locations are considerably higher than the prices of DC located on the east side. Among the possible location in the West, Inland Empire and Central Valley have been considered the possible best choices.

- Inland Empire is Located 45 miles east of the ports of Los Angeles and Long Beach and with excellent freeway access and proximity to a large consumer base. It is one of the most sought-after industrial markets in the country. One of the largest warehouse labor forces in the country and expected to grow 18% by 2030. The average wage for a non-supervisory warehouse worker is $16.65 per hour, 12% higher than the national average,

but lowest in California. First-year taking rents increased 38% to $9.04 per sq. ft. per year (figure 30). The lack of available land will keep the vacancy rate below 1% and rents rising.

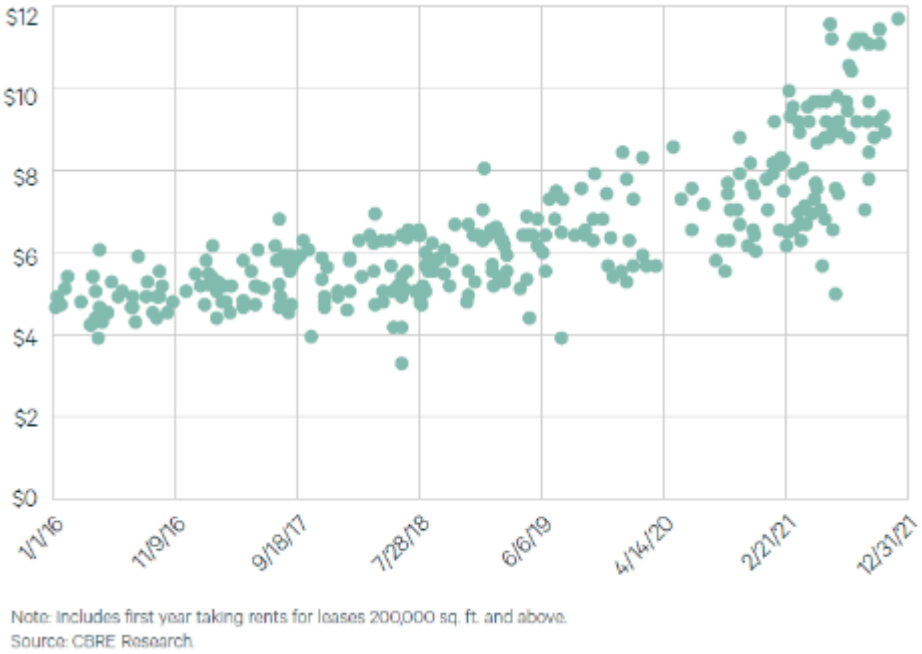

Figure 30. Historical first year taking rents (psf/year)

- The Central Valley is the premier location from which to serve Northern California and the western U.S. thanks to the combination of location, transportation modalities and labor accessibility. Local warehouse labor force is expected to grow by a nation-leading 24% by 2030. The average wage for a non-supervisory warehouse worker is $17.31 per hour, 16.1% higher than the national average. First-year taking rents increased 17.7% to $7.20 per sq. ft. year (figure 31), which remains the lowest of any California market.

Figure 31. Historical first year taking rents (psf/year)

7.5.2 Modelling approach

Following the construction of reliable inputs through the input data analysis, the definition of the warehouse modelling (chapter 6.1.2) and transportation modelling (chapters 6.2.1 and 7.4), it is time to proceed to the construction of a network modelling tool. As shown in figure 32 this phase is constituted by three main steps:

1. The definition of new centres of gravity
2. Define the new flows (which flow pass through which warehouse)
3. Scenario analysis (test and compare multiple scenarios)

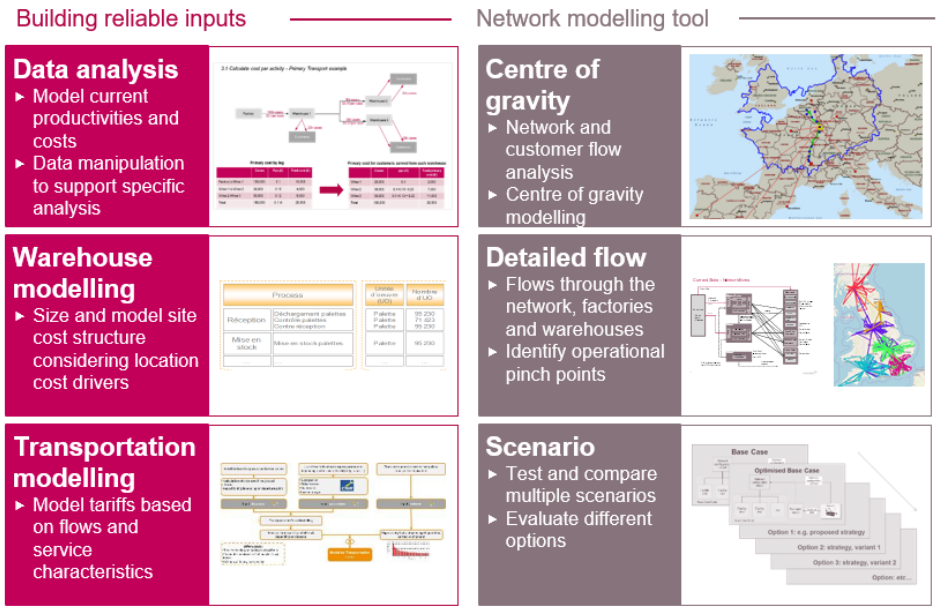

Figure 32. Logistics project standard approach

7.5.2.1 Scenarios and new centres of gravity definition

The first thing has been discussed among all the stakeholders of the project was the definition of the scenarios to be evaluated. It has been agreed to analyse 6 different scenarios presented in the table 5.

Table 5. Approved scenarios to be modelled

	DC locations	Pros	Cons
1 DC scenarios	Edinburg (actual company DC)	• Easy to implement/ limited change • High service level on the East Coast	• Limited to current available area • Actual DC layout &
	Jamesburg (actual distributor's DC)		

			operations not best-in-class • Low service level on the West Coast
	Saint Louis or Memphis (barycentre)	• High service level on the East Coast • Transportation cost reduction • Warehouse cost reduction possible with optimal operations	• Big impacts on current logistics teams • Low service level on the West Coast
2 DC scenarios	▶ East: WH located in Edinburg ▶ West: Las Vegas	• Easy to implement/ limited change • High service level on the East and West coast • Transportation cost reduction	• Increase of inventory and warehouse costs
	▶ East: WH located in Jamesburg ▶ West: Las Vegas		
	▶ East: Columbus OH / Cincinnati OH / Indianapolis IN / Louisville KY ▶ West: Las Vegas NV	• Highest service level achievable US wide • Highest transportation cost reduction	• Big impacts on current logistics teams • Increase of inventory and warehouse costs

As presented, it has been decided that it is not necessary to explore more than 2 DC scenarios. It has been considered relevant to analyse the possibility to keep the actual DC located in Edinburg or the actual DC located in Jamesburg. The last DC currently active located in Taylor, hasn't been considered as it manages very low volumes compared to the other two. Finally, a new optimal location has been computed. Given the actual clients location it has

been computed the barycentre weighted by the volumes delivered yearly to each client. The latter minimizes the downstream delivered distance. Once obtained the result, the most reasonable location closes to the calculated barycentre point has been considered (figure 33). The same reasoning has been applied when considering 2 DC, where the second DC located in the west was the location resulted from the barycentre calculation when considering to points minimizing the distances.

The points minimizing the downstream distances are reported in table 6.

Table 6. Result of optimal DC locations in respect to downstream distances to the actual clients' portfolio

Scenario		X	Y
Scenario 1 DC	DC 1	37,401	-89,784
Scenario 2 DC	DC 1	38,350	-82,469
	DC 2	35,963	-115,055

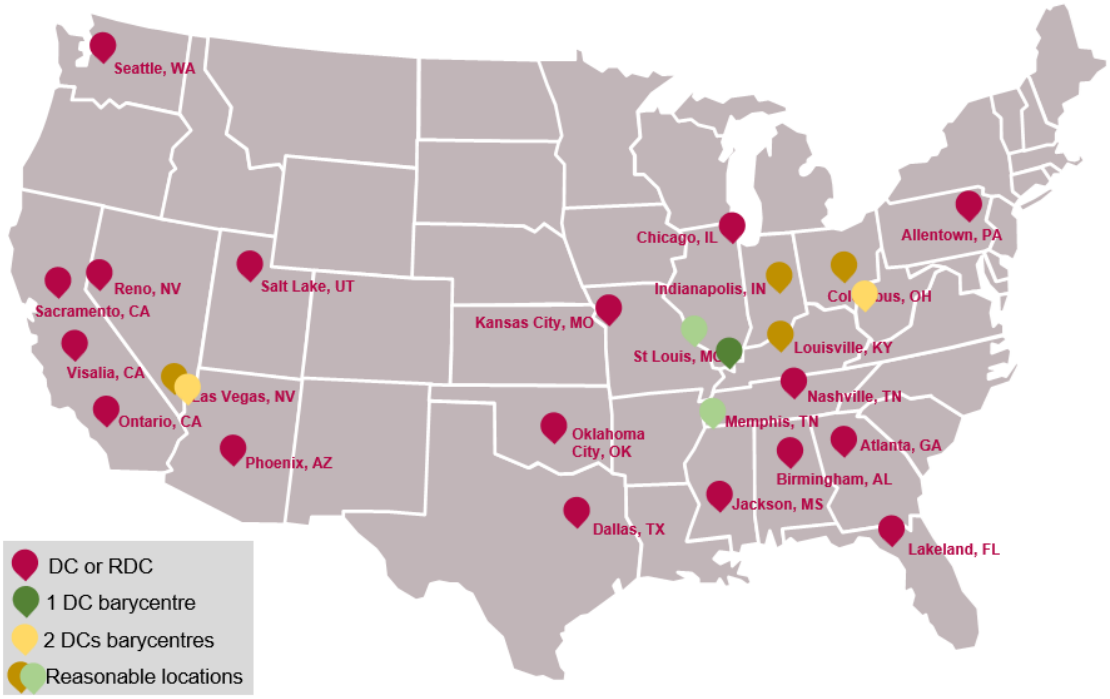

Figure 33. Mapping of the optimal locations

In the map shown in the figure 33 are shown the points who resulted to be logistically optimal in respect to the actual client portfolio. The locations highlighted in the map in light brown and in light green are the ones that concretely make more sense and can be considered in the future scenarios modelling.

7.5.2.2 New flows definition and scenarios analysis

Now that the scenarios to be analysed are clear, the next move is to start the modelling of the scenarios. To do so, 4 steps have been highlighted:

1. The definition of the future sales forecast
2. The definition of the new flows
3. Modelling of the transport, warehousing, service level and inventory functions
4. Result synthesis on 3 axes: service level, cost, inventory

7.5.2.2.1 The definition of the future sales forecast

The integration of the company's business ambition on its ambient range of product by geography and by family of products until 2027 is essential to allow the correct dimensioning of the warehouses and of the flows management (figure 34). The forecast have been developed by the company sales team, who has all the historical of the sales and detailed insights on the market.

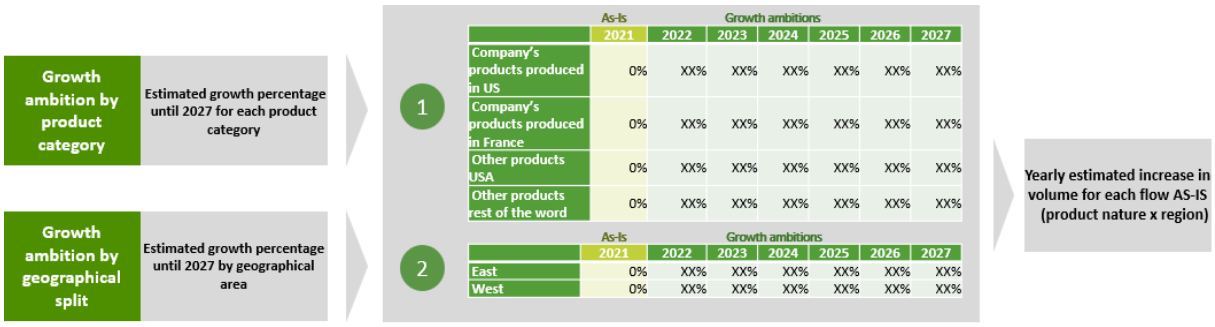

Figure 34. Overview of sales forecast format

One received the sales forecast, the latter are included in the model in order to transform the AS-IS data and be able to transform it into the TO-BE.

7.5.2.2.2 The assignment of the flows of purchased and manufactured products per DC (in case of 2 DCs scenario)

It has been proposed a different approach for the two different types of products.

- The company's product produced in Edinburg are stocked in the nearest DC to the client in order to optimize the downstream costs and to be able to have a higher reactivity to clients' needs. In addition, when considering the business sales projection, it has been considered that if a client was receiving a higher number of 20 pallets per delivery, the pallets won't be stocked in the warehouse, but directly delivered (figure 35).

Figure 35. Delivery approach for manufactured products

- All imported and purchased products are, insead, associated to the DC who will minimize the total inland transportation costs. This means that, for simplicity, for all products imported from other continents, the maritime route was not considered. Instead, the route from the port of arrival to the warehouse was additionally evaluated. Moreover, for this category of products it hasn't been applied the same logic as for the produced products according to which deliveries with more than 20 pallets became direct. In fact, as in this category are also included products not form the company, there might be some unknown specificty for the delivery that must be discussed client by client. Therefore, all the distributor's flows that where passing through DC remaind unchanged as well as all the dirct flows remained direct.

7.5.2.2.3 Modelling of the transport, warehousing, service level and inventory functions

For the modelling of transport costs and warehousing costs, the rules explained in the chapter n. 6.1.2 & 6.2.1 & 7.4 of this thesis have been applied. On the other hand, we still need to explain how the service level and the inventory level have been evaluated.

The service level was esteemed through the computation of the expected lead time. For the evaluation of the latter a large set of parameters has been taken into account, who has been defined in accordance with the company's logistic department and thanks to Argon's experience. Talking with the project stakeholders it has been agreed that usually there is no

more than one driver per delivery as it is very expensive. In China for example, the deliveries are usually taken by two drivers in order to optimize the LT. This resulted not to be possible in the US due to cost reasons. In addition, given the trucking hours of service limits regulations, the parameters for the LT calculation are reported into table 7.

Table 7. Parameters for the evaluation of the delivery LT

Parameters for delivery LT	Value
Loading (h) / delivery	1,5
Unloading (h) / delivery	2
Max continuous driving hour / driver	4
Punctual break hour	1
Max driving hour / day / truck - 1 driver	8
Max driving hour / day / truck - 2 drivers	22
Night break hour / day - 1 driver	15
Night break hour / day - 2 drivers	2
Picking hours (departure D)	6
Picking hours (departure D+1)	20
Coefficient of correction	1,3

Table 8. Average truck speed in respect to min driven distance

Min Delivery Distance (miles)	Speed (mph)
0	30
100	50
200	65

Overall, the LT can be esteemed as follows:

$$Lead\ Time\ (h) = Driving\ hours + Truck\ immobilization\ hours + Picking\ LT\ hours$$

The driving hours were defined by dividing the distance by the average speed. The average speed was considered as specified by the table 8. The latter defines the average speed to be

considered according to o the minimum driven distance. In fact, the shorter the distances, the greater the likelihood of driving on urban roads where travel speed is limited.
The immobilization hours represent the time during which the truck is still and the time is used to carry on all the logistics activities involved such as the truck loading, unloading, driving breaks etc…
Picking hours represent the time needed to prepare the order that must be shipped. If the delivery is priority or urgent, it is assumed that the order can be completed in 6 hours after the receiving of it, if not the standard picking time is assumed around 20 hours.

Secondly, the definition of the inventory level has to be still discussed. In our case, it has been considered only the DC inventory level, and it has been considered a general inventory level of 30 days in accordance with the actual inventories. Consequently, the inventory level, in this specific project has been treated more as a parameter than as a variable.

7.5.2.2.4 Results synthesis on 3 axes: service level, inventory and costs

In the figure here below are synthetised the result obtained thanks to our model. The analysis was evolved without considering the original direct flows (the flows that were delivered directly already in the AS-IS scenario). Moreover, the results presented here are related to the AS-IS data set. In fact, due to internal problems, there has been a delay in the reception before the scheduled end of the project of the business projections, who couldn't be inserted in the model. In any case, the model created is dynamic and built for considering the integration of the sales forecast, who for the moment have been set to zero. This means that, once the latter will be received and incorporated into the model, the new updated results can be easily computed.

[8] From port entry to Warehouse – Maritime costs are not integrated
[9] WH model under review to distinguish WH locations

Service level

	1 DC scenarios			2 DCs scenarios		
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
DC1 location	Edinburg (BAP)	Jamesburg (PSS)	Columbus (optimal location)	Edinburg (BAP)	Jamesburg (PSS)	Columbus (optimal location)
DC2 location	-	-	-	Las Vegas	Las Vegas	Las Vegas
LT 1 day	*29 %*	*30 %*	*9 %*	*39 %*	*40 %*	*25 %*
LT 2 days	*43 %*	*38 %*	*17 %*	*60 %*	*55 %*	*58 %*
LT 3 days	*70 %*	*61 %*	*69 %*	*93 %*	*87 %*	*93 %*
LT 4 days	*79 %*	*77 %*	*97 %*	*100 %*	*100 %*	*100 %*
LT 5 days	*97 %*	*95 %*	*100 %*	*100 %*	*100 %*	*100 %*
LT 6 days	*100 %*	*100 %*	*100 %*	*100 %*	*100 %*	*100 %*

Costs

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
DC location	Edinburg (BAP)	Jamesburg (PSS)	Columbus (optimal location)	Edinburg (BAP)	Jamesburg (PSS)	Columbus (optimal location)
DC2 location	-	-	-	Las Vegas	Las Vegas	Las Vegas
Transport costs	*24,2 M*	*31,1 M*	*29,7 M*	*22,1 M*	*27,5 M*	*25,4 M*
Upstream[10]	1,90 M$	6,26 M$	9,43 M$	6,86 M$	10,94 M$	10,32 M$
Downstream	22,32 M$	24,86 M$	20,22 M$	15,20 M$	16,52 M$	15,05 M$
Direct	0 M$	0 M$	0 M$	0 M$	0 M$	0 M$
WH costs[11]	*3,7 M$*	*3,7 M$*	*3,7 M$*	*3,75 M$*	*3,76 M$*	*3,74 M$*
WH costs DC1	3,7 M$	3,7 M$	3,7 M$	2,75 M$	2,61 M$	2,88 M$
WH costs DC2	-	-	-	1,00 M$	1,15 M$	0,86 M$
TOT costs	***27,9 M$***	***34,8 M$***	***33,4 M$***	***25,8 M$***	***31,2 M$***	***29,1 M$***
TOT costs (NO upstream)	***26,00 M$***	***28,39 M$***	***23,97 M$***	***18,94 M$***	***20,26 M$***	***18,78 M$***

Inventory

30 days stock coverage

Figure 36. Scenarios analysis synthesis

As shown in the figure n.36, there are reported the results in term of cost, stock and service level per each scenario. As mentioned before, in our case, the stock doesn't represent an element of discernment for choosing which scenario is best. The value has been treated as a parameter; therefore, the value is equal in every scenario. The choice of the best network configuration is, consequently, linked to the service level and the total costs. The scenarios considering Jamesburg DC (scenario 2 and scenario 5) are always the worst both in term of costs and service level. Overall, the 2 DCs scenarios result to be better than the one DC scenarios.

Of course, the costs of the 2 DC scenarios do not consider the investments that need to be put in place for the construction of the new warehouse. In addition, it can be also noted that the warehouse costs for the one DC scenarios are equal. This is due to the fact that the parameters used for the computation of the warehouses' costs are not differentiated in term of specific location. The latter have been only diversified for the east and west coast (annex 3). Therefore, for a more accurate analysis, more precise prices related to the chosen locations should be researched.

In conclusion, the best solution for the French-agrifood company is to keep the main warehouse located in Edinburg and open a new DC in the west coast to shorten distances, gain in reactivity and transportation costs.

As a matter of fact, many simplifications have been done in the modelling of the US network, but sometimes companies do not need incredibly precise models to decide which are the best next steps, but only clear and simple directories.

It is also very important the flexibility of the modelling. The model created for the company is able to recompute all the data automatically if some parameters are changed. If the location who want to be considered changes or other.

8 Conclusion

The reshaping of a company's logistics system has become a fundamental and frequent issue nowadays. Companies need to be able to respond as promptly as possible to the needs of their customers through certainly the realization of accurate and reliable sales forecasts, but also through efficient management of distribution flows through the optimization of all the functions involved in the logistics network of a supply chain: warehouses, transportation and the logistics configuration itself. An example of this is embodied by the French company presented in this thesis, which, in order to achieve important growth objectives, found it necessary to revisit its logistics system in north America following the acquisition of one of its 3PL providers and starting to exploit the possible synergies created as soon as possible.

This implies a great work in data analysis and modelling to identify the possible best future scenarios. It must be indeed discussed the opening/closing of possible DCs, the relocation of these and, following an acquisition, it is also necessary to implement all possible synergies: identify common customers, massify the transports, as well as the homogenization and internal reorganization of the information systems and personnel.

Additionally, given companies' need for agility, the modelling must be dynamic and able to obviously take into account future growth prospects in order to appropriately estimate the sizing and cost of flows and warehousing.

In the case study presented, after the analysis of different scenarios, the scenario with the more reasonable implementation was identified as possible option, considering the estimation of the service level that it would be possible to offer on average to customers and the total costs that would then be incurred, taking into account transportation and warehousing costs.

In fact, as explained, the best solution is never obvious. The final choice for restructuring a business network is given by considering several trade-offs generally represented by 4 variables: cost, stock, service level and environmental impact.

Bibliography

Articles

[1] Martin Christopher (2000). The Agile Supply Chain : Competing in Volatile Markets, Industrial Marketing Management. Vol 29, No. 1., pg. 37-44

[2] Theodore P. Stank, Beth R. Davis, & Brian S. Fugate. 2005. A strategic framework for supply chain oriented logistics, Journal of business logistics. Vol. 26, No. 2.

[3] Amanda J. Schmitt, Siyuan Anthony Sun, Lawrence V. Snyder, & Zuo-Jun Max Shen. 2014. Centralization versus Decentralization: Risk Pooling, Risk Diversification, and Supply Chain Disruptions.

[4] Şimal Çelikkol, Murat Sağbaş, & Ibrahim Yikilmaz. 2021. Agile supply chain management.

[5] Raoul Dubeauclard, Kerstin Kubik, and Venu Nagal. 2015. How agile is your supply chain?. McKinsey&Company.

[6] D. M. Gligor, & M. C. Holcomb. 2012. "Understanding the Role of Logistics Capabilities in Achieving Supply Chain Agility: A Systematic Literature Review," Supply Chain Management: An International Journal, Vol. 17, No. 4, pp. 438-453.

[7] Sean Monahan, Alberto Oca, & Fabio Faria. 2017. Logistics Challenges Can Make or Break CPG Integrations. The way in which an acquiring food and beverage company combines supply chains is important—it can generate or squander post-merger value. Addressing four key areas helps avoid the pitfalls.

[8] Erich L. Gampenrieder. 2016. Demand-driven Supply Chain 2.0 – A direct link to profitability.

[9] Ashish Dwivedi, & Sanjoy Kumar Paul. 2022. A framework for digital supply chains in the era of circular economy: Implications on environmental sustainability, Business strategy and the environment volume 31, issue 4, Pages 1249-1274.

[10] Anne-Titia Bové, & Steven Swartz. 2016. Starting at the source: Sustainability in supply chains. McKinsey Company.

[11] Paolo Angelucci, Sonya Bhonsle, Lori Chao, & Hugh Jones. 2018. Sustainability. The missing link.

[12] Annachiara Longoni, & Raffaella Cagliano. 2018. Inclusive environmental disclosure practices and firm performance: The role of Green Supply Chain Management.

[13] Mohammad Najjar, Michael H. Small, & Mahmoud M. Yasin. 2020. Social Sustainability Strategy across the Supply Chain: A Conceptual Approach from the Organisational Perspective.

Dissertations and theses, academic conferences, web pages, etc..

[14] Développement d'une stratégie de transport routier de marchandises adaptée aux besoins de l'activité, Fabrice Payet

[15] Environmental, Social, and Goveçrnance (ESG) Criteria (investopedia.com)

[16] 7 Areas of Supply Chain - Supply Chain 4 Me

[17] Supply Chain Definition (investopedia.com)

[18] Importance of Agile Supply Chain - Advantages & Benefits (jiga.io)

[19] The Most Sustainable Modes of Transport – is Snail Travel the Answer? | WorkingAbroad

[20] https://www.argonandco.com/en/news-insights/articles/logistics-adoption-of-digital-innovation-is-fundamental-to-perform-and-meet-the-needs-of-a-future-that-has-arrived-early/

[21] Presentation on logistics and Supply Chain – Internal material

Glossary

CAC40: *Cotation Assistée en Continu* is a benchmark French stock market index. The index represents a capitalization-weighted measure of the 40 most significant stocks among the 100 largest market caps on the Paris Bourse.

DC: Distribution centre

FG: Finished Goods

FTL: Full Truck Load

GSM: Green Supply Chain Management

LT: Lead Time

LTL: Less than full Truck Load

M&A: Mergers and Acquisitions

NA: North America

RM: Ram materials

S&OP: Sales and Operations Planning

SCA: Supply Chain Agility

SCM: Supply Chain Management

SME: Small medium enterprises

WH: Warehouse

Annexes

Annex 1 – EU and US regressivity coefficients

Nb pallets	Surface EU (cm²)	Regressivity coefficient EU	Surface USA (cm²)	Regressivity coefficient USA
1	9 600,00	5,10	12 000,00	4,59
2	19 200,00	3,71	24 000,00	3,32
3	28 800,00	3,08	36 000,00	2,75
4	38 400,00	2,70	48 000,00	2,40
5	48 000,00	2,43	60 000,00	2,16
6	57 600,00	2,23	72 000,00	1,99
7	67 200,00	2,08	84 000,00	1,85
8	76 800,00	1,95	96 000,00	1,74
9	86 400,00	1,85	108 000,00	1,64
10	96 000,00	1,76	120 000,00	1,57
11	105 600,00	1,68	132 000,00	1,50
12	115 200,00	1,62	144 000,00	1,44
13	124 800,00	1,56	156 000,00	1,38
14	134 400,00	1,50	168 000,00	1,34
15	144 000,00	1,45	180 000,00	1,30
16	153 600,00	1,41	192 000,00	1,26
17	163 200,00	1,37	204 000,00	1,22
18	172 800,00	1,33	216 000,00	1,19
19	182 400,00	1,30	228 000,00	1,16
20	192 000,00	1,27	240 000,00	1,13
21	201 600,00	1,24	252 000,00	1,11
22	211 200,00	1,21	264 000,00	1,08
23	220 800,00	1,19	276 000,00	1,06
24	230 400,00	1,16	288 000,00	1,04
25	240 000,00	1,14	300 000,00	1,02
26	249 600,00	1,12	312 000,00	1,00
27	259 200,00	1,10		
28	268 800,00	1,08		
29	278 400,00	1,06		
30	288 000,00	1,05		
31	297 600,00	1,03		
32	307 200,00	1,01		
33	316 800,00	1,00		

Annex 2 – Transportation cost grid

Distance (miles) \ Nb. Pallets	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
50	202,9	146,8	121,4	106,1	95,6	87,8	81,7	76,8	72,7	69,2	66,2	63,5	61,2	59,1	57,2	55,5	54,0	52,5	51,2	50,0	48,9	47,8	46,9	45,9	45,1	44,2
100	211,9	153,3	126,8	110,8	99,9	91,7	85,3	80,2	75,9	72,2	69,1	66,3	63,9	61,7	59,8	58,0	56,4	54,9	53,5	52,2	51,1	50,0	48,9	48,0	47,1	46,1
150	220,9	159,8	132,2	115,5	104,1	95,6	89,0	83,6	79,1	75,3	72,0	69,1	66,6	64,3	62,3	60,4	58,8	57,2	55,8	54,5	53,2	52,1	51,0	50,0	49,1	48,1
200	229,9	166,3	137,6	120,2	108,3	99,5	92,6	87,0	82,3	78,4	74,9	72,0	69,3	67,0	64,8	62,9	61,1	59,5	58,0	56,7	55,4	54,2	53,1	52,0	51,1	50,1
250	238,9	172,8	142,9	124,9	112,6	103,4	96,2	90,4	85,5	81,4	77,9	74,8	72,0	69,6	67,4	65,4	63,5	61,9	60,3	58,9	57,6	56,3	55,2	54,1	53,1	52,0
300	247,8	179,3	148,3	129,6	116,8	107,3	99,8	93,8	88,7	84,5	80,8	77,6	74,7	72,2	69,9	67,8	65,9	64,2	62,6	61,1	59,7	58,4	57,2	56,1	55,1	54,0
350	256,8	185,8	153,7	134,3	121,0	111,2	103,4	97,2	92,0	87,5	83,7	80,4	77,4	74,8	72,4	70,3	68,3	66,5	64,9	63,3	61,9	60,6	59,3	58,1	57,0	55,9
400	265,8	192,3	159,1	139,0	125,3	115,0	107,0	100,6	95,2	90,6	86,7	83,2	80,2	77,4	75,0	72,7	70,7	68,8	67,1	65,5	64,1	62,7	61,4	60,2	59,0	57,9
450	274,8	198,8	164,4	143,8	129,5	118,9	110,7	104,0	98,4	93,7	89,6	86,0	82,9	80,0	77,5	75,2	73,1	71,2	69,4	67,7	66,2	64,8	63,5	62,2	61,0	59,8
500	283,8	205,3	169,8	148,5	133,7	122,8	114,3	107,4	101,6	96,7	92,5	88,8	85,6	82,7	80,0	77,7	75,5	73,5	71,7	70,0	68,4	66,9	65,5	64,2	63,0	61,8
550	292,8	211,8	175,2	153,2	138,0	126,7	117,9	110,8	104,8	99,8	95,5	91,6	88,3	85,3	82,6	80,1	77,9	75,8	73,9	72,2	70,6	69,0	67,6	66,3	65,0	63,8
600	301,8	218,3	180,6	157,9	142,2	130,6	121,5	114,2	108,1	102,9	98,4	94,5	91,0	87,9	85,1	82,6	80,3	78,2	76,2	74,4	72,7	71,2	69,7	68,3	67,0	65,7
650	310,7	224,8	186,0	162,6	146,5	134,5	125,1	117,6	111,3	105,9	101,3	97,3	93,7	90,5	87,6	85,0	82,7	80,5	78,5	76,6	74,9	73,3	71,8	70,4	69,0	67,7
700	319,7	231,3	191,3	167,3	150,7	138,4	128,8	121,0	114,5	109,0	104,2	100,1	96,4	93,1	90,2	87,5	85,0	82,8	80,7	78,8	77,1	75,4	73,8	72,4	71,0	69,6
750	328,7	237,8	196,7	172,0	154,9	142,3	132,4	124,4	117,7	112,1	107,2	102,9	99,1	95,7	92,7	90,0	87,4	85,1	83,0	81,0	79,2	77,5	75,9	74,4	73,0	71,6
800	337,7	244,3	202,1	176,7	159,2	146,2	136,0	127,8	120,9	115,1	110,1	105,7	101,8	98,4	95,2	92,4	89,8	87,5	85,3	83,3	81,4	79,6	78,0	76,5	75,0	73,5
850	346,7	250,8	207,5	181,4	163,4	150,0	139,6	131,2	124,1	118,2	113,0	108,5	104,5	101,0	97,8	94,9	92,2	89,8	87,5	85,5	83,5	81,8	80,1	78,5	77,0	75,5
900	355,7	257,3	212,8	186,1	167,6	153,9	143,2	134,6	127,4	121,2	116,0	111,3	107,2	103,6	100,3	97,3	94,6	92,1	89,8	87,7	85,7	83,9	82,1	80,5	79,0	77,5
950	364,7	263,8	218,2	190,8	171,9	157,8	146,9	138,0	130,6	124,3	118,9	114,2	110,0	106,2	102,8	99,8	97,0	94,4	92,1	89,9	87,9	86,0	84,2	82,6	81,0	79,4
1000	373,7	270,3	223,6	195,5	176,1	161,7	150,5	141,4	133,8	127,4	121,8	117,0	112,7	108,8	105,4	102,2	99,4	96,8	94,4	92,1	90,0	88,1	86,3	84,6	83,0	81,4
1050	382,6	276,8	229,0	200,2	180,3	165,6	154,1	144,8	137,0	130,4	124,7	119,8	115,4	111,5	107,9	104,7	101,8	99,1	96,6	94,3	92,2	90,2	88,4	86,6	85,0	83,3
1100	391,6	283,3	234,3	204,9	184,6	169,5	157,7	148,2	140,2	133,5	127,7	122,6	118,1	114,1	110,4	107,2	104,2	101,4	98,9	96,6	94,4	92,3	90,4	88,7	87,0	85,3
1150	400,6	289,8	239,7	209,6	188,8	173,4	161,3	151,6	143,5	136,6	130,6	125,4	120,8	116,7	113,0	109,6	106,6	103,8	101,2	98,8	96,5	94,5	92,5	90,7	89,0	87,2
1200	409,6	296,3	245,1	214,3	193,0	177,3	165,0	155,0	146,7	139,6	133,5	128,2	123,5	119,3	115,5	112,1	109,0	106,1	103,4	101,0	98,7	96,6	94,6	92,7	91,0	89,2
1250	418,6	302,8	250,5	219,0	197,3	181,2	168,6	158,4	149,9	142,7	136,5	131,0	126,2	121,9	118,1	114,5	111,3	108,4	105,7	103,2	100,9	98,7	96,7	94,8	93,0	91,2
1300	427,6	309,2	255,9	223,7	201,5	185,1	172,2	161,8	153,1	145,7	139,4	133,8	128,9	124,5	120,6	117,0	113,7	110,7	108,0	105,4	103,0	100,8	98,7	96,8	95,0	93,1
1350	583,3	421,9	349,1	305,1	274,9	252,5	234,9	220,7	208,9	198,8	190,2	182,6	175,9	169,9	164,5	159,6	155,2	151,1	147,3	143,8	140,6	137,5	134,7	132,1	129,6	127,0
1400	599,0	433,3	358,5	313,4	282,3	259,3	241,2	226,6	214,5	204,2	195,3	187,5	180,6	174,5	168,9	163,9	159,3	155,1	151,3	147,7	144,4	141,3	138,4	135,6	133,1	130,5
1450	614,8	444,6	367,9	321,6	289,7	266,1	247,6	232,6	220,1	209,6	200,4	192,4	185,4	179,1	173,4	168,2	163,5	159,2	155,2	151,6	148,2	145,0	142,0	139,2	136,6	133,9
1500	630,5	456,0	377,3	329,8	297,2	272,9	253,9	238,6	225,8	214,9	205,6	197,4	190,1	183,6	177,8	172,5	167,7	163,3	159,2	155,4	151,9	148,7	145,6	142,7	140,1	137,3
1550	646,2	467,4	386,7	338,1	304,6	279,7	260,3	244,5	231,4	220,3	210,7	202,3	194,9	188,2	182,3	176,8	171,9	167,4	163,2	159,3	155,7	152,4	149,3	146,3	143,5	140,7
1600	662,0	478,8	396,1	346,3	312,0	286,5	266,6	250,5	237,0	225,7	215,8	207,2	199,6	192,8	186,7	181,1	176,1	171,4	167,2	163,2	159,5	156,1	152,9	149,9	147,0	144,2
1650	677,7	490,2	405,5	354,5	319,4	293,3	272,9	256,4	242,7	231,0	220,9	212,1	204,4	197,4	191,1	185,5	180,3	175,5	171,1	167,1	163,3	159,8	156,5	153,4	150,5	147,6
1700	693,4	501,5	415,0	362,8	326,8	300,1	279,3	262,4	248,3	236,4	226,1	217,1	209,1	202,0	195,6	189,8	184,5	179,6	175,1	171,0	167,1	163,5	160,2	157,0	154,0	151,0
1750	709,2	512,9	424,4	371,0	334,2	306,9	285,6	268,3	253,9	241,7	231,2	222,0	213,8	206,6	200,0	194,1	188,6	183,7	179,1	174,8	170,9	167,2	163,8	160,6	157,5	154,4
1800	724,9	524,3	433,8	379,2	341,7	313,7	291,9	274,3	259,6	247,1	236,3	226,9	218,6	211,1	204,4	198,4	192,8	187,7	183,1	178,7	174,7	170,9	167,4	164,1	161,0	157,9
1850	740,6	535,7	443,2	387,4	349,1	320,6	298,3	280,2	265,2	252,5	241,5	231,8	223,3	215,7	208,9	202,7	197,0	191,8	187,0	182,6	178,5	174,6	171,1	167,7	164,5	161,3
1900	756,4	547,1	452,6	395,7	356,5	327,4	304,6	286,2	270,8	257,8	246,6	236,8	228,1	220,3	213,3	207,0	201,2	195,9	191,0	186,5	182,3	178,4	174,7	171,2	168,0	164,7
1950	772,1	558,4	462,0	403,9	363,9	334,2	310,9	292,1	276,5	263,2	251,7	241,7	232,8	224,9	217,8	211,3	205,4	200,0	195,0	190,4	186,1	182,1	178,3	174,8	171,5	168,1
2000	787,9	569,8	471,4	412,1	371,3	341,0	317,3	298,1	282,1	268,6	256,9	246,6	237,6	229,5	222,2	215,6	209,6	204,0	199,0	194,2	189,9	185,8	182,0	178,4	175,0	171,6
2050	803,6	581,2	480,9	420,4	378,7	347,8	323,6	304,0	287,7	273,9	262,0	251,5	242,3	234,1	226,6	219,9	213,8	208,1	202,9	198,1	193,7	189,5	185,6	181,9	178,5	175,0
2100	819,3	592,6	490,3	428,6	386,1	354,6	330,0	310,0	293,4	279,3	267,1	256,5	247,1	238,6	231,1	224,2	217,9	212,2	206,9	202,0	197,4	193,2	189,2	185,5	182,0	178,4

Annex 3 – Warehouse modelling parameters

General parameters

			West	East
Warehouse	**Wharehouse costs modelling** (Simplified approach - Argon USA insights)	Handling - Pallet in/out ($)	9,8	9,31
		Pallet storage – upon receipt ($)	7,75	7,3625
		Pallet storage – 1st of month ($)	9,7	9,215
		Receiving admin charge	0,3	0,285
		Shipping admin charge	0,3	0,285
		Overflow coefficient	1,2	1,2
		Surface cost (psf/year)	9,00 $	5,04 $
		Labour rate ($/hour)	17,20 $	15,33 $
	Warehouse surface modeling	Nb days of reception/delivery	260	260
		Fluctuation coefficient	1,2	1,2
		Nb of rotation per day	2	2
		Nb of pallets per location	1	1
		Fill rate	85%	85%
		Nb of references	1500	1500
		Nb of locations per reference	1	1
		Nb of storage levels	3	3
		Stock coverage (1 MONTH)	12	12
		Pallet's occupation on ground (m	3,6	3,6
		Office *Office w/conference hall* *Social areas* *Engines area* *Green areas* **% in respect to total DC area**	5%	5%