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Implementing Real time Transportation Visibility in a complex supply chain

The Barilla case

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Abstract

The purpose of this thesis is to highlight the steps that have been taken to successfully implement a Real Time Visibility platform, based on a case study in Barilla company, highlighting the challenges of the project, and showing the effects that Real Time Visibility can have in the supply chain. The thesis starts by introducing the company, in order to provide a comprehensive overview of the firm and to make the reader aware of the environment and complexity of the supply chain in which the project took place as well as the challenges that it is currently facing. Successively, a literature review is presented. In this section the concept of supply chain management is analyzed, as well as solutions that provide visibility to the supply chain such as Real Time Transportation Visibility (which is the main focal point of this thesis) and the Control Tower.

After the presentation of the previous information, the reader has enough knowledge to be introduced to the RTTV project. This project was implemented as a response to those challenges explained in the initial chapters. It is described in its entirety, from the beginning, to the current moment, covering a period of almost two years; however not all of its phases are discussed in depth in order to focus on those tasks and activities in which I was involved over the course of my internship (which took place between November 2021 and April 2022). The case study begins with a market analysis to explore the various providers of Real Time Visibility platforms. Then in the Proof of Concept phase two of those solutions have been tested simultaneously. After having chosen the most adequate solution for Barilla's needs, we moved on to the production phase which mainly consists of onboarding of transport suppliers and making sure good data quality is achieved in order to start introducing the platform to other teams within the supply chain. Reflections are also given on the advantages that this project can bring as well as a brief focus on future developments, namely the integration of this system into the larger Logistic Control Tower.

This document can be considered as an attempt to show what the possible benefits from using a Real Time Transportation Visibility system are and introducing it to different actors in the supply chain, while suggesting actions to take and highlighting those aspects which are important for a successful implementation of such a platform.

Acknowledgements

Firstly, I would like to thank Professor Marco Cantamessa for accepting my thesis proposal and for guiding me through the process of writing this thesis.
Secondly, I would like to express my gratitude to my parents, Giuseppina and Francesco, and my brother Salvatore for the constant encouragement and support they have given me throughout my whole life and especially during my university experience in Polytechnic of Turin. Moreover, I would like to thank my friends for making this experience in Turin a unique and unforgettable one. A special thanks goes also to those colleagues which I have met during my internship in Barilla, who were willing to teach me and give me the knowledge necessary for the realization of this work.

Index

1. Introduction

1.1 Barilla G. e R. Fratelli S.p.A.

Barilla is an Italian family-owned food company. Established in 1877, it's now an international Group present in more than 100 countries. The Barilla Group is active in the production and marketing of pasta, sauces and bakery products at national and international levels. It is a leader in the markets for pasta worldwide, for ready-made sauces in Europe, for bakery products in Italy and for crisp breads in Scandinavia. For almost 140 years the company has been run by the same family, except a small window of time in the 70's when it was bought by an American company and then bought back by Pietro Barilla 10 years later (Barilla).

The Group employs over 8,500 people and owns 30 production districts (including one or more sites) half of which are in Italy and the rest of them distributed all over the world. Every year its factories produce 2,099,000 tons of products, under many brands: Barilla, Mulino Bianco, Harrys, Pavesi, Wasa, Filiz, Yemina e Vesta, Misko, Voiello, Academia Barilla (Barilla, 2020).

Despite the challenges brought by the global Covid-19 pandemic, Barilla group maintained its long-term vision, continuing to invest in innovation and in the quality of its products and production processes, to ensure it is always ready for the future.
In 2020 Barilla Group's net turnover reached €3.89 billion, which represents a 7% increase compared to the previous year, net of the foreign exchange effect (Barilla, 2020). The following image depicts Barilla's different areas of business and the corresponding percentages of turnover:

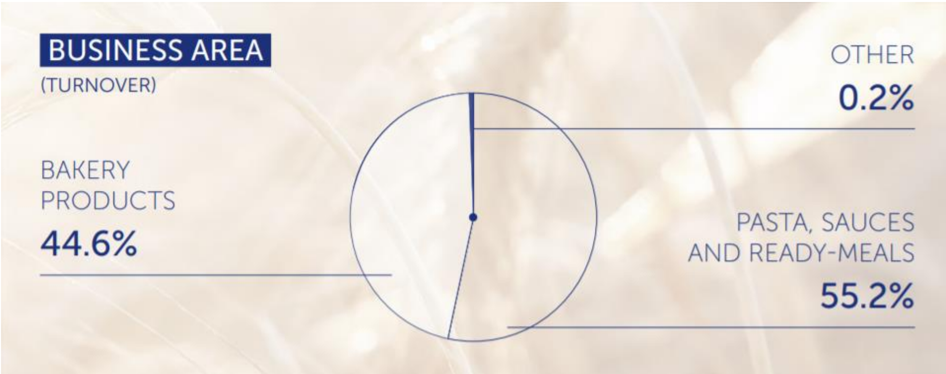


Figure 1: Areas of business – Turnover percentages

Increases in volume and value were recorded both in Italy and abroad. Overseas sales currently account for approximately 57% of Barilla's total turnover. The turnover percentages are divided into 4 clusters which include all the markets in which the company operates (Barilla, 2020).

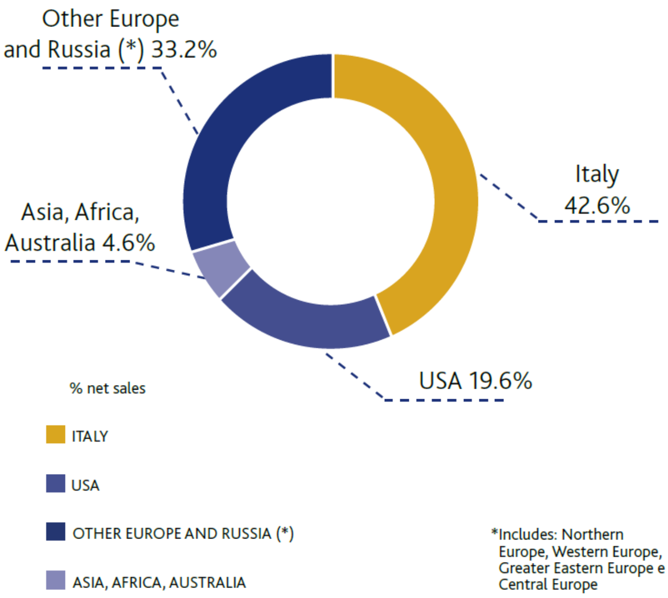


Figure 2: Regions Turnover

1.2 The history of the company

Barilla was born in 1877, when Pietro Barilla opened a small bread and pasta shop in Parma. In the early years of the 20th century Pietro was succeeded by his two sons Gualtiero and Riccardo who started the process of industrialization of Barilla.
In 1910 the first factory opened, employing 100 workers and producing 80 tons of pasta per day. In the same year they introduced a "continuous baking" oven, which allowed the non-stop production of the bread (Barilla).

Figure 3: The first production plant, Archivio Storico Barilla

In the same year Barilla registered its first trademark: a little boy cracking an egg yolk into a flour trough.

Figure 4: The first Barilla trademark, Archivio Storico Barilla

After the death of his father and brother, Riccardo took the reins of the family business for the next 20 years. By introducing innovative technology and machinery he was able to reduce the production times and improve the quality of the product.

In 1936 Pietro, Riccardo's son, got involved in the company and dealt with the development of the commercial area, marking the start of a commercial expansion on a national and international level.

In order to increase the sales Pietro focused on the quality of the product and on advertising. At the same time a new packaging was launched, and the Company management was improved, based on division of work and specialization of employees. The explosion of World War II had tragic effects on the Country as well as on the Company, such as the reduction of production, part of which was confiscated for sending supplies to the army.

In the Fifties, after the death of Riccardo, Pietro and his brother Gianni managed the company with a new strategy: their focus was to enhance the brand image. Those years were characterized by investments in communication campaigns and new technologies, which allowed the company to grow.

The brothers split the tasks: Gianni took care of the plant, administration and purchasing while Pietro dealt with market, sales, advertising and public relations. In 1950, Pietro Barilla went to the United States to learn about innovative packaging techniques, advertising and large-scale distribution. He came up with the design of the packaging, of the iconic blue color background and the definition of the corporate image, one of the first in Italy that spaced from the means of transport to the trade exhibitions' stands, from posters to newspaper's pages.

With the birth of Italian television, Barilla was aware of the huge potential offered by the new medium and threw itself into the TV advertising world, being featured in the Carosello TV program and cooperating with some prestigious testimonials such as Giorgio Albertazzi, Dario Fo and Mina (Barilla).

Figure 5: Mina Mazzini testimonial Barilla, Archivio Storico Barilla

In 1952, Pietro and Gianni decided to close the bakery section of the company, choosing to invest everything on pasta. Pasta production became the core business of the Company and this proved to be a successful move: they were able to reach a production

of 600 tons of pasta per day, implementing a more modern drying system that completed the continuous production supply chain.
In the Sixties Barilla went back to producing bread, with the objective of diversifying the business, so the new plant in Rubbiano (PR) was built, dedicated to the production of crackers and breadsticks.
In 1969, in Pedrignano (PR), the Company opened the biggest pasta production plant in the world, characterized by 120 meters of production line.

Figure 6: The new Pedrignano plant, Archivio Storico Barilla

The beginning of the Seventies brought hardships for Barilla. In an unstable social climate beset by conflict and marked by dramatic terrorist attacks, belief in Italy's growth and development seemed to waver. Many entrepreneurs drew pessimistic conclusions from this and decided to reduce or suspend their commitment to the industry. In January 1971, the Barilla brothers sold a majority stake in Barilla to the American multinational Grace, which would keep control of it until 1979.
This was a very difficult time for Pietro Barilla: "*During those years, I was really unhappy, for a number of reasons, I was suffering for different reasons, but the most important one was that I had abandoned the "ship" that had been entrusted to me and on which I had sailed until the age of 58...*".

In 1973, the year in which the Voiello Pasta Factory in Torre Annunziata was acquired, the oil crisis and the blocking of the price of pasta imposed by the Italian government led the company to diversify its production and create a new line of bakery products. This was inaugurated in 1975 under the name of “Mulino Bianco”. The brand, initially limited to biscuits, was gradually extended to snacks, cakes and breads.
In 1979 Pietro Barilla finally bought back the company from the Americans and took his place once again at its helm. Since then, the company has stayed in the hands of the Barilla family.

CRONACA

cav. del lavoro Pietro Bari[lla] torna alla guida della «sua» azien[da]

Con l'acquisto del pacchetto di maggioranza dall'americana Grace

Barilla torna a casa

Pietro Barilla ci ripensa e rivuole la sua azienda

Barilla - Grace: nuovi particolari dell'operazione

Da oggi la torna parm[...]

Il compiacimento e il saluto del presidente degli industri[...]

Figure 7: 1979- Pietro Barilla riacquista l'azienda di famiglia, Archivio storico Barilla

The 80s represent a new starting point: The historic re-acquisition coincided with the resumption of a long-term industrial and advertising strategy, based on the idea of re-launching pasta and the Italian first course and developing the offer of bakery products. The turnover increased tenfold in ten years. The number of factories increased from 5 to 25, while employees grew from 2,000 to 8,500.
The Nineties and the first decade of the new millennium were characterized by a strong internationalization process, with the growth of Barilla’s presence in European and US markets, the opening of new production plants and the acquisition of important brands such as Misko (a leader brand of pasta in Greece) and Pavesi in 1992 (historical brand of bread and pastries).

When Pietro passed away on September 16, 1993, the presidency of the company passed to the elder son, Guido, while Luca and Paolo became Vice-Presidents.

Figure 8: Guido, Luca and Paolo Barilla take Pietro's place at the leadership of the company,

The process of expansion continued with a series of acquisitions: Filiz, one of the main pasta production companies in Turkey (1994); Wasa, a Swedish company world leader in crispbread production (1999); Yemina and Vesta, a market leader in Mexican pasta (2002) and Harry's, the leader in soft breads and bakery products in France (2002). Barilla became a European leader in the pasta production sector and arrived also in the United States, where the Company already exported pasta since the beginning of the XX century. On the 16th of June 1999, the twin plants of Ames (Iowa) and Foggia (Italy) were inaugurated at the same time in presence of respectively Guido and Paolo Barilla; with a ceremony broadcasted live via satellite.

Since the '2000 onwards, the Barilla brothers have focused on social, environmental and cultural aspects such as minimizing environmental impact and enhancing their contribution to local areas and to the communities in which the company operates. Therefore in 2004 Academia Barilla was created. It is an international project aimed at the defense, the development and the promotion of the regional Italian gastronomy, as unique patrimony in the world for its variety and quality.

In 2009, a new and innovative project was born: The Barilla Center for Food & Nutrition. It was founded with the objective to collect the knowledge, experience and skills of experts on a worldwide level, to analyze and propose solutions to face the nutrition challenges for the next future. The results are then made available to both decision makers and to the public in order to guide collective and individual choices towards a healthier and more sustainable lifestyle.

Barilla has continued innovating and expanding even in the most recent years. In 2009 a huge mill was built in the Pedrignano pasta plant, and a few years later a railway for the supply of durum wheat was inaugurated. This work marks the completion of a supply chain from field to fork. Between 2013 and 2015, Academia Barilla opened three Italian cuisine restaurants in New York. Between 2017 and 2018, several important industrial investments were made, such as the expansion of Rubbiano sauces plant, the increase of the production capacity of both the American plant in Ames, with new lines for the gluten free pasta production, and the Russian plant in Solne, in addition to an ambitious project for the expansion of the historic Pedrignano plant.

Barilla stands out from other food companies for always making the consumer and the environment a priority, and for its efforts to improve the nutritional profile of its products. The strength of this company also resides in its governance, which understood the importance of investing in innovation in order to keep a competitive advantage over other companies. The continuous improvements of processes and technologies is guaranteed by constant investments towards the future: Barilla announced in 2018 that they expected to invest about 1 billion Euros over five years with the aim of boosting competitiveness and sustainability by improving processes, innovating and expanding to new geographies.

Figure 9: From left to right: Pietro, Riccardo, Pietro, Guido, Luca, Paolo, Archivio Storico Barilla

1.3 The brands

Since 2012 Barilla Group is organized in a two-dimensional structure (Processes, Regions). Process Units act as a global competence center, by ensuring strategic alignment, standard processes, and the development of key capabilities.
Each region has the purpose of ensuring the business growth and profitability, through the development of a solid portfolio of brands and product categories. One of the advantages of Barilla Group is that it holds a big portfolio of brands, all of which have their own unique personality.

The Marketing area is divided into two macro-categories: Bakery and Meal Solution (Barilla, 2020).

The bakery category mostly interests the Italian market and partially the European one and a few other countries in south Asia, this is because of its very short shelf life. This category includes a variety of products including cookies, snacks, crackers, and rusks. The bakery is produced in over 10 production plants all over Europe:

- **Italy:** Novara, Cremona, Ascoli and Castiglione delle Stiviere where they make products for the Italian brands Pavesi, Mulino Bianco and Pan di Stelle;
- **France**: La Malterie, Talmont Saint-Hilaire, Plaine de l'Ain, Valenciennes, Gauchy for the production of the French brand Harry's;
- **Germany:** Celle for the production of the Swedish brand Wasa;
- **Sweden**: Filipstad to produce Wasa.

The N°1 bakery brand in Italy	The N°1 brand for whole grain snacks	Cookies and chocolate snacks	The N°1 dry snacks brand in Italy	The N°1 crispy bread brand in the world	The N°1 soft bread brand in France

Figure 10: The Bakery brands

The Meal Solution category includes numerous products, mainly pasta and sauces, the two categories in which Barilla is the world leader. This category has the aim to provide a taste of the Italian cuisine; however it can be adapted to the different tastes and culture of every country. Each brand is subdivided into different category qualifications, such as gluten free, egg noodles or cereal grains. Over 70% of the raw material is furnished directly from mills that are owned or controlled by the company (Barilla, 2021). Durum wheat represents for Barilla one of the main materials in terms of volumes used. Barilla owns eight pasta production plants which produce around 900,000 tons of pasta per year, divided into 160 different shapes of semolina pasta and over 30 different kinds of egg pasta and filled pasta.

The following are the Meal Solution production plants:

- **Italy**: Pedrignano (PR), Foggia, Caserta, Muggia, Rubbiano, Melfi,
- **Greece:** Thiva,
- **Turkey:** Bolu,
- **USA:** Ames (Iowa, USA), Avon (New York, USA),
- **Mexico:** San Luis,
- **Russia:** Solne,
- **Canada:** Montreal.

Figure 11: The Meal Solution Brands

2. Barilla’s Supply Chain Structure

To design and develop an industrial network oriented to the expansion of the supply chain boundaries (customers, suppliers, market), Barilla implements an organization, systems and methods that guarantee:

- A profitable and innovative business development,
- The maximization of the return on invested capital optimizing operative costs,
- The ‘designed’ service level for customers,
- Quality and safety for the product, the people, and the planet.

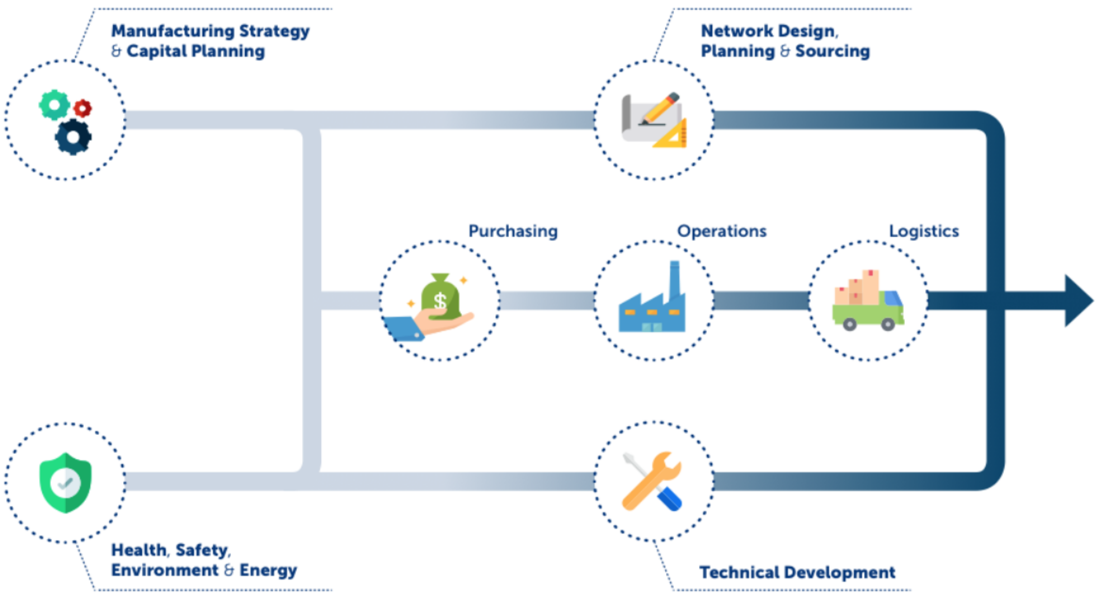


Figure 12: Barilla's Supply Chain flow

In detail Barilla’s supply chain includes the following functions:

- Manufacturing Strategy & Capital Planning,
- Network Design, Planning & Sourcing,
- Technical Development,
- Purchasing,
- Logistics,
- Health, Safety, Environment & Energy.

Manufacturing Strategy & Capital Planning

This unit is responsible for planning and achieving the objectives of production. It deals with managing the development of the manufacturing system, defining the resources, processes and the technical support needed from IT. The Capital Planning deals with the evaluation, approval, execution and follow up of all the investment and related generated assets: every single investment, even if included in the investment budget, is subjected to a rigorous evaluation and approval process before proceeding with the implementation.

This unit is also responsible for the Barilla Operational Excellence, which represents the collection of all the best manufacturing practices that allow to achieve excellent levels of performance.

Network Design, Planning & Sourcing

The Network Design unit has the aim to define the objectives and the planning of the distribution of the Group. It takes decisions about the industrial asset network sizing and resource allocation. The planning area includes the demand planning, the production capacity planning, and the replenishment to Barilla's network (including VMI distribution), according to service level requirements and delivery costs.

Technical Development

The Technical Development unit is responsible for the development of the production plants, as well as for the maintenance, testing of systems and standardization of packaging.

Purchasing

The Purchasing unit deals with the procurement, maintenance of supply and the identification of new potential suppliers.

Logistics

The Logistics unit has the task of purchasing, managing and planning logistics services at the corporation level. Their goal is to constantly pursue the best performance in effectiveness and efficiency.

Health, Safety, Environment & Energy

The HSEE unit is responsible for identifying the objectives and actions to ensure sustainability in terms of health, safety, fire prevention, environment and energy in the short and long term.

2.1 The distribution network

Barilla's distribution network includes three main kinds of flows of finished products:

- **Plant to Plant (PtP):** flow of finished products that go from one of Barilla's plants/warehouses to another Barilla's plant/warehouse,
- **Plant to Deposit (PtD):** flow of finished goods that go from a Barilla plant to a deposit,
- **Plant/Deposit to Customer (DtC):** flow of finished goods that go from a plant/deposit to the client's warehouse.

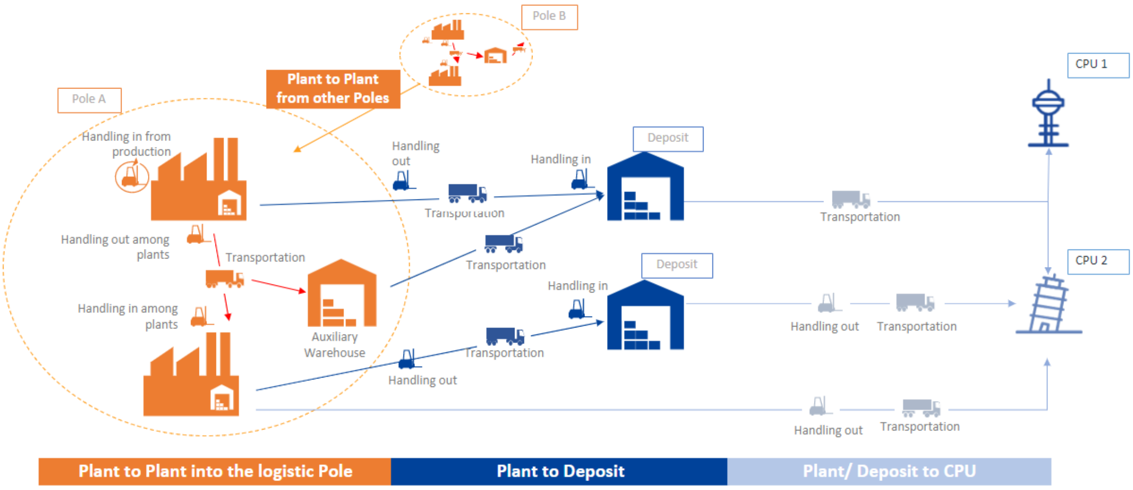


Figure 13: Barilla's distribution network

By talking to a member of the Logistics Italy team I was able to gather information about Barilla's distribution network and below I will summarize what has been said. In the Italian logistics network, we have a primary network, which includes the bakery and meal solution warehouses, and a secondary distribution network. The **primary network** mainly consists of the plant warehouses (each plant in fact has its own warehouse in its proximity). The only exception is Rubbiano Sauces plant since it does not have its own warehouse like the other plants do, but it has only a small warehouse space that contains the production of a day and a half, about 1000-1200 pallets, and every day there are flows from the warehouse of Rubbiano sauces to the other warehouses. Although not shown on the map below, auxiliary warehouses are also part of the primary network. There are currently three auxiliary warehouses in use: Sabel, SAC, Unione Aux. These warehouses have the function of absorbing any stock peaks in the moments in which production stops due to projects of transformation or maintenance of lines that sometimes impact several thousand pallet places. Since Barilla plants are dedicated to either bakery or meal solution, internal flows of finished goods within Barilla's plants or warehouses are necessary in order to always have the right mix of products in the warehouses and the optimal level of stock.

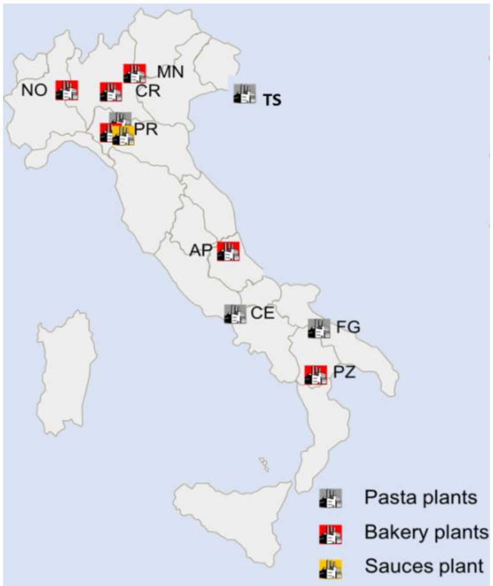


Figure 14: The primary network (source: Logistic Italy Induction Meeting)

The type of flows that are outbound from plant warehouses are usually either optimized orders destined to customers that request high volumes of products or replenishments orders for other warehouses or hubs. Primary network flows are almost always fully saturated (FTL); however there are a few cases when this is not possible.

Full truckload allocation, also known as FTL, refers to a mode of transport where shippers (i.e.: Barilla) have enough products going to a specific destination to completely fill a truck. If a shipment has enough freight to fill an entire truck, and the shipment has a single place of origin and destination, FTL transport will be less expensive than LTL (less than truckload). Because of their non-stop transit to the destination, full truckload freights require less gas, no stop off fees, and less wear and tear on the truck, all resulting in reduced shipping costs (Langham Logistics, 2019). There are also a few other advantages. The transit times are faster as the truck isn't making any other stops, so the load goes straight to the drop-off destination, this implies that the estimated arrival time (ETA) of the driver won't be affected by delays at multiple stops along the way and that the driver doesn't have to move the goods to unload someone else's shipment. There's less risk, therefore, that the goods will be damaged or lost in transit.

When loading a truck the aim is to reduce the loading complexity as much as possible, so the ideal hypothesis would be to load entire pallets on a full truck, without picking. In reality this does not always happen, both because there are constraints on the palletization, but also because some customers do not order whole pallets but rather layers or cases.

Picking activities depend both on the physical characteristics such as the height of the pallets and on the type of product as well. For the meal solution, products typically have a longer shelf life; therefore it is possible to have a lower picking rate, such as that of Pedrignano warehouse which is of the order of 3-5%. As far as bakery is concerned, the matter is much more complex because in that case, both dry and fresh products have to be transported. Fresh products of low-rotating items are mostly loaded in smaller handling units such as layers or cases instead of whole pallets. This is done in order to reduce inventory risk. Shelf life is the length of time that a product may be stored without becoming unfit for use, consumption, or sale. If a product remains in storage and exceeds this threshold, it can no longer be sold and it has to be devalued. So the tradeoff is to harmonize the complexity of replenishment with the inventory risk in the warehouses.

When delivering the products to the client directly from the plant warehouses is not possible, Barilla utilizes deposits or hubs that are operated by external logistics operators. This is referred to as the "secondary network".

Figure 15: The secondary network (source: Logistic Italy Induction Meeting)

The secondary distribution network is made of 7 hubs. It also includes sites known as transit points (TPs), which belong to an external operator, from which shipments to customers are also made. The TPs consist of product storage points, where the product is sorted and then sent to customers. Both hubs and TPs are 3PL (third party logistic) warehouses and they contain not only Barilla products but also products of other companies. Repackaging activities are also often managed in these platforms, mainly for the production of exhibitors or other elements for promotional activities.

Another actor of the distribution network are co-packers. Barilla relies on them for the production of goods when there's a lack of production capacity or a lack of the right technology to produce them. A co-packer, or co-manufacturer, is an established food company that processes and packages Barilla's products according to their specifications (Barilla, 2021). They are fully responsible for achieving finished products that conform to the requirements specified, attached to the purchase contract, and they must continually ensure its realization. However, the products purchased from co-packers account only 10 % of total volumes. There are over 40 co-packers utilized by Barilla and more than 70% of them are Italian, with a few exceptions in Switzerland, Greece, UK, Sweden, and Finland.

2.2 Logistics and Transports

The logistics in Barilla accounts for about 400 mln € spent per year, which corresponds to roughly 10% of the group net sales. The main area is transportation which is accountable for around 70% of those expenses (Barilla, 2022). There are different logistic units within Barilla which have different competences:

- purchasing logistic services,
- managing the budget of logistic costs,
- implementing improvement projects on logistic processes,
- ensuring the effectiveness and efficiency of logistic performances group-wide.

'Logistics Italy' mainly deals with the purchasing, managing, and monitoring the performance of carriers (transportation service providers) that operate within Italy. These carriers transport loads from Barilla's plants/warehouses to either another Barilla's plant/warehouse or a client's one. Around 90% of the total shipments are carried out by four main carriers out of a total of twenty.

Figure 16: The main carriers in the Italian distribution network

The 'International Logistics' deals with the purchasing of logistic and transportation services, management and monitoring of the performance of carriers who operate outside of Italy. These carriers transport Barilla's goods from one of Barilla's plants/warehouses to another plant or warehouse (either Barilla's or client's one) located anywhere in the world. In this case, compared to Logistics Italy, the operations are less standardized and more complex because each country has their own different procedures, which become increasingly more complex for those countries outside of Europe, due to longer preparation times and higher risks involved. The number of carriers for international shipments is bigger than that of Italian carriers.

2.2.1 Types of transport

As explained above, Barilla's network is very big and its products have to reach over 100 countries, therefore there are different transportation modes being used (depending on different factors such as the distance to be travelled, the expiration date, and the characteristics of the products being transported):

- **Road**: This kind of transport is the most flexible, fast and reliable out of the following ones. It is mainly used to cover shorter distances since it's the least sustainable for the environment. It's also not the cheapest solution and the load being carried needs to comply with specific weight and size limits.
- **Rail**: This solution is cheap and quite reliable. It has higher cargo capacity and it's more sustainable for the environment.
- **Intermodal:** This is a combination of two different types of transport, for example part of the trip is covered by a truck and another part by train. This is one of the most utilized ways of transport, where most of the transport is done by railroad and only the last mile delivery is done by using a truck. The speed advantage that trucks have over short distances don't apply over long distances cause rail transportation is not that much slower, but it's much cheaper. Intermodal mode maximizes the advantages of one mode while minimizing the disadvantages of the other mode: it allows to use trucking when it's most efficient and rail when it's most efficient so the whole transportation overall becomes cheaper, more efficient and less impactful on the environment.
- **Sea shipment**: This is the cheapest solution out there, with the least restrictions on the weight of the load being carried; however it is also the slowest one.
- **Air freight**: this is the fastest way of transport; however it's the most expensive and not very sustainable.

Barilla utilizes all the aforementioned transportation modes except for air cargo. Whenever it is possible, intermodal transportation is preferred especially for long distances and when there are reliable and high performing services. In case of high-volume shipments Barilla utilizes the company train. Since March 2021, 70% of Barilla's products that are destined for the German market (around 100,000 tons of pasta, sauces and pesto per year) are transported by three trains per week (Barilla, 2020) thanks to a new rail service that connects the Parma interport with the Ulm one in Baden-Württemberg, in southern Germany. Intercontinental shipments travel by sea. National shipments on the other hand mostly travel by road.

2.3 The global context and supply chain challenges

Managing a complex distribution network such as this one is not an easy task, and this is added onto the already difficult global situation that we have experienced in the last couple years. The supply chain and transport domain are a rapidly changing environment. We are in a world where costs are quickly and suddenly increasing, independently on the type of transportation. Even pallet costs are skyrocketing, despite that the service level is going down to quite a poor level.

Figure 17: Logistic Situation Overview (source: Barilla Global Supply Chain Work plan Meeting)

The 2022 World Economic Situation and Prospects (WESP) report, produced by the UN Department of Economic and Social Affairs (DESA), cites a series of factors which are contributing to the disruption of the supply chain.

First, global economic recovery depends on a delicate balance amid new waves of COVID-19 infections, persistent labor market challenges, lingering supply-chain constraints and rising inflationary pressures. After a global contraction of 3.4 per cent in 2020, there was a following expansion of 5.5 per cent in 2021, the highest rate of growth in more than four decades (United Nations , 2022). The economic recovery therefore was well above the typical rate of 2% and this led to an **increase in the demand**. Global recovery in output in 2021 was mainly driven by robust consumer spending and some uptake in investment. Trade in goods bounced back, surpassing the pre-pandemic level. Growth momentum, however, has slowed considerably by the end of 2021 including in big economies like China, the European Union and the United States of America, because the effects of fiscal and monetary stimuli dissipated and major supply-chain disruptions have emerged (United Nations , 2022).

As mentioned by one of Barilla's logistics and international transportation experts, both in Europe and in the US **inventories are at an all-time low**, contributing to make the effect of the demand increase even higher. Looking back to the start of the Covid 19 pandemic, the first shock waves to hit global supply chains were all related to demand (McKinsey Global Institute, 2020). Many companies haven't given enough consideration to the impact of the demand shock upstream, through the supply chain, right to the suppliers. Therefore, the sudden increase in demand lead to a short-term reflexive thinking response: *Let's get everyone producing a lot more.* That led – inevitably – to a surge in goods, but also to an inability to get all those goods into scarce containers, or to get the containers onto ships, or get the ships through clogged up ports, or get the ships unloaded. In the overseas market ocean disruptions, port congestions, equipment availability and container imbalance are in fact at their worst.

As Matt Elenjickal, CEO of FourKites, mentioned in a recent article, equipment constraints and labor constraints are intertwined and will persist for a while. "While labor issues tend to garner more headlines, ocean shipping is dealing with a combination of equipment constraints and labor constraints, and you cannot solve one without the other. You can put more containers on a chassis, but if there aren't enough people to move the goods, it's of no use. Likewise, labor can't do its thing when there are severe equipment shortages, and rectifying those shortages requires difficult-to-source raw materials" (logisticsviewpoints, 2021).

The image below well exemplifies the main problems related to ocean shipping:

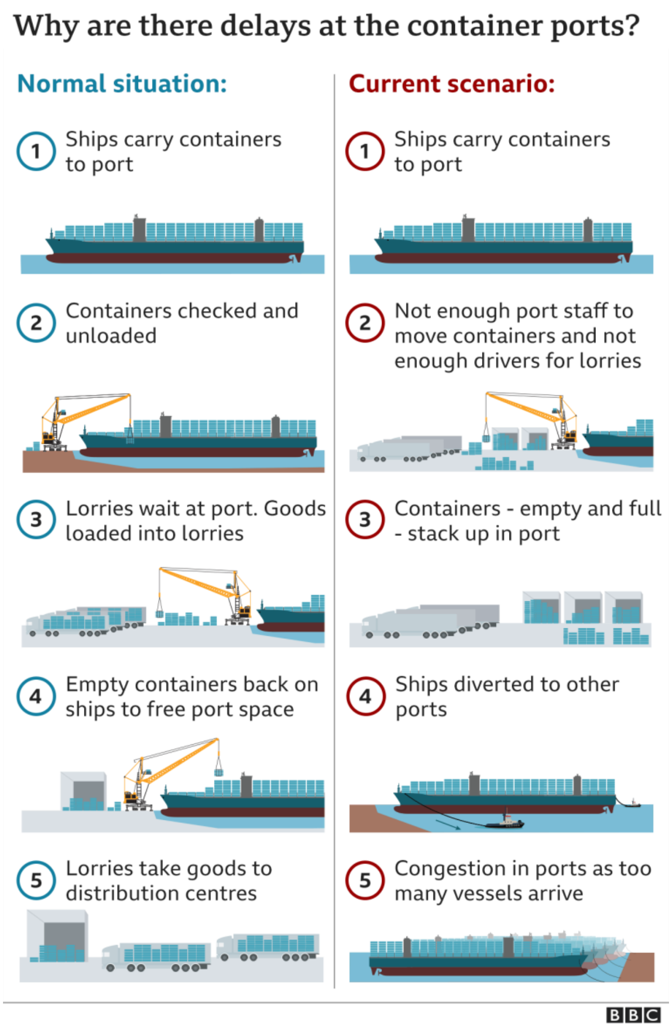


Figure 18: Shipping disruptions, source: BBC

Europe is also currently facing a **truck driver shortage crisis**. The economic growth, results in growing demand for transport. However the carriers are not currently able to meet the market demands. At the same time a lot of truck drivers are resigning from work or retiring, while younger people have a little interest in that profession. Considering that Barilla outsources around 85% of its logistic activities (warehouses and transportation) and doesn't own its own fleet, this is a risk for the company since the transportation companies which Barilla utilizes to deliver its goods have a very high bargaining power against them.

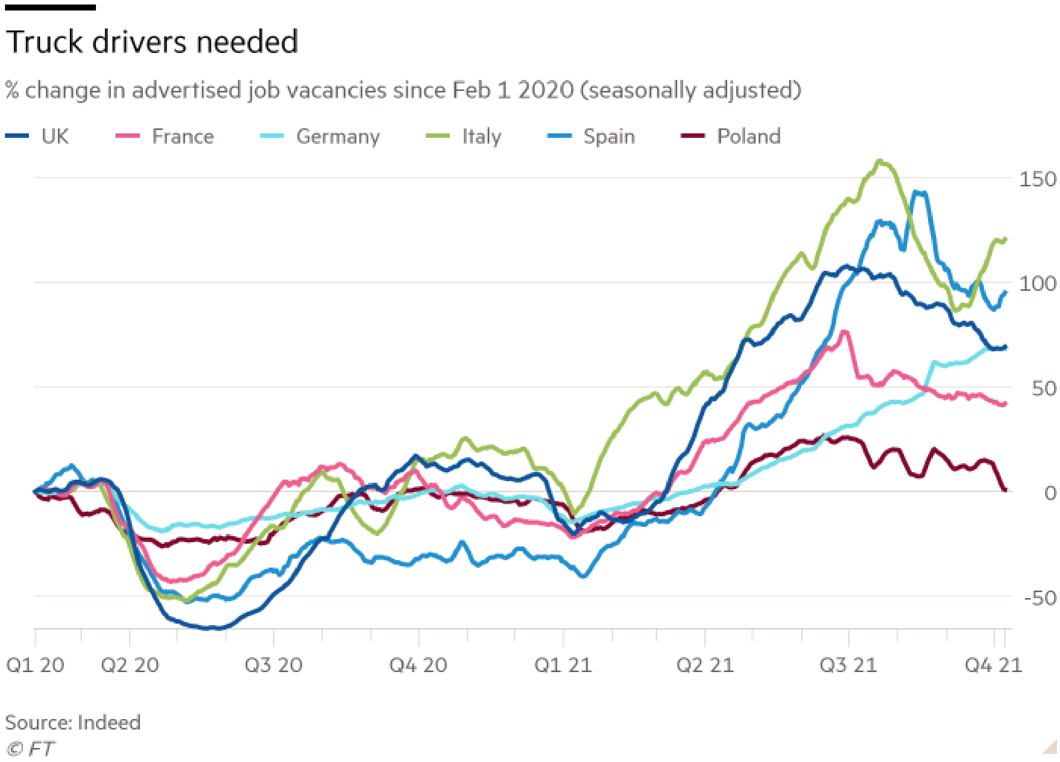


Figure 19: Truck drivers needed in Europe (source: Indeed)

Ongoing supply shortages and network disruptions will continue to be a problem for the global trade in the near term and will take months to unwind. Although they are expected to recede over time, their severity and duration remains uncertain. Supply-chain constraints are likely to persist in 2022 for several reasons. First, businesses usually do not hold excessive inventory to avoid additional storage costs. This means that producers and retailers may not effectively respond to consumer demand swings due to sudden events such as renewed waves of COVID-19 infection. Second, industry consolidation and dependence on key manufacturers contribute to supply-chain chokepoints. Third, possible renewed virus waves as well as extreme weather events, cyber-attacks, geopolitical trade constraints, wars, could keep the costs of shipping high and disrupt operations at a few critical international container ports (United Nations , 2022). **Disruptions to sea transportation** and port operations have also triggered a humanitarian crew-change crisis (Beukelaer, 2021). Due to the Coronavirus crisis and travel bans brought in by many governments to contain the new variants of Covid-19, hundreds of thousands of seafarers in 2021 have been unable to leave the ships and remained stranded at sea, far beyond the expiry of their contracts. During the pandemic, misallocation of containers led to a significant rise in shipping costs, which increased sevenfold from an average of $1,446 per container at the end of 2019 to above $10,000 in September and November 2021 (United Nations , 2022). The recovery in energy prices also contributed to higher rates. New virus variants could prolong bottlenecks in international shipping, resulting in delays and further cost hikes.

In addition to this, the Russian invasion of Ukraine has rattled global supply chains that are still affected by the disruptive consequences of the pandemic, adding to surging costs, prolonged deliveries and other challenges for companies trying to move goods around the world (Attinasi, Gerinovics, Gunnella, Mancini, & Metelli, 2022). For example, because of this conflict, shipping ports around the Black Sea have closed, halting dozens of cargo vessels. The economic implications of the war and sanctions on Russia are not yet clear, the effects will depend on the industry and on the length of the invasion, but the impacts will be magnified due to the already vulnerable supply chain. If the conflict is prolonged, it could threaten the summer wheat harvest, which could impact companies dedicated to the production of pasta, bread and other bakery products, such as Barilla (Lu, Gramer, & Pezeshki, 2022). Both Russia and Ukraine are major exporters of wheat, barley, corn, fertilizer, and sunflower oil, which is one of the key ingredients that Barilla has been using since 2016 to substitute palm oil entirely from the production of its bakery goods. Food prices have already skyrocketed because of disruptions in the global supply chain, increasing the risk of social unrest in poorer countries (The New York Times, 2022).

The consequences of such environment is that in all of Barilla's major markets they are going to sail in a very stormy sea: either in Europe or in North America or in the overseas market the outlook is cost increase and volatility, as well as poor service. Traffic congestion, whether by road or by sea or rail, results in some cases in a waste of valuable time, and customers must wait unreasonably long without having any reliable information about the actual arrival times of the vehicles. In these circumstances, it becomes difficult to satisfy the time windows during which the customers expect the goods to be delivered. This increases supply chain and logistics cost and worsens the level of service.

3. Theoretical research

The literature review is organized in three main sections: the first presents a review of scientific contributions relating to Supply Chain Management (including different relevant topics such as defining the supply chain, supply chain complexity, its agility, visibility, velocity and the adoption of digital technologies in the supply chain), the second part is related to Real time Transportation Visibility and the third one to the Logistic Control Tower.

Starting from websites such as Google Scholar, Web of Science, Elsevier and Scopus I have conducted a systematic theoretical research which allowed me to find over 50 articles or papers which were related to the aforementioned topics. I have not limited myself to only articles or papers, but I have also considered reports from consulting companies, books and websites, as long as the sources was deemed reliable. I have then refined the search and studied carefully each paper to only select the most relevant ones, reducing their number to around 20 papers, which I have summarized in the following chapter.

3.1 Supply Chain Management

There is no universal definition for the term **supply chain**: some definitions are more focused on a ‘product’ point of view and others on a ‘process’ or ‘enterprise’ point of view. The literature shows that a supply chain usually refers to the whole process of producing and selling goods, including every stage from the supply of raw materials to the manufacturing of finished goods until their distribution and sale. These activities are commonly grouped into two types (Ravagnan, 2020):

- Upstream activities, which is the stage in which raw materials suppliers, parts suppliers collaborate in order to ensure the flow of products and information through the chain,
- Downstream activities, when the flow of products and information pass through the manufacturer, distribution services, and eventually reach the final customer.

It is a complex system which involves many different stakeholders such as suppliers, producers, subcontractors, retailers, wholesalers, and customers, between whom material, information and financial flows are exchanged (Raaidi, Bouhaddou, & Benghabrit, 2018).

Definitions of SCM also differ across authors; some of them in fact define **Supply Chain Management** as a management philosophy, as an implementation of a management philosophy or as a set of management processes. The alternative definitions and the categories they represent suggest that the term "supply chain management" presents a source of confusion and there is a high degree of variability by what is meant by this term (Mentzer, et al., 2001). Nevertheless, Mentzer et al. proposed a broad definition for supply chain management, which is not confined to any specific discipline and which reflects the variety of issues that are covered under this concept:
"Supply chain management is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." The objective of Supply Chain Management is to maximize the customer's benefits and to reduce costs along the network with the help of effective methods and integrated instruments (Alias, Jawale, Goudz, & Noche, 2014).

While in the past the terms Supply Chain Management and Logistics were used interchangeably, there is a difference between those two. Logistics typically refers to activities that occur within the boundaries of a single organization while instead supply chains refer to networks of companies that work together and coordinate their actions to deliver a product to the market. (Hugos, 2011)

In order to implement supply chain management successfully, some level of coordination across organizational boundaries is needed. If taken individually, different supply chain requirements often have conflicting needs. For example, the requirement of maintaining high levels of customer service calls for maintaining high levels of inventory, but then the requirement to operate efficiently calls for reducing the inventory levels. Only when these requirements are seen together as parts of a larger picture is it possible to find ways to effectively balance these different demands (Hugos, 2011). Therefore it is important to integrate processes and functions within organizations and across the supply chain. As mentioned by Martha C. Cooper et al., "*A driving force behind SCM is the recognition that sub-optimization occurs if each* *organization in the supply chain attempts to optimize its own results rather than to integrate its goals and activities with other organizations to optimize the result of the chain. Organizational relationships tie firms to each other and may tie their success to the chain as a whole*".

Supply chain complexity doesn't mean it is complicated in the real sense of the word, but it depicts the condition of inter-connectedness and inter-dependencies across a network where a change in one element can affect other elements, often in unforeseen ways. Companies, such as Barilla, can deal with multiple tiers of suppliers, outsourced service providers, and carriers. This complexity has evolved in response to changes in the way products are sold, increased customer service expectations, and the need to respond quickly to new market demands. (Hugos, 2011)
Since many of the interactions between these agents and entities within the network can have a cumulative and combinatorial effect, it is not always possible to predict the impact of these interactions, so this increases supply chain risk.
Nowadays the challenge for businesses is to manage and mitigate that risk through creating more resilient and "integrated" supply chains (Christopher & Peck, 2004). Better management and control of internal processes together with more open information flows within and between organizations can have positive effects on bettering the efficiency and optimizing costs. Modern commercial supply chains are in fact dynamic networks of interconnected firms and industries, which allows them to adapt quickly to changes in demand, to improve the demand planning, to provide a better service level in terms of delivered goods and punctuality, and to have a reduction of logistic costs and better management of warehouses (Christopher & Peck, 2004).

3.1.1 SCM key drivers of performance

SCM focuses on some key drivers which affect the whole supply chain performance. These **key drivers of performance**, as indicated in Chapra and Meindl's book, can be divided into logistical ones (facilities, inventory, and transportation) and cross-functional ones (information, sourcing, and pricing). These drivers interact to determine the supply chain's performance in terms of responsiveness and efficiency (Chopra & Meindl, 2012). SCM needs to evaluate the trade-offs of various mixes of these drivers to reach a sustainable and efficient strategy.

They can be described and summarized as follows (Chopra & Meindl, 2012):

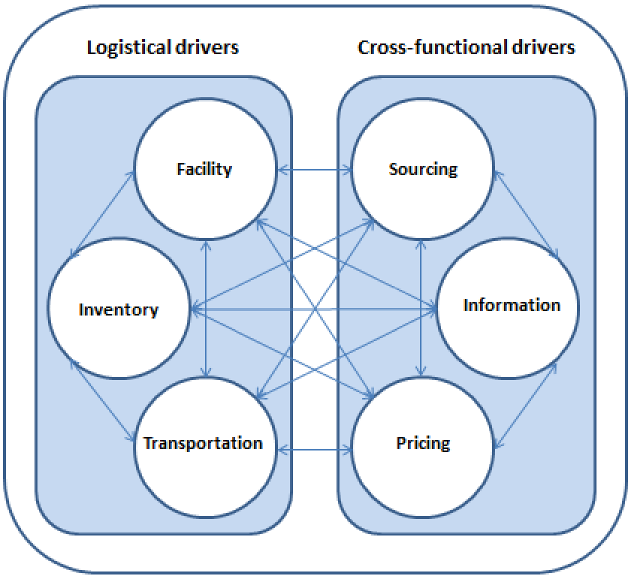


Figure 20: Personal visual adaptation on Chopra & Meindl 'Supply Chain Management' 5th edition

- **Facilities:** these are the actual physical locations in the supply chain network where the product is stored, assembled, or fabricated; namely production sites or storage sites. Decisions regarding their role, location, capacity, and flexibility can have a significant impact on the supply chain's performance affecting the tradeoff between responsiveness and efficiency. In particular increasing the number of facilities increases facility and inventory costs but decreases transportation costs and reduces response time. Increasing the flexibility or capacity of a facility increases facility costs but decreases inventory costs and response time.
- **Inventories**: this term encompasses all the materials and goods stored within the supply chain. Inventory exists in the supply chain because of a mismatch between supply and demand, in many cases this is intentional because inventory can be held in anticipation of future demand and it can be used as a way to reduce cost by exploiting economies of scale that may exist during production and distribution. On the other hand, having too much inventory generates higher costs of maintenance and storage for the company. The goal would be to find the right form, location, and quantity of inventory that assures the right level of responsiveness while keeping costs as low as possible.

- **Transportation:** it entails how the products are moved from point to point in the supply chain. Transportation can have many combinations of modes and routes, each with their own characteristics. The choices related to transportation can have a big impact on the supply chain responsiveness and efficiency. The choice of the best transportation strategy depends mainly on two components: the *design of transportation network* (the collection of transportation modes, locations, and routes along which product can be shipped) and the *choice of transportation mode* (each mode has different characteristics with respect to the speed, size of shipments, costs, and flexibility, e.g.: air, truck, rail, sea)
- **Sourcing:** this is the choice of who will perform a particular activity in the supply chain (such as production, storage, transportation, or the management of information). There are multiple decisions that a supply chain manager can take regarding sourcing:
  - In-house vs outsourcing: These decisions will determine what functions a firm will perform in-house and what functions will be outsourced. In some instances, firms decide to outsource to responsive third parties if it is too expensive for them to develop this responsiveness on their own. Firms also outsource for efficiency if the third party can achieve significant economies of scale or has a lower underlying cost structure for other reasons. However It is not only based on the lower cost, but it needs to take into consideration also what degree of control the company wants to have on that specific task and the loss/gain of efficiency in outsourcing (Ravagnan, 2020).
  - Supplier selection: Managers need to decide on the number of suppliers needed and they have to identify the criteria based on which the suppliers will be evaluated and selected. Having a joint vision and building a long-lasting relationship with suppliers is fundamental for Supply Chain Management.
  - Procurement: These decisions are related to the process of obtaining goods and services within a supply chain.
- **Information:** this is one of the most important drivers of performance, it consists of data and analysis concerning all aspects of the supply chain (such as facilities, inventory, transportation, costs, prices, and customers). The appropriate investment in information technology improves visibility of transactions and coordination of decisions across the whole supply chain,

ultimately allowing to better meet the customer needs at a lower cost. The goal should be to share the minimum amount of information required to achieve coordination. The most important technologies that allow to share and analyze data in the supply chain are:

  - Electronic data interchange (EDI) which allows to place instant paperless orders making transactions faster and more accurate,
  - Enterprise resource planning (ERP) which is a software used to manage business processes and to gather real-time information within the company and the whole supply chain,
  - Radiofrequency identification (RFID) which are tags used to track items whenever they move along the supply chain.

- **Pricing:** this driver determines how much a firm is willing to charge for its products or services. Pricing affects the behavior of the buyers, therefore affecting the supply chain performance. Pricing strategy aims to cover the supply chain costs, and hopefully, generate a surplus. It can also be used to control the demand level by rising prices, or making discounts.

3.1.2 Supply chain agility

Supply chain agility can be defined as the ability to respond rapidly to unpredictable changes in the demand or supply. As mentioned by Martin Christopher and Helen Peck, the main ingredients to achieve supply chain agility are supply chain velocity and visibility (Christopher & Peck, 2004).

- **Supply Chain Velocity**

In order to increase velocity, time must be reduced; in this context time is referred as the ‘end-to-end’ pipeline time or in other words the total time it takes to move product and materials from one end of the supply chain to the other (from when a firm places an order to its first tier supplier, to when it delivers to its customers). Supply chain velocity indicates how rapidly the supply chain can react to changes in demand (Christopher & Peck, 2004).
As written by Christopher and Peck, in order to improve supply chain velocity three things are necessary:

- *streamlined processes*:
  Streamlined processes are simplified processes that have been developed in such a way that the number of stages or activities involved are reduced, they are performed in parallel rather than in series and e-based rather than paper-based.
- *reduced in-bound lead-times:*
  One of the criteria for the selection of suppliers should be their ability to respond quickly in terms of delivery and their ability to deal with short-term changes in volume and mix requirements. Synchronizing schedules based on shared information can enable suppliers to become more agile without necessarily having to rely on using inventory as a buffer (with its consequential problems).
- *non-value added time reduction:*
  Reducing the non-value added time can increase supply chain velocity. Most of the time spent in a supply chain from the customer's point of view is not value-adding; it is very often idle time.

- **Supply Chain Visibility**

The second ingredient of supply chain agility is supply chain visibility. According to IBM, 87% of chief supply chain officers find it difficult to predict and manage supply chain disruptions and 84% of them report that a lack of visibility is their biggest challenge (IBM, 2019). According to a survey conducted by Gartner, supply chain visibility is the top funded investment initiative for 46% of organizations (Gartner, 2020).

Supply chain visibility can be defined as "*the awareness of, and control over, specific information related to product demand forecast, orders and product supply and inventory plus physical shipments, including transport and other logistic activities, and the status of events and milestones that occur prior to, and in transit*" (Trzuskawska-Grzesińska, 2017).

As mentioned by Wycislak, two critical resources in the development of supply chain visibility are **supply chain connectivity** and **information sharing**. The utility of supply chain connectivity is dependent on the nature and quality of the information shared. Quality of information is in fact a crucial aspect for supply chain visibility. It is reflected by characteristics such as timeliness, accuracy, and completeness (Wycislak, 2021).

In order to achieve supply chain visibility there needs to be close collaboration among customers and suppliers as well as internal integration within the business. A significant barrier to supply chain visibility is encountered within the firm's organizational structure: the presence of 'functional silos' inhibits the free flow of information. This situation is often exacerbated when the company has internal suppliers or customers with limited integration between them. Therefore it is necessary to break down these silos to create multi-disciplinary, cross-functional process teams (Christopher & Peck, 2004).

Many organizations, as indicated in Capgemini's study, have already implemented or are in the process of implementing Supply Chain Visibility solutions. However, these solutions can have different levels of maturity:

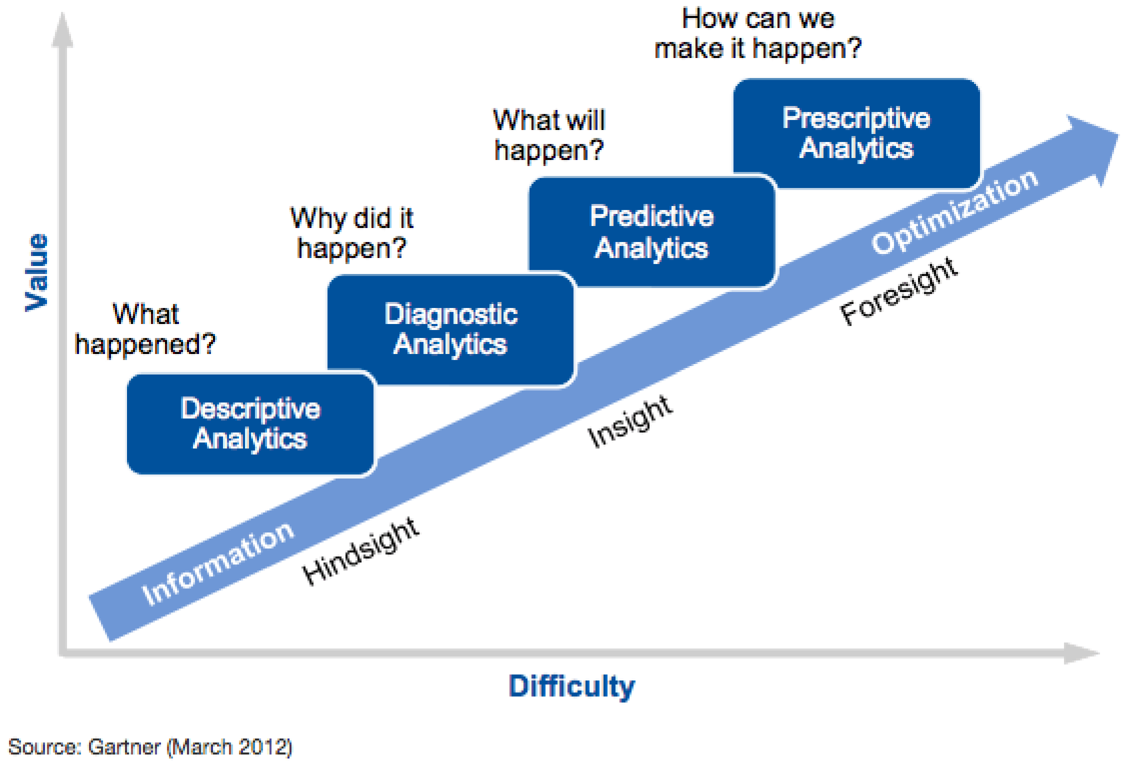


Figure 21: Level of maturity RTV solutions (Gartner)

The maturity level depends on the associated tools, processes and skills of the people involved and they can be grouped in one of three phases, where each phase reflects a higher level of maturity than the previous one (Capgemini Consulting).

I will summarize them below:

- **Lowest level**: At the most rudimentary level, the focus is on achieving basic operational level visibility on supply chain data such as shipment and inventory status. The scope in this case is usually limited to one or a couple processes, such as either outbound or inbound logistics depending on their strategic importance. The tools focus on collecting data. The capabilities of staff are very much on operational level.

- **Middle level**: The second phase focuses on following the status of shipments across multiple supply chain nodes and tracing the problems that are occurring in between. The scope in this case is wider: it includes all the processes related to inbound and outbound logistics. There is the possibility of providing alerts for exceptions and events. These applications are incorporated with some basic reporting and analytics capabilities and a knowledge bank for decision support. The organization has the capabilities to proactively act upon issues that could emerge in the supply chain.
- **Top level:** The last most advanced phase, also known as predictive visibility, focuses on self-learning algorithms to predict the potential problems and generate alerts for upcoming events. These types of solutions are becoming increasingly popular as they allow proactively monitoring the supply chain functions and helping with decision support systems. Such visibility also enables improved planning capabilities and allows companies to make better tactical or strategic decisions for the optimization of the supply chain.

3.1.3 Digital supply chain

Research shows that digital technologies can help firms improve their supply chain performance by enhancing efficiency, visibility, resilience and robustness, as well as reduce supply chain risks and supply uncertainties. Digital technologies have transformed the traditional ways of managing supply chains towards a more data-driven approach. In fact, the digitalization of supply chains produces large volumes of data, which has the potential to create value and enhance competitiveness (Yang, Fu, & Zhang, 2021).

It is important for firms to understand what drives them to adopt digital technologies, as the drivers could significantly influence the adoption behavior and outcomes. As written in the study done by Yang et al. these drivers can be categorized as internal and external and they can be summarized as follows (Yang, Fu, & Zhang, 2021):

- *Internal drivers:*
  - *Operational*: Many firms adopt digital technologies as a response to internal operational problems or in other words to improve the operational performance. Nowadays it is no longer efficient to rely only on manual work due to the complexity of operations and the increasing cost of labor. There's a great need of cutting down costs and improving the efficiency in procurement, production, warehousing and logistics. That's why many firms have chosen to replace the traditional, inefficient management method and adopt instead faster and more accurate digital management systems.
  - *Strategic*: Adopting digital technologies can be also driven by strategic decisions. Many firms are in fact developing digital strategies as part of their core business directions. They believe that adopting digital technologies has the potential to trigger both incremental and disruptive innovation. Firms also adopt digital technologies to gain the first mover advantage. For example, the early adopters of IoT (Internet of Things) have benefited from the improved supply chain visibility, transparency and sustainability.
- *External drivers:*
  - *Customer*: Many studies show that customer needs is an important driver for adopting digital technologies. Firms in fact use digital technologies to better fulfill the market needs and manage customer relationships. Some firms also use it as a powerful marketing tool, as it creates a positive image of firms being innovative.
  - *Supplier or supply chain partner*: The digitalization of one firm can influence other players in the supply chain. When a core player chooses to use a certain digital system, other firms within the supply chain feel pressured to also adapt to that system. The digitalization of a supply chain is usually initiated by the dominant firm due to its stronger bargain power. This gives pressure, and at the same time can serve as an example, to the other firms by changing their supplier selection criteria, cooperation strategy, and other routines. Therefore the other firms will need to adapt and respond to their digital innovation, keep close cooperation with the dominant firm and upgrade to avoid being weeded out.

- *Competition*: Competition can also be a driver for the adoption of digital technologies. Most firms tend to adopt a digital technology if one of their competitors does, because they believe that it is the direction of the entire industry and they fear facing the risk of being left behind. Digital solutions can also help firms to significantly reduce supply chain costs compared to those who only rely on conventional approaches. Many incumbent firms try to adopt the latest digital technologies to match digital frontrunners.

Digital technologies can be applied in various supply chain processes (e.g., demand management, procurement, production, warehousing and logistics) to enhance different supply chain functions (e.g., supplier selection, demand prediction and logistic planning). Advanced intelligent technologies could help firms to better identify the underlying business value from large volumes of data and make data-driven decisions. Advanced data analytics can help to have a faster and more accurate analysis for SCM. Data can in fact be used to support decision making and to increase the firm's flexibility (for example by helping firms make decisions based on real-time data and make better plans based on the predictions of the future). Digital technologies can increase the connectivity within and between firms and by reducing information asymmetry, they can lower transaction costs and avoid unnecessary communication (Yang, Fu, & Zhang, 2021).

3.2 Real Time Transportation Visibility

As written in chapter 3.1.4, supply chain visibility allows to have controlled access and transparency to accurate, timely and complete data and events within and across the organizations to support the execution of supply chain operations. Now we will focus more on the concept of real time visibility in the context of transportation, RTTV is in fact a sub-segment of the supply chain visibility space.

Real-time transportation visibility platforms provide customers with real-time insights and alerts into their orders and shipments in transit (once they have left the supplier's, 3pl's or own warehouses). Such platforms are typically owned and managed by third-party software vendors. They can cover multiple modes of transportation, but predominantly road transportation. RTTV platforms can obtain data through integration with carrier systems (for example, API or EDI), direct feeds from telematics (for example, in-cab or trailer devices) or other devices such as mobile or smartphone (Gartner, 2020). Telematics can be defined as the use of wireless devices and “black box” technologies that are able to transmit real time data back to an organization; they can collect and transmit data on vehicle usage, maintenance requirements or automotive servicing (Gartner).

Companies choose to implement RTTV platforms for a multitude of reasons but principally to improve customer satisfaction and retention, to improve on-time delivery performance, to increase labor efficiency and productivity, and to use real-time data to make better and faster decisions such as rerouting and reducing costs. The availability of real time information in fact allows for real-time dynamic optimization of transportation routes and deliveries (Chopra & Meindl, 2012).

In the past, implementing a Real Time Transportation Visibility platform could have been a differentiator for companies, but nowadays RTTV platforms are becoming increasingly popular and it’s quickly transforming into a requirement (Gartner, 2020). Visibility and automation have become even more important during the COVID-19 pandemic and will most likely remain a key capability in the future. Although visibility is high in demand and a key priority, companies still struggle with low market maturity for these solutions. This often results in lack of understanding of the quantitative benefits, a lack of quick carrier onboarding and often low quality and consistency of data.

3.2.1 RTTVP Benefits

Defining and quantifying the benefits for the business can prove challenging, in fact the benefits that can be realized include both tangible and nonfinancial returns as well. In a research done by Gartner, the most typical and most common benefits of organizations that implement RTTV have been identified in the following areas:

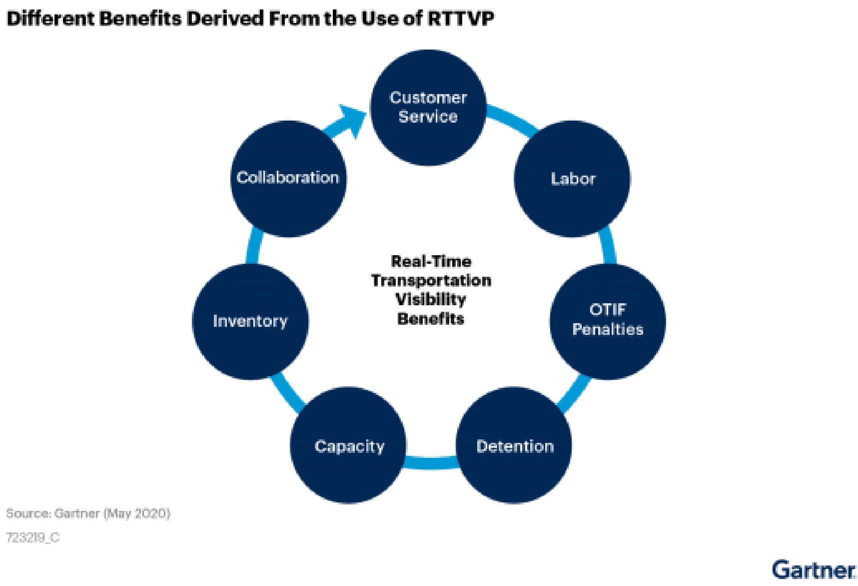


Figure 22: RTTV benefits

- **Customer service:** Thanks to proactive notifications and to having visibility of the shipments in transit, RTTV can improve customer service (Wycislak, 2021).
- **Labor:** Labor efficiencies can be realized within different teams of a company. Real time transportation visibility can in fact give the possibility of freeing resources that are no longer committed to checking the status of a transport to communicate to the customer or to the warehouse operators. These resources can then be committed to other activities.
- **OTIF Penalties:** On time in full is a logistics performance measurement which indicates how many deliveries are supplied on time without any product missing. These penalties can be reduced through RTTV thanks to both the real-time knowledge of the vehicle and the possibility of the customer himself to know the expected arrival time. Reduction in these penalties creates savings.
- **Detention**: RTTV allows reducing waiting times for vehicles to load or unload thanks to possibility to have an arrival forecast and then manage the operations of warehouse accordingly.
- **Capacity**: By reducing detention and dwell, drivers are able to be on the road longer instead of waiting at facilities; this helps return capacity to the market.
- **Inventory:** Companies are able to reduce the safety stock once the real-time visibility is available and ETAs are accurate.

- **Collaboration:** Using the data from RTTVPs companies throughout the supply chain can collaborate and create synergies with each other, for example filling empty miles (making sure the space in trucks is fully exploited).
- **Reducing carbon footprint**: An additional advantage is that by tracking all the trips companies can know the quantity of emission produced by them. This can then help the company monitor and reduce their carbon foot print.

3.3 Logistic Control Tower

As defined by Capgemini, a control tower is "*a central hub with the required technology, organization and processes to capture and use supply chain data to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives*" (Capgemini Consulting). A logistic control tower provides end to end, real-time visibility (across functions, countries and modalities) into the operating business ecosystem and enables collaboration for optimized response and prevention of failures. The visibility provided by a logistic control tower can help to anticipate and mitigate potential failures as well as identify patterns with systemic issues, assist with root cause analysis and help to simulate scenarios to implement structural countermeasures that better suit the end-to-end process.

Control towers combine organizations (people), systems and processes in order to provide the supply chain partners with a high level of product visibility all throughout the entire supply chain. This enables three levels of management control (Capgemini Consulting):

- Strategic: provides control over the design of the overall supply chain network;
- Tactical: enables proactive planning of procurement, operations and distribution according to market demand;
- Operational: encompasses various real time functionality including transportation management, inventory tracking and exception management.

The logistic control tower can be a way to address the problems that are afflicting logistics. First of all the logistics function is fragmented: there are in fact many parties involved, who don't have a centralized view or control over the whole end-to-end logistics process. Additionally, there are a number of issues that are undermining logistics effectiveness: the logistics function is exposed to emerging risks and accelerating disruptions such as global trade instability, epidemics/ pandemics, cybersecurity and climate change. This can cause volume decline, transport delays, lack of capacity, and delays on delivering to customers. Lack of visibility is amongst the top 5 internal obstacles to achieving supply chain goals and objectives (Gartner, 2019).

The logistic control tower provides a 'single source of truth' by retrieving data from multiple systems, provides real-time logistics data and predictive decision-making capabilities, as well as integrates multiple logistics capabilities onto a single platform.

The role and responsibility of the logistic control tower and its span of control can be summarized by the six pillars of capability depicted in the graph below. (Gartner, 2020)

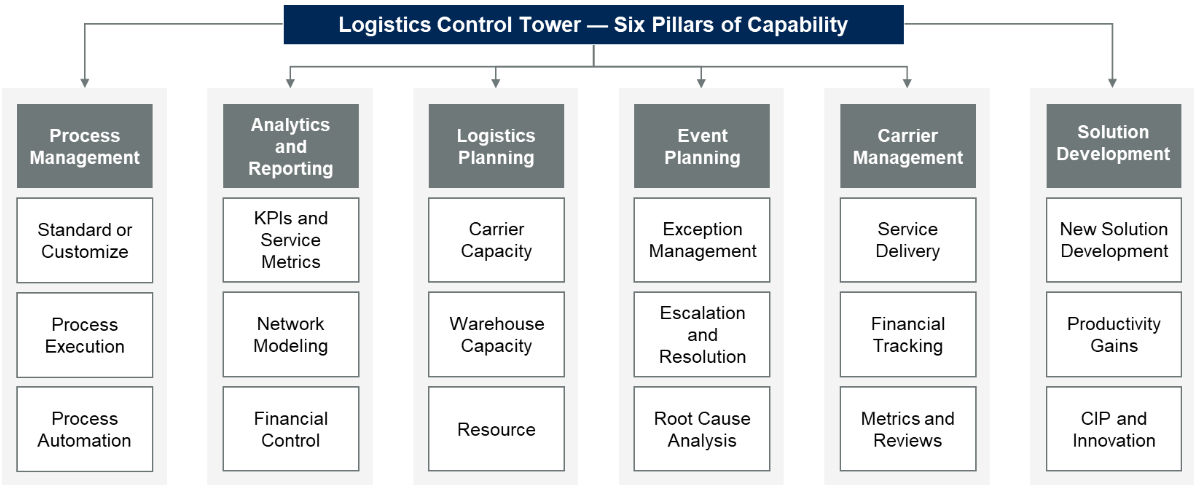


Figure 23: Logistic Control Tower span of control (Gartner)

The Logistics Control Tower aims to manage information flows. Effective and integrated information flows are what allows to manage material flows efficiently.

Monitoring material flows reduces the risks in transportation activities, so efficient material flows allow the company to maintain healthy cash flow. Understanding those consequences enable one to understand how each activity provides and affects the final value that is produced by the Logistics Control Tower.

In particular the Logistic control tower can affect operational transparency and adaptability, process automation and localization, profit-focused decision making and stakeholder collaboration and customer experience in the following ways:

	Operational Transparency and Adaptability	Process Automation and Localization	Profit-focused Decision Making	Stakeholder Collaboration and Customer Experience
Logistics Control Tower	Visibility and real-time tracking enable: • Real-time, end-to-end view (including stock availability and raw material and finished goods in transit) • Alerts on risks and disruptions • Ability to scale solutions and enable business growth	Visibility, data capture, governance and advanced analytics enable: • Increased productivity resulting from more efficient processes • Improvement in carrier management and contract negotiations • Better management of regional or local needs	Visibility and predictive and prescriptive analytics enable: • Inventory optimization across the network • Reduction in customer claims and costs related to disruptions (less express freight and penalties cost) • Reduction of stock-outs and loss sales	Real-time tracking, single version of truth (data) and analytics lead to: • Creation of efficiencies between different departments • Shorter reaction time for plan changes and market requests • Improvement in order fulfillment and higher levels of service delivery

Figure 24: Adaptation from Gartner's Business case for investing in a CT

Gartner has highlighted some of the main potential concerns when implementing a Logistic Control Tower, which are summarized below:

- **Lack of clarity on the span of control**
  Overcomplicating the span/scope of operations managed by a logistics control tower could lead to unrealistic expectations for benefits that cannot be delivered. Therefore it is necessary to set out in a clear way the scope of the control tower, how it will be resourced and where it will report within the organization.

- **No consensus on build-versus-buy decision**
  Without a well-rounded understanding of what is required to design, implement, deploy and maintain a control tower it is difficult to evaluate whether the control tower should be in-house, hybrid or outsourced. This is why

in order to make a build-versus-buy decision the IT team should be engaged and there will need to be an evaluation of the pros and cons of in-house control versus outsourcing it.

- **Inability to identify the right technology requirements**
  Investing a significant amount of time in reviewing and evaluating many different technology platforms each with different and multiple capabilities and functionalities can lead to an 'analysis paralysis' and an inability to make a technology investment decision, therefore it's important to Incorporate a step-by-step development plan or roadmap.

  Other possible challenges which have been highlighted by Ville Reinilä are the following (Reinilä, 2021):

- **Internal knowledge within the company**
  While many people are starting to become familiar with the concept of control tower, it is still relatively new and the understanding of what is the control tower and what are its responsibilities is still weak. Clear communication about its scope to the employees would be useful for its implementation.

- **Lack of standardization**
  One of the biggest challenges in the control tower is that the teams located in different regions can have different policies and ways of working, which makes supporting other control tower teams harder and it also decreases the quality of services delivered to the customers. Besides the lack of standardization inside the control tower, processes with internal and external stakeholders often lack standard policies, which can cause overlapping work (e.g.: multiple organizations doing transportation monitoring at the same time). As it is mentioned: "*In addition to extra work and lost resources, the lack of global and regional standardization causes communication disruptions, delays, incomplete information flows and limited visibility*". Companies must design and set out a globally standardized blueprint for their logistics control towers.

4. Barilla’s Real Time Transportation Visibility Project

As previously mentioned, Barilla’s supply chain is a very complex one and it involves a number of different stakeholders, both internal and external to the company. It would be almost impossible or at least very time consuming and labor intensive to monitor and manage all the dynamics that happen within such a complex organization without the help of software.

Up until now, the only way to keep the punctuality of the shipments under control and to make sure that the carriers respected the various loading and unloading programs was to keep a close relationship with the many transport providers in order to warn them and to be notified if any problems arose that prevented them from carrying out the transportation planned. Most of those communications happened over email or phone, therefore subject to human errors and forgetfulness. It was an inefficient process also because more time was being spent trying to track deliveries than actually analyzing and optimizing the operations. A lack of visibility also created operational inefficiencies throughout the chain, particularly at the delivery sites, often leading to yard congestion. Loading docks can’t be managed efficiently without knowing in advance possible early arrivals or delays. An early arrival could result in long dwell times because the truck would have to wait for its scheduled dock slot. A late arrival instead would be forced to wait for a gap in the schedule in order to deliver or pick up the load, again increasing dwell times and associated costs.

Thanks to the availability of new technologies and industry 4.0 driven by Big Data, Barilla too had decided to adopt a real time visibility system of its transportation that is able to guarantee real time control of the trucks that carry Barilla’s products and highlight anomalies even before a human operator has a chance to notice.

While real time visibility is essential for the future of the supply chain, it’s not easy to implement it overnight. Gartner has created a guide for organizations that want to pursue real time visibility, which highlights the various stages to follow and which steps to take to incorporate visibility over time. They recommend taking a strategic approach, starting with the transportation mode (such as OTR, intermodal etc.) that would offer the most value to the organization, then expanding the visibility coverage and capabilities (Project 44, 2019).

The RTTV project in Barilla will be implemented in multiple steps.

The first step is to **explore the market** and investigate RTTVP providers that provide a solution to best match the company's needs. It's important to partner with the right type of RTTVP company to help drive the benefit that the business defines (Gartner, 2020). In order to choose the right provider a test (**Proof of Concept**) has been done where two different platforms were tested simultaneously and compared.

The next step is the **production phase** of the project which consists of 3 macro steps:

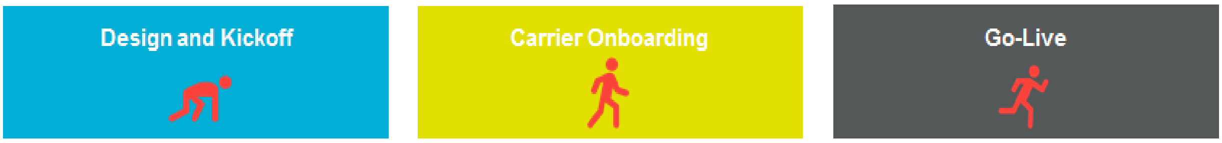


Figure 25: Macro steps of production phase

- **Design and Kickoff**: this first step involves qualification and education of Barilla users regarding the platform of the chosen provider and setting the layout according to Barilla's needs;
- **Carrier Onboarding**: this consists in the involvement of Barilla's fleet in the platform. It is done by analyzing and applying for each carrier the most appropriate methodology for tracking their transport. Once the transport tracking has begun, this step involves also the monitoring of the quality of the shipment tracking by intervening in case of problems and carrier performance analysis;
- **Go-Live**: Once a good number of transports are tracked with good data quality, Barilla will proceed with the live launch of the system by introducing it into the Barilla supply chain and connecting it to the warehouses and to customer service by setting special alerts where anomalies occur.

The team that took part in the RTV project in Barilla was made up of 8 people who had different roles shown in the table below (some people covered multiple roles).

Project Lead, Business	• Attend weekly project status call • Regular communication with Implementation Manager • Coordinate with Implementation Manager to schedule meetings and trainings • Manage workflow internally to align with project timeline
Project Sponsor	• Point of contact for escalated issues • Provides support to Project Leads to mitigate risks and clear blockers
Project Lead, Carrier Onboarding	• Reviews Carrier integrationdashboard regularly for updates and progress • Attend weekly project status call • Regular communication with Implementation Manager • Weekly communication with carrier base • Responsible for carrier integrationsuccess
Project Lead, IT	• Attend weekly project status call • Review all FourKites documentation provided in order to complete technical integration • Actively build what is needed and troubleshoot on the Barilla side in a timely manner that aligns with the project plan
Super Users	• Attend Super User training sessions • Identify internal department user base • Outline deployment plan based on internal department user base • Continue End User education/training post-implementation
Local Operations Manager(s) Procurement Manager(s)	• Play a key role in carrier escalation process • Support FourKites integrationteam in case of carrier integrationprocess issues (not willing to participate in the project, non-responsiveness, communication issues etc.)

Figure 26: Barilla actors of the project and responsibilities

Over the course of my internship I have worked in the second step of the production phase, actively participating in the carrier onboarding process alongside the Project Lead. In particular my main task was monitoring the quality of the tracking by analyzing the problems that occurred during the tracking of the shipments for each carrier and finding the possible causes.

4.1 Market Analysis of RTV providers

The RTTVP market has doubled in size in North America in 2020. This growth was accelerated due to the supply chain disruptions created by the pandemic. This was also observed in Europe, while instead in Asia the low technology adoption of shippers and carriers is still impeding fast growth (Gartner, 2021).

Since the real-time transportation visibility market is thriving, new companies have decided to join this market while incumbents are extending their capabilities and their modal and regional coverage. Today there are over 100 platforms that offer real time visibility services, and despite their similarities they all have different key focus points. The six criteria used for the selection of a Real-Time Transportation Visibility platform, in line with Gartner's 2020 Market Guide for RTTVP, are the following:

- **Modes of transportation covered:** Most shippers have a large percentage of their freight spend (on average 70% of their freight spend) in over-the-road transportation, therefore the main volume of these solutions is for road transportation, however many of these vendors also offer real time visibility coverage for other modes such as intermodal, rail, parcel, ocean and air. Since Barilla ships its products using different modes of transport, the suppliers that were able to cover the tracking of all of those modes were taken into consideration.
- **Industries covered:** Barilla took into consideration those vendors that could cover all the industries in which Barilla operates and with whom it collaborates with.
- **Geographies covered:** Many of the vendors operate in a single region or a limited number of regions, but Gartner observes that an increasing number of them have a more global scope. Since Barilla operates in over 100 countries, it's necessary to choose a vendor that offers a global coverage.
- **Functionality offered (including via partnerships):** For Barilla it was important to choose a vendor that could offer all the functionalities that were needed to address its own business problems and technical concerns. Those functionalities include messaging/alerts, predictive ETA, dashboards etc.
- **Methods of tracking data:** RTTVPs use different methods to obtain data which include integration with the carrier systems, direct feeds from telematics (such as in-cab or trailer devices) or other devices such as smartphones. The more methods the vendor is able to use, the easier and faster it will be to integrate the carriers.
- **Partnerships with TMS providers (based on certified partnerships):** RTTVPs often work complementary to a TMS (transportation management system).

Having existing integrations to a TMS can speed up implementation and impact how the data can be used to drive workflows.

Below is the analysis of the main suppliers of Real-Time Transportation Visibility platforms for each of the previously mentioned criteria:

Modes of Transportation Supported

Full Capability | Via Partner | Partial Capability | No Capability

Modes Supported:	OTR FTL	OTR LTL	Reefer	Flatbed	Intermodal	Rail	Parcel	Last-Mile Delivery	Ocean	Barge	Air
Vendor											
Autoplant System India	Full Capability	Full Capability	Full Capability	Full Capability	Via Partner	Full Capability	No Capability	Full Capability	Via Partner	No Capability	No Capability
Blume Global	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability
C.H. Robinson (TMC)	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	Full Capability
Convey	No Capability	Full Capability	No Capability	No Capability	No Capability	No Capability	Full Capability	Full Capability	Via Partner	No Capability	Full Capability
Descartes	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability
FourKites	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Via Partner	Full Capability	No Capability
FreightVerify	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability
IntelliTrans	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	No Capability	Full Capability	Full Capability	Full Capability
nuVizz	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	No Capability	No Capability	Full Capability	No Capability	No Capability	No Capability
project44	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability
RateLinx	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	Full Capability
Shippeo	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	No Capability
Sixfold	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	No Capability	No Capability
SupplyStack	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability
Tive	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	Full Capability	Full Capability	No Capability	Full Capability
TransVoyant	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability	Full Capability
Trimble	Full Capability	Full Capability	Full Capability	Full Capability	Via Partner	Via Partner	Full Capability	Full Capability	Via Partner	Via Partner	Full Capability
Trucker Tools	Full Capability	Full Capability	Full Capability	Full Capability	No Capability	No Capability	Full Capability	Full Capability	No Capability	No Capability	No Capability

Source: Gartner (February 2020)
ID: 380260_C

Figure 27: Analysis of RTTV providers based on modes of transportation supported

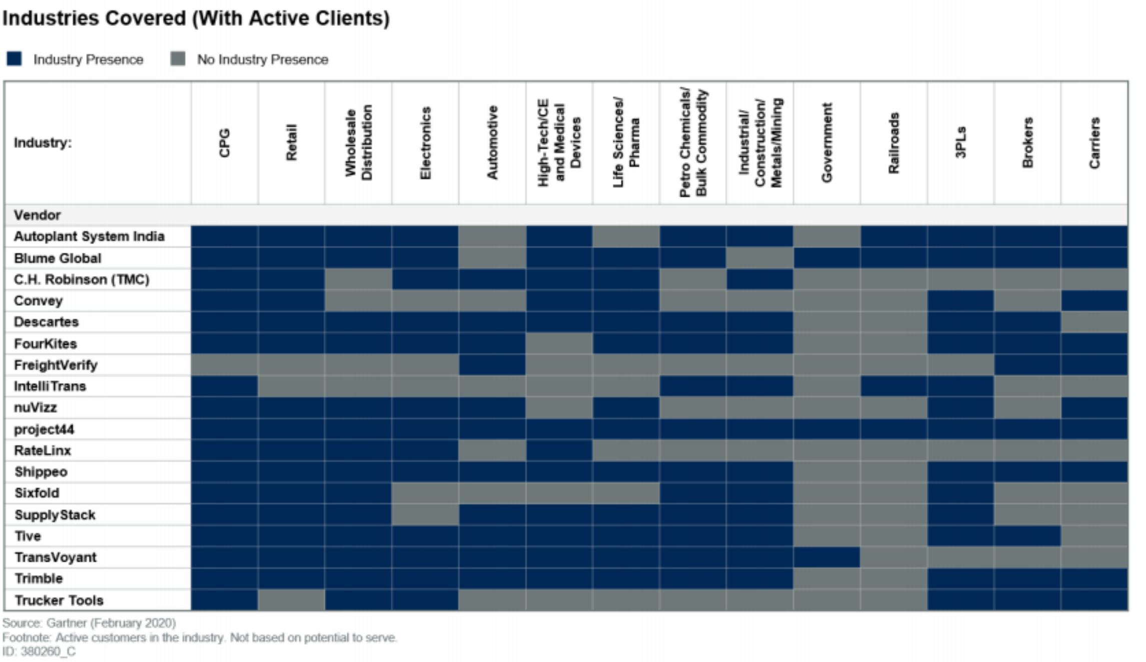


Figure 28: Analysis of RTTV providers based on industries covered

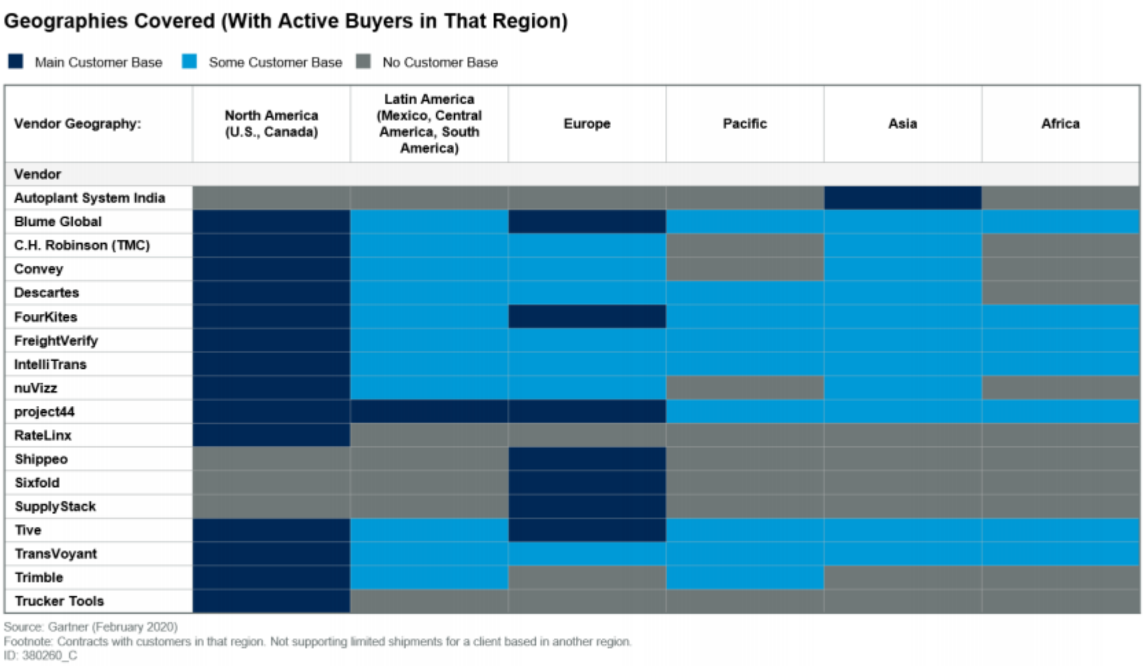


Figure 29: Analysis of RTTV providers based on geographies covered

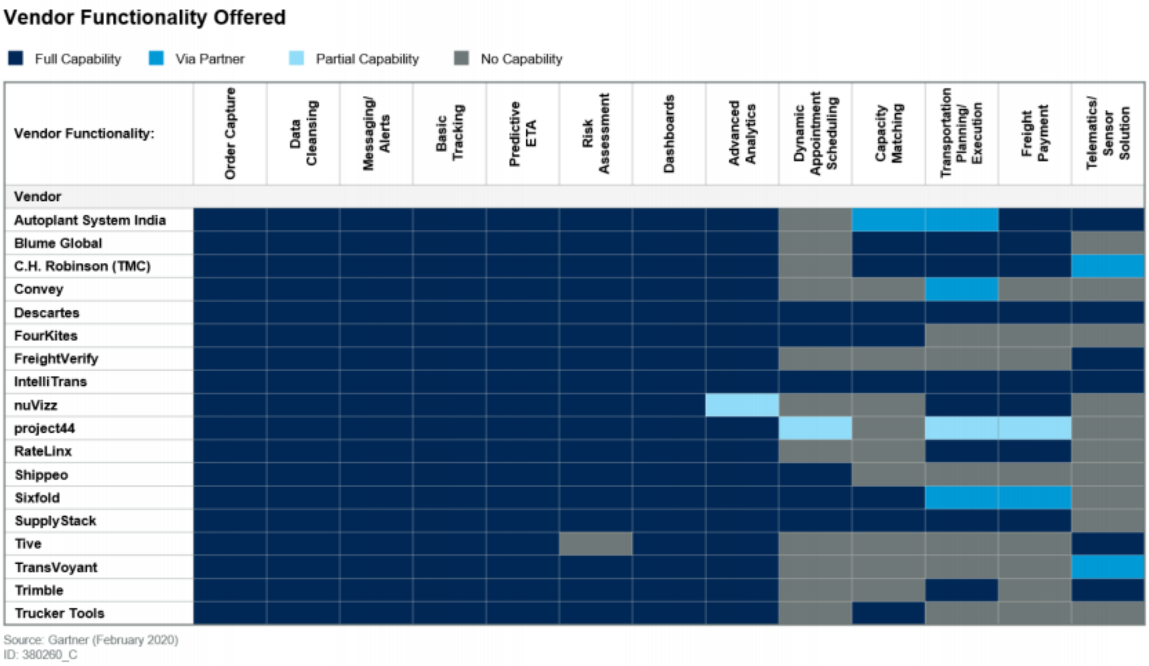


Figure 30: Analysis of RTTV providers based on vendor functionality offered

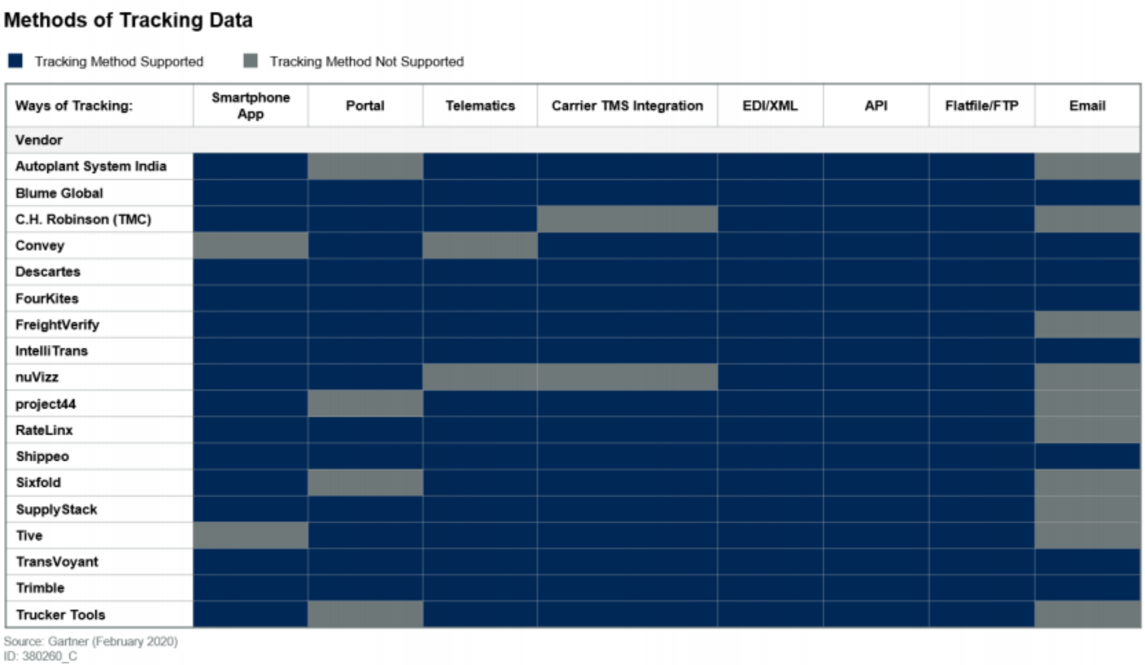


Figure 31: Analysis of RTTV providers based on methods of tracking data

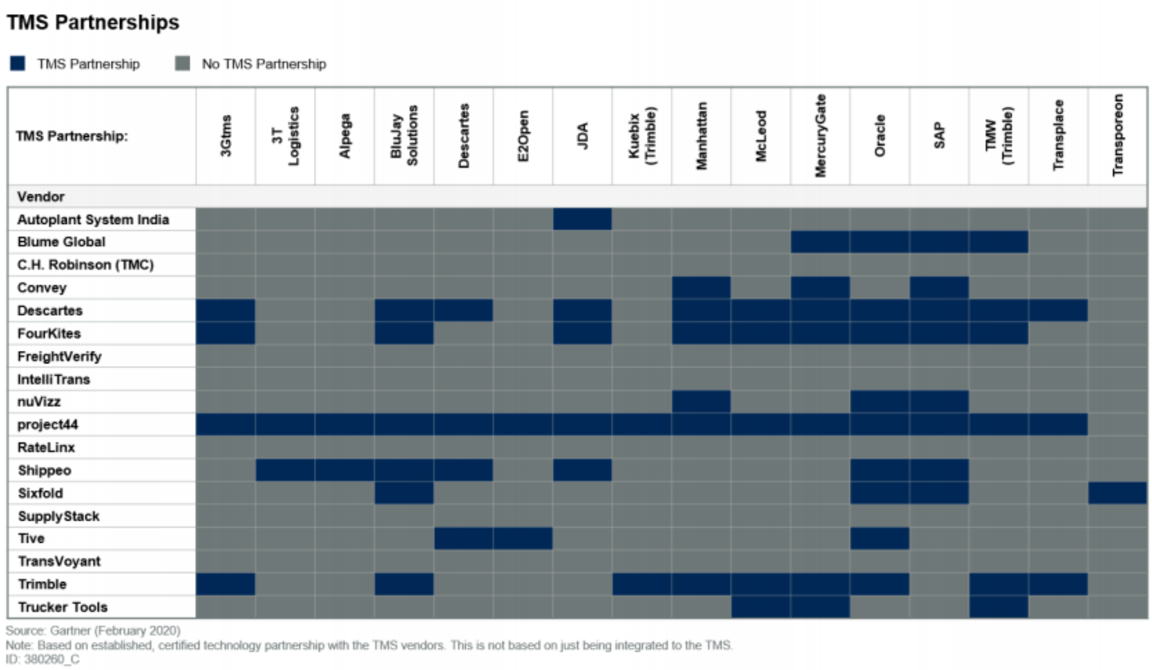


Figure 32: Analysis of RTTV providers based on TMS partnerships

As shown in the tables above, the solutions of the various providers are very different among themselves. In this first phase of the project there was a need to decide which solutions to test. In order to do so, the criteria deemed as the most important for the company were identified as follows:

- Modes of transport supported;
- Integrations already in place;
- Geographical areas covered;
- Diffusion in the industrial sector in which the company operates.

On the basis of these rationales, it was decided to test simultaneously the solutions provided by two different providers:

- **SUPPLIER A** which was chosen for its great diffusion, the level of maturity of the solution and for the completeness of both geographical areas and modes of transport covered;

- **SUPPLIER B** which differentiated itself from the other solutions thanks to its integration already in place with other services (i.e. TMS) used by Barilla.

4.2 Proof of concept

Once the two RTTVP solutions to be tested have been identified, attention was then switched to the carriers that would have been tested in the Proof of Concept (PoC). Barilla has selected these carriers using the following selection criteria:

- Type of transport: it concerns both the mode of transport (by road, intermodal, etc.) and whether they have their own fleet or they use subcontractors;
- Geographic areas covered: in how many and which regions the carrier carries out transports on behalf of Barilla;
- Technology available to the carrier: GPS on trucks or trailers, TMS, etc.
- Importance of collaboration: the carriers that were chosen have been collaborating with Barilla for years and Barilla has a solid partnership with them.

The information exchange with the two platforms during the PoC (Proof of Concept) has been structured according to the level of integration of the solutions with the already existing company systems. The generic mechanism of operation of a real-time visibility system is the following:

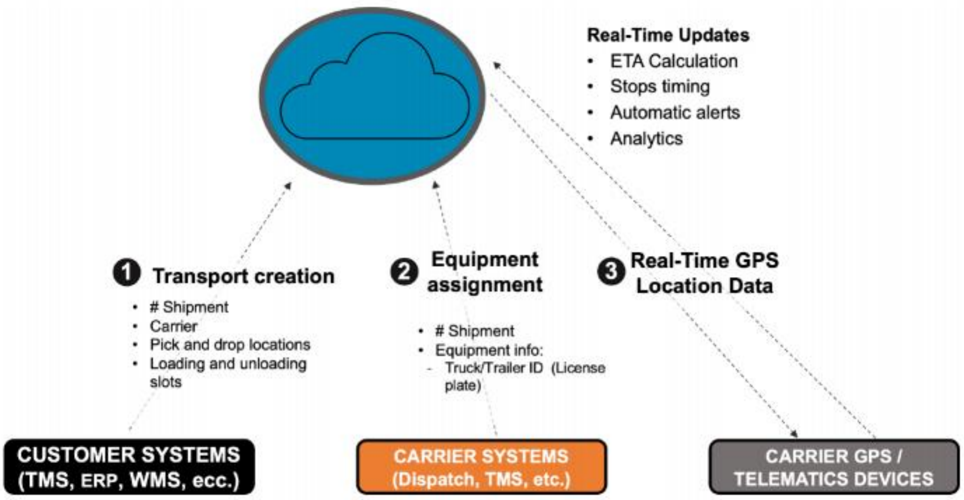


Figure 33: Functioning of an RTV system

As seen, the solutions are developed as cloud services, therefore the software of the providers themselves act as an interface between the various actors in the process.

The main steps for the functioning of the process are:

- Sending of transport data by the sender (typically managed through interface with the carrier's management system);
- Assignment of transport equipment by the carrier;
- Sending the transport tracking data from the assigned equipment;
- Status update, estimated arrival time calculations and activation of automatisms (e.g. notification of delay).

After a careful analysis of the entire fleet of carriers with which Barilla collaborates, a mix of Italian and foreign carriers was selected, which were already in possession of systems for real-time tracking of their shipments, including both intermodal and not intermodal modes. The carriers selected were the following:

- TN Logistica SK
- Torello Trasporti
- UAB Girteka
- LKW Walter

- Favaro
- Ambrogio
- Gruber
- Berger

Figure 34: List of carriers involved in the PoC

In the following pages the carriers will be referenced with numbers, in no particular order (e.g.: Carrier 1, Carrier 2 etc.), in order to not disclose their identity.

4.2.1 Supplier A

Supplier A is an RTTVP company headquartered in Chicago and founded in 2013. It provides cloud-based visibility software solutions to shippers, carriers, 3PLs and freight brokers offering predictive, real-time visibility across all modes. Supplier A is one of the largest RTTV vendors in terms of revenue, customers and presence in RTTVP deals, especially in North America (Gartner, 2021).

The proposed solution is extremely flexible and versatile for the type of connection that it can establish with carriers and shippers in order to acquire data that feeds the platform. Other than simple tracking and offering basic status updates of the transport, being a well-established company in the RTTVP market, Supplier A is able to provide different additional services such as:

- The vendor’s mobile driver app that allows those carriers not equipped with on-board telematics to exchange the transport data in real time using the smartphone of the driver;
- Visibility on ocean transport;
- A service which facilitates collaboration between partners to reduce empty backhaul miles (by facilitating the aggregation of loads on similar routes between different freight forwarders who do not have load optimization);
- Arrival time prediction system which has been confirmed as the most accurate in the industry.

Since there wasn’t any existing integration between Supplier A and the company systems, the sending of transport information to be tracked has been done by exchanging a daily Excel file. The interface is structured with a predominantly informative rather than visual approach, but it is still clear and complete and above all it is continuously being developed to better adapt to the needs of the users.

The tracking logic of SUPPLIER A produces the following outputs:

- **Not tracked**: transports for which the equipment (i.e. truck or trailer’s license plate) has not been assigned by the carrier;
- **Tracked**: when the shipment is tracked but not consistently;
- **Tracked consistently**: when the load is tracked well throughout the whole route;
- **Delivered**: transports that appear to be delivered to the destination.

4.2.2 Supplier B

Supplier B, headquartered in Ulm, Germany, was founded in 2017. It is a market leader in RTTVP in Europe with a very strong and extensive carrier network. It offers a real time visibility solution that provides shippers the location, ETA and shipment status, including potential delays or other problems that could affect the transportation and require attention. In 2020, Supplier B was acquired by Transporeon (a TMS software already used in Barilla). Through its partnership with Transporeon, Supplier B can access and interconnect not only with Transporeon's carrier network but also with other common relevant business systems. The integration between Supplier B and Transporeon was a key element for Barilla in deciding to test this solution, since the data was already present in Transporeon and exchanged directly between the two systems as shown below:

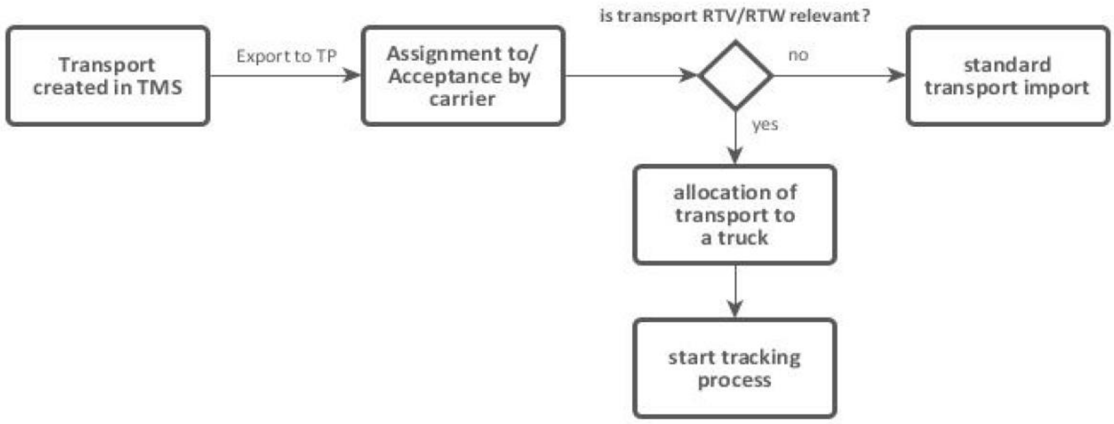


Figure 35: Method of data transfer Supplier B

The shipment is created in the TMS, once the shipment has been assigned/accepted from the carrier, it is passed to Supplier B if relevant for RTV, or in other words if the carrier is the object of RTV. The carrier must link to the shipment a license plate then the tracking process can start.
This platform offers:

- Tracking of the position in real time;

- Calculation of the Estimated Time of Arrival (ETA) with robust prediction algorithms that take into consideration various factors, like shipment information, plan and external impactors;
- Transport status updates;
- Integration with existing systems.

The platform interface is very user-friendly and easy to read also for the appearance of the status of transport. For SUPPLIER B the system differentiates the transport data based on the tracking and the data provided by the carriers. When the carrier enters the data of the equipment on the platform, transport is marked as **Assigned**, otherwise as **Canceled**, but in the event that problems occur in the tracking, then the freight is classified as **Canceled**. When the tracking comes to an end without errors it is classified as **Completed**.

4.2.3 PoC Results

The test period lasted 6 months, during which the two solutions provided by Supplier A and Supplier B were tested in parallel. In order to have a term of comparison it was decided that there had to be a common base of carriers involved:

Supplier A	Supplier B
Carrier 13 (a & b)	Carrier 13 (a & b)
Carrier 8	Carrier 8
Carrier 11	Carrier 11
Carrier 2	Carrier 2
	Carrier 5
	Carrier 9
	Carrier 14

Figure 36: List of carriers considered for each supplier

As shown in the list above, more carriers were tested for Supplier B since they were already integrated with the TMS system already in use in the company. The purpose of the PoC was to judge the good functioning of the systems and not the ability to connect to new carriers.

The results of the PoC are based on the analysis of the common carriers which were present on both platforms in order to make a comparative evaluation of the performance of the two systems. This has been done by downloading data reports directly from the platforms and using tools like Power BI to create graphic analyses that show the progress of the project. The percentages of shipments tracked by Supplier A and Supplier B are summarized in the table below:

	Supplier A	Supplier B
Carrier 13 (a & b)	79%	42%
Carrier 8	46%	65%
Carrier 11	85%	30%
Carrier 2	100%	35%

Figure 37: Percentages of shipments tracked by Supplier A and Supplier B

Carrier 2

This carrier mainly deals with intermodal transportation and the data exchange is carried out through the use of a proprietary app of the carrier instead of the on-board telematics of the vehicle. As shown in the graphs below (*Figure 38*), the amount of shipments tracked by supplier B are only 35%, which is not satisfactory if compared to supplier A, which was able to track 100% of the shipments.

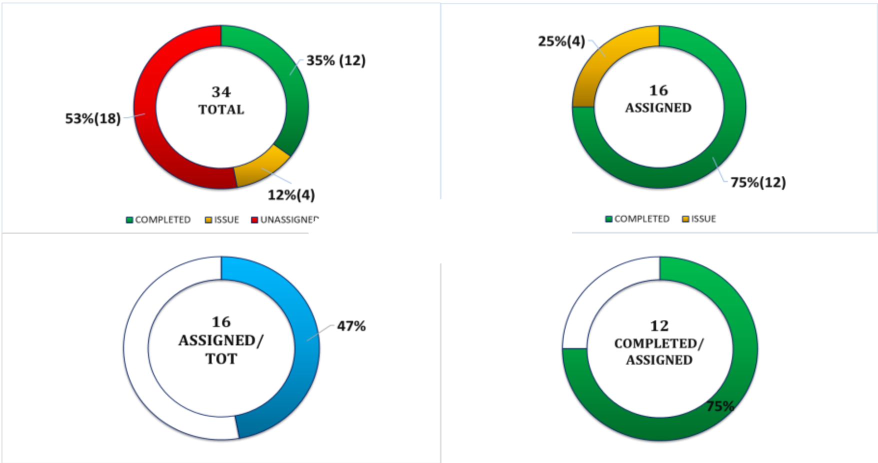


Figure 38: Carrier 2 tracking percentages by Supplier B

Figure 39: Carrier 2 tracking percentages by Supplier A

Carrier 11

Carrier 11 also provides intermodal type of transport, like Carrier 2, as well as road transport. The performance of Supplier B (30%) is again lower than that of Supplier A (85%), indicating that Supplier B has a more difficulty in tracking intermodal transportation.

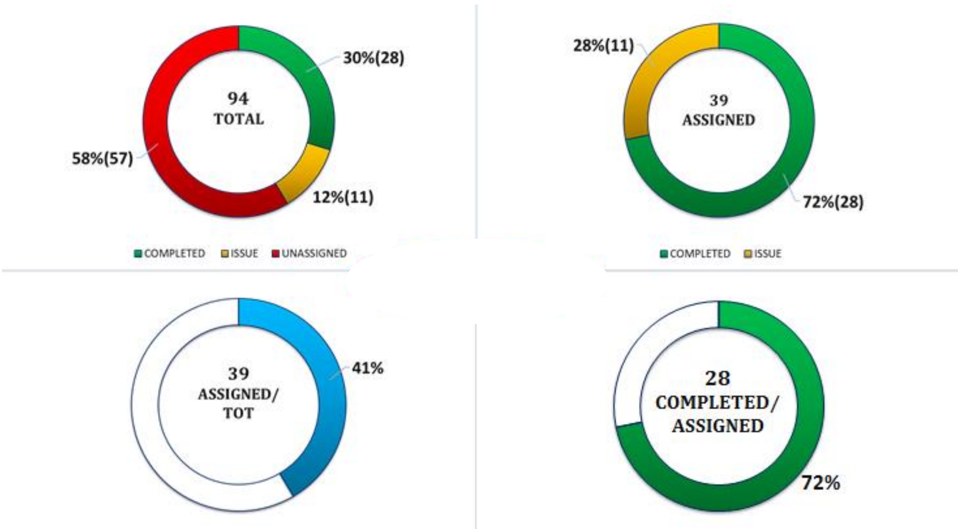


Figure 40: Carrier 11 tracking percentages by Supplier B

Figure 41: Carrier 11 tracking percentages by Supplier A

Carrier 8

Carrier 8 is mainly a road carrier. In this case, differently from the previous two carriers, Supplier B performed quite well with 65% of tracking, compared to Supplier A whose platform was able to track only 46% of transport. This was found to be related to the fact that the carriers needed to make manual assignments on the systems and they had already some familiarity with the platform offered by Supplier B, therefore making it easier for them to use.

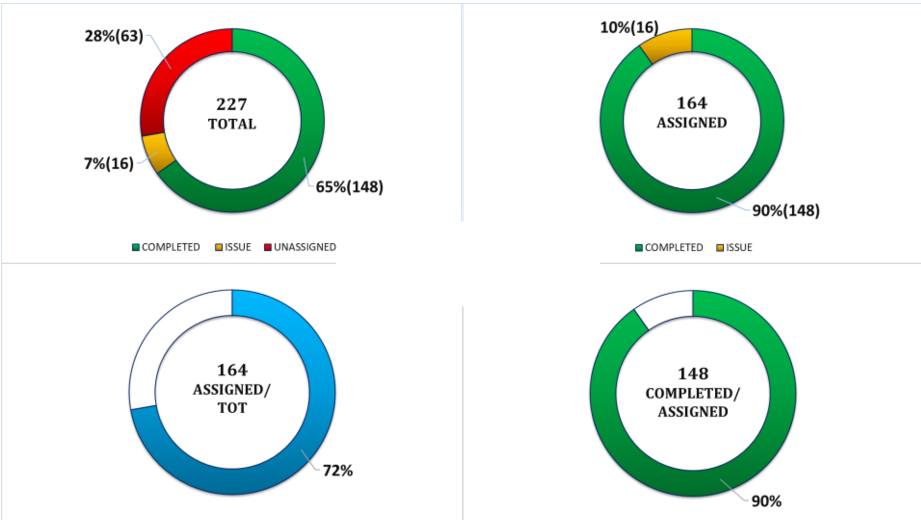
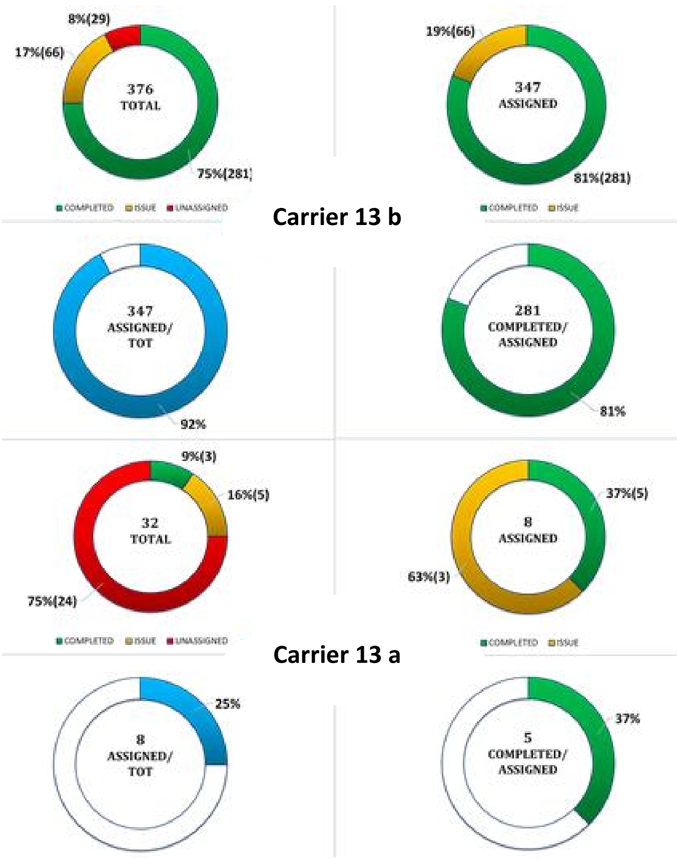


Figure 42: Carrier 8 tracking percentage by Supplier B

Figure 43: Carrier 8 tracking percentage by Supplier A

Carrier 13 (a & b)

Carrier 13 (a & b) is a road carrier, and it is differentiated into two business segments: national (Carrier *13a*) and international (Carrier *13b*). These two were differentiated on Supplier B's platform, while on SUPPLIER A they were under a single name, so the data for Supplier A is cumulative.



By looking at Figure 44, it is observable that the two company branches 13b and *13a* have very different tracking percentages. Carrier 13a has only 9% of tracking while Carrier 13b has a much higher rate of 75%, for a combined value of 42%. Supplier A (*Figure)* has instead a combined percentage of 79%. Following a contact with the carrier to understand the reason for this discrepancy, it has been reported that Supplier B demanded more manual effort, while with Supplier A it was possible to use automatic data exchange right from the beginning.

Figure 44: Carrier 13 (a & b) tracking percentage by Supplier B

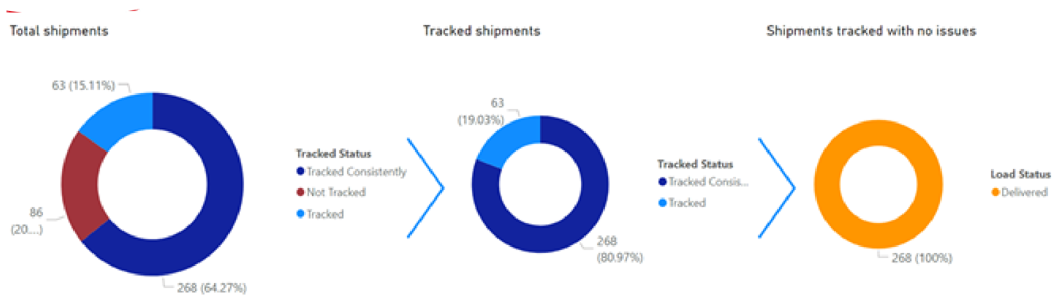


Figure 45: Carrier 13 (a & b) tracking percentage by Supplier A

By looking at the overall situation, we can see how despite starting from a disadvantage of not having a natively integrated data source, Supplier A performs much better than Supplier B, reaching an overall percentage of tracked transports of 73% while Supplier B stops at 52%. The quality of tracking of Supplier B is worse, and this is mirrored by the percentages of the journeys traced in a complete way with respect to the total (*Figure 47*).

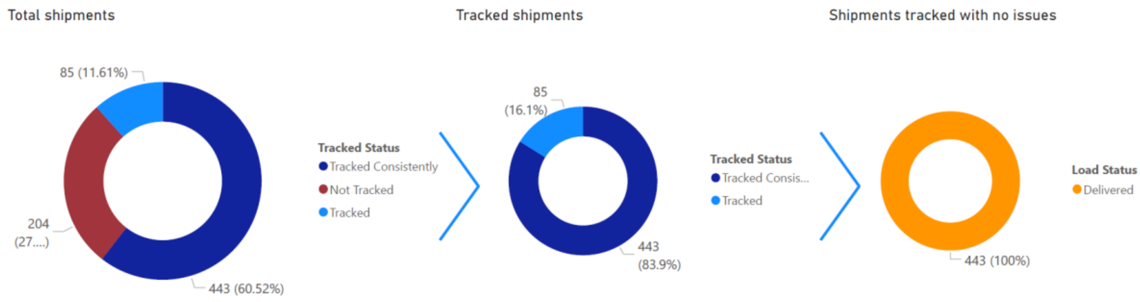


Figure 46: Overall tracking percentages Supplier A

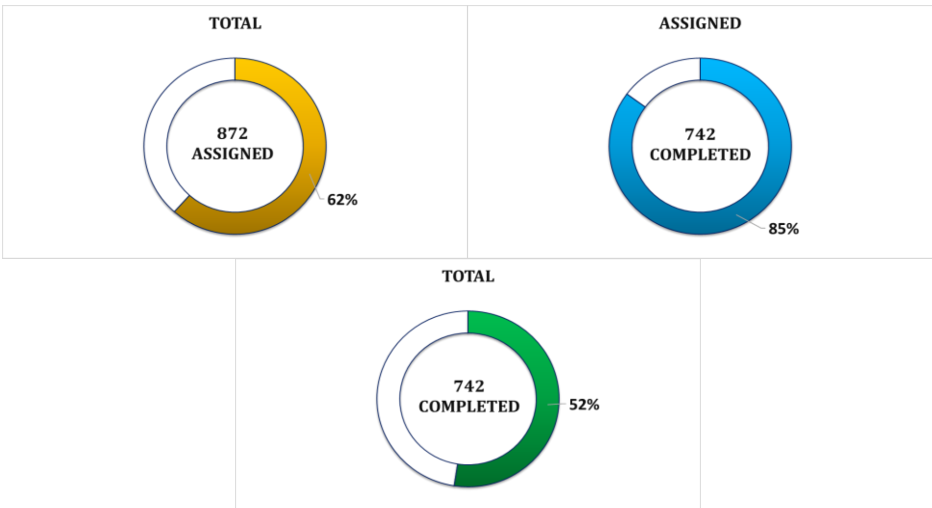


Figure 47: Overall tracking percentages Supplier B

For both Supplier A and Supplier B it can be noted that different carriers have different technical capabilities, different modes of tracking and different previous experiences with TMS systems, therefore this affects the tracking results (*Figures 48* and *49*).

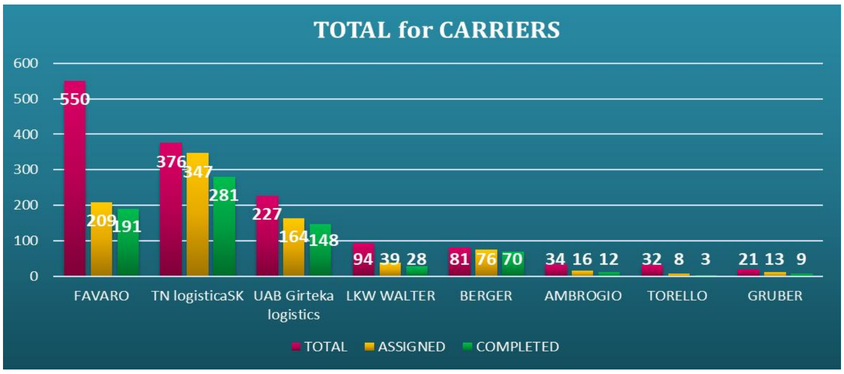


Figure 48: Tracked status per carrier, Supplier B

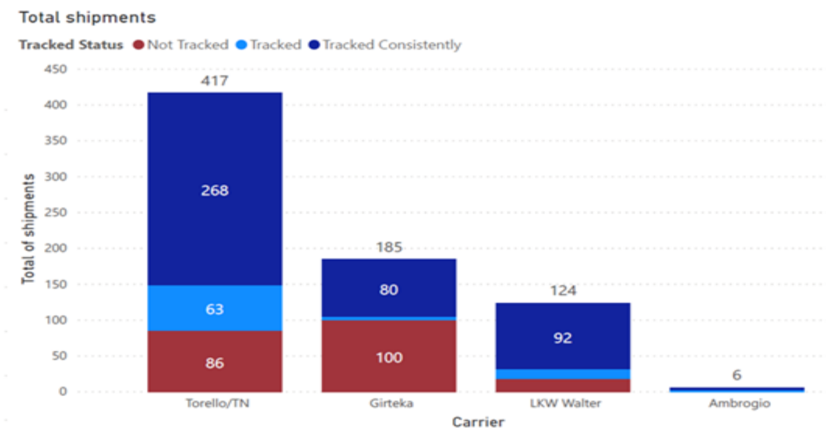


Figure 49: Tracked status per carrier, Supplier A

For Supplier A most of the untracked journeys date back only to the first phase of the project when the carriers were still unfamiliar with the platform and how it worked. With the advancement of time and by continually giving guidelines to the carriers, a growing trend of tracked trips occurred (*Figure 50*). Also for Supplier B the trend of correct data tracking is growing, however it seems to have reached a plateau at the end of the test phase, despite not having reached 100% of the journeys tracked in a complete way (*Figure 51*).

If we look at the same trend in terms of percentages of shipments tracked instead of number of trips tracked, it is even more evident how Supplier A has been improving while Supplier B's ability to track shipments seems to be somewhat constant over time (*Figure 52*).

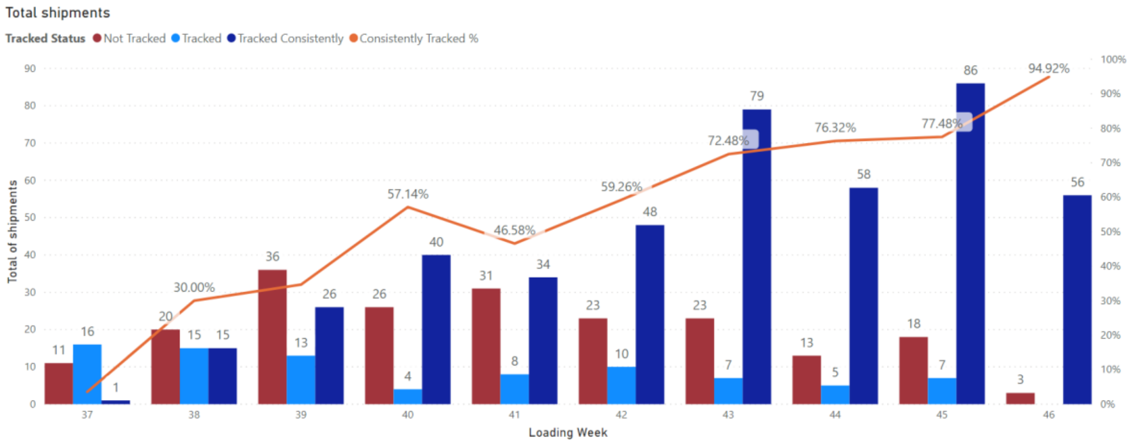


Figure 50: Tracking trend Supplier A

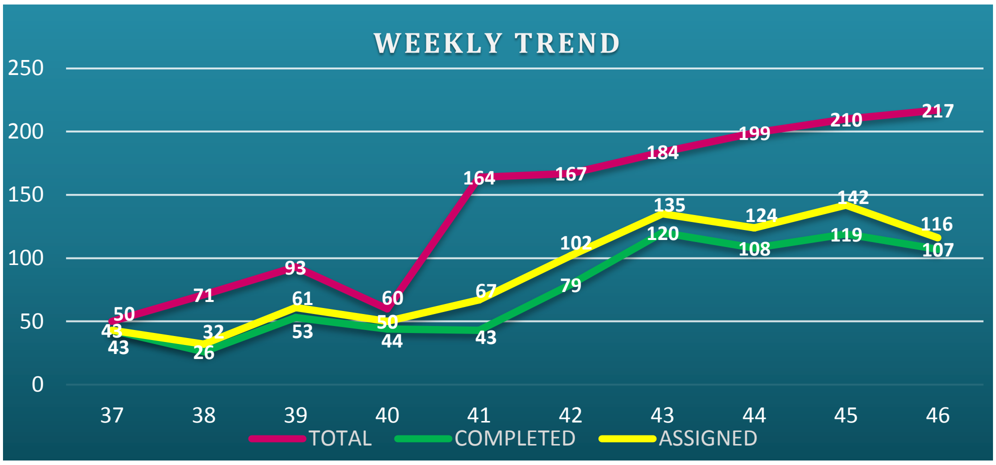


Figure 51: Tracking trend Supplier B

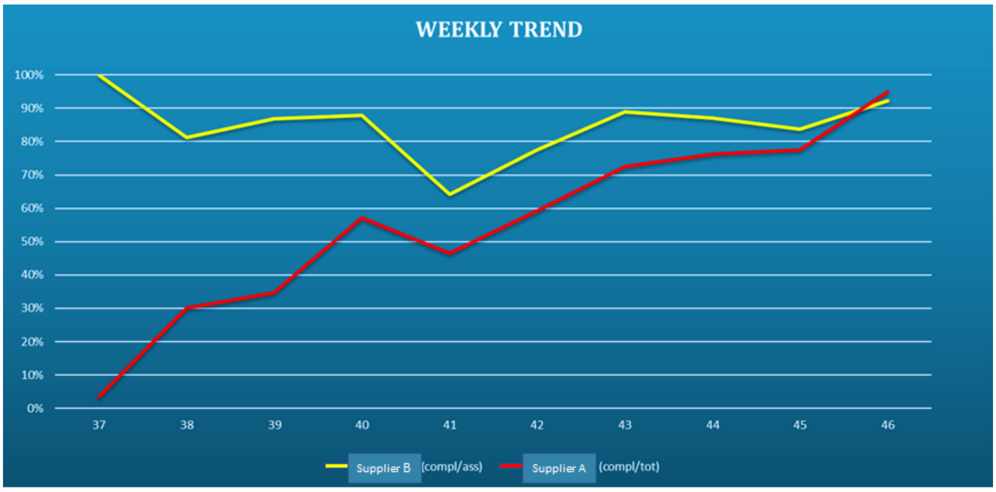


Figure 52: Comparison weekly tracking percentages Suppliers A and B

4.2.4 PoC Conclusions

The following table summarizes the main differences between the two platforms considered:

Supplier A	Supplier B
Possibility of managing multiple license plates on the same shipment	Complex tracking management when using different license plates for the same shipment
Very good tracking coverage for intermodal (railway and overseas)	Very poor intermodal transports tracking
Capability to self-determine events in case of tracking gaps	Low capability to self-determine events (i.e. pick-up done)
Fast and reactive in issues fixing	Low flexibility, issues are not solved in a timely manner
No need to manage a license plates master data	Need to manage a license plates master data and transport is canceled when license plate is missing
Completely new integration to be defined and implemented (but native integration agreed with Transporeon)	Native integration with Transporeon for shipment's data and slots
UI complex, designed for specialists of the field, not immediately readable (but rolling out a simpler beta interface)	Clear and user friendly interface
Complete reporting and alerting solution	Very lacking alerts possibilities, not completely reliable

Figure 53: Comparison table Supplier A and B

At the end of this period of evaluation of the two solutions and considering the data obtained, it is possible to conclude that the solution that performs best with the same carrier base is that of **Supplier A**. The system provided by them is very reliable and in continuous evolution, and it is able to cover well multiple transportation modes. In particular Supplier A's platform performs much better in the tracking of intermodal/multimodal transport. This a very important point for Barilla: the strategic direction of the company has a strong focus on the environmental sustainability of transport, so it is foreseeable that intermodal transport by truck - train will become even more prominent in the future, therefore it's extremely important to choose a platform that is able to track it well. A few other aspects have been considered:

- Supplier A wants to enlarge their presence in Europe. Barilla can be a strategical customer for them and as consequence they are very committed to assess

Barilla's needs. Supplier A has a dedicated support team which conducted weekly meetings with Barilla to check the progress of the implementation of their platform and to correct any problems. They have shown maximum availability and flexibility to make the test phase as fruitful as possible, both for the Company and for the carriers;

- There is no direct cost for carriers to integrate with Supplier A.
  Supplier A in fact does not charge their LSPs or carrier partners to track Barilla's loads in the platform nor do they charge for setup and onboarding efforts (FourKites). Supplier A has in-house resources who assist carrier partners with technical requirements. Barilla pays a subscription fee to access the platform. After the merger with Transporeon, Supplier B has offered free visibility for all Transporeon customers for a limited time period with a modified pricing structure after that time. Customers like Barilla have expressed concerns with quoted inflated costs after the free period, and with the possibility that there will be integration costs both for carriers and for Barilla.
- The notification systems already active and tested on Supplier A and fully aligned to Barilla's business needs while on Supplier B they are not present and therefore would become the subject of a customization project for Barilla, with a consequent waste of resources.

For these reasons Supplier A has been chosen to be the provider of the real-time transport visibility system in the company.

4.3 Design and Kickoff

The provider chosen (Supplier A) offers a wide range of customizable interfaces to satisfy the needs of each customer. In fact, this first step consists in creating the layout of the various interfaces with which Barilla operators will have to deal with during their work after having undergone special training offered by the provider itself. Barilla wanted to have a simple and easy to use interface, which at the same time contained all the information necessary for the various users of the platform. The most important thing in the platform are the individual shipments, therefore the following information has been chosen to represent them:

- Barilla shipment number (a shipment may contain multiple orders);
- Name of the carrier;
- Place of loading and place of delivery (there may be more than one, in that case the shipment is referred to as a multi-pick or multi-drop shipment);
- Theoretical timetable for loading and delivery (called appointment times);
- ETA (Estimated Time of Arrival): estimated time of arrival at the delivery calculated from the system;
- Travel status (such as ‘load has been picked up’, ‘load in transit’, ‘load delivered’, ‘expired’ etc.);
- GPS tracking illustration;
- Information on any roadblocks.

In addition, summary sections have been created to help Barilla monitor the shipments that are at risk of being delivered late or not being picked up at the scheduled time:

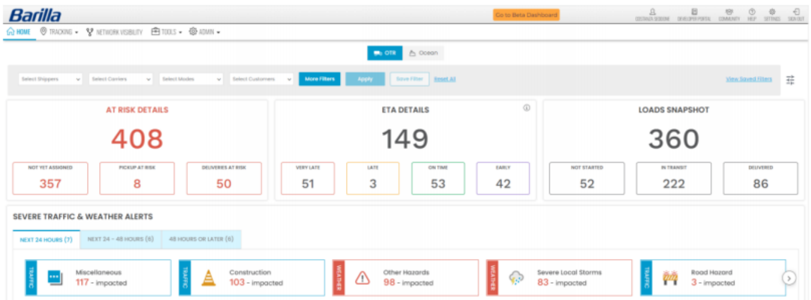


Figure 54: Executive Dashboard Overview

There is also another section called *Tracking Quality Dashboard* which helps Barilla monitor the number of journeys tracked and information on the tracking and performance qualities of each carrier.

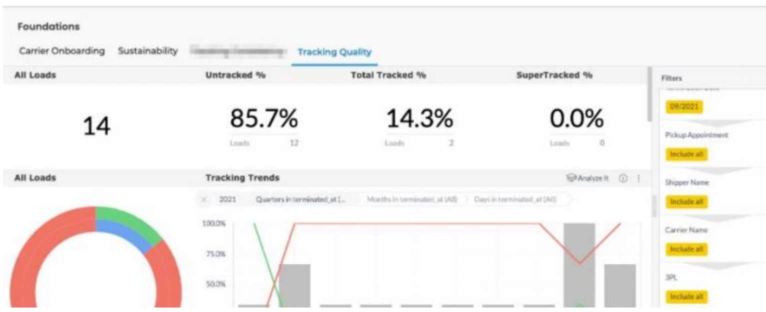


Figure 55: Tracking Quality Dashboard Overview

The alerts have also been set up. Alerts or notifications are chosen based on who will be the user (for example Customer Service or Transportation/Logistic team) and they can be customized to include all the information that the user needs. These notifications can be configured based on:

- Carriers: Alerts can be received about shipments being hauled by all carriers or by a smaller set of shipments specific to one or a few carriers that are more critical and need to be more closely monitored.
- Pick Up or Delivery Locations: Alerts can be set based on pick up stop names or delivery locations.
- Customers: Alerts can be set for shipments that are destined to one specific client or group of clients.

4.4 Carrier Onboarding

This step is the central one of the production phase and it is fundamental for the success of the project. Barilla's fleet of carriers is very large both in terms of the number of carriers involved and in terms of different types of transport that are used. The carriers in **scope** at the moment are all those that cover the biggest part of the primary network, so everything except LTL (from distribution center to customer) and all the transport modes are included except for ocean (although it will likely be included in the near future). The carriers are very varied among themselves; each carrier has different technical capabilities, their own tracking systems, their own GPS provider and TMS. The purpose of this step is precisely to find the system most suitable to link each individual carrier to the platform in order to guarantee the most precise and consistent tracking for the entire duration of the transport. In addition to the onboarding of the carrier, there is a continuous monitoring of the consistency of the tracking of the shipments.

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Carrier onboarding status

As mentioned earlier Barilla's s transportation is carried out by a large number of carriers, therefore it has been decided to onboard them in different waves. As shown in the table below, at the end of 2021 the onboarding of a first group of carriers has been concluded and a second wave of carriers has just started the onboarding process.

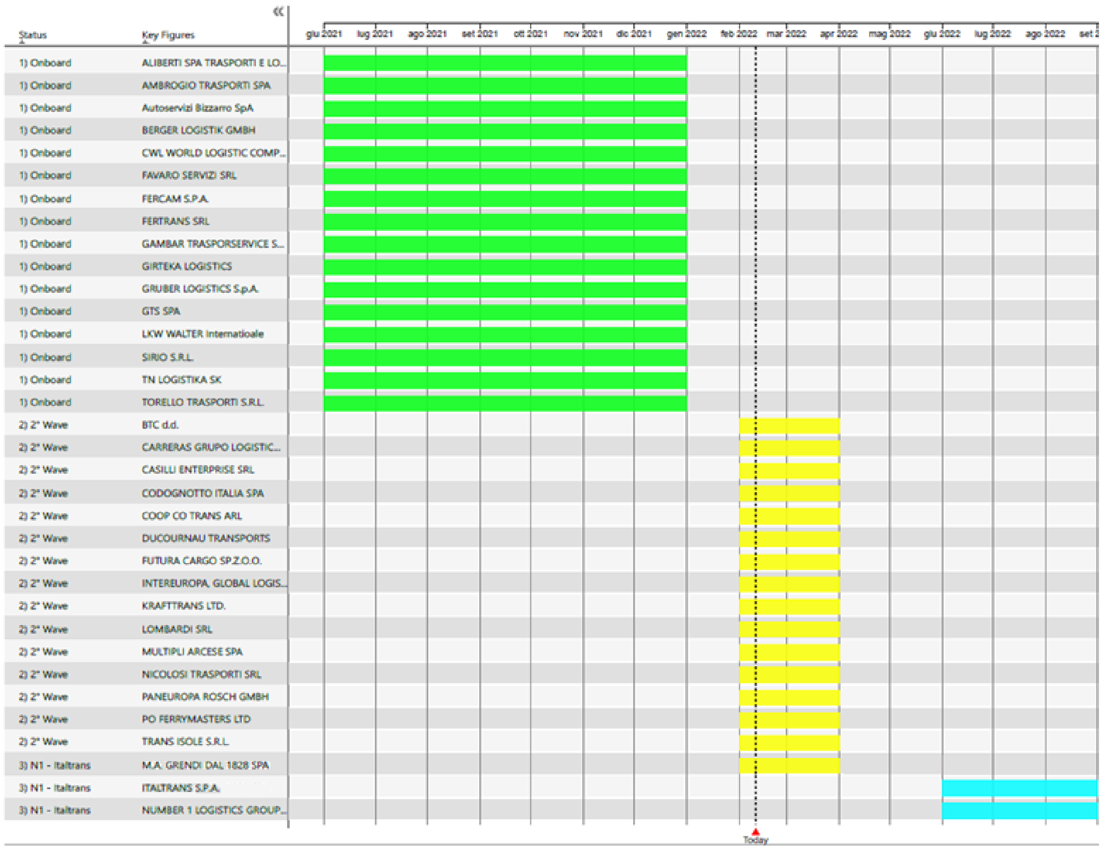

Figure 56: Carrier Onboarding Timeline

Figure 57 shows the percentages of coverage that Barilla currently has for the RTV of their transport and also what it will look like in the next future phases once second and third waves will have been completed.

The export chart (top left) shows the percentage of coverage for all the trips that are made from Italy to abroad (not including overseas trips via ocean and all transports with incoterm ex-works which is *'a shipping arrangement in which a seller makes a product available at a specific location, but the buyer has to pay the transport costs'* (Twill by Maersk)). As of today Barilla has a coverage of around 76% of all export transport and after all the carriers of the second wave will have been on-boarded, the coverage will reach approximately 97-98%. The remaining 2% of shipments belong to a group of carriers that make only about ten trips a year so their integration on the RTV platform was not of primary importance for the time-being.

Figure 57: Percentages of coverage Onboarding

The Italian counter of shipment per status chart (top right) shows a very different situation: only a few carriers from the first wave are already on board for the Italian primary network and a few other small carriers will be included in the second wave. The third and last wave will consist on the integration of two main carriers who have the largest share of travel, which amounts to 79% of Italian shipments and 64% of the total shipments. Barilla currently has an overall coverage of almost 24% of their total shipments. A further 11% will be integrated in the second wave and the largest slice will remain that of the third wave.

Carrier integration process

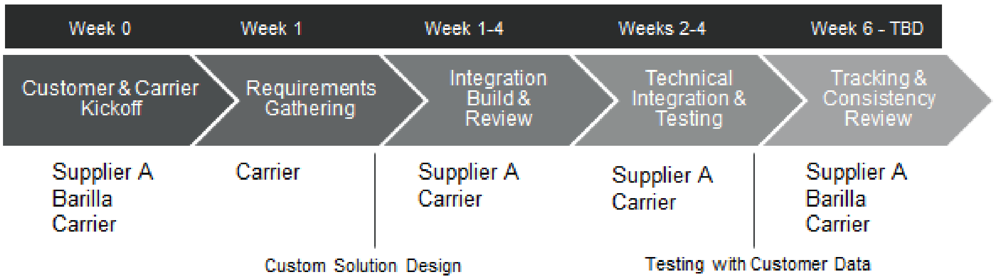

Figure 58: Timeline of integrating a carrier

The integration process typically starts with a call between Barilla and the carrier, where Barilla introduces to the carrier the project and explains to them the importance of real time visibility tracking. The carrier is also asked to fill out a questionnaire (*Attachment 2*) needed to understand their technical capabilities and whether the carrier is already familiar with similar platforms. The carrier is then contacted by Supplier A who will discuss with the carrier the technical aspects of the project such as figuring out which is the best method to integrate the carrier into the platform.

In order to gather more information about the carrier integration process and Supplier A's main preferences and difficulties when integrating a new carrier, I have decided to interview an employee from Supplier A company, and I have summarized below the main findings.

Carriers can connect to Supplier A's platform in four different ways, illustrated in the image below, depending on their own technical capabilities or preferences:

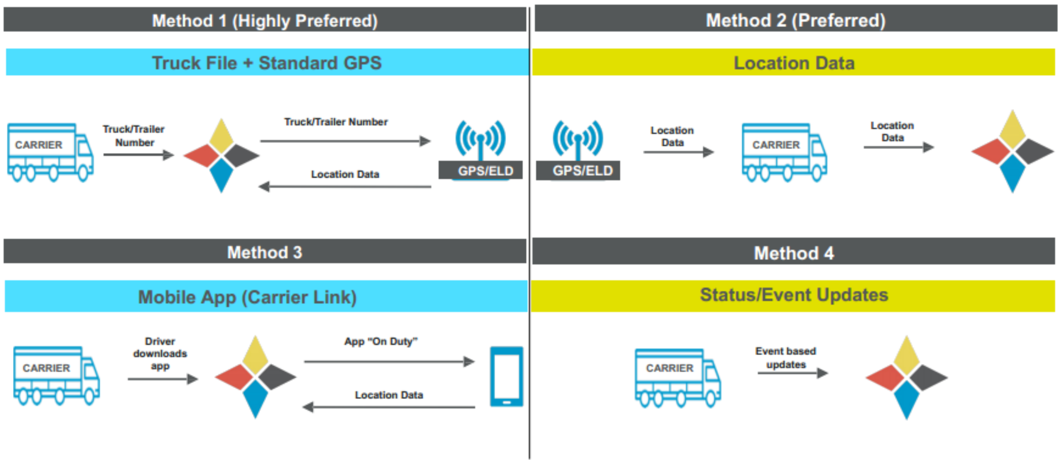

Figure 59: Carrier integration methods

Method 1: The carrier sends Supplier A a file that contains the license plate of the vehicle associated with the order. Supplier A integrates the GPS to which they send the license plate of the vehicle and the GPS provider (telematics) sends them back the position of the vehicle. This data exchange happens only once, unless there are changes during the shipment, in that case the carrier has to send another file. Once Supplier A receives this file, every 15 minutes they send a request to the GPS supplier until the order is delivered, which is seen through the geo-fence: as soon as the vehicle exits from the delivery area it is considered as delivered and Supplier A stops requesting the GPS position.

Method 2: in this case the carrier already has the GPS geolocation data in their management system. In their TMS they already receive the geolocation from their supplier and then directly send Supplier A the file containing the position of the vehicle every 15 minutes. So from a data point of view, Supplier A receives the same data in method 1 and 2, the only difference is that in this case they do not have a direct integration with the GPS but it is the carrier that is integrated with the GPS and they send Supplier A the data already ready.

From a data quality point of view, the first method is better because the data is fresher; Supplier A takes it from the GPS with a frequency of 15 minutes. The maximum delay that the data can have is 14 minutes. In the second case instead, being that the carrier sends Supplier A the data with a frequency of 15 minutes, it is possible that between when the position is detected by the GPS and when it arrives in the carrier's system 5/10/15 minutes could have already passed. Therefore there may be a difference between when the position really occurred and when it is reported in Supplier A's system of up to half an hour or 40 minutes. So the quality of the data is better in solution 1, while in solution 2 there is more security with regard to data sharing in the sense that the carrier has full control over what data it shares. In method 2 the carrier would send Supplier A the position of their vehicles only and exclusively when they transport Barilla products, while in method 1 Supplier A could theoretically access the position of the vehicle at any time even if they do not transport Barilla products.

Method 3: This method works through an app. In this case, it is the driver himself who enters the delivery or delivery note number in the app and Supplier A begins to track the app via the GPS device of the smartphone. It then works like a GPS device with position updates every 15 minutes and the delivery event also works in the same way, it is detected through the geo-fence.

Method 4: If none of the three previous methods can be used then Supplier A can only ask for events. This is done through the carrier's TMS. If at any time they have events available in their system (i.e.: 'the order has been picked up', 'the order has arrived at the terminal', 'the order has been delivered'), they are sent to Supplier A. Usually this method is used more for intermodal transport where there is a multitude of means of transport being used or LTL shipments (although LTL is currently not in scope for Barilla's project). Whenever it is not the same means of transport that collects the load and delivers it, it becomes more complicated to use the GPS. Especially when the truck/train contains both Barilla's products as well as products from other shippers: it often happens that the carrier does not want to share the live position because by doing so Supplier A could also theoretically track the load of other customers who may not be willing to be tracked.

From a more technical point of view, the file transfer method can happen in one of two ways:

- **API (Application Programming Interface):** The API is an interface that is commonly used today by many of the most popular web applications which involve the exchange of data between systems (IBM, 2020). APIs sit between an application and the web server, acting as an intermediary interface that processes the transfer of data between those two systems. It works so that

there is a client application that initiates an API call to retrieve some information (also known as a request). The API then makes a call to the external program or web server. The server sends a response to the API with the requested information and the API transfers the data back to the initial requesting application (IBM, 2020).
This is the most used method by Supplier A to date even if until a few years ago there was a tendency to use the second method more.

- **Flat file:** This consists in the exchange of an Excel, csv, xml file, which is loaded into Supplier A's server through the use of an FTP (file transfer protocol) or a SFTP (secure file transfer protocol). FTP is the traditional file transfer protocol used to share files through the internet. SFTP instead is an alternative to FTP that also allows transferring files, but adds a layer of security to the process. With SFTP there is more confidentiality of the data that is transferred since data is protected by a cryptographic key so anyone who intercepts the transmission between the client and server would be unable to read the data due to the encryption (Red Hat, 2021), therefore security is at the highest levels unlike FTP which could be easily hacked.
  In this case the carrier is connected to Supplier A's server through a link which contains a directory, and the carrier is asked to upload the files with a frequency of 15 minutes.

Main difficulties in integrating a carrier:

- **Technical capabilities and collaboration of the carrier**

One of the main difficulties is related to the technical capabilities of the carrier. For example many small companies do not have an IT office or a computer scientist, or they may not have a management system capable of sending data automatically. A carrier that does not have a TMS is particularly difficult to integrate and therefore some manual work will be required on their part. The other major difficulty comes from the low participation on the part of the carrier: Supplier A gives the carriers indications on how to send them the data, then the work has to be done by them. Often due to forgetfulness or lack of interest, weeks and months could pass and they may still have not done what was requested of them. To avoid this situation Supplier A usually has an ‘escalation progress’ where they always ask for the customer’s support, the customer being Barilla in this case. It is important that Barilla communicates the importance of the project to the carriers several times and reminds them how being able to use the Real Time Visibility Platform is essential to continue collaborating with them, also because just as Barilla is moving in this direction many other companies are starting to use real time visibility platforms too so if the carriers don’t want to be left behind they have to get onboard as well.

- **Privacy problems**

Another difficulty in Europe is due to the *General Data Protection Regulation (*GDPR) which is the European regulation on the sharing of personal data. The GDPR is one of the toughest privacy and security laws in the world. Although it was drafted and created by the EU, it is valid worldwide as it imposes obligations onto all organizations anywhere in the world, so long as they collect or target data related to people in the European Union. The GDPR will impose harsh fines against those who violate it (Wolford, 2022).

Supplier A is an American company so when they started operating in Europe they realized they had to face a challenge: some aspects of their product were not in line with the European regulation, so they had to adapt the product to the European market needs. However now this is no longer a problem because Supplier A has found methods to keep themselves in line with the regulation even while still using the first original solution. Initially Supplier A would send the GPS suppliers the request of the location data of the entire fleet of the carrier, regardless of whether it was transporting Barilla’s products or not, now instead they are using a new integration method that allows them to send the request on the single plate number (so they go to interrogate the vehicle’s GPS only if that specific plate associated with an order is present in the file they have received from the carrier).

Due to a difference in legislation, in the USA there is a little more freedom in sharing data in fact for example, for what concerns the app used by the drivers, there are currently no regulations that prohibit the sharing of cell phone data. In the USA the carrier sends Supplier A the telephone numbers associated with the order, e.g.: “the number 320xxxx will carry the order 1234“, so Supplier A can automatically track that mobile phone. In Europe this is completely illegal; Supplier A cannot receive phone numbers which are personal data via a file or even from the company itself. For this reason Supplier A has updated the application, making it possible to self-assign the order. When the driver uses the app for the first time, after having consented to the use of the data he enters his phone number through which he receives the verification code in order to log in, then the driver enters the order number of the load that he has to transport. This way the data is received by Supplier A (not by Barilla) directly from the driver's mobile phone, and there is no sending of files containing personal mobile phone numbers since it is the driver himself who inserts it when using the app.

- **Subcontracting**

In Europe and especially in Italy carriers have a high percentage of subcontractors. This could become a problem because tracking one single carrier and getting all the data from them is much easier than having to integrate not only the carrier but also a number of sub-carriers with which they collaborate. If the sub-carrier covers a large volume of orders it is not a problem because they will give Supplier A the data and they will give them access, but if there are about twenty sub-carriers that operate a volume of 100-200 trips each per year, they are usually not very willing to give them the data since those limited number of trips do not bring them a significant economic return, those trips are usually trips that they make to occupy empty space or vehicles that would otherwise travel empty. The carrier's effort is proportional to how much they care about providing the service to the customer who is requesting it, therefore Barilla. So for example a company that with Barilla invoices 10k € per year is less likely to cooperate than a company that invoices 200k € per year.

- **Difficulties with the client company (i.e. Barilla)**

With Barilla the greatest difficulty was integrating Transporeon (the TMS used by Barilla) to Supplier A's platform, the difficulty arose because of a matter of interest. Transporeon is natively integrated to another RTTVP solution, a competitor of Supplier A which was considered in the Market Analysis of providers and in the PoC, so it took a lot of time and discussions before the cooperation could start and before they started sending to Supplier A the data. Before Transporeon was integrated with Supplier A, a Barilla logistic operator would have to daily extract shipments data from Transporeon and send it to Supplier A. Now thanks to the automatic interface between the two, Transporeon does an Excel extraction three times a day, deposits it on a Supplier A's SFTP, from which Supplier A draws and uploads the data to its own system.

Regarding the integration of the carriers, there were no particular problems between Supplier A and Barilla because Barilla has made an effort to keep constant communication with the carriers, organizing one-on.one meetings in which the carrier would be reminded of the importance of the project. There are other clients instead who are not so proactive and only expect Supplier A to bring them the results. It is important that the clients as well put an effort in keeping the carriers accountable and responsive, because unresponsiveness can extend the duration of activities and can lead to going beyond the scheduled timing of the project.

4.4.1 Troubleshooting

As mentioned earlier, the real time visibility platform can be introduced to the other actors of Barilla's supply chain such as Customer Service, warehouses and logistic operator teams, only when a good level of coverage is reached and when shipments are tracked correctly. Therefore it's important that when RTTV platform is released to the company the data is trustworthy.

For this reason each carrier that had been on-boarded on the platform has been monitored periodically (on a weekly basis) to make sure that their shipments were being tracked properly. I would choose a random sample of shipments for each carrier, paying close attention in particular to those shipments that were at risk of being very late or expired. When a problem occurred in the tracking of any of those shipments, I would make an effort to try to find the cause and possible solution so that it wouldn't be repeated in the future and so that the tracking percentage of that carrier would improve. If the cause of the problem was not found, then I would escalate the problem to Barilla's project lead or to the Supplier A who would further investigate the problem.

On a monthly basis the carriers would be contacted to be updated on how their shipments are performing on the platform and giving them suggestions on what they could do to improve their tracking percentage.

A tracked shipment can be either basic tracked or super tracked:

- A **Basic Tracked** load is one that receives at least one location update (ping, breadcrumb, etc.) during the active life of that load.

Figure 60: Basic tracked shipment example

- A **Super tracked** shipment is one which receives at least one location update between pickup and delivery for every one third of the trip distance. For example, if a trip is 900 km we divide that into three 300 km segments and expect a unique location within each segment.

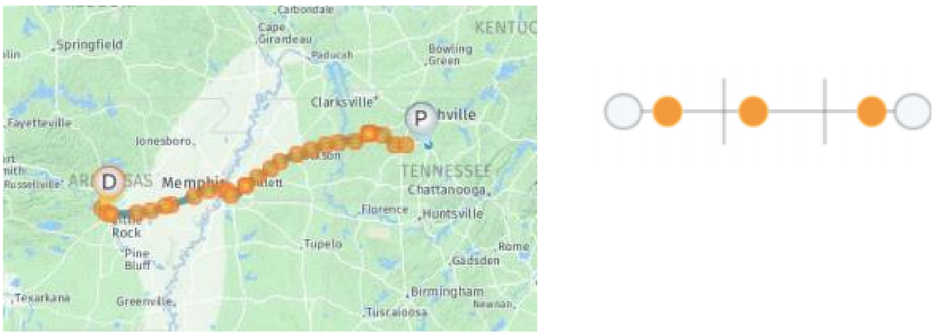

Figure 61: Super tracked shipment example

For this analysis (*Attachment 1)* I have considered the shipments that occurred in the first 8 weeks of 2022, extracting them from Supplier A's platform. By using Excel, I have indicated for each of the carriers of the first wave the mode of transport covered (road or intermodal), their integration method with the platform of Supplier A and the method they use to exchange data, in order to see if these factors could have a correlation with the error types that may occur during tracking. For each carrier I have indicated the count of shipments done over that period and for each error type the number of shipments in which that error has occurred (*Attachment 1*).

The error types I have considered are the following:

Asset not assigned
Tracking started late
Assignment After First Stop Appointment
Check Calls Infrequent
No Location Updates
Assignment After Final Stop Appointment
Address Located Outside Geofence
Load appointment time too old
Carrier integration Down
Load created after delivery
Load created after pickup
Load delivery before pickup

When there were no errors or the error couldn't be traced back to any of the other issue types it would be indicated as N/A.

I have also indicated for each carrier the percentage of those shipments that were not tracked; this allowed me to see if a certain type of error is more likely to compromise the tracking. In fact some tracking errors may occur and they may lower the tracking quality but not always necessarily impede tracking.

Out of 3748 shipments, 19% of them were not tracked. Most of those shipments that were not tracked belonged to two carriers (see *Attachment 1*). One of these carriers (Carrier 1) still uses manual updates to exchange data with Supplier A's platform, almost all of this carrier's shipments could not be tracked due to problems related to asset assignment (assigning a license plate to the shipment), these amounted to 28% of the total not tracked shipments and 5% of the total shipments. The other carrier (Carrier 5) which has asset assigning problems accounts for 27% out of the total non-tracked shipments, probably due to a high subcontracting percentage and due to the fact that they are currently substituting their outdated GPS devices on their trucks. However that represents only 29% out the total of their own shipments, meaning they have a tracking percentage of over 70% which is not bad considering that Barilla's target is for carriers to have a tracking percentage of about 80%, however the carrier could still improve it.

The table below (*Figure 62*) shows how both carrier 1 and 5 who have problems related to asset not assigned also have a high number of expired shipments: in fact when an asset is not assigned the tracking can't start and after a certain time limit the shipment will expire.

Count of Tracking Issue			
Carriers	**Delivered**	**Expired**	**Total**
Carrier 1	4	203	207
Carrier 2	28	33	61
Carrier 3	120	25	145
Carrier 4	6	62	68
Carrier 5	398	277	675
Carrier 6	42	33	75
Carrier 7	92	25	117
Carrier 8	25	2	27
Carrier 9	22	30	52
Carrier 10	1300	25	1325
Carrier 11	130	9	139
Carrier 12	73	47	120
Carrier 13	552	57	609
Carrier 14	123	5	128
Total	**2915**	**833**	**3748**

Figure 62: Table Carrier - Delivered vs Expired

By analyzing and comparing each error type with the data exchange method chosen by the carrier (*Figure 63*) I noticed that for those shipments of carriers that opted for direct assignment instead of automated, the most common problems are: asset not assigned, assignment after first stop, infrequent check calls, and tracking starting late. Those kind of mistakes can also happen for automated data exchange but they are less impactful.

Count of Data Exchange Method (Setup)				
Error types	Automated	Direct Assignment	Other	Total
Address Located Outside Geofence	11			11
Asset Not Assigned	445	19	48	512
Assignment After Final Stop Appointme	11	2	1	14
Assignment After First Stop Appointme	108	25	10	143
Carrier Integration Down	1			1
Check Calls Infrequent	32	18	43	93
Load Appointment Times Too Old	7	3		10
No Location Updates	24	5	12	41
Tracking Started Late	113	29	11	153
N/A	2575	170	25	2770
Total	**3327**	**271**	**150**	**3748**

Figure 63: Table Error type - Data Exchange method

I tried to find a correlation between the tracking method and the error types (*Figure 64*) and I have concluded that for method 2 (Carrier GPS/ELD updates) the most frequent mistakes are infrequent check calls, assignment after first stop, asset not assigned, and tracking starting late, on the other hand for integration method 1 (GPS / ELD Provider) the problems are almost the same except for 'check calls infrequent'. This can be explained and confirmed by the fact that having a direct integration between Supplier A and the GPS provider (method 1) allows for data to be fresher and since there is no intermediate step (data doesn't have to go from the GPS to the carrier's TMS to Supplier A), there are less delays between when the position occurs and when Supplier A's platform displays it.

Those carriers that choose to connect to Supplier A using an app on mobile phone are more likely to incur in asset not assigned and infrequent check calls.

The remaining shipments are those of the carriers that prefer to only give status updates, in that case it's most likely that infrequent check calls will occur as well as asset not assigned and no location updates received. This is probably explained by human errors, like forgetting to update the shipment status, leading to either sporadic updates or no updates at all.

Count di Tracking Method (Setup)					
Error types	Carrier GPS / ELD Updates	GPS / ELD Provider	Mobile	Status updates	Total
Address Located Outside Geofence		11			11
Asset Not Assigned	14	460	26	12	512
Assignment After Final Stop Appointme	4	9	1		14
Assignment After First Stop Appointmer	17	126			143
Carrier Integration Down	1				1
Check Calls Infrequent	32	20	22	19	93
Load Appointment Times Too Old		10			10
No Location Updates	10	19	4	8	41
Tracking Started Late	14	126	8	5	153
N/A	315	1115	9	1331	2770
Total	**407**	**1896**	**70**	**1375**	**3748**

Figure 64: Table Error Type - Integration method

It is interesting to notice that the GPS/ELD Provider method is the one that provides the highest percentage of super-tracked shipments (*Figure 65*). Mobile updates is instead the method that is less performing out of the four in terms of quality of tracking since most of the shipments tracked via app are either Basic tracked or not tracked.

Count of Tracking Issue				
	Not Tracked	Basic Tracked	Super Tracked	Total
Carrier GPS / ELD Updates	73	77	257	407
GPS / ELD Provider	551	243	1102	1896
Mobile	27	35	8	70
Status Updates	72	304	999	1375
Total	**723**	**659**	**2366**	**3748**

Figure 65: Table Integration method - Tracked status

From the table below (*Figure 66*) it is also possible to see how intermodal shipments are often not tracked and never super tracked, while OTR shipments are more likely to be super tracked.

Count of Tracking Issue			
Tracked status	Intermodal	OTR	Total
Not Tracked	28	695	723
Basic Tracked	6	653	659
SuperTracked		2366	2366
Total	**34**	**3714**	**3748**

Figure 66: Table Tracked status - Transportation mode

From *Attachment 1* it is observable how the intermodal shipments fall into the N/A category, meaning that the platform could not find any issue or it couldn't be traced back to any of the other issue types.

By checking those shipments manually I was able to observe that being an intermodal shipment, the first part which is carried by truck is usually tracked well. Then the standing trailer would be put on the train and then loaded onto another truck which would bring it to the final destination. During the train portion of the shipment there would usually be no tracking (*Figure 67*), since usually only trucks are provided with GPS devices, while trailers aren't, therefore this makes it impossible for intermodal shipments to be super tracked. Furthermore there would sometimes be problems in assigning the license plate of the second truck for the final leg of the journey: often the wrong truck was assigned so the platform would be tracking the wrong truck, the shipment would expire as it seemed like it never reached the destination.

Figure 67: Example tracking of an intermodal shipment

Suggested solutions

Tracking quality is a shared responsibility between the carrier, shipper (in this case Barilla), and Supplier A. All parties have to work together in a collaborative effort for loads to be tracked with the desired visibility. When we start looking deeper into data, we see how different issues are categorized, and if those issues are stemming from the carrier side or the shipper side. The issue can then be resolved faster. A number of actions can be taken to address the root cause of untracked loads and loads that track at a Basic level.

As the owner of load data, Barilla should verify they have clean and accurate data to ensure quality tracking. Barilla needs to focus on carrier management and engagement. Most of the times (other than in a few cases) the tracking errors are due to the carriers. The more a carrier organization has invested in technology (GPS, TMS) the more likely they will track with quality, however regardless of their tech capabilities, it is extremely important for Barilla to instruct them and to have constant communication with them to ensure they are doing everything possible so that their shipments are tracked well and to help them increase their tracking performance. To do so Barilla can use quantifiable data to show them what and where improvements are needed, understand where challenges lie and who can fix them.

Supplier A also has an important role in communicating best practices and metrics with Barilla teams to ensure they are up to date on the most effective tactics to achieve full visibility and also resolving any technical disruptions and bugs and helping both carriers and Barilla maintain a high level of tracking.

Below you can see a list of common tracking issues that have been observed, with the related suggested actions that could be taken (*Figure 66 & 67*).

	Issue	Definition	Issue Owner	Recommended Action
Address Located Outside Geofence	The address is located outside custom geofence	The address pin is located outside of a manually curated geofence	Barilla	Barilla should adjust the address latitude/longitude to be inside of the custom geofence
	At least one stop has a geofence that is too small	One of the stops on the load has a circular geofence whose radius was too small to detect geofence entry/exit	Barilla	Barilla should expand the radius of the circular geofence
	At least one stop may be in the wrong location	One of the stops on the loads could not be verified by Supplier A's maps providers	Barilla	Barilla should edit the address in Address Manager to make sure there are accurate latitudes/longitudes and address information
	Unable to identify at least one stop location/address	One of the stops on the load has incorrect or invalid latitude/longitude	Barilla	Barilla should edit the address in Address Manager to make sure there are accurate latitudes/longitudes and address information
Asset Assignment problems	No asset assigned	Supplier A was anticipating a truck, trailer, or mobile phone assignment and never received one	Carrier	Carrier should ensure a truck, trailer, device, or driver phone number is assigned to the load
	Tracking assignment made after final stop's appointment	The asset assignment occurred after the load's final delivery appointment time	Carrier	Carrier should ensure asset assignment is prior to the load's delivery appointment
	Tracking assignment made after first stop's appointment	The asset assignment occurred after the load's first pickup appointment time	Carrier	Carrier should ensure asset assignment is prior to the load's pickup appointment
Tracking starts late	Tracking started after pickup occurred	The load started receiving locations updates after it was either manually marked as picked up or auto picked up	Carrier	Carrier should ensure location updates are sent to Supplier A starting at least from the load's pickup location
Carrier integration Down	Carrier integration interrupted during load lifecycle	An alert has been generated, notifying Barilla that the carrier's integration is down	Carrier	Carrier should resolve the integration issues with Supplier A

Figure 68: Recommended actions part 1

No Location Updates	Carrier's data source is returning an error	The carrier is sending Supplier A an error instead of a location update on the load	Carrier	Carrier should ensure they have the correct integration set up for the load's tracking method
	Driver's phone is not supported for app tracking	Driver's mobile phone carrier is not supported for app tracking	Carrier	Carrier should enforce driver to download the app
	Driver did not respond to opt in request	Driver did not opt in (and did not opt out) of app tracking	Carrier	Carrier should enforce driver to opt in on the app
	Driver opted out of Supplier A tracking	Driver explicitly opted out of app tracking	Carrier	Carrier should enforce driver to opt in on the app
	CarrierLink's GPS turned off	Driver has GPS disabled on his phone app at some point in the haul	Carrier	Carrier should enforce driver to turn on GPS while using the app
	No location updates received from the carrier's data source	Supplier A expected to get location information from an ELD, but they didn't receive any locations	Carrier	Carrier should push Supplier A timely and accurate location updates
	No location updates received from the location provider	Load is expected to get updates from push-based event and none occurred	Carrier	Carrier should check the integration health with their location provider
	No location updates received	Supplier A expected to get status updates from the carrier's data provider, but we did not receive any status updates	Carrier	Carrier should push Supplier A timely and accurate location updates
	Carrier did not provide a status update	The carrier did not provide a status update on the load, when a status update was expected	Carrier	Carrier should provide Supplier A with timely and accurate status updates
Check Calls Infrequent	Check calls are in future	The load has at least one check call that is at least 5 minutes in the future	Carrier	Carrier should check the timezone in which they are configured, and Carrier should reduce reliance on manual data entry
	Check calls are old	The load has at least one check call that is at least 24 hours older than the time it was received	Carrier	Carrier should check the timezone in which they are configured and should reduce reliance on manual data entry
	Infrequent location updates received	Median time between check calls is greater than 60 minutes or median distance between check calls is greater than 60 miles	Carrier	Carrier should increase frequency of location updates with Supplier A to comply with tracking quality
Load delivery before pickup	Pickup and delivery appointments are scheduled out of order	The load has a final delivery appointment time before the first pickup appointment time	Barilla	Barilla should correct the appointment times to make sure they are accurate and logical
	Pickup and delivery appointments are scheduled at the same time	The load has the first pickup appointment time equaling the final delivery appointment time	Barilla	Barilla should correct the appointment times to make sure they are accurate and logical
Load creation problems	Load created after delivery appointment	The load was created after the final delivery appointment time has already passed	Barilla	Barilla should ensure load is created before the delivery appointment time
	Load created after pickup appointment	The load was created after the first pickup appointment time has already passed	Barilla	Barilla should ensure load is created before the pickup appointment time
Load appointment time too old	Appointment times too old	Location updates were provided days after the appointment time, resulting in the load expiring.	Barilla or Carrier	Barilla should ensure appointment times are up to date and accurate.
				Carrier should ensure correct truck is assigned to the proper load

Figure 69: Recommended actions part 2

4.5 Go Live

Once a good number of carriers who cover different geographical areas have been on-boarded and once a good quality of data is reached, the third and last step of the production phase can start: the live launch of the platform. By 'live launch' we mean making the platform operational for the various members of the supply chain and no longer just for the Barilla team that closely follows the project. Indicatively the platform will be introduced to the customer service once the second wave of carrier onboarding is concluded (for international export shipments) because by then most of the carriers that cover the European region will be integrated in the platform, while for Italian shipments the third wave will have to be concluded.

In particular, the main actors involved in this step are:

- **Customer Service**: by receiving automatic alerts as soon as the platform calculates a possible delay in delivery they can notify in advance the customer;
- **Warehouse**: by receiving automatic alerts as soon as the platform calculates a possible delay in loading they will be able to manage in advance and optimize the preparation of the goods and the preparation of the loading docks avoiding that the trucks overcrowd the area while waiting their turn to be loaded;
- **Barilla logistics operators**: by receiving automatic alerts as soon as a transport anomaly occurs they can check with the carrier and handle the problem in time.

From the list above, it is clear that it's important to correctly set the automatic alerts so that the system sends them at the right time. The closer the truck is to the loading/unloading point, the more the ETA will be accurate and the more trips will be monitored on the same route, the more the algorithms of the platform's machine learning will be able to provide an accurate ETA (*Figure 70*).

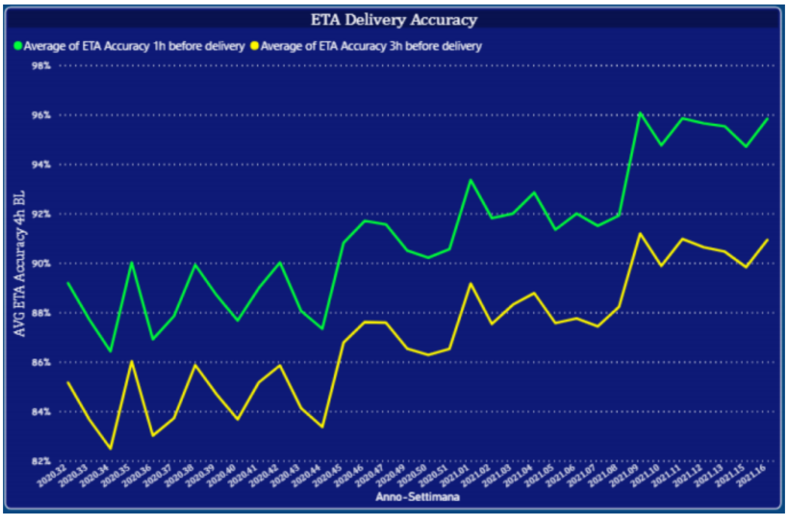

Figure 70: ETA accuracy trend as a function of time (1 h vs 3h) and trips made

Therefore, sending alerts too early could be misleading because they could be based on information that is not yet well known and uncertain. For example if the ETA is calculated 4 h before the appointment time, there is the chance that that truck is still unloading in another warehouse, so it's still stationary, and the ETA is only useful for loads that are currently moving. Typically the ETA is considered reliable when it's at least 1 hour and a half before the appointment time. It is therefore necessary to find the right trade-off so that the system does not send information too early and therefore prone to errors, but not too late either so that the problem can be addressed.

We will now look more in detail what are the benefits for each one of those three actors that will be involved.

4.5.1 Customer service benefits

In order to gain a better understanding on the benefits that RTV could bring to the Customer Service I have talked with the manager of the Customer Service team and here I will report the main insights.

In short, the main benefits to the CS are the possibility to **avoid penalties**, showing the customer that Barilla has the situation under **control** and **avoiding waste of time**. All of these in turn can **improve the service level** for the clients.

Barilla works on around 900,000 orders a year which give rise to more than 8,000 claims; it has 30,000 delivery points worldwide spread over 120 countries. The Customer Service team, with the cooperation of the IOT team, has to define more than 200 combinations of lead times (time from order to delivery) which are constantly changing and they need to communicate it to countries and markets. The number of combinations is greater than the number of countries because it depends on the method of transportation (e.g., going to Sweden by train or truck will have two different lead times).

When Barilla is not able to deliver the loads within the agreed upon times, a penalty is applied. In France and in America they calculate and pre-deduct penalties in their unilateral contracts, in other words, they automatically deduct the penalties from their payments. Barilla can then verify and discuss whether or not they are true and try to negotiate. Knowing in advance if a shipment will be delivered late is essential because it would allow the Customer Service to inform the clients in time and avoid the penalty, as indicated in the contracts.

Currently penalties are not managed. In the context of today's transport it is unrealistic to think that the drivers will call to say they are late in a proactive way. In order to anticipate the penalty the Customer Service must have at least 24 - 48 h visibility because it allows them to make the client reallocate the unloading slot. If the client is not warned in time and the unloading slot that was booked remains unused, the client will penalize Barilla because they made them waste the possibility to allocate the unloading slot to another truck and waste the staff that was prepared and ready to unload it. If, on the other hand, Barilla is able to know in advance that the delivery expected for tomorrow will be late or never arrive, Barilla is able to tell them proactively and move the delivery date. These penalty systems are automatic, they have analytics that automatically create the report, therefore, obtaining the collaboration of the interlocutor (client) who changes the dates also ensures that the system does not detect an anomaly and doesn’t apply the penalty.

The Customer Service deems very important testing the RTTV platform in particular on France, where there are the greatest penalties, and the Nordics where there’s a high risk of penalties: on the Nordics Region there are a lot of delays due to the transport structure, for the logistics team having a percentage of about 75% punctuality would be considered acceptable, however the client asks Barilla for a 98% punctuality, therefore there is a big gap.

The alert of any delay in delivery should ideally occur within the time limit in which the customer can administer a penalty to Barilla for the delay. However, even if that's not the case (ETA is not so accurate too many hours in advance), knowing this information even with a few hours advance would still be beneficial. It would allow Barilla to offer a better service to the client by keeping them informed, to avoid a non-professional figure and to not waste all the time that is currently lost in investigating the punctuality of a load.

In the **AS-IS** situation we have a reverse flow: the customer calls Barilla's CS inquiring about a shipment that is late. The CS contacts the IOT, IOT contacts the carrier, the carrier asks the driver if and why they are late and maybe the driver does not respond. This is time consuming, it involves different phone calls and emails, and it is a process that could last a day. Instead, knowing about the delay in advance could avoid all this work. So there is also a saving of time and dissatisfaction. The number of late deliveries depends on the country: on a country with a punctuality percentage of about 75%-80%, on average there are around 10-20 cases a day that the CS need to investigate. Some of these shipments can be more or less urgent, for example, if there is a promo inside, the calls are much more frequent.

In the **TO-BE** situation instead, the system would send an automatic notification to Customer Service or directly to the customer. The notification is sent when the system calculates an almost certain delay. Over time, thanks to machine learning these warnings will become less and less subject to errors.

QUANTITATIVE EXAMPLE CUSTOMER SERVICE:

	AS IS	TO BE
Number of late shipments per day	15	15
Time used by CS to manage the late shipment (min)	30	10
Time used by CS in a day (min)	450	150
Hours used by CS in a day (hours)	7,5	2,5
Full Time Equivalent	0,94	0,31

If we consider that in a day there can be between 10 and 20 late shipments, so on average 15 late shipments per day, comparing the time needed to manage the delays in the AS IS situation with the TO BE situation when RTV will be implemented, we can see that there could be a saving of around 65% of FTE, thanks to the use of automatic alerts which allow to proactively manage the delays.

4.5.2 Warehouse benefits

One of the main benefits that Real Time Visibility could bring to the warehouses is to improve and increase the efficiency. Barilla owns many automatic warehouses with different technologies and it's very important to have **better synchronization** between transportation and warehouses. Warehouses nowadays, especially automatic ones, are managed by IT systems. Through these systems the carrier reports the arrival time of the truck to be loaded by booking a slot of time and the warehouse prepares the goods by carrying out the various picking operations before the truck arrives. This allows to optimize the waiting time of the trucks for loading. However, it happens quite often that those slots are not respected by the carriers. If a vehicle does not arrive to the warehouse at the scheduled time to be loaded, this could create problems: the loading bay would be occupied and the preparation of goods of the other trucks would be delayed, even though they may arrive on time.

This is where the real time transportation visibility comes into play: thanks to a real time visibility system, there is the possibility of notifying the warehouse in advance about the delay of the vehicles that are coming to the warehouse to be loaded.

The amount of advance in which the alert is sent would depend on the type of warehouse. Barilla's biggest warehouse is highly automated: it has 5 stacker cranes with a storage capacity of about 36k pallet places and since 2012 the LGV shuttles were implemented. They work with a GPS system that transfers all the various missions without the need for handling through a human operator and take care of all storage and retrieval activities on the drive-in shelves. An automatic warehouse, such as this one would require a longer time (i.e. 4 h notice) compared to a traditional warehouse (where 1-1,5 h would suffice), that is because human operators are much more flexible and would need less forewarning than a machine would. Another aspect to take into consideration is that when the warehouse is automated Barilla utilizes many stand trailers or stand by trailers: a stand trailer is a type of trailer that is left at Barilla's warehouse for them to load. Barilla then arranges for another carrier to swap the full trailer for an empty one. This is different to 'live loading' where a truck arrives and the freight is loaded while it waits. The stand trailer can be prepared in advance because the warehouse operators can start loading it even if the driver hasn't arrived yet. So the timing of the alert should also depend on the type of vehicle.

These alerts would allow the warehouse to manage the preparation of the goods in an efficient way, by giving priority to the preparation of the goods for vehicles that arrive on time, while preparing and occupying the bay of late vehicles only shortly before their arrival. That would mean reaching the ideal case without delays: the trucks would not have to wait to be loaded and instead they would be loaded immediately at their arrival at the loading bay, therefore there would be a reduction of the occupation time of loading bays.

The decrease in the time of occupation of the bay leads to the possibility of increasing the outbound capacity, and therefore a greater rotation of goods which translates into a possible decrease in the amount of goods kept in stock.

This better synchronization will also have a positive effect on transportation availability. As seen in the global context chapter, one of the problems of the supply chain is that of the high demand and low supply of transportation, so it is important that the trucks are actively being used instead of being stuck in a warehouse waiting to be loaded. Having a good synchronization between transportation and warehouses could allow Barilla to be a preferable customer for the carriers and differentiate itself from competitors.

4.5.3 Logistic -Transportation operators benefits

Transportation management is also heavily impacted by the introduction of RTTVP.
In particular, both the international logistics office (IOT) and the Italian logistics office dedicate every day part of their time to solve problems arising from transport anomalies such as loading or unloading delays. In fact in both of those cases the logistic operators act as an intermediary between the carriers and the warehouse or the carriers and the Customer Service. These activities are managed through emails or phone calls and they imply the passage of information across many different actors. As we have also seen in

the customer service section, this is subject to human errors as well as time consuming. With the introduction of RTV (and therefore fully configurable automatic alerts), there would be a significant reduction of the time taken daily for the resolution of transport problems. This could allow the team to save hours of time weekly that could be dedicated instead to other tasks.

Another activity that is carried out by Barilla's logistic teams is the evaluation of the **carriers' performance**. When companies like Barilla choose to focus on their core competencies and outsource other activities to third parties (such as transportation or logistic services), their success becomes dependent on the performance of these suppliers, so it's important to evaluate their performance. Organizations always seek to have high performance from their suppliers so that they can not only source more from those suppliers that are cost effective, well performing and responsive, but also on the other hand, they can reduce or terminate their business with those suppliers (in this case carriers) who are underperforming (Oracle). Suppliers have been proven to perform better when aware that they are "measured", proving the truthfulness of the famous statement: "you can manage, what you can measure". The monitoring and evaluation process of suppliers' performance can be done through KPIs (Key Performance Indicators). A key performance indicator is a defined and quantifiable measure that an organization uses to determine to what extent the set operational and strategic objectives are achieved. The choice of what to evaluate and the methods of evaluation requires a complex research process that involves different teams in the company.

Real time visibility would be a helpful tool to analyze and compare the punctuality as well as tracking quality of carriers. The Real Time Visibility platform in fact has a dedicated section, which is customizable, that can show the stats related to each carrier, therefore there would not be the need to create graphs separately on PWBI as they are already offered within the RTTV platform. Power BI is a business analytics service from Microsoft, a cloud-based reporting and analytics platform that connects users to a wide range of data through business intelligence capabilities, interactive reports, dashboards and intuitive representations. This software is used to extract information from an organization's data. Power BI can connect different datasets, transform and clean up the data, and create graphs or charts to provide a graphical representation. As of today the carrier's performance is in fact monitored through graphs created in PWBI, however it is limited to a few parameters related to on-time performance (delivery or pick up punctuality).

In the future, utilizing a Logistic Control Tower would allow to measure in a more accurate way the overall performance of carriers. Since it would include data from multiple sources such as the Customer Service, warehouses, Transportation Planning, IoT and Logistic Italy, it would be able to take into account many other parameters which could be useful for carrier rating such as (and not limited to) (Freightcenter, 2022):

- On-Time Performance: A measure of the percentage of shipments that are picked up, that have departed and that have been delivered on time.
- Number of Damage Claims: This KPI can measure the risk of damaged freight during shipping. It is necessary to measure the amount and types of claims filed. It can be calculated by dividing the total cost of loss/damage claims by the total freight costs. The higher the number, the higher the likelihood that problems on the carrier's end will occur, therefore the worse the performance.
- Invoice Accuracy: Verifying that the invoices are being properly issued will help to determine if a carrier is meeting service standards. So it's important to measure the number of accurate invoices and categorize the ones that are inaccurate by carrier and reason.
- Monitor Driver Performance: Knowing which carriers have the highest performing drivers could help when evaluating carriers as this can ensure that the freight gets where it needs to be on time with a lower risk of damage.
- Monitor Tenders Accepted Versus Tenders Declined: Monitoring tenders accepted and declined indicates whether the carriers are meeting their contractual obligations. There are different reasons for which carriers will reject tenders, however if this happens frequently, there is a need to discuss ways to improve this measurement.
- Carriers' responsiveness: It's important to take into consideration how quickly the carrier is able to reply in case of an issue and how long it takes for them to find a solution. Keeping track of their response time will allow to measure their communication, responsiveness, and follow up (Allyn International). Having a good responsiveness will reduce time spent so in turn improve the efficiency.

5. Future developments

The next steps related to the RTV project in Barilla should be expanding the visibility coverage and capabilities, as well as introducing the platform to other teams in Barilla. In particular:

- **Third wave onboarding**

Expanding the visibility coverage will be done through the onboarding of the third wave of carriers, which is expected to be implemented within the end of 2022. Despite only two carriers belong to the third wave, this is a very important step and it could be challenging.

As indicated in the Carrier onboarding status section, those two carriers cover 78% of the shipments in Italy and they have a high percentage of subcontractors. In particular one of the two, Carrier 34, has an internal fleet that covers only 30% of its shipments, while the rest of their shipments are subcontracted to a lot (more than 100) of smaller carriers. As seen in the carrier onboarding timeline, the onboarding of the first two waves which consisted of almost 30 carriers took around 9 months, which means that onboarding Carrier 34's subcontractors could take an even longer time.

However some of the carriers that Barilla has already integrated on the first two waves, may also be Carrier 34's subcontractors, so some of them may have already been integrated on Supplier A's platform, this would help speed up the process of onboarding. Carrier 34 already has some experience with RTV platforms which could also make the onboarding easier and most of their trailers are equipped with a GPS device, which could help raise the quality of intermodal tracking. Considering the high number of carrier companies involved, a good idea would be to divide the onboarding in 2 steps, first onboarding Carrier 34's internal fleet and then its subcontractors.

- **Expanding the modes of transportation covered**

While initially only road and intermodal transport were included in Barilla's RTV project, the next step would be to also include other modes of transport, i.e. ocean tracking.

Similarly to what has been done for the selection of a provider (supplier A) of real time visibility for road and intermodal, a new trial will have to be done in the next coming months to evaluate the tracking capabilities of other providers for ocean tracking. In particular the suppliers that are currently being considered are Supplier A and Supplier C. Supplier C is created by the partnership between a well-known shipping conglomerate and an American multinational technology corporation. By 2019, Supplier C's platform covered nearly half of the world's shipments of cargo containers (IBM, 2019). This indicates that Supplier C's platform is much more geared towards ocean tracking and very widespread. However the advantage of choosing Supplier A for Barilla would be that it is the same provider of RTTVP that has already been chosen for road and intermodal tracking, so Barilla users are already familiar with the way it works and all the data would be kept in only one platform.

- **Extending the scope**

As mentioned at the beginning of chapter 4.4, currently the scope of the RTV project is to cover those shipments of the primary network, therefore from the plant warehouses and auxiliary warehouses, while the secondary network (from hub to client) at the moment is excluded. The secondary network in fact is managed entirely by an external logistic provider which takes care of all the logistics, handling and transport aspects. This third party manages the hubs from which the product is delivered to customers (usually smaller ones). Barilla gives them the orders that need to be fulfilled and then the logistic provider decides how to organize them, how many orders to load together, whether to pass through a transit point or not, so Barilla has no visibility on the truck load. In the future Barilla could include in the scope of RTV the secondary network, in order to extend the visibility perimeter.

However it's important to consider that in this case, there would no longer be a reference to the shipment number on the platform (as it is currently done), therefore to a vehicle, but instead there would be a reference to orders (LTL). The level of complexity is higher because one vehicle could load up to 100 orders (since the customers in the secondary network usually request smaller quantities) and defining a sequence would be more complicated. Furthermore, Barilla would no longer be the master of that information but the logistics operator would, so the creation of orders on the Supplier A's platform would also have to be done by that logistics operator.

- **Customer Service Involvement**

As mentioned in section 4.5.1, Barilla's customer service is eager to start testing the platform and experiencing its benefits. The testing will probably be done for a few selected customers in the upcoming month and for a wider implementation it will probably be implemented in Europe first (after the second wave of carriers will be completely on-boarded) and in Italy afterwards (after the onboarding of the two big carriers of the third wave).

5.1 Logistic Control Tower

The next biggest project that will take place in Barilla is that of the Logistic Control Tower.

Real time visibility is a precondition to create a Logistic Control Tower. Barilla's goal is to create an integrated tool which acts as a lighthouse for their logistic operations, giving end to end visibility to its extended and geographically dispersed distribution network.

The LCT will integrate data from various systems and allow a forward looking actionable capability via analytics, alerts and event management. This will reduce reporting complexity and bring continuous improvement. The Logistic Control Tower will include real time tools to monitor and optimize daily operations on carriers, engagement, transportation, and warehouse management. Alerts will be set up for corrective action directed to Barilla and their external stakeholders.

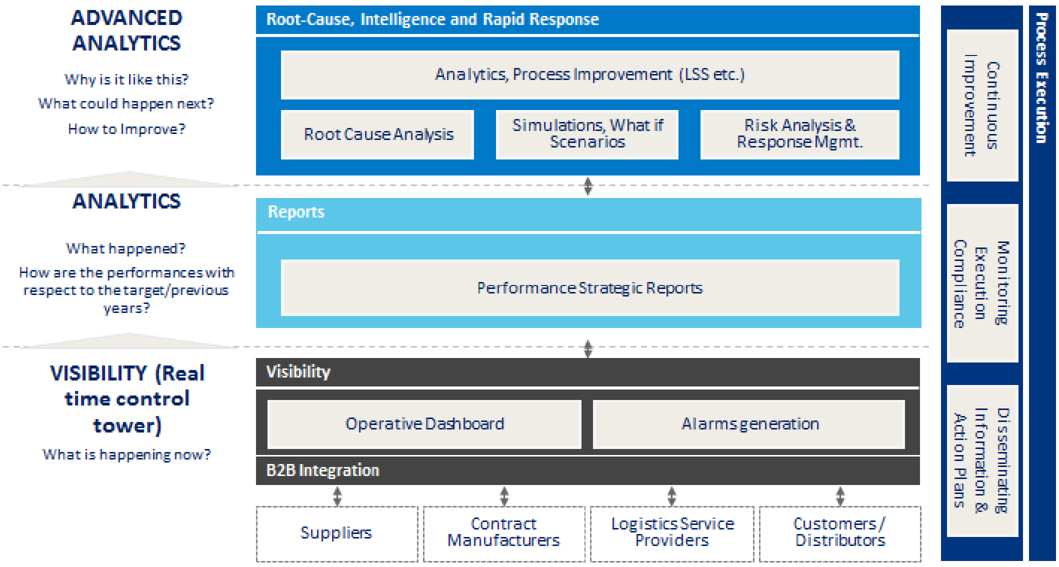

Figure 71: Three layer control tower

As seen from previous chapters, supply chain data is distributed, it is collected in different systems both inside and outside the enterprise (since Barilla collaborates with many different suppliers, suppliers of suppliers and logistic 3PLs who manage the warehouses). However, the potential value of this data is not fully exploited if it is kept “siloed” and not visible to everyone. The Control Tower is able to bring these different sources of data and streams of data together. This can not only increase the visibility but also opens the door for seamless collaboration amongst all the actors. The Control Tower in fact should also be able to help forecast, optimize, and automate operations by leveraging on technologies like AI and Machine Learning. This could ultimately help make supply chain management easier and less dependent on human touch and improve the promptness of corrective actions. For example a control tower could immediately spot where a bottleneck lies, such as a group of late shipments or a delay in the preparation of a load in the warehouse, analyze the reason behind it, find the root cause and also suggest the best action to take. It could also be a powerful tool to create reports like carrier rating, comparing the performance of carriers not only in terms of tracking ability, or punctuality but also on other aspects such as their percentage of acceptance of shipments assigned to them, as explained in section 4.5.3.

So the level of visibility that a Control Tower can bring is not only expanded in scope but it gains much more dept. While also the control tower will be able to send alerts like RTTV platform could do, it will go a step further by analyzing what if scenarios, simulating future scenarios and suggesting solutions.

As you can see from the project timeline below the kickoff happened at the beginning of April 2022, so during my last week of internship I had the chance to take part in a couple preliminary meetings and see the beginning of the project unfold:

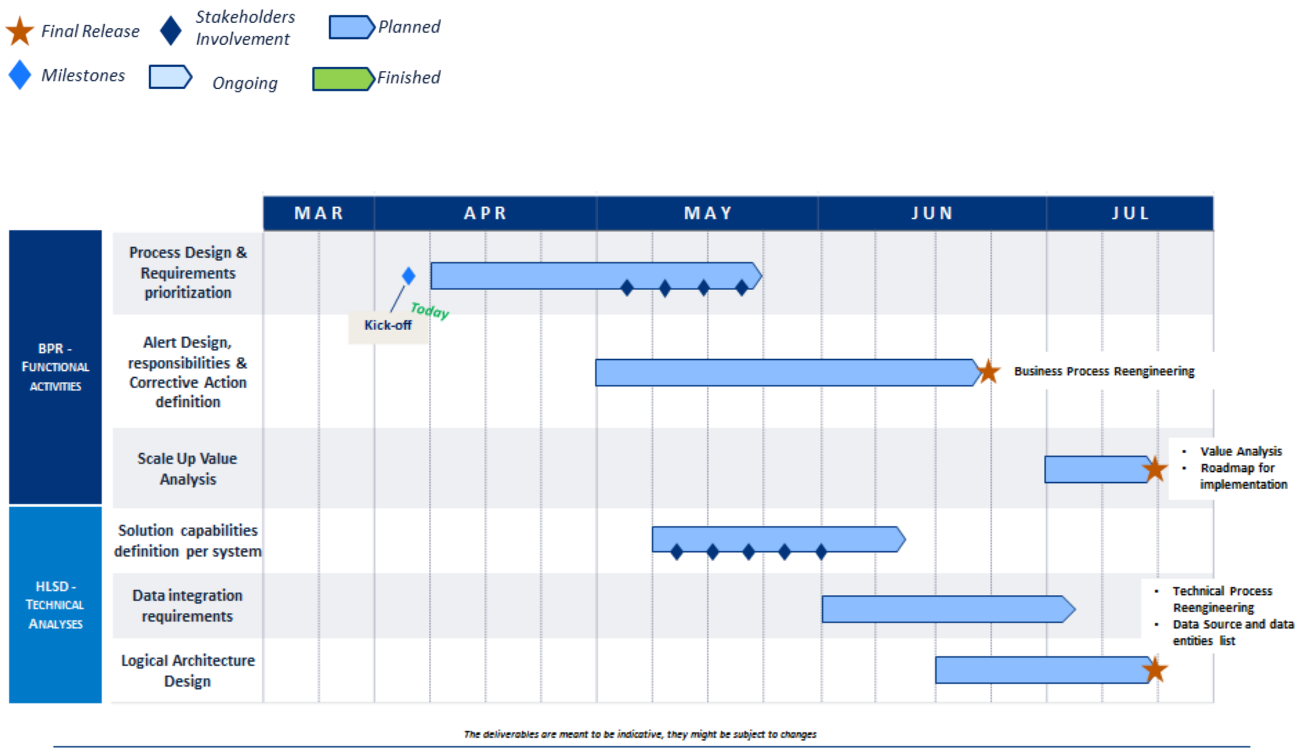

Figure 72: Timeline Control Tower Project

The first step to take in order to set up the logistic control tower is to provide an overview and redesign of the logistics process which consists in:

- **Business Process Reengineering**: defining the optimal event-based logistic process (without considering the technical issues for now);
- **High-level Solution Design**: recognizing all the macro inputs and process requirements; addressing them in a coherent, albeit high-level design.

The **project scope**, similarly to the RTV project scope, includes all the shipments planned from Barilla in the primary network, which includes:

- Shipments from Italy (from plants, auxiliary warehouses, co-packers, excluding hubs);

- Shipments to Italy;
- Shipments from Filipstad and Celle;

The transportation modes included are both those inland (road, train, and intermodal) and also overseas (ocean).

While the control tower will include all the aforementioned cases, the Business Process Reengineering and High-level Solution Design will be initially restricted to only shipments **from Italy** since this is the most complete case and it has more particularities in all the various events, so it would make sense to do a pilot test on this case first.

The **process scope** will include all the events in the operative process from the creation of the shipment to the delivery to the customer. The following is just an exemplifying list of some of the events that have been considered, that happen before the tracking of the load starts:

Event	Who	Where	Description/Timing
Shipment Creation	TP in Italy IoT abroad	SAP -> Transporeon	The shipment can be created from one month before to a day before.
Availability Check	Stock & Flows	SAP -> Click	The information is then sent to the warehouse.
Carrier Selection	TP in Italy IoT abroad	Transporeon	The TP or IOT office selects a carrier to carry out the shipment. This is still done manually but the goal would be to make it automatic
Carrier Acceptance	Carrier	Transporeon --> SAP	The carrier can accept or refuse to carry out the shipment.
Loading / Unloading Slot & gate booking	Carrier	Transporeon --> SAP	If the carrier has accepted the shipment, they can select on Transporeon the loading/unloading slot until one day before the pickup appointment. If they do not reserve the slot, they are put in a queue and they are loaded for last.This information is passed onto the warehouse who adapts its work plan based on the slot booked.
Asset assignment (information about trailer number, truck's license plate, driver's phone number)	Carrier	Transporeon --> SAP	This information needs to be given at least 4-8h in advance for a standing trailer (this information must be given well in advance as loading takes time and the warehouse needs to know which trailer to load), while in all the other cases there's time until shortly before the check in.

Figure 73: Example of events before tracking starts

It is important to keep track of where all the information is stored (in which system) and who are the actors involved in each event as well as when the event has to happen. Mapping out all these information will be useful for the creation of alerts (e.g.: a carrier has not accepted the shipment or hasn't sent the trailer number within a certain time limit, the warehouse is late in the preparation of the load, etc.).

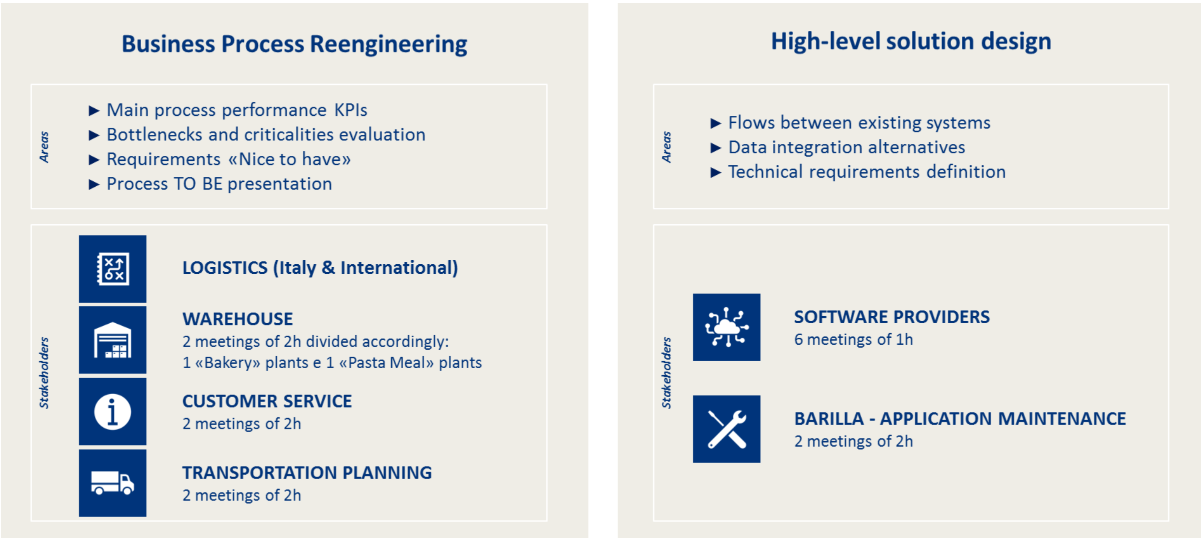

Figure 74: Business Process Reengineering & High-level solution design Stakeholders

The above figure illustrates the main activities included in the Business Process Reengineering and in the High level solution design and which are the **stakeholders** involved. The interviews that will be carried out with those stakeholders will be useful to define the AS-IS process as well as collecting of TO BE process requirements and designing the final process.

After **Business Process Reengineering** and **High Level Solution Design** will be completed, as seen from the timeline (*Figure 70*) the next steps are:

- **Technical Process Reengineering:** Collection of data integration requirements, technical integration requirements and data architecture requirements to support the TO BE design of the Integrated Logistics Control Tower solution architecture.

- **Data Source and data entities list:** Data and data sources included in the pilot, including any source filters and/or transformations required.

- **Value Analysis**: Areas of business value that the Integrated Logistics Control Tower can deliver in terms of KPIs, both quantitative and qualitative, including the time required to achieve the stated value (this deliverable is not intended to build an economic business case for the Integrated Logistics Control Tower project).

- **Roadmap for implementation:** Roadmap for Integrated Logistics Control Tower implementation, proposing perimeter and scope for a pilot.

6. Conclusions

In this paper I wanted to explain and highlight the importance and the benefits of utilizing a Real Time Visibility platform in a complex supply chain such as that of Barilla and in a challenging global context.

Following the various steps of the project in a chronological sense, I have described the market analysis of the suppliers of Real-Time Visibility platforms and the choice of the two suppliers that were tested in parallel in the Proof of Concept. This phase brought to light the differences between the two providers and determined the choice of one of these, that is, the one of the two who most satisfied Barilla's needs.

Then I moved onto describing the production phase in which I have given particular attention to the methods of integration and onboarding of new carriers into the platform, where interviewing a worker from the RTV supplier's company was useful to gather more insights on what aspects were critical for a successful process of onboarding carriers. I have then analyzed the tracking quality of shipments and in particular I tried to highlight what were the main causes of missed or low quality tracking and suggested possible actions to take to improve it and to ensure the correct functioning of the platform. In this phase we have seen the impact that subcontracting can have in the percentage of tracked shipments as well as other aspects such as the different methods in which carriers are integrated into the platform or the methods they use to exchange data. This study shows in fact that supply chain visibility can be hindered by the carrier network complexity. Insufficient cooperation, insufficient resources, digital skills of drivers, technical capabilities, privacy concerns are all factors that can affect the effectiveness in achieving real time visibility. I have then analyzed the last step of the production phase which is the introduction of the platform to various entities within the supply chain. While it is difficult to predict the economic savings that real time visibility will bring in the supply chains in which it will be implemented and it is even more difficult to define the time horizon of these gains, I have tried to highlight the benefits that the users (customer service, warehouse and transportation teams) could experience. I have then explored some of the future developments of the project and briefly explained the set-up of the control tower, which is a powerful tool that would allow not only to have real-time view of transportation, but it could be extended to all the logistic activities and processes within the supply chain, thus managing to monitor them in real time and make managerial decisions based on complete and correct information.

With this example from Barilla, I wanted to concretely demonstrate how a company with a complex supply chain can reap numerous advantages from using a Real Time Visibility system and highlight the steps to take for its successful implementation.

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List of Acronyms

API: Application Programming Interface

CT: Control Tower

EDI: Electronic Data Interface

ERP: Enterprise Resource Planning

ETA: Estimated Time of Arrival

FTE: Full Time Equivalent

FTL: Full Truck Load

GDPR: General Data Protection Regulation

GPS: Global Positioning System

HSEE: Health, Safety, Environment & Energy

IOT: International and Overseas Transport

IoT: Internet of Things

IT: Information Technology

LCT: Logistic Control Tower

LGV: Laser Guided Vehicle

LSP: Logistic Service Provider

LTL: Less than Truck Load

OTIF: On Time In Full

OTR: Over the Road

PoC: Proof of Concept

PWBI: Power BI

Radiofrequency identification (RFID)

RTV: Real Time Visibility

RTTV: Real Time Transportation Visibility

RTTVP: Real Time Transportation Visibility Provider

SCM: Supply Chain Management

TMS: Transportation Management System

TP: Transportation Planning

3PL: Third Party Logistics

VMI: Vendor Managed Inventory

Index of figures

Annexes

	Number of shipments out of total	% over total number of shipments	Data Exchange Method (Setup)	Integration method	notes	mode covered	count of not tracked	not tracked over tot carrier %	out of the not tracked total	not tracked over tot %	error tracking Address Located Outside Geofence	Asset not assigned	Assignment After Final Stop Appointment	Assignment After First Stop Appointment	Carrier integration Down	Check Calls Infrequent	Load appointment time too old	Load created after delivery	Load created after pickup	Load delivery before pickup	No Location Updates	Tracking started late	N/A
Carrier 1	207	6%	Automated	GPS / ELD Provider	File sent manually via email + GPS integration	road	202	98%	28%	5%	5	191		3							2		6
Carrier 2	61	2%	Automated	Carrier GPS / ELD Updates	Location data and statuses (for rail legs) received from carrier's TMS via EDI	intermodal	28	46%	4%	1%													61
Carrier 3	145	4%	Direct Assignment	GPS / ELD Provider	Direct assignment + GPS	road	15	10%	2%	0%		6		8		6	2				5	14	104
Carrier 4	68	2%	Automated	GPS / ELD Provider	Manual file + GPS	road	62	91%	9%	2%		61		2								1	4
Carrier 5	675	18%	Automated	GPS / ELD Provider	Automated file from TMS + GPS integration	road	196	29%	27%	5%	4	156	4	37		4	4				10	30	426
Carrier 6	75	2%	Automated	GPS / ELD Provider	Automated file from TMS + GPS integration	road	32	43%	4%	1%		26		6								1	42
Carrier 7	117	3%	Direct Assignment	GPS / ELD Provider	Direct assignment + GPS	road	9	8%	1%	0%		10	2	17		8	1					13	66
Carrier 8	27	1%	Automated	Carrier GPS / ELD Updates	Supplier A is integrated with the carrier's TMS wihch stores trucks' location	road	2	7%	0%	0%				1							2	1	23
Carrier 9	52	1%	Automated + Other	Carrier GPS / ELD Updates	Location data received from carrier's TMS via API	road	25	48%	3%	1%		14		12		6						3	17
Carrier 10	1325	35%	Automated	Status Updates	Automated status update (Pickup and Delivery statuses only)	road + intermodal	53	4%	7%	1%													1325
Carrier 11	139	4%	Automated	Carrier GPS / ELD Updates	Location data received from carrier's TMS via API	road	17	12%	2%	0%			4	4	1	26					8	10	86
Carrier 12	120	3%	Direct Assignmenr + Other	Mobile	CarrierLink	road	46	38%	6%	1%		38	1			41					12	13	15
Carrier 13	609	16%	Automated	GPS / ELD Provider	Automated file from TMS + GPS integration	road	35	6%	5%	1%	2	10	3	53		2	3				2	67	467
Carrier 14	128	3%	Automated	Carrier GPS / ELD Updates	Supplier A is integrated with carrier's TMS which stores trucks' location	road	1	1%	0%	0%													128
tot	3748	100%					723			19%	11	512	14	143	1	93	10				41	153	2770

Annex 1: Shipments - Error type table

Carrier Landscape Survey

Operational Overview				
1	How many shipments do you transport a year for Barilla?			
2	What is the percentage split of your shipments across different modes?	**FTL**	**LTL**	**Rail**
3	What are the lanes you currently operate? (Origin - Destination)			
4	Do you store appointment times (scheduled pickup and/or delivery times) in your system?			
Operational Discovery : FTL & LTL			**FTL**	**LTL**
1	What percentage of your shipments for Barilla is on your own equipment and what percentage is subcontracted?	% of own equipment		
		% of subcontracted equipment		
2	For the subcon shipments, please share the split up between the dedicated and spot subcontractors?	Total number of dedicated subcontractors		
		% of volume contributed by dedicated subcontractors		
		% of volume contributed by spot subcontractors		
***FourKites does not disclose subcontractors names to the customer**				
Operational Discovery: Cross Docking				
1	Do you currently use crossdocking while delivering your shipments?	Is cross docking involved?		
		Do you store actual arrival and departure times at cross docks in your system?		
		Do you store the address of all cross docking terminals in your system?		
Techincal Discovery: TMS				
1	Please elaborate on your TMS Capabilities	Do you have a TMS system for storing shipment numbers, truck plates, GPS locations or status updates and customer information ? If yes, Which TMS do you use?		
		Do you have webservice capabilities?		
		Can your TMS system generate reports (CSV, XLS, XLSX)?		
		Can your TMS automate the sending of these reports? (via email, via FTP, via SFTP)?		
Technical Discovery: Telematics				
1	Please elaborate on your Telematics capabilities	Do you have GPS on your fleets?		
		Who is/are your GPS providers?		
		What is the percentage split of GPS:		
		% of GPS devices in trucks		
		% of GPS devices in trailers		
		Will you be able to provide us a sample truck/trailer plates for testing?		
***FourKites starts tracking only right before the pick up appointment time and stops tracking once a truck reaches delivery**				

Annex 2: Supplier A's Carrier Landscape Survey