POLITECNICO DI TORINO

Master of Science in Engineering and Management

Master Thesis

Towards logistics 4.0: Michelin S.p.a

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ABSTRACT

Supply chain is the handling of the entire production flow of a good or a service. Supply chain activities start from the raw components all the way to delivering the final product to the consumer. Less than ten years ago, companies could not guess what changes the technology would bring to their businesses and how their supply chains would be affected. Logistics was an operational function that reported either to sales or to manufacturing and focused on ensuring the supply of production lines and the delivery to customers, and the old big challenge was to have the right product, at the right place, at the right time. Industry 4.0 creates a disruption and requires companies to rethink the way they design their supply chain. The logistics industry, like many others, is experiencing a deep change in the digital era as a result of new customers' expectations, new competitors and technological breakthrough which are re-shaping its functions and operating models.

This thesis has been developed during a one-year collaboration with one of the companies leading the tire-manufacturing industry worldwide: Michelin S.p.a. During this year, I had the opportunity to give a remarkable contribution to the development of one of the most important projects that Michelin is carrying on at European level: The Bib Track Project. The project is a significant proof of Michelin's approach towards the digital transformation. Indeed, it aims at strengthening the customer-centricity and then enhance the customer satisfaction while pursuing the new trends of logistics 4.0.

In the first part of the paper two chapters will present the main innovations characterizing the digital supply chain; what experts and analysts revealed from their researches and what are the main challenges and opportunities in the digital era, with a focus on the transportation & logistics (T&L) industry. Subsequently it is described the downstream supply chain of Michelin Italiana S.p.a, with more emphasis on the activities performed by the European Distribution Center (EDC) of Turin.

In chapter 5, it is presented a detailed description of the Bib Track project. The chapter starts with the analysis of customers' needs and requests, then it follows the description of the core features of the project and how Michelin's digital structure changed to sustain the project. Then, it is explained my role in the project, with actual analyses carried out to support decision making for delivery optimization processes. Finally, an overview of the main challenges brought by the project and a brief presentation of its future evolution.

1. Michelin S.p.a

In 1889 the Michelin brothers, André and Edouard, started what was to become a great challenge in both human and industrial terms: putting innovation to work in developing modern means of transportation, which could spur freedom of movement and economic growth. Michelin has significantly contributed at every phase of the automobile age, from the invention of the radial tire to the vertically anchored tire and from the first hotel and restaurant guide to the steel wheel.

Today, Michelin is one of the largest tire manufacturers of the world with more than 12 different brands, facilities on every continent and its products sold in more than 170 countries worldwide.

1.1 Bibliography

In 1829, Edouard Daubrée married Elizabeth Pugh Barker, nephew of the scientist Macintosh who discovered the solubility of rubber in benzene. With her know-how, she introduced rubber into the French Auvergne region and started manufacturing play balls for children. After a couple of years, in 1832, Edouard Daubrée opened a small farm machinery and rubber ball manufacturing plant in Clermont-Ferrand, together with his cousin Aristide Barbier. It did not take much for them to recognize the potential industrial applications of rubber, then, they started using it to manufacture gaskets, valves and tubing.

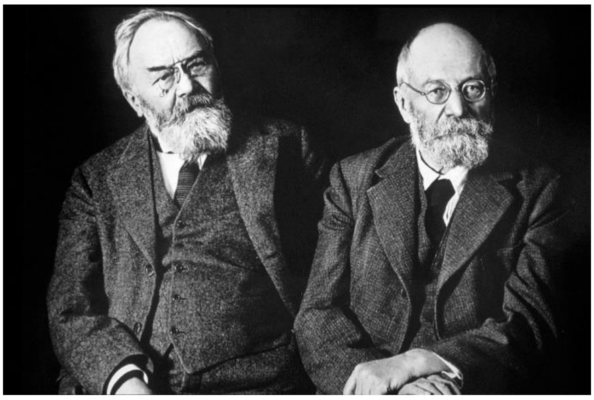


Figure 1 André and Edouard Michelin.

In the following years, Jules Michelin, a French painter, married Adèle Barbier, daughter of Aristide Barbier, and had two sons from her: André and Edouard Michelin (Figure 1). Although at the beginning they thought of pursuing other avenues than those leading to the family business, their grandfather asked them to help in the attempt to innovate the business activities and spot new opportunities for growth.

Only in 1889, the brothers joined the family business, and the company founded in 1863 by their grandfather was renamed Michelin & Co. However, the core business of the company was still based on rubber manufacturing to produce various products but not directly related to the transportation industry.

At least not before 1891, when a cyclist casually turned up to the factory to purchase materials to repair his Dunlop bicycle tires. The tire was glued to the rim, and it took over three hours to remove and repair the tire, which then needed to be left overnight to dry. Edouard Michelin had the chance to think of a new tire that did not need to be glued to the rim, that idea would disrupt the transportation industry. The same year, the first removable tire patents was filed. Repair works now required only a quarter of an hour. During the same period, the Paris-Brest-Paris bicycle race won by Charles Terront riding on Michelin detachable tires, helped advertise the new product (Figure 2).

Figure 2 Charles Terront after winning the Paris-Brest-Paris bicycle race.

In 1895, *The Éclair*, built and driven by the Michelin brothers in the Paris-Bordeaux-Paris automobile race, was the first car to be fitted with the new pneumatic tires (Figure 3). Further, Michelin took part and won many prestigious automobile races of the time, this inevitably contributed to early worldwide recognition of the Michelin brand.

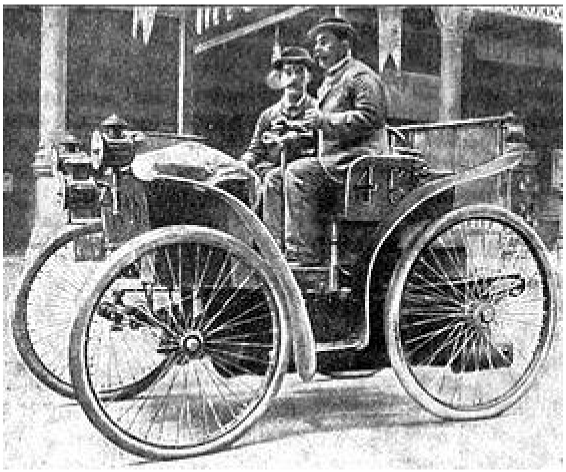


Figure 3 The Éclair, the first car in the world to participate in a motor race with pneumatic tires.

In 1898, when the word of the many achievements of the Michelin brand were spreading worldwide, the company lived another important moment for its growth: the birth of the colloquially called Michelin man, the "*Bibendum*" (Figure 4). This character, inspired on a column of tires of different dimensions, will have a huge fame around the world and will help the company in marketing and advertising its products.

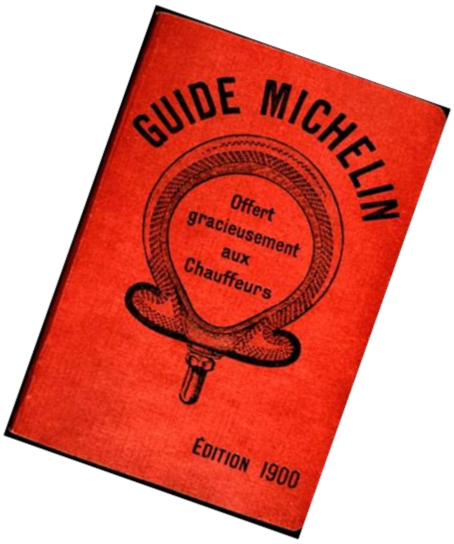


Figure 4 On the left, first appearance of Michelin's icon Bibendum. On the right, the first Michelin guide, in 1900.

During the nineties, Michelin will be a main promoter of the rise of the pneumatic tires for automobiles. In 1990, the company releases the first official Guide (Figure 4), printing 35,000 copies with these words: "This handbook is brought out at the turn of this century, and it will live through it."

In the meanwhile, the company expands its hometown facility in Clermont-Ferrand and starts building new plants abroad as well. In 1906, Michelin built its first plant outside France in Turin, Italy. After that one, others were built in the United States.

Within three weeks after the world war started, Michelin offered to contribute to the war effort by building aircraft. The first 100 were built free of charge. Michelin's Clermont-Ferrand plant built almost 2500 aircraft in that period. After the war, Michelin resumed its tire manufacturing operations and soon replaced crossed textile plies by parallel textile plies, boosting product performance. By the end of 1927, Michelin Clermont-Ferrand workforce upwards of 10,000 people, and Michelin already had built production facilities in three continents.

During World War II tire manufacturing operations slowed down. Faced with a shortage of raw materials, Michelin researched into substitutes and embarked on production of all kind of basic goods no longer available in the market. Also, one of its plant in Germany was bombed and destroyed but rebuilt in record time after one year and completely modernized.

Figure 5 The radial tire patented in 1946

In 1946, Michelin developed and patented a key innovation in tire industry, the Radial tire (Figure 5) technology was developed for truck tires as well (Figure 6Figure 5). In 1966, Michelin Group had 81,000 employees worldwide, including 37,400 only in France. The same year, Michelin partnered with Sears to produce radial tires under the Allstate brand and was selling 1 million units annually by 1970. In 1968, Consumer Reports, an influential American magazine, acknowledged the superiority of the radial construction, setting off a rapid decline in Michelin's competitor technology. In the U.S., the radial tire had a market share of 100%.

Figure 6 Advertising of Michelin's radial tire.

In 1979, Ferrari won the Formula One World Championship on Michelin radial tires (Figure 7). A few years later, the company developed Michelin Air X, the first radial tire for aircraft, and launched the first radial tire for motorcycle.

Figure 7 Ferrari won the Formula One World championship on Michelin radial tire.

In 1992, there was the release of the first low rolling resistance tire, giving birth to the Michelin Energy range in 1994. The same year the space shuttle landed on Michelin tires (Figure 8). In all these years the company had keep on expanding. In 1998, “Bibendum” celebrates its 100 years, and a couple of years later it will be elected the best logo of the world by an international panel of professionals brought together by the Financial Times. To celebrate the 100th birthday of Bibendum, Michelin created the Challenge Bibendum, which is a global clean vehicle and sustainable mobility forum.

Figure 8 The space shuttle landing on Michelin tires.

In the following years, Michelin focused on new technologies and innovative products while consolidating its leadership in the industry. In 2001, it launched a 4-meter-high, earthmover tire weighting 5 tons. Based on a low-pressure technology, this solution will carry up to 100 tons per tire. NZG radial technology was developed specifically for Concorde supersonic aircraft, in order to put it back in the skies. Lately those years, Michelin launched XeoBib, the first agricultural tire to run at a constant low pressure.

In 2004, the company adapted a baseline reflecting Michelin’s worldwide commitment to enhanced mobility based on continuous improvement of performance and exercise of responsibilities: “Michelin, a better way forward”.

Between 2006 and 2010, Michelin launched 4 different products:

- Michelin XDN 2 Grip truck tire with a regenerating tread.
- Michelin power race dual-compound motorbike tire developed from racing technology.
- Michelin Energy Saver tire, contributing to significantly reduce fuel consumption by trucks.
- Michelin Energy XM2, designed for specific roads.

In 2012, the Group produced 166 million tires at 69 facilities located in 18 countries.

For years, Montreal has become the headquarters of the mobility and sustainable development projects. Thanks to the organization of the “MovinOn” event with which Michelin, who launched this forum in 1998 with the name “ Challenge Bibendum”, brings together players from all over the world to identify and discuss the opportunities leading to the reduction of the impacts of automobiles and other means of transportation on the environment.

In 2019, Michelin presented its new tire concept of the future intended to revolutionize the tire industry (Figure 9). The Prototype name for this tire is Uptis, shorthand for Unique Puncture-Proof Tire System. The new product is based on Michelin’s pillars of “Airless”, “Connected”, “3D Printable” and “100% sustainable”.

Figure 9 Michelin Uptis

The product represents an important milestone for the tire industry’s objective of a more sustainable production. “Uptis shows that Michelin’s vision for a sustainable mobility future is clearly a viable dream”, these are the words of Florent Menegaux, former CEO of Michelin Group.

2. Supply Chain 4.0

2.1 The next generation Digital Supply Chain

The Digital Supply Chain Initiative describes the DSC as a customer-centric platform model that captures and maximizes utilization of real-time data coming from a variety of sources. The essence of Supply Chain 4.0 is based on the exploitation of new technologies and digital capabilities to create a new ecosystem in which sensors are in everything, networks are created everywhere, and everything is deeply analyzed to improve performances and end-user satisfaction.

According to this definition, the interconnections between the different activities become more important than ever to share real-time data, and instead the traditional supply chain organizations, which are mostly fragmented and operate in functional silos that focus on optimizing a specific aspect of the supply chain, must reorganize if they want to survive in the upcoming generation.

Consequently, the traditional linear Supply Chains are turning into a grid-based network that adapts to fulfill the variety of different needs of the customer, who is now in the center of this network.

This next generation supply chain enables companies to address the new requirements of the customers by taking advantage of the opportunities brought by the digitalization.

According to the literature, the Digital Supply Chain (DSC) will have:

Rapidness: In the very first place, new distribution methods will dramatically reduce the delivery time. Then, advanced forecasting approaches such as "demand sensing[1]" of both internal data (market demand) and external data (market trends, weather, market indexes) will be used to more accurately forecast the customer demand. Lastly, the automation of both physical tasks and planning will boost the efficiency, with robotic workforce and machines handling the products automatically along the warehouse activities for both inbound and outbound, thus from receiving and stocking to picking, packing, and shipping. Not to mention the efficiency brought by the transportation of products made by autonomous trucks within the network.

Organizational-Flexibility: While boosting the efficiency the new DSC also provides a high degree of flexibility. The real-time planning allows a flexible reaction to changing demand or supply situations. This produces plenty of advantages since planning cycles and frozen periods are constantly minimized. The new planning activity becomes a continuous optimization process that is able to react dynamically to changing requirements or constraints.

Granularity: Digital Supply Chains will give a strong push towards micro-segmentation, because of an increased necessity of individualized and customized products by the customers. For this reason, new technologies will allow companies

[1] It is mainly a short-term forecasting analytics method that combines historical internal transactional data with external data to predict demand in the near future. This methodology provides a more accurate forecast of baseline demand. Experts sustain that it can reduce the number of planning changes and results in lower operational waste and inventories.

to offer a broader portfolio of products, without affecting the efficiency of production nor transportation.

Organizational-Connection: The next generation of performance management systems provides real-time, end-to-end transparency throughout the supply chain. Companies will be then structured as connected ecosystems and these infrastructures will enhance collaboration and coordination among functions. Also, managers of the different functions will be provided joint information and will have the opportunity to make decisions based on the same knowledge.

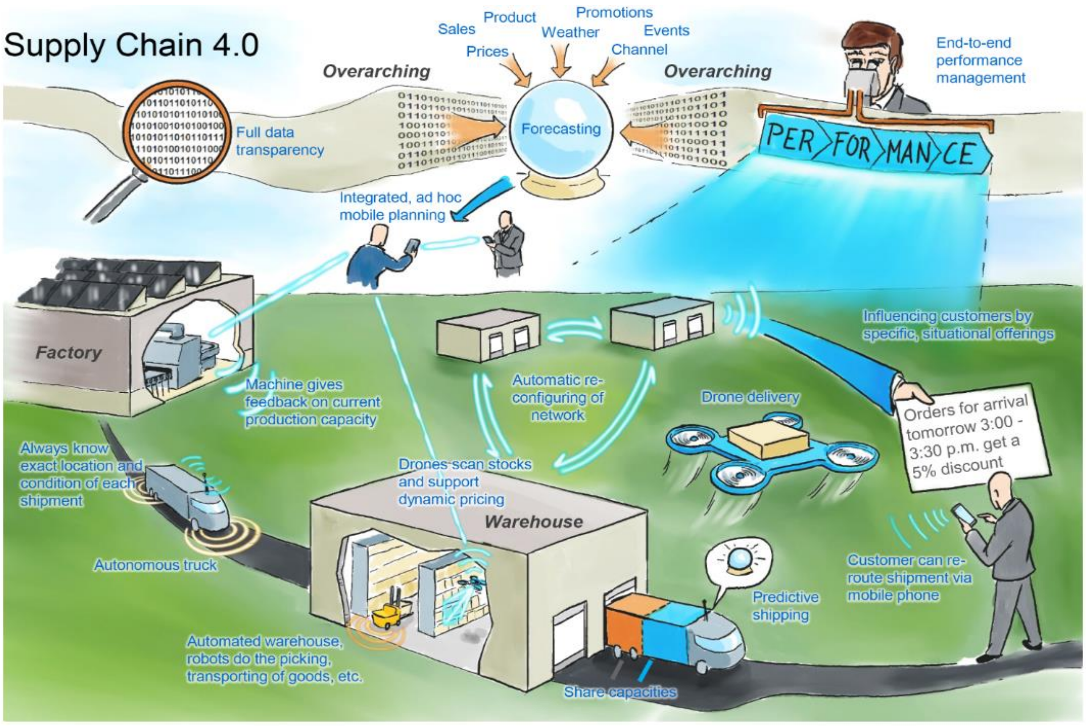


Figure 10 Source: McKinsey-Supply Chain 4.0.

2.2 The Disruptive Supply chain management

Supply Chain 4.0 is expected to disrupt all the business processes and question the real source of profits for companies. Hence the traditional supply chain performance triangle, that was used to drive the business strategy in the past, changes its natural shape to include another key pillar: the business agility (Figure 11).

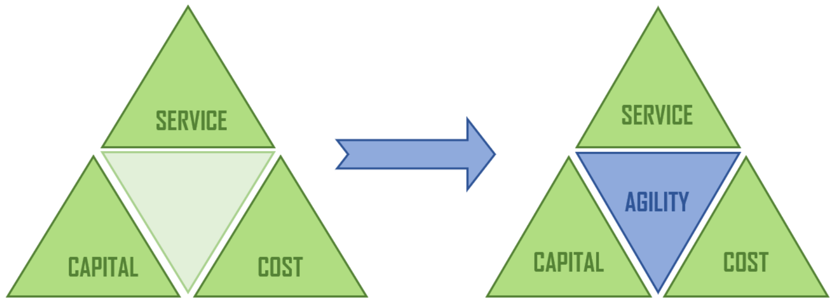


Figure 11 The SC performance triangle transformation.

In order to show expected improvements of the new DSC, McKinsey (2016) developed a new structure (Figure 12) that is based on the four DSCM key pillars and additionally applies them to push six main value drivers (Figure 13).

Figure 12 Source: McKinsey- Digital Supply Chain Compass.

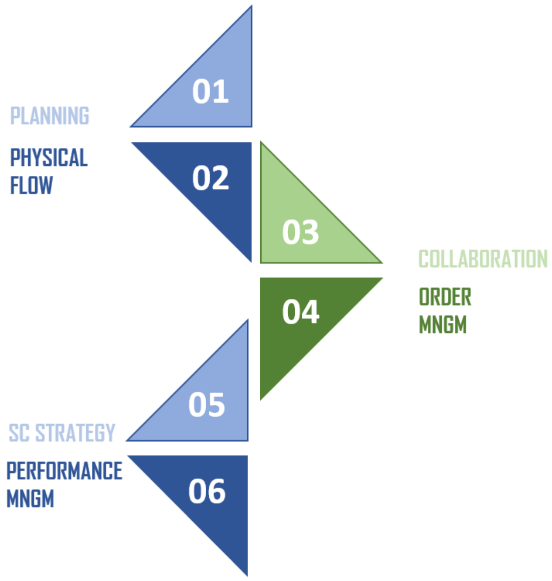


Figure 13 McKinsey six main value drivers for Supply Chain 4.0

Planning

Planning will be one of the activities that will change the most in this new era for supply chains. As a matter of fact, the infusion of big data, advanced analytics, artificial intelligence and machine learning will be used to develop new trends and approaches. For instance, a major new trend is characterized by the merging of time horizons for planning. Consequently, integrating the different planning horizons means combining needs from various functions to produce a single planning solution, that simultaneously groups different input. This new methodology creates transparency through the supply chain and establishes a link between long-term strategic planning, mid-term tactical planning and day-to-day operational planning.

Another major trend is related to the concept of innovative planning. In other words, planning processes use advanced scenario planning tools to perform an optimal planning simulation. Thus, the optimal scenario is founded on the basis of updated supply chain data and production capacity constraints.

Further, new other methodologies based on data manipulation can support planners in their forecasting analytics. Key examples are "predictive analytics" and "closed-loop planning."

The first one heavily relies on the analysis of many thousands of data concerning demand influencing variables, with artificial intelligence exploited to model their relationships and derive an accurate and granular demand plan. The application of these algorithms makes it possible to considerably reduce the forecasting error by 30 to 50 % (McKinsey). In the S&Ops, top managers and directors would have vision over probability distributions of the expected demand volume rather than a single number, consequently risks would be less, and at the same time a stronger control over the decisions to take would be given to the executives.

The second one transforms planning into a continuous and flexible process. This system contains an information feedback feature that enables plans to be continuously checked and adjusted. Thus, the closed loop definition refers to the fact that its feedback activity “closes the loop” of planning. The system adapts as the probability distributions change, hence, on the basis of demand influencing variables, both internal and external, and according to a certain level of service that the company wants to achieve. With this synchronization feature it is also possible to integrate pricing decisions with the demand and supply planning, which means that synchronizing in real-time the expected demand, stock levels, capacity to restock and other influencing parameters, prices could be continuously adjusted.

Physical flow

Logistics will approach a new era, not only its old operational function will shift to an independent supply chain management function, gaining much more responsibility in the chain, but it will have to deal with advanced analytics, advanced automation, robotics and IoT. The application of new touch, voice, and graphical user interfaces facilitates a much better coexistence between humans and machines in almost any process in warehousing operations. Advanced robotics will boost the warehouse productivity when it comes to consider the warehouse performance during picking or stocking activities. Smart or autonomous vehicles will be used in order to reduce as much as possible warehouse costs such as transportation cost and product handling cost.

Order management

The next generation of OM will embrace advanced technologies to fulfill increasing the customer demand by minimizing input costs. Order management processes will be in fact mostly driven by analytical tools and supported by automation. An ambitious example of automated ordering process is the “no touch” process, where no manual intervention is required between order intake and order confirmation. Hence, Artificial Intelligence (AI) ensures 24/7 working accuracy while minimizing costs and boosting productivity.

Performance management

The performance management process has moved from a systematic process, to an operational process aimed at exception handling and continuous improvement. The new technologies driving supply chain digitalization are being used for ad-hoc analyses and predictive analytics as well as improving report visualization.

The performance management system can identify the root causes of an exception by either comparing it to a predetermined set of potential causes or by conducting big data analyses, leveraging data mining and machine learning techniques. What is valuable of these systems is not only the continuous monitoring they offer, which allows to conduct automated root–cause analysis, but also that once a root cause has been successfully identified, these systems can also automatically trigger countermeasures, such as activating a procurement order or issuing alerts to operational teams .

Collaboration

Companies that are able to develop a collaborative supply chain can exploit all the advantages of an end-to-end connectivity. With joint supply chain platforms, the customers, the company and suppliers have shared information concerning supply-chain tasks; consequently, it is much simpler to reduce potential inefficiencies. Collaboration enhances the ability to react fast to disruptions anywhere in the chain either in terms of preventive actions, with the development a reactive warning-system, or in terms of corrective actions, with the development of machine-based systems able to dynamically suggest countermeasures to changes of demand influencing variables.

Supply Chain Strategy

The future Supply Chain will be characterized by two big and essential prerequisites:

- Globalization
- Digitalization

Supply Chains 4.0 are not only facing the globalization opportunities and constraints, but also the digitalization challenges and benefits. Hence, companies that target the global market must also develop a digital infrastructure (DI) that supports the Supply Chain strategies. According to this view, companies not only have to manage a global network but at the same time they should embrace digitalization to work with a level of flexibility such to control micro-segmentation of orders, omnichannel sales and so on.

Figure 14 Source: https://www.elemize.com/benefits-of-digitalization-in-the-power-industry/

2.3 Weaknesses of the traditional configuration

Most of today's Supply chains are still under a traditional configuration that does not exploit the benefits resulting from newer technologies and strategies. These Supply Chains will struggle over the years as the digitalization evolves, the common challenges in the sector will become major issues and at the same time, while trying to prevent these threats they will have to fight against disruptive supply chains that will try to put them aside in the industry.

Accenture (Accenture, 2017) reports that among the many challenge faced by traditional supply chains, some of the most pressing are:

Poor response times: This is mainly a consequence of the fragmentation of the traditional Supply Chain, for which each section works as an independent function. Delays are created every time information must be exchanged between functions. Thus, decision making becomes linear and companies lack organizational flexibility.

Lack of visibility: Current technologies and processes do not give any chance to have end-to-end supply chain visibility at order, product or shipment levels. Consequently, it is much more complicated to manage and resolve problems when they arise since functions suffer information asymmetry and lack of transparency. Additionally, inefficiencies are more likely to be produced along the SC because business plans and mid-term objectives would be inaccurate if they do not account for every function needs and constraints.

Conflicting priorities: Another main consequence of the fragmented structure of traditional Supply Chains. Each Supply Chain function has its own priorities and short-term objectives. Sometimes this makes it difficult to find the right balance between functional goals and overall supply chain objectives and outcomes.

Inefficient Fulfillment Model: Most companies' fulfillment models have not changed in many years and indeed become inefficient in the new era. The digital era is not only characterized by new technologies, it also comes with different customer expectations including much stronger granularization of orders, further customization for the products, last-mile delivery options and at the top of these the possibility to interact with the company in an omni-channel world. Therefore, companies must experiment new fulfillment models that can align with the growing customer needs.

When it comes to evaluate the companies that will be affected by major changes as a result of a paradigm shift in the business model, market analysts predict big companies and long-term leaders of the specific industry to be the one most disrupted. The analysts show that companies characterized by a lower degree of preparation to meet supply chain challenges over the next five to ten years, are more likely to be those that have survived in the industry for a longer time. What put these companies more at risk is their organizational inertia; which basically means that they struggle to change their business strategy direction and instead tend to accomplish new target goals with older strategies.

2.4 Challenges on the path of the digital transformation

When it comes to consider disruptive transformations, it is never easy for companies to adapt. The digitalization indeed, has produced one of the biggest storms affecting the configuration of supply chains of all times. Digital transformation does not end with implementing new technologies and letting them run, it cannot simply happen in vacuum. Rather, true digital transformation typically has deep implications for an organization, it has high impacts on the strategy, talent, business models, and even the way the company is organized.

To better figure out which could be the most important challenges on the path of companies' digital transformation and how these companies are investing in Industry 4.0 to unlock the opportunities coming from the digitalization, Deloitte fielded a global survey of 361 executives across 11 countries (2018). This survey made it possible to identify four crucial industry 4.0 paradoxes:

The survey revealed that the majority of respondents pointed the digital transformation as one of the top strategic goals for their organization. The real problem is that even though they understood the strategic importance of the digitalization, it does not mean that they are concretely willing to embrace it. As a matter of fact, many fewer see it as an avenue for profitability (Figure 15). Further, just a small fraction of these executives has already planned to adapt to this change. Deloitte defined this phenomenon as the *strategy paradox*: "*Organizations are largely still finding a path that balances improving current operations with the opportunities afforded by Industry 4.0 technologies for innovation and business model transformation.*"

Top management is aware of the strategic importance of digital transformation but neither explore nor exploit the possibilities brought by this new economy because either do not actually think they could be profitable, or they are underestimating possible negative effects on the organization. As evident from the table below, only 68% of the overall respondents recognized the digital transformation as a critical aspect to maintain profitability.

	Total (N_T=361)	Americas (NAM=161)	US (N=80)	Mexico (N=31)	Brazil (N=30)	Canada (N=20)
Digital transformation is a top strategic priority at my organization	94%	91%	94%	87%	87%	95%
Implementing new technology is key to market differentiation for my organization	88%	84%	85%	84%	80%	90%
We have a strategic plan for how digital technology can be a competitive differentiator across our business units	88%	86%	89%	71%	83%	100%
My organization knows exactly what to do when it comes to digital transformation	87%	80%	88%	84%	63%	70%
My organization has exactly the workforce and skillset it needs to support digital transformation	85%	84%	88%	84%	77%	85%
My organization is always successful at navigating digital transformation initiatives	83%	76%	86%	58%	67%	75%
My organization has exactly the culture it needs to support digital transformation	81%	76%	81%	77%	60%	75%
Funding for digital transformation priorities is seldom (or never) a problem	76%	71%	76%	74%	53%	70%
Digital transformation is critical to maintaining the profitability of my organization	68%	57%	59%	52%	47%	75%

Figure 15 Source: Deloitte Industry 4.0 Investment Survey, 2018.

Another key contradiction emerging from Deloitte's report involves the company's concrete approach towards the digital transformation. According to the survey, most executives pointed out that their digitalization initiatives are mainly driven by improving their current processes, rather than innovating. Hence, companies mostly focus on operational and productivity goals as top factors driving digitalization initiatives rather than being motivated by the desire for innovation or by the need of facing competitive forces (Figure 16). This "*innovation paradox"* has been widely recognized as one of the most pressing factors preventing a successful digital transformation.

	Total (N_T=361)	Americas (NAM=161)	US (N=80)	Mexico (N=31)	Brazil (N=30)	Canada (N=20)
Productivity goals (e.g., improved efficiency, etc.)	50%	58%	65%	58%	43%	55%
Operational goals (e.g., reduced risk, etc.)	47%	54%	56%	42%	60%	55%
Customer requirements	36%	34%	35%	32%	20%	55%
Internal strategy focus	29%	27%	25%	19%	23%	50%
Competitive pressures	29%	27%	21%	35%	40%	20%
Increased desire for innovation	23%	26%	23%	39%	33%	10%
Employee demand	19%	15%	16%	13%	17%	10%
Supplier requirements	19%	15%	16%	19%	10%	10%
Shareholder engagement/demand	19%	15%	18%	10%	13%	15%
Partner requirements	15%	10%	5%	19%	10%	15%
Regulatory pressure	13%	16%	18%	10%	27%	5%

Figure 16 Source: Deloitte Industry 4.0 Investment Survey, 2018.

Additionally, the results show that even those companies who reported a significant profitability improvement as a result of digital transformation efforts are practically driven by productivity goals rather than innovation.

Companies must understand that leveraging advanced technology in order to do the same things better, does not work in this new era. They need to be convinced that it is time to change, that they cannot simply improve current operations and processes for future developments because this approach will not work anymore and that if they do not undertake the digital transformation objective seriously, then new entrants and disruptors will likely take control of the lion's share[2] in the market.

[2] The lion's share is an idiom used to indicate the majority of something.

The last key contradiction emerging from the global survey is a phenomenon defined by Deloitte as "the *Supply Chain paradox".* This paradox concerns the strategic importance of investments in the Supply Chain as a main driver for digital transformation success and the undervalued role of the chief supply chain officer (CSCO).

For the first consideration, even if the survey results appear to confirm the necessity of investment in the digital supply chain; results also show that the supply chain is not considered as a particularly strong conductor of innovation. For the second consideration, the survey results suggest that the chief supply chain officer (CSCO), who is supposed to be the leader of supply chain strategy, typically plays a relatively minor role in shaping digital transformation decision-making.

To stress out these points, the survey results are reported as follows:

62% among overall respondents indicated Supply Chain as a top-prioritized function (Figure 18), ahead of planning, product design, marketing and so on. Then, companies are aware that in order to face the disruptive evolution the Supply Chain must be a key function in the upcoming years.

	US (N=80)	Mexico (N=31)	Brazil (N=30)	Canada (N=20)
Supply chain	73%	48%	50%	80%
Planning	64%	65%	50%	65%
Product design	59%	55%	37%	55%
Marketing	56%	45%	23%	60%
Inbound/outbound logistics	45%	29%	30%	45%
Sales	45%	45%	30%	45%
Customer/Fielded asset support	44%	52%	33%	50%
Talent and Human resources	40%	42%	33%	45%
Shop Floor Production	40%	39%	33%	40%
Smart facilities	39%	35%	17%	40%

Figure 17 Source: Deloitte Industry 4.0 Investment Survey, 2018.

Which functions are you prioritizing for future digital investment?

	Total respondents
Supply chain	62%
Planning	61%
Product design	50%
Marketing	50%
Sales	43%
Talent/HR	39%
Customer/field asset support	38%
Inbound/outbound logistics	36%
Smart facilities	35%
Shop floor production	30%

Source: Deloitte Industry 4.0 investment survey, 2018.

Figure 18 Supply Chain is the most frequently prioritized function for future digital investment.

However, what is a valuable indicator of prioritized function for digital transformation purposes is whether the organization has digital transformation efforts underway in that function and not simply where the company recognizes its priority. To this extent, 63% of the overall respondents declared that their companies already had digital transformation efforts in progress in the Supply Chain function, immediately after planning and sales.

Where do you currently have digital transformation efforts underway?

	Total respondents
Planning	67%
Sales	64%
Supply chain	**63%**
Marketing	62%
Shop floor production	60%
Inbound/outbound logistics	60%
Product design	58%
Customer/field asset support	58%
Smart facilities	58%
Talent/HR	58%

Note: Above percentages based on highest two response choices ("4" and "5," combined, on a 1-to-5 scale).
Source: Deloitte Industry 4.0 investment survey, 2018.

Figure 19 Supply Chain is in the top three areas in which digital transformation investments are already in progress.

The first real contradiction shaping the Supply chain paradox emerges when it comes to consider the perception that executives who participated to the survey had on the Supply Chain as a real conductor for the digital transformation. Results show that only 34% of the executives really believes that Supply chain is the function driving the digital innovation. As emerges from the figure below, it classified in the middle of the ranking, far behind information technology and operations/production.

In my organization, I am seeing the most digital innovation driven from ...

	Total respondents
Information technology	60%
Operations/production	57%
Finance	35%
Supply chain	**34%**
Engineering	33%
Marketing and sales	30%
Aftermarket/customer support	23%
Talent/HR	22%

Note: Respondents were asked to select up to three functions as exhibiting the most digital innovation.
Source: Deloitte Industry 4.0 investment survey, 2018.

Figure 20 Supply Chain is not recognized as a critical component of digital transformation.

The other key contradiction shaping the Supply chain paradox concerns the role of the chief supply chain officer (CSCO) within the organization. Kevin O'Marah, in his article "*What's the point of the CSCO?*", published in Forbes Magazine, tries to explain the purpose of the CSCO, and how this position has changed over the years. In the early 2000s, the CSCO, previously identified with a different name, was responsible for monitoring the efficiency of the supply chain, mostly in terms of cost-savings. Lately, there have been more than 70 new CSCO positions created between 2002 and 2012 among S&P 1500 firms. The new role included both a tactical oversight of day-to-day supply chain operations, as well as the strategic vision of how the supply chain fitted into the larger digital organization.

Since this new role has been introduced in the executive suite as a consequence of emerging technologies and essentially the emergence of the digital economy, it would stand to reason that the CSCO should have a key role in decision-making concerning investments in digital transformation technologies, but the responses of Deloitte global survey suggest otherwise.

Based on the data, only 22% of the overall respondents sustain that the CSCO is either a key decision-maker or highly involved in the decision-making process concerning digital investments (Figure 21).

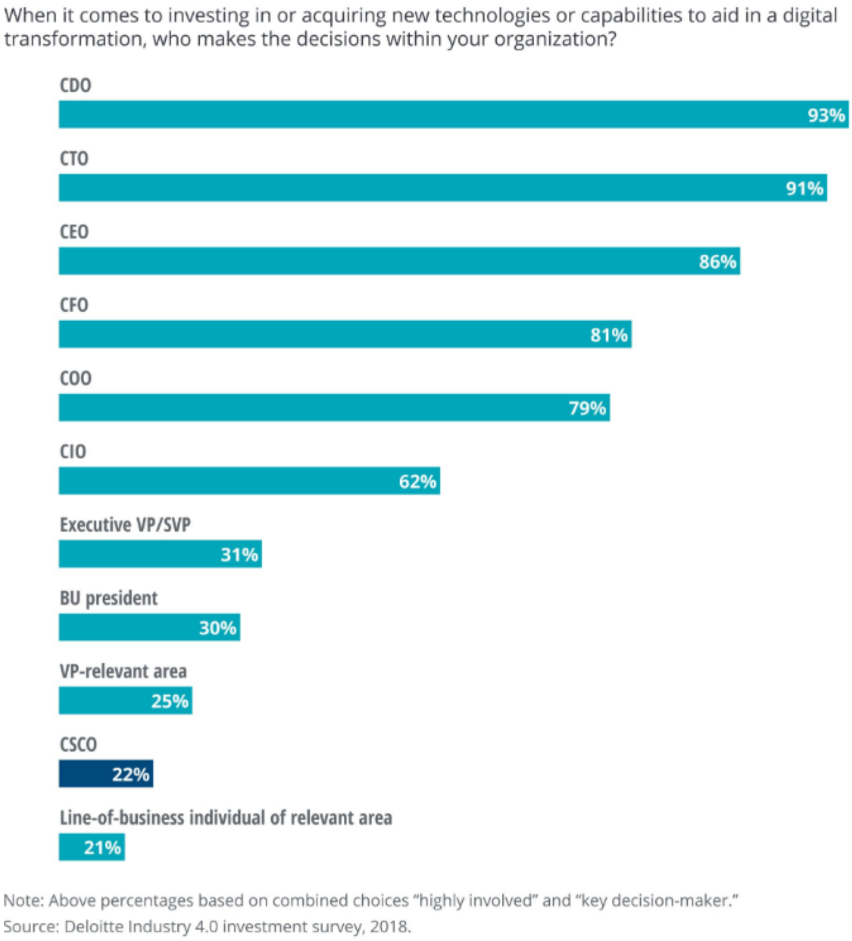


Figure 21 The CSCO does not have much power in decision-making about digital investments.

Further, in a complementary question concerning the personal involvement in digital transformation investment decisions, none of the CSCO attending the survey said he was highly involved in such decisions, surprisingly they ranked themselves much lower than other C-suite executives did (Figure 22).

How involved are you personally in investment or purchasing decisions related to digital transformation within your organization?

	Key decision-maker/ highly involved in decision	Somewhat involved in decision	Play a role/ not at all involved
C-suite respondents (excluding CSCOs)	90%	8%	2%
Non-C-suite respondents	37%	63%	0%
CSCOs	0%	93%	7%

Source: Deloitte Industry 4.0 investment survey, 2018.

Figure 22 No CSCO recognized he was personally involved in digital investments decisions.

Deloitte underlines the point, concluding that *“the CSCO is by far the C-suite executive with the least involvement in the digital acquisition decision, and among the least overall”.*

So, why do these paradoxes and what is fueling them?

In a nutshell, a lack of robust preparation and understanding it is said to be hindering the transformation process. Even though companies said that they have started digital supply chain transformation, that they are constantly pursuing innovation and they are ready to adapt the digitalization; just a few of these companies actually took the right path, others are simply stuck in the middle of this storm produced by the digitalization. Many organizations may lack a clear understanding of what exactly this transformation entails, and what practically is supposed to change. Worse, other organizations are still blinded by their status quo, and struggle to accept such a radical change because cannot believe to be at serious risk of disruption. These companies are those which are risking the most indeed.

2.5 Building Blocks for DSC success

In the previous paragraphs it has been given an idea of what are the expected features of this new DSC and how companies are dealing with the digital transformation. In this part of the paper instead, the reader will have the chance to understand what analysts say will likely be the building blocks to achieve digital supply chain success.

- **Customer-centricity:** One of the most disruptive change in this new digital era has been customer expectations regarding their experience when purchasing a new product or service. The crucial point organizations have to think about is that customers' expectations have never been so high; the awareness that the digitalization is constantly growing and the desire to pursue it make the demand for new products much more complicated for companies to fulfill. In order to understand how the customer expectations have changed compared to the past years, it is necessary to consider them from two different perspectives. The first one, mostly practical, in terms of customer needs and requirements. The second one, in terms of customer experience.

  The first key point refers to the customer needs, how these have changed compared to the past. For illustration purposes, take the Kano Model (Figure 23), potentially applied for new products. The Must-be attributes ("*Basic Expectations*") have never been as complex as they are right now; the basket of needs classified as One-dimensional ("*Satisfiers*") attributes has increased such to challenge the manufacturers more heavily and at the same time attractive attributes ("*Delighters*") have become more difficult to address. Further, the reverse attributes, which basically involve the risk of dissatisfying the customers when the product features certain characteristics that are negatively judged by customers based on their subjective preferences, have never been so difficult to be identified. Hence, customers' choices and need have become much more dynamic and then changes more frequently and heavily than in the past years. To stress out this point, the very first thing that companies should keep in mind is that delighters, hence the attractive attributes, are turning into Must-be attributes much faster and often than in the past. Consequently, if companies do not reconfigure to reach the level of flexibility required in this digital economy, their attempts of innovation will always be worthless, because once they think they have finally understood to address the new attractive attributes, these will be already changed.

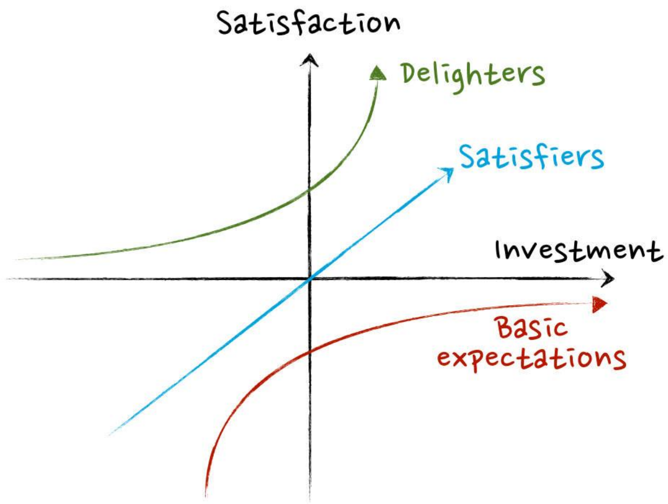


Figure 23 Kano-Model.

When it comes to consider the customer experience, it's illuminating to quote the words of a man who discovered the value it brings much earlier than many others.

"You've got to start with the customer experience and work back toward the technology, not the other way around."

Steve Jobs

The second key point concerns the customer experience. More than ever, customers value how they experience brands above all else. That extends to both online and offline stores, as well as social media. PwC surveyed (2017/2018) a sample of 15,000 people from 12 countries, in order to get information concerning what really matters for customers when they connect with a new company. Survey results show that 73% of all respondents recognize the customer experience as a key factor in their purchasing decisions (Figure 24).

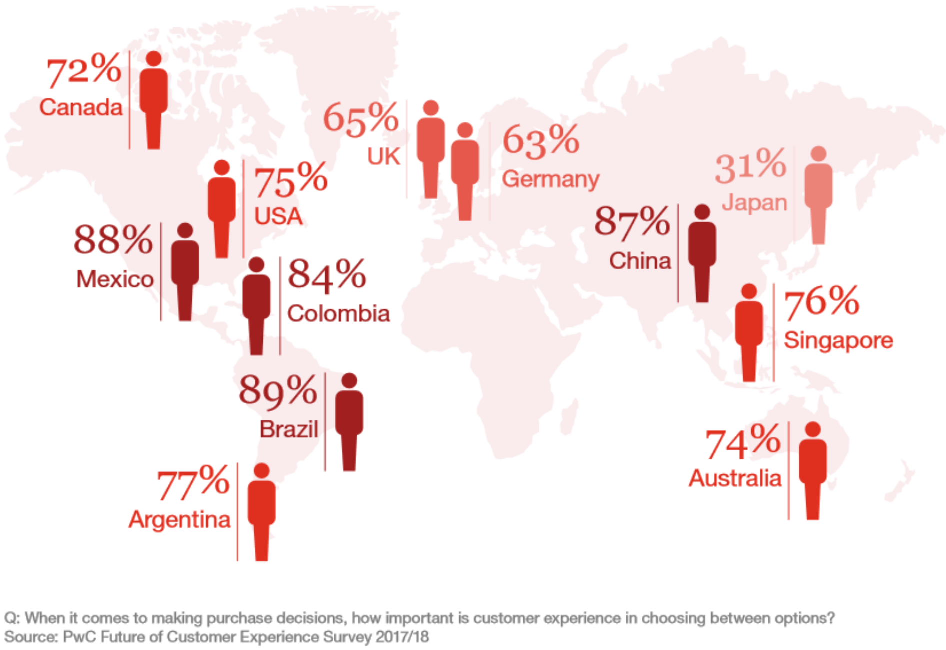


Figure 24 Survey results across the 12 countries involved.

More in detail, the survey results also reveal what people value the most in their customer experience. At this purpose, customers would pay more for a friendly, knowledgeable help service along with speed and convenience in the operations (Figure 26). In the digital era, new and advanced technologies can help in improving the quality of the digital service that companies offer. Thus, making it more reliable, efficient, fast and user-friendly. Automation can help, but companies must have the digital skills required to handle it. Further, companies must be able to find a balance between automation and human interaction. Both are considered important elements for the customer experience, and both are drivers of price premiums. However, it is up to the company to figure out to what extends automation should come before human interaction with customers. What is sure is that customers want to have the chance to reach a human if needed (Figure 25).

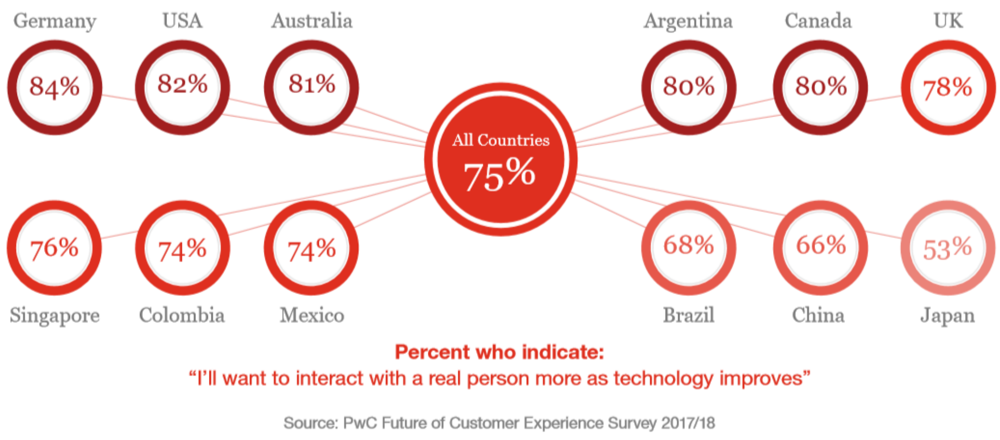


Figure 25 Request of human interaction as technology improves.

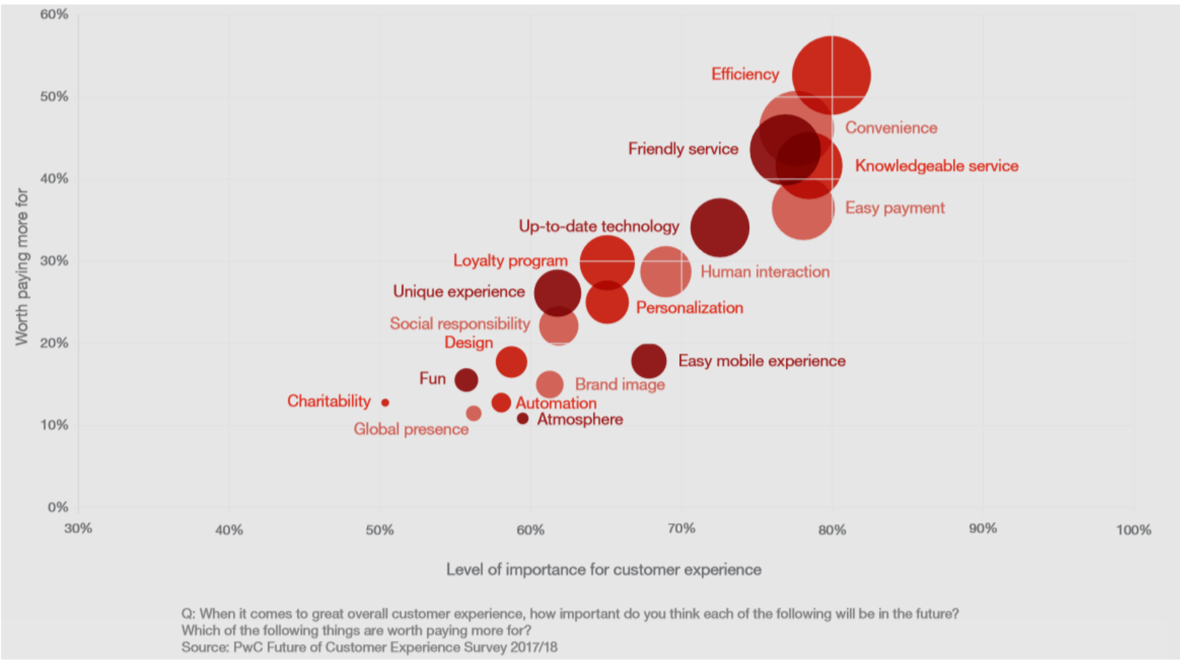


Figure 26 The elements of a positive customer experience.

Customer satisfaction is not only harder than in the past years for companies to address, it is also concretely challenging the companies' profitability, since globalization and digitalization together made it easier for unhappy customers to switch providers and brands. PwC's survey results show that 32% of all customers of the sample would interrupt doing business with a brand they liked after only one bad experience. In Latin America that percentage rises to 49% (Figure 27).

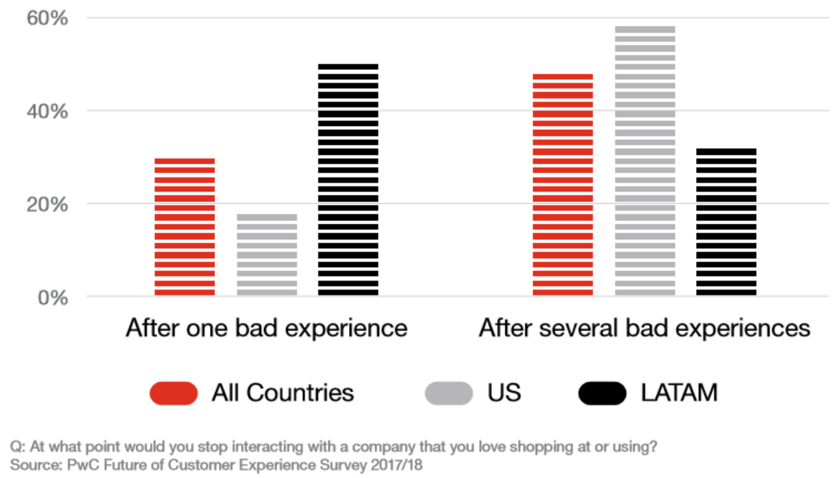


Figure 27 When would customers stop interacting with a brand they like?

The digital era also changed the way in which customers can interact with a brand by extending the number of touchpoints between the customer and the organization. In the last years, organizations have experienced the emergence of a new trend, that is unlikely to stop anytime soon: the omnichannel shopper. The omnichannel shopper is a potential customer who jumps from channel to channel when making a purchase. He will look on your website, search from mobile devices, check on social media, or even stop by your store only to buy online later. This is the reason why if a company does not want to take the risk of leading almost 60% of its potential customers away from its brand, according to the data provided by Mc Kinsey, then it must adapt on the omnichannel concept and know that people can order goods from anywhere, on any device and at any time. Hence, retailers need to find ways to integrate their online and offline channels to avoid segregated campaigns, and once developed the consciousness that shoppers will swap across channels and devices, no matter what channel or touchpoint will be used, companies must provide consistency across all of them.

Changing the customer experience means that organizations must optimize customer touchpoints along their journeys, and this is not just a matter of support systems; nowadays it is much more a matter of involvement, customers want to feel part of the company ecosystem, they need to have visibility over the company activities and news. Also, the more customers are involved in the processes and the easier will be for the company to understand their needs, ultimately the faster will be the company to reconfigure in order to target those needs. By 2020, most businesses believe customer service will become the main way to differentiate themselves from their competitors.

- **Micro-segmentation:** Businesses must be prepared to sell to a market of one. Customers are more than ever looking for personalized versions of products; for certain product categories they pretend to have the opportunity to choose the characteristics of the final product, as they could compose their own version for themselves. Traditionally, supply chains believed in a “one size fits all” concept which eventually translated in few customers being over-served and few customers being under-served. In the 1990s Dell stirred a revolution in the computer and supply chain sector when it segmented its supply chain into multiple smaller segments to serve customers of varied interests, eventually resorting to a direct-to-customer model to deliver customized services to all of its customers. Micro-segmentation is the act of creating a profitable supply chain by breaking it down into smaller (micro) segments, and since companies have a detailed knowledge of all the micro-segments, they can deliver the promised value proposition equally to all of them.

- **Sustainability to mitigate digital culture scarcity**: One of the things that has been introduced as a key driver for digital transformation is the presence of talented resources which are both able to promote the digitalization and to bring new competencies into the organization. Supply chains instead, seem to be experiencing a digital skills gap. According to a recent study of PwC (2017) one of the main challenges affecting the “digital gap” is represented by the lack of digital culture and training (Figure 28).

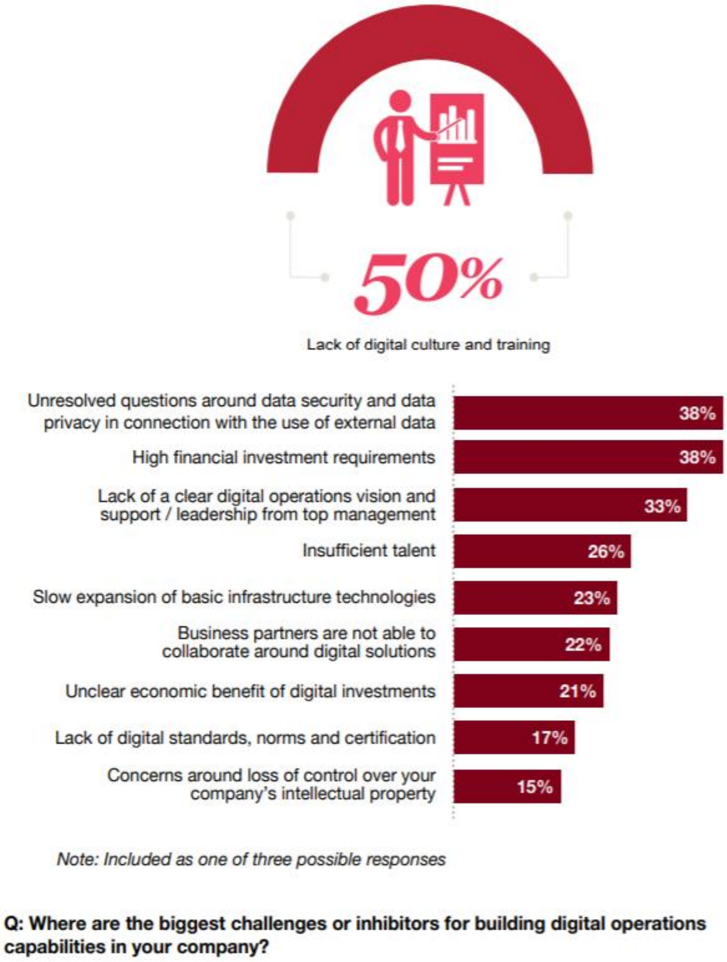


Figure 28 Lack of digital culture and training is the biggest challenges facing companies.

The real problem is that this gap between demand and supply increases as the technology becomes more important in all the industries. Organizations then, must mitigate for digital skills scarcity and build capabilities for the workforce of the future. For a successful digital transformation, the first thing to do is that of promoting the cultural shift that digitalization brings into the company. Organizations must stop thinking that if they produce revenues and deliver high-quality products to customers, innovation does not really matter. For this reason, it is important to redesign individuals' roles and responsibilities, so they align with the transformation's goals. The purpose is that of empowering people to work in new ways, which means that employees should be encouraged to challenge old ways of working. However, employees must understand the "why" it is needed this digital transformation, otherwise they will just produce a certain resistance to this change. Nobody is comfortable with new challenges given a satisfying status quo; even worse if it is not clear the real objective of the change. Then, it is necessary for the company to engage the specific roles of integrators and technology-innovation managers, who bridge potential gaps between the traditional and digital parts of the business.

- **Collaborative Supply Chain:** The future Supply chain will be more connected, responsive, intelligent and predictive. After their digital transformation, organizations will be structured as digital ecosystems, in which valuable data and information will flow through all the processes in real time, and this sharing of information will lead to enhance knowledge across the chain that ultimately will produce added value for every actor belonging to it. Therefore, collaboration must not be considered as purely inside the company's boundaries, thus between functions, rather, it is conceived as a broader collaborative approach, involving the suppliers and the customers as well. Also, differently from the traditional configuration in which the collaboration was linear across independent silos, the new configuration provides an integration of supply chain processes and an end-to-end collaboration (pwc, 2016) (Figure 29).

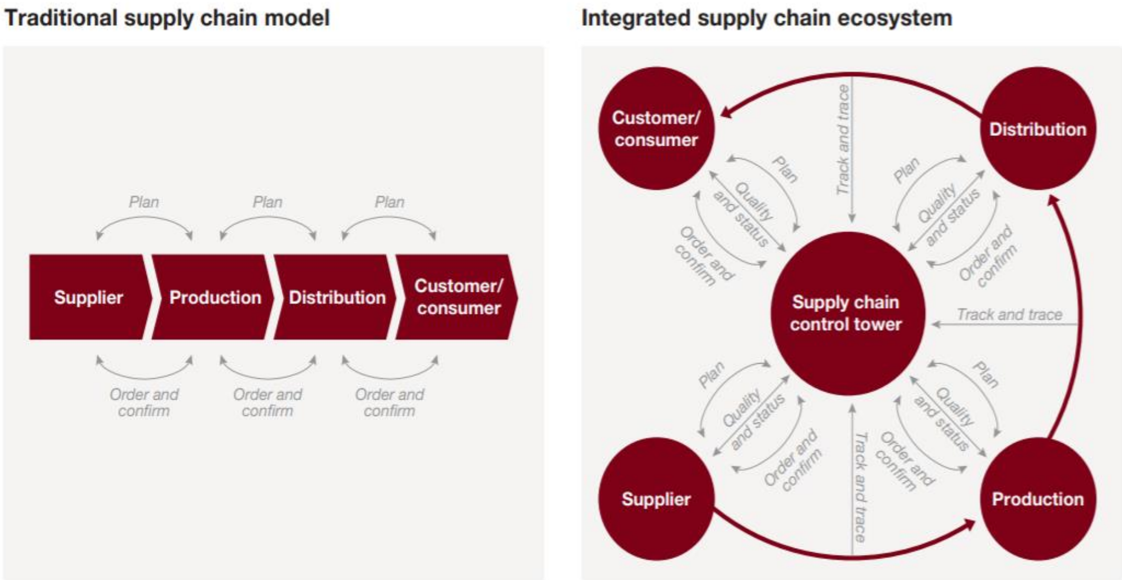


Figure 29 The traditional linear Supply Chain vs. the digital ecosystem.

Here the stakeholders interact with each other's and share real time data and information. In this way, reports and scenarios can be shared, discussed, reviewed and approved in the supply chain system and every actor would have a better visibility over the entire supply chain's progress, which in turn would favor decision-making.

The new configuration of the Supply Chain also relies on an "Integrated control tower", that is to say a technology platform used to collect and manage real-time data exchanges in the different processes. While collecting this data, the control tower will have visibility of the end-to-end supply chain.

One of the major mistakes when trying to pursue Supply Chain Collaboration with suppliers is being tempted to use collaboration as a way to fill gaps in your own capabilities. Practically, the most successful collaborations are built on strengths rather than weaknesses. Further, potential collaborators should be sure they have the right supporting infrastructure in place in advance of any collaborative effort. This is to say, employees must be committed to the collaboration process, and ready to offer support if needed; and inhouse IT systems must be robust enough to facilitate the exchange of real-time data. Another mistake companies are likely to make is trying to establish win-lose situations with partners, offering unbalanced benefit-sharing models. Collaboration, instead, works as long as it is set to produce benefits for both parties. Some collaborations promise equal benefits; others create value, but the benefit could fall more to one partner than to the other. Therefore, sophisticated benefit sharing models help in overcoming this issue and balance the relationship. When it comes to select the potential partner, a very good mindset is based on the idea that *"The biggest potential partner may not be the best one"*. Many companies think that the largest customers or suppliers can deliver the greatest value, but this is not necessarily true. Choosing the best partner is not only a matter of value potential, but also, as mentioned, a matter of capabilities and strategic goals. Very large potential partners could not be as committed as small partners and may easily have misaligned goals. Also, unlike small partners, large ones may have already started many of these collaborative initiatives.

2.6 The development of new competencies

The transformation towards the next generation digital supply chain is not only a matter of capital and tech-investments. Supply Chains must invest in the development of new and complex capabilities to support the business redesign. In the attempt to move towards the digital transformation, it is necessary to push organizations to invest in the development of new competencies if they want to have a chance to survive to the new era. Competencies are capabilities that are strategically exploited by the company, which means capabilities driven by know-how and routines. However, these capabilities can be deployed as long as the company invests in valuable resources. Today, many organizations struggle to identify what are these “valuable resources” for the transformation process. Indeed, the lack of digital preparation and understanding of what the digital transformation entails have been among the major constraints for progress, as shown in the previous paragraph.

Therefore, to face the digital transformation, companies must invest in both digital technologies and in the development of digital skills. For the first purpose, a research made by PwC (2016) reveals that in all industries companies have planned to allocate a % of their annual revenues for digital operation solutions (Figure 30).

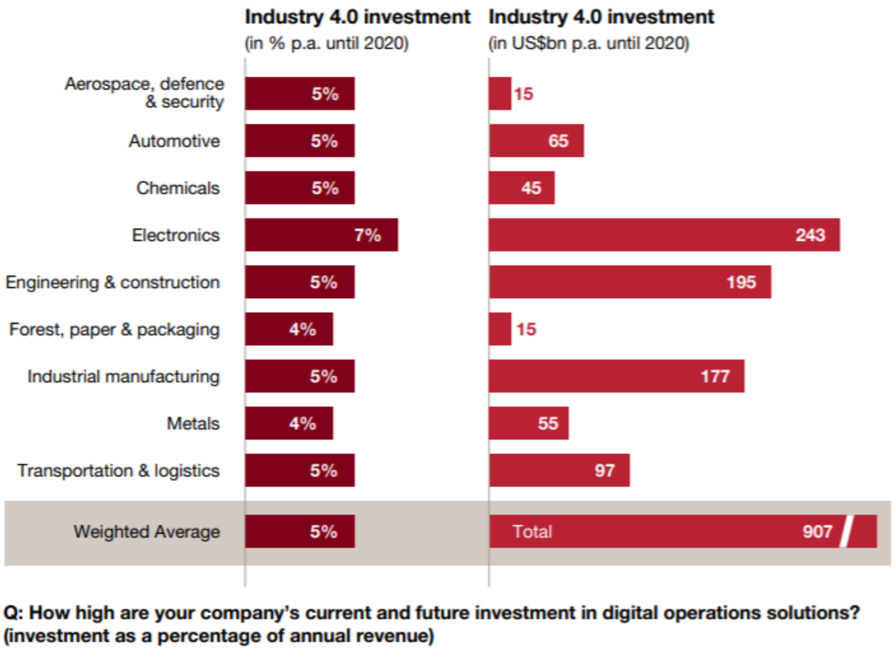


Figure 30 Companies in every sector are planning substantial investments in digital solutions.

Also, the same research shows that 20% of companies are planning to invest more than 10% of annual revenues in new technologies over the next five years.

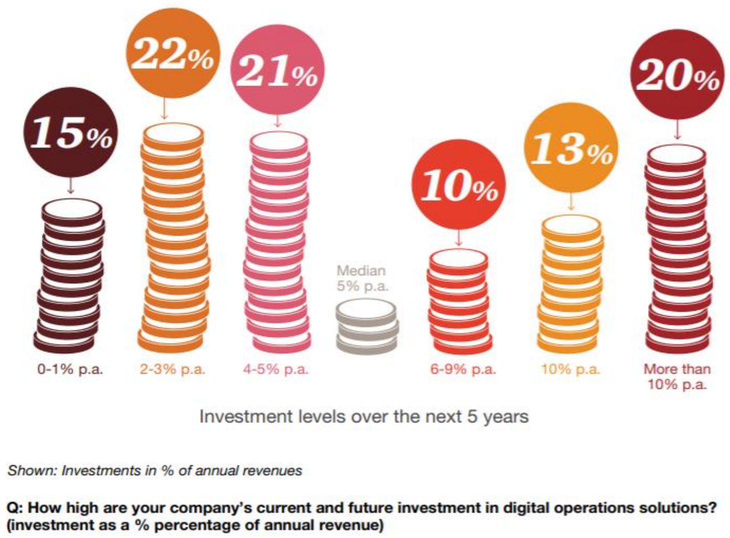


Figure 31 Digital Investments in % of annual revenues over the next five years.

For the second purpose, to face the digital skills scarcity, companies must focus on people. They must both attract people with the right digital skills and train existing employees who can put digitalization into place. The combination of new talent and existing know-how represents the right receipt to follow for digital transformation success.

Well, Supply Chain leadership must combine traditional functional capabilities with new digital skills that involve data, algorithms, and technologies. They have to understand more than just what these innovations are, practically, they must also understand where and how they create value added in the processes they support; and this is actually the most important part of the understanding process.

To better grasp the idea, consider the experience of a consumer-goods company. This company can recruit a group of data scientists to help it implement a more data-driven supply-chain strategy. Despite great knowledge in functional areas such as demand and supply planning, the entire talent pool would have only a few end-to-end experts, hence people who could transform supply-chain and business requirements into digital projects and then apply the potential solutions. Consequently, even if the organization is committed to this new digital SC, it will not succeed unless it does not figure out how to match know-how, then veterans, with new capabilities, brought by new talent.

The real important part of the investment for the company then, is an intensive training effort to help both existing employees and new employees make technology effective in solving real business problems.

In the short term, the digital transformation will create new roles for talents, who will bring new competencies to the Supply Chains, but in order to produce satisfactory results these talents will have to be trained by existing employees in Supply Chain Management or assisted by “integrators” and digital-innovation managers who have both functional and digital knowledge. After this first phase, once people will have developed a certain knowledge about supply-chain realities and will have built an end-to-end expertise to sustain integrated business decisions, organizations can begin the gradual transformation of the supply chain. In the last phase of evolution, which would take place in the mid-to long-term, there would no longer be the mix between new and old roles, because the progress will produce a proper redefinition of the existing job profiles in each Supply Chain function.

3. The digital transformation in logistics

The transportation and logistics (T&L) industry, like many others, is experiencing a deep change in the new digital era. New and advanced technologies, new competitors, new customer expectations and new business models. The digital transformation is re-shaping the function and the operating models of logistics, which is not an operational function reporting to sales or to manufacturing anymore, rather, it now has end-to-end real-time visibility over the supply chain processes and has the power to create and deliver value to customers. In this chapter I will describe the key disrupting factors in the logistics industry and some potential futures of the industry.

On this purpose, the 4th Edition of the Logistics Trend Radar, created by DHL Trend Research (Logistics Trend Radar, 2018/2019), is a strategic and powerful tool that serves as a valuable source of insight and inspiration to describe the incoming trends and disruptive changes.

3.1 The Logistics Trend Radar

The Logistics Trend Radar (Figure 32) represents a road map for logistics innovation. It is realized by deeply analyzing global megatrends such as digitalization and sustainability, by exchanging information with start-ups, and by taking input from other key sources such as customers and industry experts. All the information derived from different sources are grouped and then strategically integrated to develop the Logistics Trend Radar. The result is a powerful and dynamic tool for trend identification and future innovations.

Figure 32 The Logistics Trend Radar 2018/2019.

The different trends identified, categorized between Technology and Social & Business Trends, are predicted to influence logistics companies in the next 5 to 10 years. From these future patterns and trends, the DHL Trend Research reveals that there are four key pillars defining the logistics of the future:

- Customer Centricity
- Sustainability
- Technology
- People

In this chapter, I will focus my attention on the Technology Trends identified by the Logistics Trend Radar that will have a major relevance within the next 5 years.

3.1.1 Internet of Things (IoT)

Transportation and Logistics (T&L) companies are facing different technological breakthroughs which can bring new opportunities for increased efficiency and more collaborative operating models but also risks at the same time. Internet of Things (IoT) is one of the primary drivers of this revolution.

The internet of things is the network of physical objects (e.g. computing devices, vehicles, domestic appliances) that are provided with technologies such as sensors, software, control systems and network connectivity that allows the connection and the transfer of data between the items over the network.

Figure 33 IoT network. Source: TechCompanyNews.

Consequently, IoT in logistics allows extraction of data from every entity belonging to the network. A data-driven company can exploit all this information coming from a variety of sources and improve strategic decision-making capabilities. The IoT makes it possible to track the location of the shipment down to the individual unit. Hence, sensors can help in location tracking, which can in turn be used to give detailed updates to customers who can then monitor the delivery process. Not to mention the potential benefits that location tracking can give to the shipping companies. They can use real-time location data to better manage potential risks during the process and apply countermeasures more quickly. Beyond operational efficiency, IoT technologies allow transportation and Logistics (T&L) companies to achieve higher standards of sustainability and corporate responsibility. On this matter, it can help companies in measuring vehicles safety and compliance with quality standards, as well as drivers' health and CO2 emissions.

Therefore, the IoT allows logistics provider to reach big payoffs by accelerating data-driven decisions and solutions. The DHL Researchers reveal key benefits resulting from the application of IoT in the logistics industry such as:

- Transparency: the grater the IoT network, the more the visibility, traceability and reliability of logistics operations.

- Productivity: IoT promises higher operational efficiency and cost minimization as a result of a more accurate decision-making in dynamic environments.

- Connectivity: real-time connectivity makes possible to enhance service quality, monitor asset utilization and increase operational security.

3.1.2 Big Data

Logistics is being transformed through the power of data-driven insights. Mainly in the last years, the digitalization breakthrough made it possible to collect large amounts of data from various sources. As mentioned, the IoT allowed for a significantly and continuously increasing number of sensors, devices, vehicles to connect and share information resulting indeed in a huge continuous data flow.

Big Data refers to data sets primary characterized by the four Vs (Figure 34).

Data is captured from multiple sources, in different formats both structured and unstructured (e.g. emails, videos, audio, images etc.), and usually resulted from a combination of internal data and data coming from outside sources.

Figure 34 The four Vs for Big Data. Source: Vector Stock

Advanced companies are already capitalizing on the value of big data to drive decision-making and optimize capacity utilization, improve customer experience, and reduce risks. Among the key developments related to the use of big data DHL researches[3] underline:

Dynamic, real-time route optimization: The information collected by different data streams (Shipping information, weather, traffic, etc.) can be correlated and drive route optimization while at the same time enabling a more accurate shipping and delivery planning.

Smarter forecasting: Big data analytics allows to more precisely forecast demand, capacity and labor. Consequently, it makes possible to minimize costs and instead optimize planning and resource utilization.

[3] Logistics Trend Radar, version 2018/2019.

Anticipatory Shipping: It is based on the analyses of customers' purchasing data, thus, predicting an order before it occurs. In this case, predictive analytics uses data and trends on previous sales history and consumption patterns to shape the customers' ordering behaviors and then suggests and execute purchase orders. This could indeed allow retailers to offer more and more same-day delivery.

3.1.3 Robotics & Automation

Robotics & Automation are the result of the ongoing trend towards automation in the logistics industry. In the last years, thanks to the fast-technological evolutions and greater affordability, robotics solutions are effectively entering the logistics workforce.

Robotics solutions are predicted to be among the firstly adopted trends of the transportation and logistics (T&L) industry. In most companies, robots will soon assist workers with warehousing and transportation given their high price/performance ratio. It is a matter of time before robotics solutions become more affordable due to rapid progresses in these technologies.

Among the key benefits resulting from the adoption of Robotics & Automation, the DHL Researchers underline:

Agility: a fleet of robotics improves the agility and elasticity of the warehouse by letting the managers strategically increase or decrease their utilization as needed. Also, it could be moved from warehouse to warehouse based on the needs of the period and eventually perform activities overnight.

Productivity: robots would boost operational productivity due to their speed, accuracy and the fact that they are programmed to make zero-defects resulting from oversights or negligence.

Efficiency: robotics solutions would be primary used to substitute the human workforce in performing repetitive and physically strenuous tasks. Consequently, they could improve health and safety while at the same time enabling workers to be assigned to more complex tasks.

3.1.4 Cloud Logistics

The cloud-based solutions and applications have started to be embraced by logistics providers in recent years. These solutions have the benefits of being highly modular, easy to manage and cost effective. They are appetible for small and middle-sized companies which are pushed by the need of being more flexible and adaptive, while large companies are mostly motivated by cost and resource savings.

Today, more than 50% of logistics providers use cloud-based services and many others are planning to adopt them as well in the next years[4].

One of the key benefits deriving from the adoption of cloud-based solutions is that T&L companies can activate and deactivate cloud services on demand using a pay-per-use approach. Consequently, it allows the companies to be much more flexible in complex environments without relying on the traditional development, setup, and maintenance of own IT services. Hence, companies would be paying only for the services they need for the period instead of paying high fixed costs for own IT infrastructure.

According to the literature the following opportunities are immediately related to the adoption of cloud logistics:

Agility: on-demand modularity of IT services allows companies to be more agile, flexible and efficient.

Cost-reduction: the cloud-based logistics is a pay-per-use model. Hence it cuts down expenditures on software maintenance and updates.

Continuous Improvement: cloud solutions offer the possibility to add new features or remove old ones in a very easy manner. Also, they give the chance to test new functionalities without creating the need of necessarily introduce them.

[4] https://www.logistik-heute.de/Logistik-News-Logistik-Nachrichten/Markt-News/15213/Cloud-Loesungen-werden-fuer-die-Logistik-immer-wichtiger-Studie-Siegeszug-de

Visibility: cloud logistics also allows real-time data visibility without any built-in application. It is easier to monitor the transporting vehicles, the delivery progress or to get in touch with warehouse partners. Hence, it improves visibility and then control over the logistics operations.

3.1.5 Augmented Reality

Augmented Reality (AR) is one of the greatest technology trends of the last years. AR is a technology based on the interaction of real-world environment with digital perceptual information. This information can be generated across different sensory modalities, it can be a visual perception, an auditory perception and so on.

By adding virtual layers of physical objects information onto digital devices, AR basically empowers workers by providing key information at the right time.

Figure 35 Augmented Reality (AR) in warehouse. Source: GBKSOFT.

AR enables its users to better understand their surroundings by integrating contextual information through computer-generated information. All this key information displayed to the users can boost process efficiency and quality by minimizing oversights and speeding up activities.

Major developments of AR in logistics concern the warehouse operations, in which smart glasses are well-known examples of AR technologies. Smart glasses can display task information, display products location and read barcodes. Consequently, they allow to reduce costs while simultaneously improving quality and performance.

3.1.6 Low-cost sensor solutions

The consumer electronics industry required the development of many sensor technologies during the years such as wearables, smartphones, and tablets. Sensor technologies have become cheaper as the consumer electronics industry expanded and the performance of the technologies embedded in each device continuously improved, creating then a mass-market for low-cost sensors.

These low-cost sensor solutions can help in improving the operational efficiency and quality control during the logistics activities through accurate dimensioning and visualization. Further, these smart sensors are key factors in the IoT network, without their price affordability it would not be sustainable creating a large network of connected sensor technologies that characterized the IoT.

Among the important benefits of these smart sensors in logistics, those expected to be experienced by transportation and logistics companies in the near future are:

Accurate dimensioning: with the use of 3D camera technologies it would be much easier to optimize every kind of dimensioning process such as load-capacity, packaging or even simply measuring product dimensions.

Accurate visual inspections: with 3D imaging systems and computer vision it is possible to enhance the accuracy and the speed needed to evaluate the products quality and aesthetic defects.

Improved sustainability and corporate responsibility: sensor technologies are being used in the T&L industry to enhance health and safety practices and then monitor workers health parameters and location. Further, advanced sensing technologies can monitor indoor air-quality or temperature in warehouses or production facilities to improve environmental sustainability.

4. The lifeblood of every company

The Supply Chain is the network of all individuals, activities, resources and technologies involved in the creation and sale of a product or a service to the final customer. For every company worldwide, the very first objective has been that of creating an efficient supply chain to drive business success in the relative industry. Once this network has been created, the SCM ("*Supply Chain Management*") must optimize the relationship, coordination and collaboration among the entities constituting the Supply Chain.

Supply-chain management is based on a cross-functional approach that includes managing the movement of raw materials into an organization, the internal processing of materials into finished goods, and the movement of finished goods out of the organization and towards the end consumer. In order for this chain to be efficient several capabilities are needed from the areas of industrial engineering, operations management, logistics, procurement, information technology, and marketing.

Further, based on what processes are taken into consideration, Supply Chain can be broken down into two main parts: The upstream and the downstream. The upstream Supply chain concentrates on processes performed on the buy-side of the firm, hence mainly its suppliers and all the intermediaries. The main activities related to this part of the Supply Chain are inbound logistics and procurement, with the latter defined as any activities that relate to operations between the firm and the suppliers, including selecting these suppliers, ordering products or services, delivery of them, invoicing and payment. The Downstream part of the Supply Chain includes processes on the sell-side of the Supply Chain, among these the key activities are the warehouse management, the outbound logistics and the customer relationship management (CRM).

In this chapter, I will describe the processes belonging to the downstream part of the Supply chain modeled on the basis of Michelin's structure. At the beginning there is a broader description of the entire Michelin's Downstream SC, then, it will be carried out a careful analysis of the activities undertaken by the EDC (European Distribution Center) of Turin.

4.1 MICHELIN Downstream SC

The upstream process starts from procurement of raw materials and other components such as additives and steel wires. Just think that a number of almost 200 raw materials are needed to produce each tire. The inbound logistics, purchasing departments, and other functions will run these first phases of the production process, even though they will not be descripted in depth, as only the activities on the sell-side of the Supply Chain will be descripted in this chapter.

In the nineties, Michelin was structured in a way that there was a physical separation between facilities in which the production was completed and warehouses to stock the output of production and then sell it to every type of customer. There was almost one warehouse per region only in Italy, according to the information provided by the company. With this physical separation, high-volume logistics operations were needed to shift the products from one facility to a specific warehouse every day.

However, during those years, the manufacturing industry worldwide was structured in almost the same way. The optimal structure and business configuration according to the customer demand wanted companies to stretch as much as possible their production. There was very little diversification and customization, then companies could better exploit economies of scale. Globalization was still incapable of influencing the customer preferences over brands due to high trade barriers, and the internet was not yet exploited to maximize the information customers could have on products and brands. Overall, the demand influencing variables were much fewer than today. Under these circumstances, Michelin as other manufacturing companies needed a lot of space to stock their products.

In the following years, customer needs and expectations started to change. Globalization and Digitalization together produced new trends and addressing customers' needs become more complicated than the past. In this new dynamic environment, the company needed to be more flexible and agile, thus Michelin was subject to a business redesign. The company was not going to produce on a make to stock strategy anymore, but it intended to change its supply chain in order to align with new customer expectations. Customers started to perceive brand's quality not only based on product quality but also on the services that the company provides to them. Hence, customer expectations started to include product diversification, delivery services, request management in addition to top-quality products.

Michelin needed a new structure that would allow bigger production facilities to handle micro segmentation of orders, absence of warehouses only designed for stocking purposes in order to be more flexible and reduce costs, and new warehouse more centralized, designed to be distribution centers over the territory and created to boost the quality of the delivery services.

The entire organization recognized it was much more convenient to stock products in warehouses, located at the end of the production-chain, and ship from these warehouses, containing the specific typology or dimension of product produced, directly to more centralized warehouses closer to customers. According to this reconfiguration, Michelin closed several small warehouses in order to expand others which were supposed to become the new hubs for production and partially for stocking and merged other warehouses to create the distribution centers.

Nowadays then, the production is completed in specific facilities, Michelin then stocks several dimensions or categories of products in these upstream warehouses called "CD amont" or MU ("*Magazine Usine*") but the separation between the two facilities is purely logical. Michelin pursues a very high degree of centralization for its production, which means that each one of these facilities is responsible for the production of only certain products or specific dimensions of the same product. The main driver affecting the decision on what should be the most appropriate portfolio of dimensions of products to be assigned to each facility is the customer demand in the territory. The supply of a specific dimension of products must always be calibrated to best match the demand. The idea is then derived from the customer needs; and the decision is taken based on how to optimally configure the supply chain to better serve the customers.

From its MUs all over Europe, Michelin ships its products to other warehouses, named EDC ("*European Distribution Center*"); the latter are downstream warehouses in which products are temporarily shipped to be distributed over the territory afterwards (Figure 36). Hence, the main difference between the MU and the EDC is that the former is effectively a warehouse for stocking purposes and it is intended to supply the OE and the EDCs all over the world; while the latter is not properly a warehouse but rather a distribution center, only intended to supply customers and/or other EDCs according to the demand. In Italy, for instance, the production is completed in specific facilities, located in Cuneo and Alessandria. Each one of these facilities is responsible for the production of different categories of products, due to the production centralization previously mentioned. For this reason, in the establishment of Cuneo Michelin produces the OE and some dimensions of car tires; while in that of Alessandria it only produces certain dimensions of tires for bus and trucks.

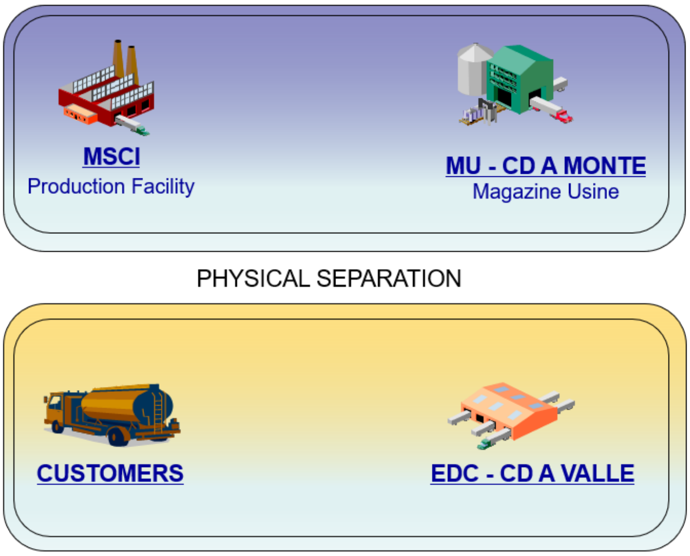


Figure 36 Michelin's different warehouses.

The transformation that the company has been experiencing from the twenties disrupts the old business model in order to align it with Michelin's new vision and core strategy which is more centered than ever to the end customer. If in the past, the production was driven based on a make to stock strategy, for which Michelin relied on a "*push manufacturing*"; this transformation guides the company through a different production strategy aimed at addressing the actual demand of the market, hence pursuing a hybrid "*push-pull manufacturing"* strategy. With this supply chain management approach, Michelin can drive part of its production based on a realized demand and another part based on demand forecasts. One of the key dimensions that makes hard the shift towards a true "*pull manufacturing*" principle is the tire production time. Being able to produce, distribute and sell based on the actual market demand implies a level of flexibility in the production process that is uncommon in the tire manufacturing industry. Thanks to the technology development this time is getting shorter and shorter but even small improvements require time to take place.

Nowadays indeed, forecasting is a key pillar to drive part of the production process. Forecasting practically concerns how much each product is likely to be sold in each territory worldwide. From these estimates, Michelin predicts how much to be produced in each of those territories to supply the estimated demands.

Since the company has a worldwide presence, it carefully studies which facility should produce which product or dimension given the sales forecasting in each territory. Generally, a global forecast is made by the Central Supply Chain in Clermont-Ferrand, where the company is based, for each territory worldwide. After that, each geographical region in its own S&OP sets up a subjective sales plan, based on its local objectives and constraints. The result of the S&OP process is that each geographical division will be committed to a specific production plan and a specific inventory plan at strategic level.

At tactical level, periodical sales forecasts drive the production for each category of product and generate specific production plans to complete production in time to efficiently sell and deliver products to customers and keep up with the demand estimates in that period. Forecast activities must be as much accurate as possible, because they are the driver of the entire supply chain. The greater the accuracy of forecasting, the greater the efficiency of the company. Every activity in this chain must respect a specific timing, which means that production and distribution must coordinate to follow the demand estimates. Michelin then, is pushing hard to reach two important objectives. The first one is to minimize the forecasting error, which could be responsible of shortage or overage of estimated demand compared to the realized demand. The second one is to minimize delays in the execution of all tasks in the supply chain. The delays resulting in the different tasks of the Supply Chain could in turn vary the estimated capacity of produce, distribute and deliver to customers and then mis-align the sales estimates.

Also, while warehouses activities can be more dynamically frozen or slowed down, the production does not have that flexibility. Generally, it is not easy to slow the production in this industry, consequently wrong or even inaccurate estimates concerning sales can produce thousands of euros of losses.

Another key activity of the downstream section of supply chains is the customer service. Nowadays, customer service and logistics have been the functions experiencing the greatest disruption in the chain. The results of several analysis on the matter show that the customer service is expected to become one of the key functions for companies to diversify from competitors in the next years. In Michelin, the customer service is pushing hard to enhance customer centricity. The philosophy is to provide high quality services to combine with high quality products and keep its leadership in the sector, even in this new era, in which supply chains are embracing a digital future. In principle, the customer service managed the demand, hence orders from customers before they reached logistics and eventually the returns. So, main activities concerned customer relationships, communication and organization. In the last years these activities have further improved, not only because the same activities have become more complex; many ways to interact with customers and much more difficulty in managing their growing customized or special requests, but also because new tasks have been added to the overall function. In this new scenario, every function in the chain is more connected than ever; the customer service has to integrate the monitoring of the performance of the logistics operations to measure the quality of the services provided to the customers. There is now a strict relationship then, between the reliability of these services such as order tracking, delivery notification and the performance of logistics operations.

Finally, the last function that will be partially analysed is the outbound logistics. The outbound logistics is the process of storing, transporting and distributing goods to final customers. In Michelin, the outbound logistics is completely outsourced, hence the company relies on a specific supplier to perform those activities in Italy.

4.2 EDC of Turin

Next paragraph will present the overall functioning and management of the EDC of Turin. The EDC of Turin is the result of the business transformation that Michelin Italiana has been experiencing in the last years. It has been created in 2018 after the process of centralization of two different facilities in the same territory. It covers an area of almost 60,000 square meters, with more than hundred warehouse workers and an average daily traffic of 25,000 tires between those incoming and outgoing the EDC. The EDC receives items from MUs of all Europe and sometimes even abroad the EU.

The EDC of Turin is one of the two hubs for distribution over the Italian territory that have been designed to make sure that the distribution of products over the territory is performed on time, to efficiently serve the customers and match their demand. The entire supply chain is based on estimates of the correct timing to perform all the tasks from production to distribution and delivery to the customers in order to make sure that demand forecasts are respected as accurately as possible. With this purpose, the activities carried out by the EDC can be basically grouped into two main functions: the unloading and stocking of items coming from multiple MUs and the loading of items intended for customers or eventually other EDCs. In addition to these primary functions, the EDC manages the returns, the storage of iron platforms and the storage of accessories for tires.

In the next paragraphs it will be described three key processes of the EDC:

- Ordering Process
- Stock management
- Returns management

To grasp the functioning of these main processes, it is possible to distinguish two different kind of responsibilities over the activities of the EDC. The first kind of responsibility concerns the digital management of the warehouse's activities. The second one, instead, the practical management. According to the different responsibility, people in the EDC can be divided in two groups: "the brain" and "the body" of the EDC.

If warehouse workers and machines concretely perform the warehouse operations; then are effectively "*the body*" of the warehouse, two different teams provide information and logic to those operations; hence they are "*the brain*" of the warehouse.

4.2.1 Ordering Process

The ordering process is totally performed by one of the two teams composing "the brain" of the EDC: the *"planners*". Planners are committed to manage the inbound and the outbound of products through the EDC. The first task of planners is to validate the orders collected by the customer service. They can organize the deliveries and assign them an estimated delivery date based on where is the customer located. Generally, Michelin guarantees a one-day delivery for all customers in the same territory in which the EDC is located; in this case, for the EDC of Turin, Michelin provides a one-day delivery for clients in the north or in the center of Italy, and a two-day delivery for customers in the southern part of Italy, while a three-day delivery for those in the islands.

Michelin has an ad-hoc delivery-organization for all its clients; as a matter of fact, *planners* group together all deliveries for clients in specific areas of Italy, and for which it is chosen the same shipping method, since it corresponds to a certain tariff, and assign them a specific label, which is called "*tournèe*". With this methodology, from the "*tournèe*", it is possible to understand where is the truck headed, hence which part of Italy and what customers will serve, what is the shipping method that has been decided, which in turn influences the way in which the truck will be loaded, and finally what is the tariff that will be applied to the carrier.

The assignment of delivery dates and the definition of each tournèe is only the first phase of the distribution planning. The core activity of planners is to efficiently allocate the deliveries gathered in different tournèe to the available fleet of the carrier.

Thus, in order to plan the journeys, planners must assign one or more tournèe to each truck on the basis of some key constraints. The first important constraint is making sure that the assignment of several deliveries to each truck is sustainable for the carrier. In other words, planners must group tournèe that are supposed to serve customers in nearby areas. The second important constraint does not concern which deliveries to group together but rather how many deliveries it is possible to allocate for each truck. Hence, this second choice is constrained by the necessity of keeping up with the orders and at the same time to respect the constraints concerning truck saturation (each truck must not be heavier than 13 t and must not have a volume of more than 70 m3).

Further, planners must optimize the distribution network by choosing what is the most efficient shipping method for each truck, then weather by milk-run[5], full truck load[6] (FTL), shared-mode[7] or temporary stop by platform[8]. Indeed, even if this information is included in the definition of the *tournèe* associated to the journey, as mentioned, *planners* may need to create special *tournèe* on a case-by-case situation. For example, take the case of a single client who made a big order, such to almost totally fill the truck, then it does not make sense for the company to choose a milk-run delivery, assuming that the customer is close enough that there is no need to make a temporary-stop by one platform, because it would be much more expensive for Michelin, in these conditions the journey of the truck would make just a couple of stops, serving just a couple of customers, while Michelin would be paying the price of an entire truck. Hence, *planners* must be able to predict this situation and choose a different shipping method, for the example a full truck load (FTL).

Lastly, "*planners*" have to manage the inbound flow, mostly performed during the night, in terms of scheduling; which means that assuming a specific number of resources available, they use estimated times to complete the unloading activity of

[5] This is the most common shipping method. It is the case of a delivery to be fulfilled in one working-day after the order has been validated by *planners.* For clients directly served by the EDC of Turin, the carrier fulfils the order one by one according to a specific journey.
[6] This is usually the case when one client orders more than 7 t of products; hence Michelin organizes a dedicated truck.
[7] This is a special shipping method. When a customer, in the southern part of Italy, then with a two working days delivery, orders from 3 to 7 t of products. The truck must temporary stop in the platform, because it is a j+2 delivery; but the head of the truck is filled by the products of only that client, so they will not be unloaded or handled in platform; while at the bottom of the truck there are the items that effectively have to be unloaded in the platform.
[8] This is a standard shipping method. When customers in the southern part of Italy order products which are not in stock in the EDC of Rome, then it is the EDC of Turin that must fulfil the order.

each truck, in order to predict the number of trucks that the warehouse is effectively able to unload.

Managing the inbound and the outbound flows by *planners* is a truly crucial activity for the overall performance of the EDC. The inbound and the outbound have never been as connected as they are right now. The management of the inbound flow become much more important than the past. While in the past, it did not matter what were the inflows of products because there was not a strictly sequential relationship between inbound and outbound, now the EDC can perform the outbound, then the distribution, only if the inbound has been properly performed. This means that the timing of all the activities belonging to this chain must be perfectly respected.

Finally, *planners* may have to handle returns or claims by customers. However, the activity of planners regarding the return slots just concerns the necessity of reintegrating these products in Michelin's internal circuits and then providing orders to collect them from customers.

The planning of these operations is contemporary shared with the company in charge for the outbound logistics, since this function is outsourced to third parties by Michelin. In this way, the suppliers of Michelin, which are physically working at the side of "*planners*", have real-time visibility over the management of flows through the warehouse, and then it is easier for them to help in managing unforeseeable events or to suggest countermeasures. One of the most important information *planners* must share with suppliers concerns the number of trucks they predict will be required to fulfill the orders. Every day, *planners* are engaged in validating orders from customers, who can make the order either by calling the customer service or by means of a dedicated platform for customers, no later than the cut-off hour, set at 6.00 p.m. For this reason, up to that hour, *planners* must process orders, and a significant part of these will be intended for delivery the next working day. So, communication and coordination with suppliers assume a key role to efficiently serve the customers and to respect the high-quality service that the company wants to offer. *Planners* indeed, while concretely assigning a certain number of trucks for orders already processed, must predict additional trucks eventually, for potential orders from customers in the last working hours before the cut-off. The supplier indeed, cannot organize its fleet only at the end of the day, then it needs to be constantly warned if variations in estimates occur.

4.2.2 Stock management

The Stock management process is entirely performed by the second team belonging to “the brain” of the EDC: the “*pilots*”. Their function is in the middle between “*planners*” and warehouse workers. *Pilots* indeed, receive information from *planners* and transform this information into instructions for warehouse workers, who are always guided by a person in charge: the RO (“*Responsable des opérations*”). Since the role of this team is complementary to that of planners, they basically work on the same activities but in a totally different manner.

They receive the planning of both incoming and outgoing trucks and have to manage the two of them almost in parallel. *Planners* release the first planning in the afternoon of the day before the inbound starts, considering that the time slot dedicated for the unloading activity is between midnight and midday, *pilots* have to complete the digital addressing of all the items present in each truck in order to provide information on where to stock them to the warehouse workers. Pilots then, give instructions in terms of where are the bin in which the items should be stocked, which is the most appropriate iron platform or carriage to use, based on the different CAI (“Codice Articolo Internazionale”) on board. The second planning instead, is usually released more than once a day, in order to let pilots better manage the digital addressing of items about to leave the EDC. If the unloading is generally performed during the night, the loading activity is usually performed in the afternoon. What is crucial to keep in mind is that a significant part of the orders Michelin receives one day, will likely be fulfilled the next working-day, and that the functions of planners and pilots are basically complementary to manage the warehouse, even though their work is sequential. Consequently then, potential problems causing delays or frozen times in the working activity of either party will substantially influence the other. This is the reason why they work as a single team; for instance, in case of outbound, once the order is validated by the planner, following the procedure already mentioned, the pilot has to complete the digital addressing of items on board, and then "*close*" the order so that the RO has the instructions and information to share with the resources in the warehouse. According to this chain of management, collaboration and coordination are key pillars. The last update about the planning for loading, is usually shared immediately after 6.00 p.m., the cut-off time.

Thanks to information systems they use, among the instructions that pilots give to the warehouse workers, there are those which are intended to enhance the efficiency of the operations whether inside the warehouse or outside, for instance during the deliveries. In case of outbound process, since certain *tournèe* will ship according to the "Milk-run" method, in order for the company to be efficient and respect the fulfillment of the daily orders, it must organize the items in the truck, according to each order. This operational sorting must be made before the items can leave the EDC to the client, hence during the loading activity. The system used by *pilots*, indeed, accounts for this need and then groups the items and places them in a specific order of picking, so that blocks of items will be loaded with a specific sequence based on the different orders that the delivery will fulfill. Consequently, it is much faster and easier for clients, even the big ones, to unload part of the truck corresponding to their order. In case of a *tournèe* that foresees a temporary-stop by platform instead, since the items will be handled in platform, in which possibly products will be added or moved based on the availability on other trucks in the platform, there is no need for *pilots* to provide an organization for those trucks in terms of sequence of unloading. However, what is useful in this case is rather providing instructions in terms of how-to pick-up the items in the warehouse to be loaded in those trucks. So, in this case, it is not a matter of planning the sequence of items to pick-up to facilitate handling at delivery or to follow the sequence of daily deliveries, but rather a matter of easing the movement of workers within the warehouse. Hence, the system figures out where are the positions of all the items which are about to be picked-up, and then suggest the sequence in which they should be taken, considering the direction of travels of the warehouse. In this way, it is possible to optimize the movements of carriages both saving time and improving the productivity of the activity.

The functions of the two teams descripted, constitute the digital organization of the warehouse, because they informatically manage the warehouse operations. Both these teams are in turn controlled by the responsible of flows through the warehouse; this manager must monitor these activities and deal with exceptions, she has to suggest countermeasures and coordinate the supplier of transportation. Even if pilots and planners are able to provide instructions to the warehouse workers, these, in turn, need to be headed by a person in charge; who is the RO. The RO has a key role within this chain of warehouse management, and along with the warehouse workers constitutes "*the body*" of the warehouse. The RO is somebody who knows very well how the different activities are performed, then the timing, the number of resources needed and so on. Practically, the RO is the interface between the organization team of the warehouse and the operational team. Hence, using the information provided by the organization, he guides the operations within the warehouse, and in the opposite way, on the basis of the performance of the operations he refers to the organization when the process starts variating with respect to plans. The RO allocates resources to the different tasks and decides which should have priority.

4.2.3 Returns management

The last key process of the EDC is the management of returns. Since it can be defined as an exceptional flow of an inbound process, the instructions given by both planners and pilots are just slightly different than the regular case of an unloading activity.

However, the activity of *planners* regarding the return slots is pretty limited, it just concerns the necessity of reintegrating these products in Michelin's internal circuits. Consequently, rather than processing orders, in this case they must issue an order to collect the products from customers.

The flow of items incoming in the warehouse as return slot must be managed by *pilots* and *planners* in parallel with the regular inbound and outbound flows.

What is complicated is not to manage this additional flow of products but the entire process of verification of the real condition of the product and the quality of delivery service. As soon as the EDC receives the products back in the warehouse, warehouse workers with the help of other resources made available by the supplier of transportation, start analyzing the products and try to understand what went wrong for the customer. They check whether the items present some kind of defects, if the products delivered were coherent to what the client ordered, if the delivery was on time and so on. All reasons why the client could have decided to return the products.

Even if the process of verification seems complex, Michelin guarantees the reimbursement for each item returned it receives. The verification is carried out to let the company figure out what went wrong in the delivery and improve its services. At the end of the verification process, if it is not spotted any defects, the *pilots* can notify the customer service that those products are available again in the EDC. In this way, the customer service manually re-inserts these products in specific databases and allows pilots to proceed with the digital addressing of these products which will be definitely re-stocked afterwards. Based on this circuit of tasks, in the warehouse there is a buffer in which all products returned are waiting for the "*mise en stock*". In case the products returned have some kind of defects, Michelin destroys the items by cutting the tires.

There are two main scenarios in which products can be returned by clients: the first one is at the moment of delivery. In this scenario the customer returns the product by simply using the sales note. This case is generally easier to handle, because products will come back in the warehouse in the same truck they were delivered. Also, it is generally faster to issue the refund, since this scenario usually occurs when there is a "*mistake in the order*". In the second scenario, products can be returned by customers at any moment after delivery. This case is more complicated to handle, because planners will have to plan specific tournèe just to pick-up returns from customers, so this requires more effort and higher costs for Michelin.

As in all industries, many can be the reasons why customers may return products, what is curious and symbolic of the high-competitive pressure that the tire manufacturing industry is living these days, is that recently clients have started returning products based on their date of manufacture. The date of manufacture is the last four digits of the DOT code (Figure 37); the first two digits of the four are the week of manufacture and the last two indicate the year. This example is just to show how customers' requirements have become more stringent and so what challenges this may produce for the companies in the industry.

Figure 37 Example of a DOT Code.

4.3 Warehouse data flows

In the previous chapters, it has been illustrated the management and the organization of the EDC of Turin, mostly in terms of processes and activities performed. This paragraph has the intent to describe the connections and the relationships between the main Information Systems that Michelin adopts to support the downstream chain from the order of the customer to the delivery of the product. The EDC, indeed, is the hub of this information network grouping all the functions in the downstream part of the SC. It continuously exchanges data with the customer service, the request management and the supplier of transportation. The information systems make the communication possible between different functions and give visibility about the status of different processes to the actors involved, in order to enhance cooperation and in accordance the efficiency.

There are three main information systems managing the entire flow of data generated from the moment in which the client makes the order to the delivery status notifications at the end of the delivery process. For privacy reasons, they will not be explicitly mentioned; each one will be indicated by a random letter. The representation of the interactions between the operations involved in the downstream SC will be described through the IDEF0 functional modelling methodology (Figure 38 and Figure 39). This methodology will help in describing how operations are carried out, what are the interactions between them and in depth what are the information systems at the bottom of this architecture. Also, to explain at full the functioning of these systems, it will be taken into consideration the case of an outbound process.

The process starts after an order requested by the client. There are two different options that the customer can choose to issue the order. With the first one he can either directly call the customer service and fulfil the order with the help of a customer assistant, who informatically processes the order for him and lately issues the order to the logistics. With the second option, the client himself processes the order through a specific platform available for customers. In this manner, the customer directly interfaces with the first information system, by-passing partially the customer service, who will only have to confirm the order to the logistics.

Once the order has been processed, it reaches the first information system, (A). This first information system is deployed by both the customer service and the team of *planners to* manage the orders at upstream and downstream level. The customer service, at upstream level, simply accepts the order, or at most it supports the clients who choose to make an order by calling the team request. Either cases, the order will be confirmed and then it will reach the logistics.

In the logistics, planners must concretely validate the orders. All orders just confirmed by the customer service will be in a status of “*ordre de livraison*”, that is to say that orders are waiting to be concretely handled and managed by the logistics.

In this phase, validating the orders means that *planners* must effectively plan the deliveries to fulfil the orders received.

They use the system (A) to assign delivery dates, specify the shipping method, fulfil the constraints of truck capacity on each delivery, and in substance to plan the deliveries assigned to each truck by means of the association with one or more tournèe.

Once they finish to plan the deliveries associated to each truck, thus as they "*close*" each tournèe*,* the orders closed will switch in a status of "*ordre livrable*", meaning that those orders have been successfully planned for being fulfilled.

Therefore, on one hand, the customer service gives the input to the system. The input is the confirmation of an order. On the other hand, the *planner* firstly consults the system, because it continuously updates for new orders to be validated, then he takes the input given by the customer service and produces an output by finally validating the order after a series of operations that involve the acceptance of the order.

Once the order has been validated by *planners,* the system (A) sends the information about the orders to be fulfilled to a different information system, (B). This second information system is what is used exclusively by the team of *pilots* to manage the warehouse operations.

By the time that orders are being validated by *planners*, the team of *pilots* need to start the phase of "*picking*". The "*Picking*" consists in the digital addressing of products required to fulfil the order and the printing of specific labels that have to be attached to each tire that is about to leave the warehouse. According to this architecture then, the *pilots* receive information from *planners,* by means of a connection between the systems (A) and (B), which communicate by means of an EAI-based infrastructure. This infrastructure between (A) and (B) makes the exchange of information possible between the systems, which are continuously communicating. In case of outflows, (A) sends an instruction of "shipping" to (B), so that (B) has the information on which products will be shipped from the EDC, then which products to pick-up. In case of inflows, (A) sends an instruction of "receiving" to (B), so that (B) has the input on what will be received, and then what will be put in stock in the EDC. In either case, (B) will send instructions back to (A), when the activities will be completed. This integration between the systems is one of the most important connections to ensure the well-functioning of warehouse operations. While the first system displays what is informatically available, based on the updates of inflows and outflows of products resulted from orders incoming and outgoing, the second system displays what is physically present in the warehouse, and a potential mismatch between the two could cause serious slowdowns and inefficiencies. Given the importance of this result, there is a person in charge among *pilots*, who has the additional task of monitoring that the communication between the systems occurs correctly, without any error. For the system (A), the changes in stock are always the result of what *planners* validate as inflows or outflows.

The system (B) updates its data without the contribution of *pilots*. It receives the input about changes in items in stock, whether because of inflows or outflows of products, by means of systems based on radiofrequency identification. The RFID is the way in which *pilots* take control of warehouse operations and have real-time stock data. Even though the radiofrequency boosts the efficiency and reduces costs of warehouse operations, the side effects should not be underestimated. Michelin has to manage almost 25,000 tyres a day, in the EDC of Turin with more than 3000 different CAI ("Codice Articolo Internazinale"). Then, what becomes valuable, to ensure the efficiency brought by this system, is the activity of warehouse workers. They must perform each activity in accordance to specific instructions to make sure that every movement of products in the warehouse is tracked and monitored. Consequently, there are stringent rules in both activities of picking and stocking; from the attachment of labels to the products about to leave or to enter the EDC, to the recognition and stocking of items, platforms, and so on. The management of warehouse workers, their formation and performance become of key value. Therefore, automation can increase the productivity of the warehouse operations, but it comes at a cost. For instance, products that lost their label or with a wrong label could be "*lost*" in the warehouse, ultimately producing a mismatch between what is reported in the two information systems mentioned.

The picking activity ends after warehouse workers have picked all items required to fill a specific truck, then all items belonging to a *tournèe* that has been closed by *planners* and have moved them close to the gate that the RO suggested to use for the loading.

At this point, there is a different actor involved: the carrier équipe. This team has to verify that everything that was supposed to be prepared for loading, on the basis of what the client ordered, has been correctly picked by the warehouse workers. Hence, a sort of control of outgoing products, to verify that there is nothing missing. If the picking activity has been performed correctly, the équipe of the carrier starts the loading activity. At last, after the truck has been loaded and secured, the équipe of the carrier must warn the *pilots* that the loading has been completed. Consequently, pilots authorize the “shipped” instruction from (B) to (A).

At this point, the équipe of the carrier can access in (A) and update the status of the *tournèe* completed, from “*ordre livrable*” to “bordereaux de livraison”; which means that the transport documents for the specific delivery are ready to be printed. The same chain of activities is performed for each *tournèe* that *planners* validate, up to the cut-off hour, at 6.00 p.m. After that hour, orders will not be accepted anymore by the customer service, then chain of activities will be interrupted and the équipe of the carrier can access in (A) and update the status of all the remaining *tournèe* completed.

In the past, at this point the transport documents were effectively printed by the carrier équipe from the system (A). Currently, this last part of the order management process has slightly changed. In the IDEF0 diagrams below is already synthetically represented the new digital architecture of the downstream supply chain that has been developed recently as a result of the evolutions brought by the Bib Track project, which will be discussed in detail in the next chapter.

After the “*shipped*” instruction has been sent to (A), the carrier does not print the transportation documents directly from the same information system. He is given access to another information system, (C). This new information system has been developed to achieve the purposes of the Bib Track project, which will be described in depth in the last chapter of the paper. With this new information system, the carrier does not print the transportation documents with the system (A), but it uses (A) to generate a PREIFTM message towards (C). This PREIFTM message is an EDI

("*Electronic data interchange*") message containing all the information needed to edit and create the transportation documents, in a digital format, in (C). Hence, once (C) receives this EDI message, it generates the documents and at the same time it sends an IFTMIN message, which is another EDI message, to the TMS ("Transport management system") of the carrier. The carrier in turn needs this information to organize the journeys for the deliveries.

In addition, thanks to the development of the project, the flow of information crossing the EDC does not end anymore with the printing of documents. The new information system, (C), creates a new flow of data which is mostly alimented during the delivery day. Currently the drivers send back information about the delivery milestones to the carrier's IS in real-time via own mobile applications and/or onboard telematic. Then, it will be the carrier to close the chain of data flows by sending EDI message to Michelin's system (C). During this new phase, the customer service can deploy the system (C) and enhance the service to the customer by eventually answering their requests concerning the delivery status.

The Bib track project brings many new features and innovations in the chain of activities that now ends after the "*delivery day*". Differently from the past, in which the process concluded with the printing of relative documents from the system (A), the carrier receives them in a digital format from a different information system, which also provides EDI messages that are used to perform other activities such as delivery tracking, delivery status notifications and to produce other documents, which can be kept in a digital form for fiscal purposes. This project then also creates a new ecosystem between Michelin and the carrier. Their information systems become more connected than ever; this continuous exchange of data and information, if managed, can create much more transparency in the processes. The transparency can be used to both enhance the customer satisfaction and boost the performance in the logistics operations by spotting eventual points of improvement. Later, it will be explained that among the greatest difficulties in the development of such network of data interchange has been not only building an architecture that supported a high-speed communication and exchange of information between different systems, but also building a different relationship with the supplier, much more based on cooperation and collaboration, in an environment in which digital trust become a key concern.

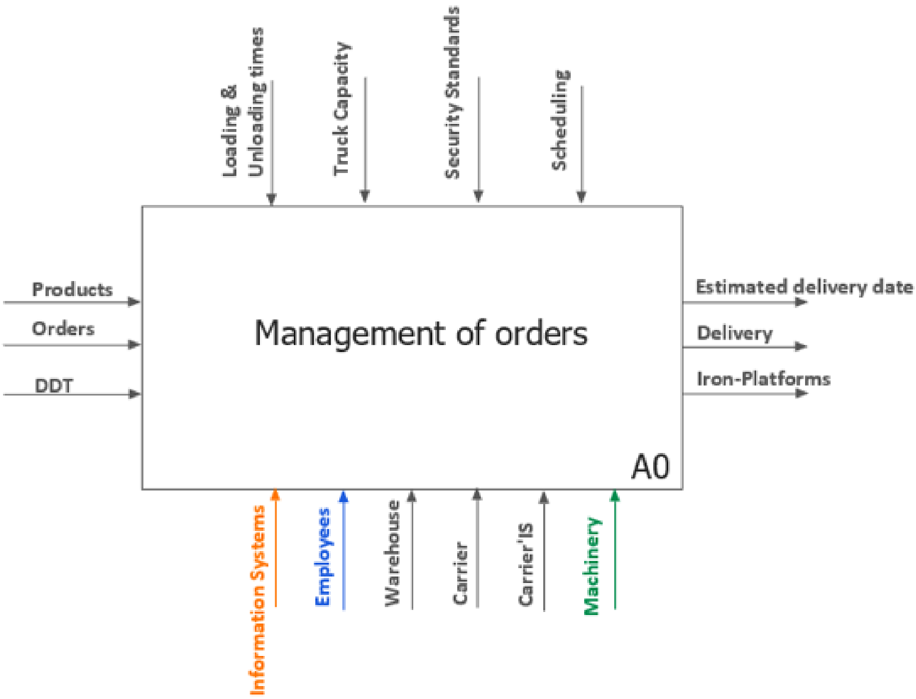


Figure 38 IDEF0-A0

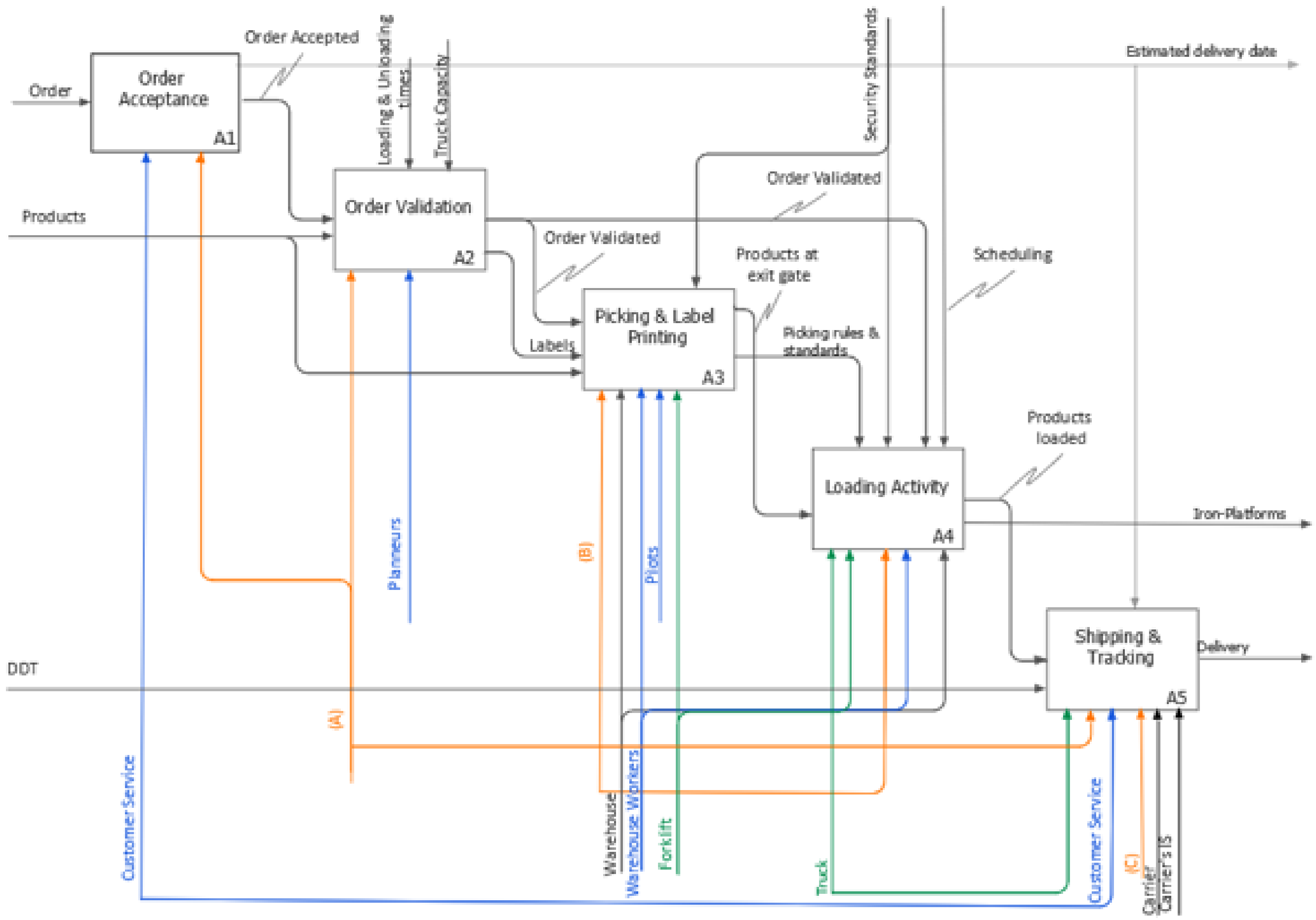


Figure 39 IDEF0 A-0

4.4 KPI of the warehouse

The EDC is a hub for distribution of products all over the specific territory of competence. It has never been conceived as a warehouse for stocking purposes and then the inbound and the outbound flows should always be strictly correlated. Michelin is indeed pushing hard to continuously minimize the quantity in stock in its warehouses, and with this objective the accurateness of the demand forecasting become one of the major insurances. The sales estimates guide the production process and then the internal distribution of many different categories of products. Hence, based partially on sales estimates and partially on real demand, the company carries out the production for a specific period. While the new products are being produced, Michelin distributes them internally from its MU to the EDCs, closer to customers. The EDC then receives these products and has the major purpose of distributing them to the customers over the territory. This sequential flow of activities from upstream to downstream emphasizes the role of one key metric affecting the performance of the entire chain; the timing. For a perfect smoothing of the production process every activity described must be performed constrained to a specific time. Going backwards, this means that to match the demand of the period, the EDC must distribute the products over the territory on time, but in turn, the EDC must have received those products from the MU on time, and lastly the production must have been completed on time.

In detail, the EDC receives the inbound of products which are either already sold to customers or that forecasts predict will be sold in that specific period, and then distributes them at the right time. Ideally, the EDC would be simply a junction between the customers and the production facility. This is indeed the core principle of the EDC functioning, which is also coherent with the current production strategy of the company as previously mentioned. This means that in theory, for the EDC, there should not be any stock of products at all, except for a very small quantity due to the lowest possible forecasting error. At the optimum, the inbound and the outbound almost perfectly matches, and logistics is assumed to always perform at its best, without causing any delays. The reality is just a bit more complicated than that. It is true that the demand forecast is a key pillar, but the real customer demand is getting harder and harder to predict. The demand influencing variables are much more than those in the past and are still increasing. Further, the quantity of data concerning everything that affects the market demand is getting bigger and bigger, and in turn it is becoming more difficult to handle. All these reasons are effectively contributing to drive the digitalization process in almost every supply chain management.

Currently, the EDC of Turin is subject to specific KPI “Key Performance Indicators” which support the monitoring of the warehouse’s performance, mainly in terms how well the activities subject to the EDC are integrated in the chain of activities starting from production to distribution to final customers from a timing perspective.

The “On-time Delivery” (OTD) is a key metric to measure delivery performance and supply chain efficiency. The On-time Delivery performance refers to the ratio of customer order lines shipped on the customer promised date versus the total number of order lines. The customer promised date is released only after that the order by the customer has been validated by the team of “*planners*” as mentioned in the previous paragraph. Then, the OTD practically measures the EDC delivery performance, in other words the downstream performance. There is another KPI, that has been instead defined to measure the upstream performance, the “Internal On-Time Delivery” (IOTD). This metric refers to the ratio of internal order lines shipped on the requested delivery date versus the total number of internal order lines. The key difference between the two indicators is that the former concerns real orders from customers while the latter concerns internal orders. Internal orders are basically expected orders, hence, what has been estimated to be sold in a short time and must then be timely shipped to the EDC in order to let it respect the last delivery time, (OTD).

The OTD measures the performance of the distribution flows, from the MU to the EDC and from the EDC to the customers. There is another important KPI that partially impacts the performance of the EDC despite being predominantly subject to the forecasting activity. The “Available to Fulfill” (ATF) is a key metric to measure forecasting accuracy. The ATF measures the number of orders that the EDC is able to fulfill at the moment in which the customer issues the order versus the total number of orders received. Based on sales forecast the company predicts what products and how much of them each EDCs must receive from the MU. If sales forecasts are inaccurate, the EDCs will not be able to fulfill hundred percent of orders on time because it did not receive the required products from upstream on time.

Finally, there is another metric affecting the warehouse management but that is only partially due to its performance, the quantity in stock. If the ATF indicator somehow measures the shortage of products resulting from inaccurate forecasts, the stock of the EDC measures the overage of products that is always the result of inaccurate forecasts. Therefore, forecasting is a key activity that directly affects the EDC activity performance.

5. BiB Track Project

The Bib Track project, promoted in 2017 at European level, has been designed as an innovation driver for Michelin in its purpose to enhance the customer centricity by changing the customer journey.

"The project indeed, intends to create new interaction points between the company and its customers by giving them more visibility on the sequential flow of activities starting from the purchasing moment and ending with the product delivery moment".

Those are the words of Julien Peignot, the European project Leader, when asked what was the core objective of the project during an interview.

In the following paragraphs of the chapter it will be described the project from the preliminary analysis of the customer needs that have been driving its development to the main features it intends to offer in this new digital era. It will be explained how the structure of the downstream digital architecture changed to support the project and what have been the challenges and the risks that Michelin faced during its development. Then, I will describe my personal involvement and contribution to the project concerning quantitative analyses of the delivery performances based on new data flows generated during the delivery process in the new digital architecture. Finally, there will be an overview of some of the critical aspects that have been affecting the project advance. Even though the project was conceived long before that my internship in Michelin started, I had the chance to have a key role in the project team and witness the achievements of most of the milestones in the evolution of the project.

5.1 Analysis of customer needs

Michelin is one of the largest tire manufacturers in the world and as leader in the industry the company has always aimed at offering top-quality products for its worldwide customers. Customer satisfaction has always had a primary role for the company and then every project it launched over the years had that objective.

However, in 2016, Michelin started perceiving that customer expectations were going to change. For someone, in fact, top-quality products were not the only thing that mattered anymore. Customers started looking around for new ways to satisfy their needs. In the same period, market researches, analysts and the professional services companies suggested that it was the beginning of an era in which customers expected a combination of high-quality products and high-quality services. Along with these considerations, Michelin started to make deeper analysis based on the requests of its customers received by the customer service. The idea was to listen to the clients in order to understand their needs, expectations and hints to let the company offer an ad-hoc delivery service that satisfied them.

Therefore, in 2016, the company decided to use two main vehicles driving the analysis of the customer needs about the delivery service:

- Customer Effort Score (CES) on delivery.
- Analysis of requests received by the customer service.

The Customer Effort Score measures how much effort a customer needs to put in during his customer journey. Elements such as time, money and risk are considered as effort. When measuring the CES, the focus is on a specific typology of service, and the customer is asked to review this service by the criterion of difficulty/ease.

The customer can answer this question on a three-point scale, with the lowest score standing for little effort and the highest score for high effort.

Michelin surveyed 617 of its customers in Italy. The results reveal that 16,5% of the customer surveyed defined “very high” the effort they experience during the delivery process (Figure 40). The weighted average CES on delivery was 1,72 in Italy.

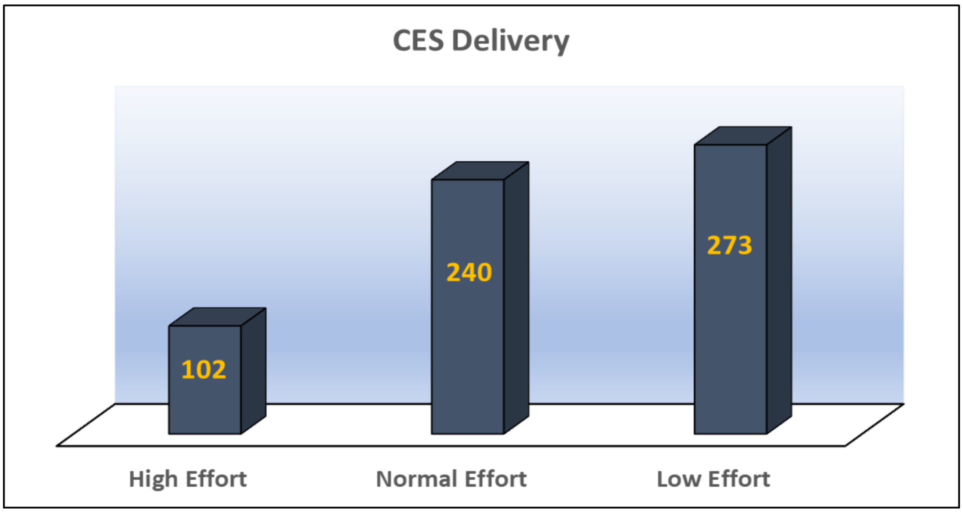


Figure 40 Customer Effort Score (CES) on Delivery in 2017 in Italy.

Based on these results, Michelin decided to interview the customers who said to have experienced the delivery process with a high effort, then who voted “3” in the CES on delivery. In this way, the company could identify the root cause that explained the reasons why the client found it high the effort experienced during the delivery process. The analysis showed that in 68,6% of the cases, the reason why a customer experienced a “High Effort” during the delivery process was attributable to timing issues (Figure 41). However, timing was not purely constituted by delivery delays. From the explanations of the customers, the timing issue was in most of the cases due to the fact that deliveries tended to realize often at different hours, thus, preventing the customer to prepare in advance for the unloading or to commit in advance with its customers. Customers found it dissatisfying to have delivery times variating at each delivery because at delivery day they did not have any clue about when in the day the carrier would deliver the products, neither they could monitor the updates of that delivery time during the day. Consequently, they used past deliveries to foresee a more likely delivery time slot and whenever this forecast did not match the real delivery time, the customers reported a “timing” issue in the delivery.

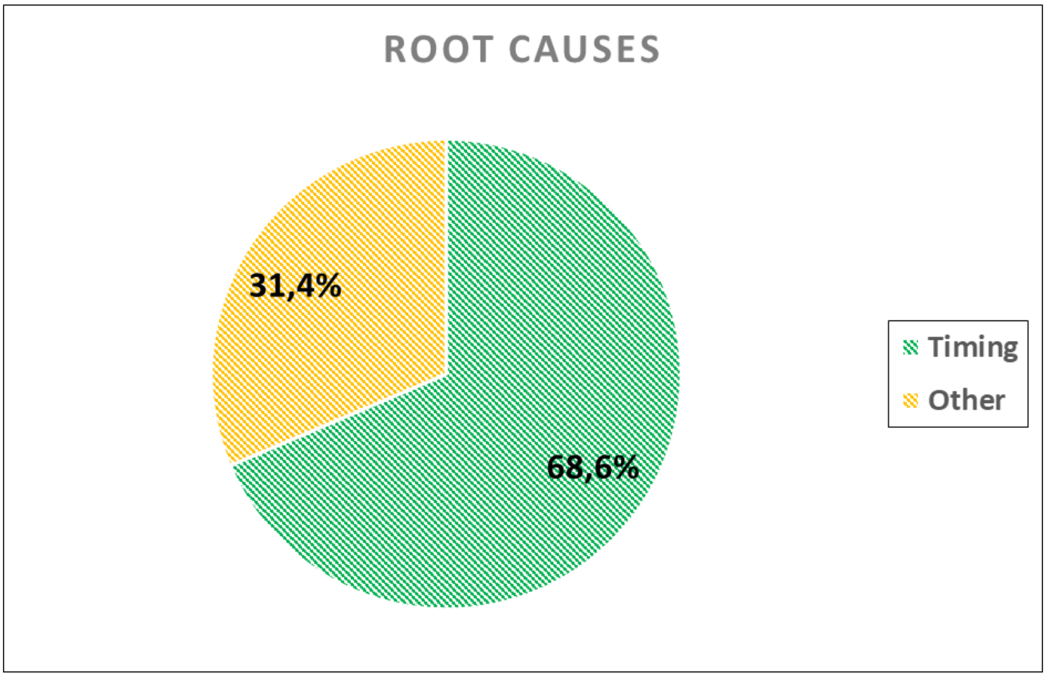


Figure 41 Root Causes for "High Effort" in CES on delivery.

Therefore, from this first analysis Michelin realized which could be the needs of its customers, who in most of the cases just wanted to have much visibility over the delivery process in order to better schedule their activity both in terms of commitment to their clients and management of time and resources.

The analysis of the requests received by the customer service has been another tool used by the company to identify points of improvements of the services offered by Michelin to its customers. Therefore, at the end of 2016, the request management team presented the insights of the analysis conducted over the requests it received during the year.

The total number of requests of the year amounted to 14.405 in Italy (Figure 42). Of those requests Michelin divided them in three different macro categories (

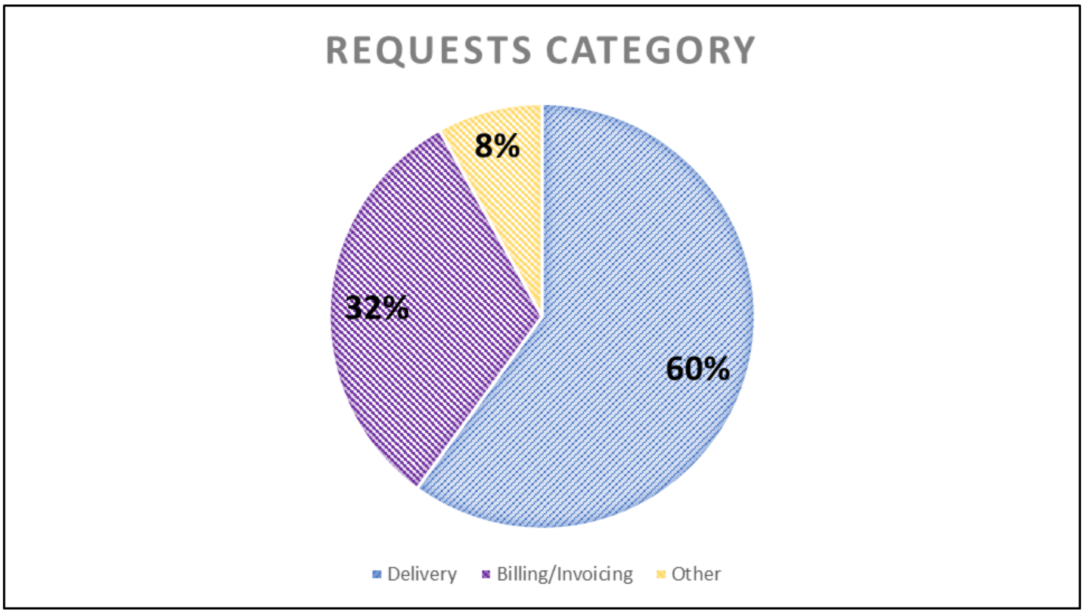


Figure 43):

- Delivery requests
- Billing/invoicing requests
- Other requests

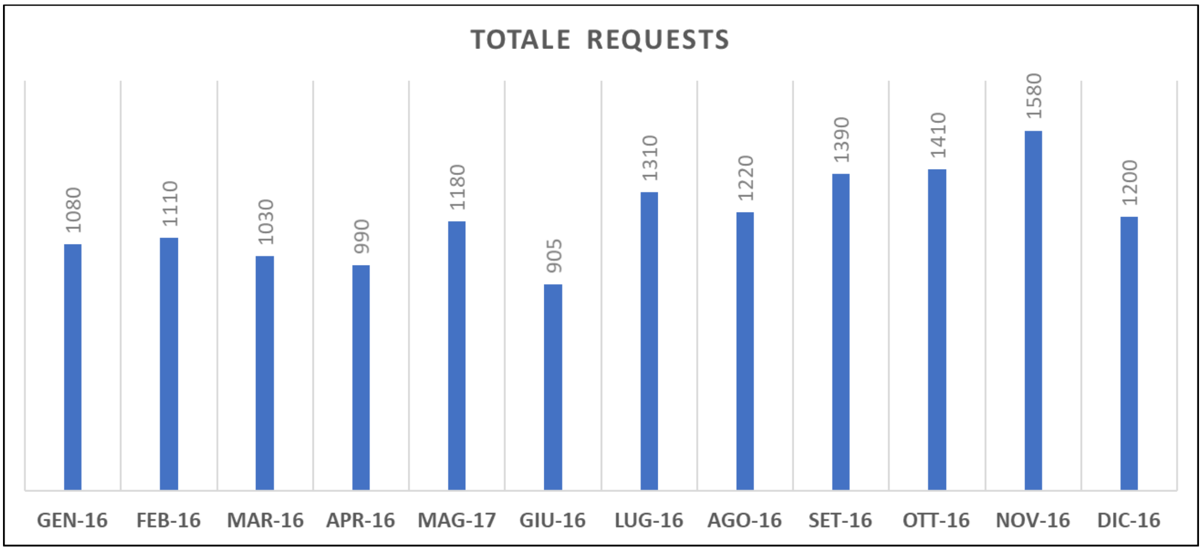


Figure 42 Total number of requests handled during 2016.

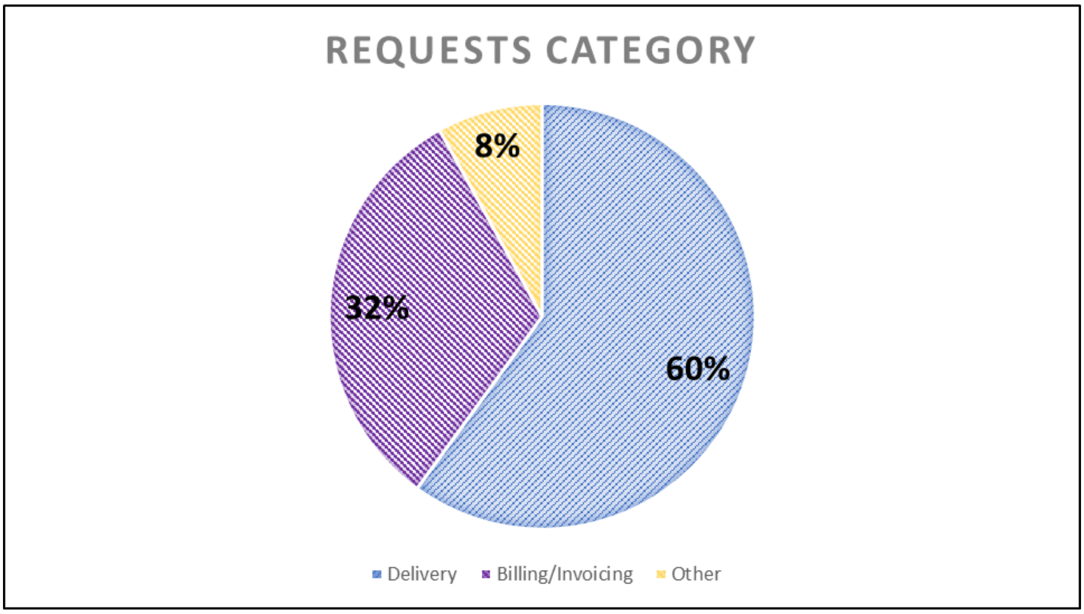


Figure 43 Total number of requests by category.

The results reveal that 60% of overall requests received during the year, then around 8.643, were categorized as delivery requests. Certainly, this first result of the analysis was quite intuitive because the fact that customers contacted the customer service for questions on the delivery process did not allow to identify a pattern in consumers' requests for a certain support/help/information. Hence, this first layer of the analysis just scratched the surface of the potential identification of the customer needs. It was interesting to note that the number of requests on delivery was increasing over time and this suggested that probably there must be something that customers were trying to communicate with their requests (Figure 44).

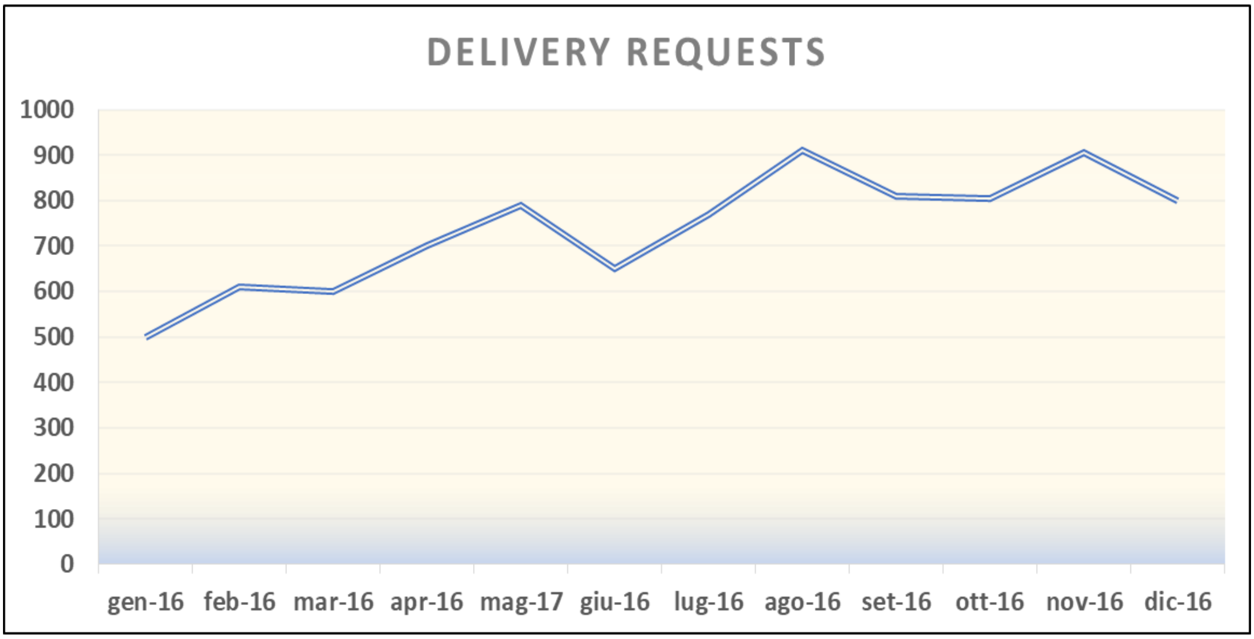


Figure 44 Delivery Requests over time, in 2016.

The second phase of the analysis has been conducted by breaking down the requests on delivery and identifying a more detailed categorization of requests related to the delivery. Hence, it was possible to identify the following subcategories:

- Delivery - Documents
- Delivery - IS issues
- Delivery - Other
- Delivery - Over/Short/Damaged
- Delivery – Timing

Then, the request management reported the incidence of each of these requests over the main category of delivery request, and it made it possible to start making the first concrete observations (Figure 45).

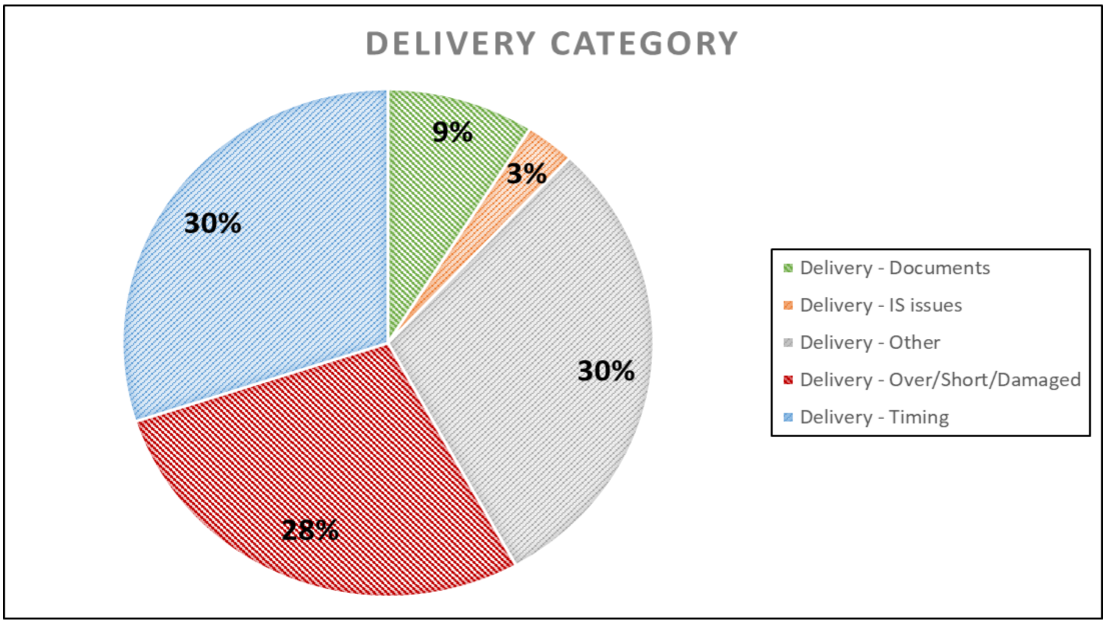


Figure 45 High-level categorization of the requests on delivery.

From the further deepening of the requests on delivery, it appeared that three main subcategories of requests were treated 90% of the cases during the year with the customers.

Further, Michelin noticed that the results achieved were coherent to what emerged from the CES on delivery, thus, customers were explaining their necessity of having a broader visibility over the delivery process, mostly in terms of delivery time and delivery status.

To support this thesis, the request management team decided to go deeper in the analysis and break down the requests on delivery subject to the subcategory “delivery-Other” and try to identify which cases have been enclosed under that subcategory. It emerged that 76% of those cases were driven by requests of scheduling information such as the estimated delivery hour (Figure 46).

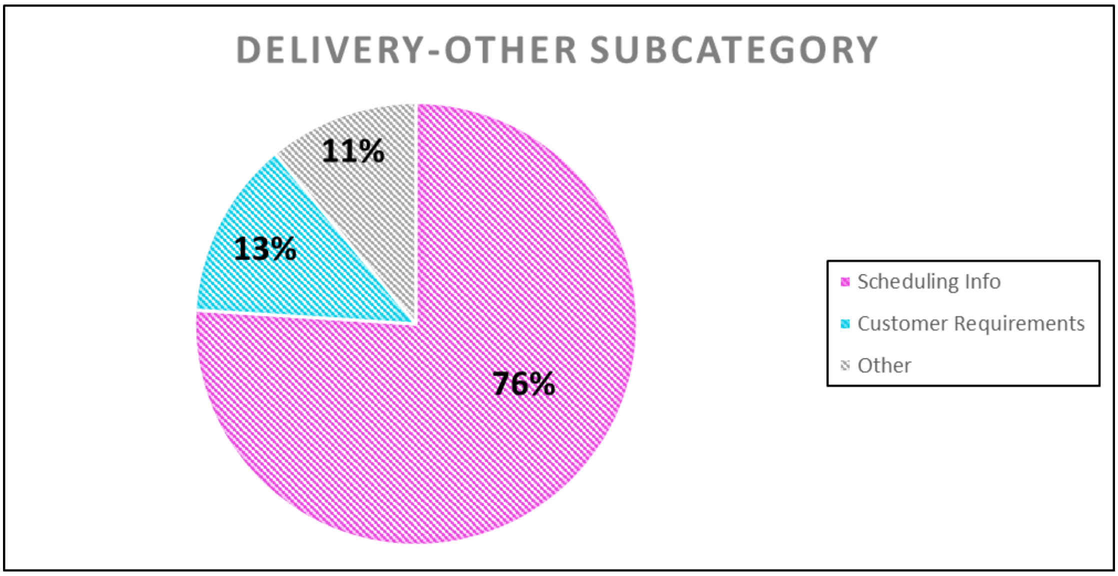


Figure 46 Key components of requests on delivery grouped as Other.

Therefore, Michelin grouped together requests on delivery categorized as “Delivery – Other” and those categorized as “Delivery – Timing” because in different ways they expressed the same necessity of the customers, which is the transparency and knowledge over the milestones of the delivery process, including transmission of information such as the estimated time of delivery, alerts when delivery are delayed and updates of the delivery status at each milestone.

Overall, the requests related to “Delivery – Timing” and “Other – Scheduling Info” accounted for almost 4.560 requests on delivery of the year, around 52,80% of the requests on delivery and 31,68% of the overall requests of the year (Figure 47).

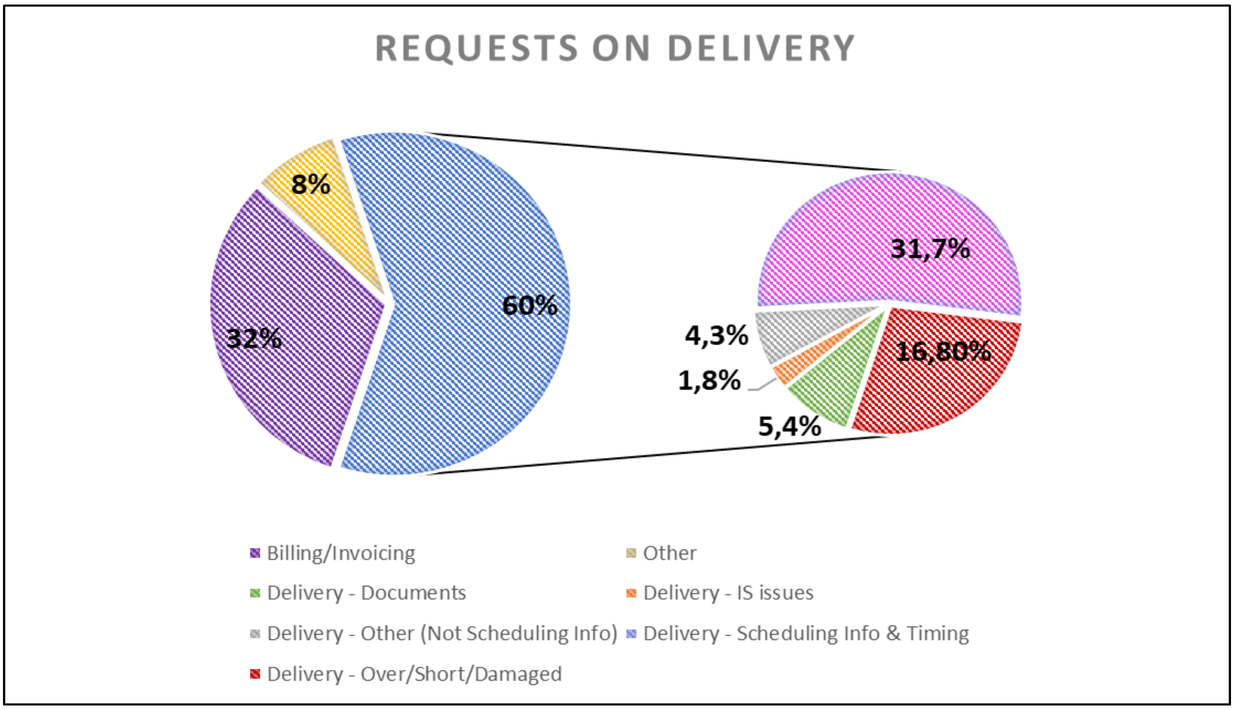


Figure 47 Detailed components of the requests on delivery for the year.

5.2 Presentation of the project

Digitalization disrupted the idea of quality of services offered by companies. Having the right product, at the right place and at the right time, is not enough anymore in the digital era. Nowadays in fact, customers want to have access to the information generated by their transactions. They want to see the summary, the invoice and the digital documents of their transactions. Also, customers expect to have the choice on what device to adopt in order to access this information, whether their smartphone or their laptop, and from everywhere and at any moment. Further, they want everything to be simple, but more than anything else they want it to be fast. This is what the technology provided most of all in the last years, real-time exchange of many information.

Product delivery service is one of the clearest examples of how much customer services have recently changed. It has grown the desire of people to have transparency and knowledge of the information related to every type of delivery. It does not matter whether the delivery involves products, food, or magazines. “*When*

I will receive what I ordered or Where is it right now" become the most frequent questions that the customer request division of all companies had to handle in the last years. In the digital supply chain, the delivery tracking becomes one of the key services that companies want to offer in order to improve the inter-connections with their customers and to deliver value to them. In the second chapter of the paper, it has been described what are the building blocks to successfully face the digital transformation. Among these, there is the importance of creating a well-structured digital ecosystem in which valuable data and information will flow through all the processes in real time, and this sharing of information will lead to enhance knowledge across the chain that ultimately will produce added value for every actor belonging to it. Further, building a collaborative supply chain, in which the customer can directly interface with the company and at the same time in which he is given visibility over the progresses that the company achieves, is simultaneously going to enhance the customer centricity, which is in turn another key aspect affecting the digital transformation success. The customer centricity is a strategy that has the aim of aligning the design, the production and the distribution of products and services with the actual needs of customers in order to increase the value that companies provide to them. Mostly in the industries with a few spaces for product differentiation, the diversification is often driven by the way in which the company is oriented towards the customer needs. Given how dramatically customer expectations and behaviors have changed over the past decade, organizations are expected to meet them at every interaction, in return for customer loyalty.

What is that customers are really looking for in the Next logistics?

It is hard to define exactly what customers expects from the delivery process, but it is sure that it plays a vital role in the overall customer journey. The real issue is the risk that companies undertake in case they get these expectations wrong, it could negatively impact the single customer's perception of the delivery service as well as the brand reputation. Most of the companies in the logistics sector are then disrupting their business models in the attempt to adapt to the new customer needs which are more than ever driven by a high customized service.

The report provided by Netcomm and Ipack-ma in 2018 shows that the two aspects related to the logistics in the E-commerce: "the quality of the delivery services" and “the Returns policy”, are evaluated as key driver for the final purchasing decision by seven customers out of ten. (Figure 48 Source NETCOMM 2017). Hence, regardless of the product or even the industry, logistics has a primary role in the supply chain of every business, and in the last years it has become a key activity also for the B2C to enhance the customer satisfaction. Customizing the delivery service means allowing the customers to interact with the company, and in turn the carrier, at multiple stages of the delivery process. Thus, customers must have the chance to choose between delivery or return, specify the delivery time according to their commitments and needs, choose a different delivery address and monitor the delivery progress.

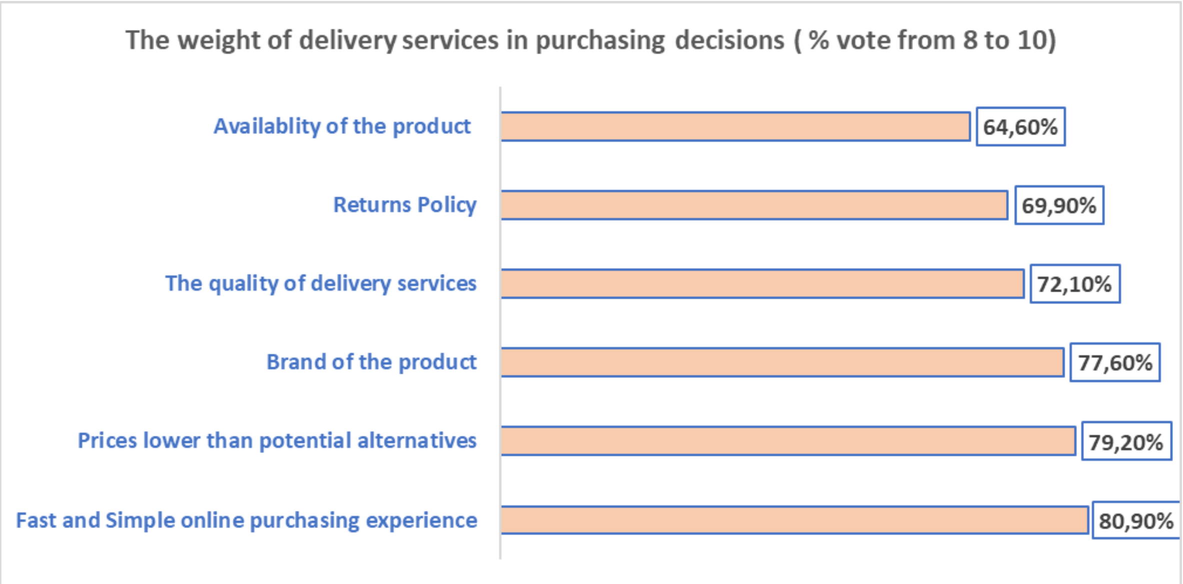


Figure 48 Source NETCOMM 2017

Therefore, the very first step in the direction of creating new interaction points with the customers that allow them to customize the product delivery is based on the development of a powerful delivery tracking software. The delivery tracking, in fact, would be the technology used to increase delivery process visibility and traceability. Consequently, the company could share the real-time information on the delivery process in progress with the customers, who in turn, could promptly interact with the company and customize the delivery service. A delivery Tracking system is not only a matter of tracking deliveries to delight customers, it is also intended to improve the companies' operations by pursuing resource optimization. An efficient delivery tracking helps business owners to redesign their regular processes, spot inefficiencies and enhance productivity and efficiency.

A better traceability of the products and the logistics activities in general is expected to be one of the major outcomes of the logistics 4.0 according to the data of the Observatory Contract Logistic Gino Marchet of the School of Management of the Polytechnic of Milan. The analysis showed that almost half of the companies of the logistics sector identifies in the denomination of logistics 4.0 an increase in automation technologies, while 35% expects an increase in processes visibility and 27% a better traceability.

One additional critical issue of the delivery service is related to the knowledge of the delivery date and hour after having ordered a product. Although the fact that it gives to the customers a value added, the reality of some years ago suggested that it was a concreate weakness for the logistics sector. From the report of NETCOMM in 2017, it emerged that in Italy only 4,5% of e-shoppers knew exactly the delivery time and date after their order has been issued (Figure 49).

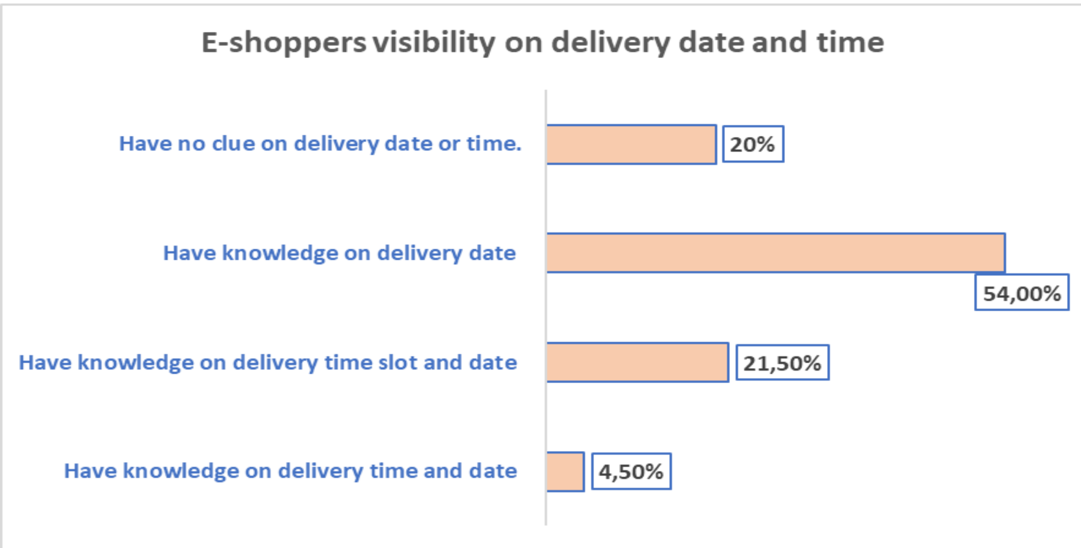


Figure 49 Source NETCOMM 2017

The project indeed, intends to create new interaction points between the company and its customers by giving them visibility on the sequential flow of activities starting from the purchasing moment and ending with the product delivery moment. In other words, creating new connection points with the clients means for Michelin developing a totally new flow of information that must be exchanged in real-time with the clients. For this purpose, Michelin had to change the structure of its downstream digital architecture. Additionally, the role of the carrier in this network changed and become more important than ever since this new flow of information is mainly generated by the carriers during the shipping phases, while Michelin must receive these data, manage them and share them with the customers.

Michelin’s customers are large retailers who tend to order several hundreds of kilos of tyres a day (each tyre is around 10 kilos). Thus, for a big portion of its business, Michelin is the supplier of these large retailers who in turn sell to smaller retailers. To put it simple, these last small retailers are basically the common tyre changers all over the cities. Michelin’s services are then reserved to large retailers who are connected to many more of these small retailers.

From the customers’ viewpoint, having access to this new flow of data means effectively feeling part of the supply chain together with the company and the suppliers. Hence, it would have an overall benefit over the entire Supply Chain management. Furthermore, the real added value lies in hands of the customers, who could substantially capture the value generated by the flow of information concerning the product delivery. They could use this added value to improve their business management in terms of planning and scheduling. They could indeed better manage their customer demand.

From Michelin’s viewpoint, the project gives the opportunity to measure the performance of its logistic operations and under these terms it provides a major accountability for the inefficiencies produced all along these activities. In this way, while gathering information to share with its customer the company also pursues internal resources optimization.

Hence, the Bib Track project mainly wants to target two key blocks for digital transformation success, the customer-centricity and the development of a more connected and collaborative supply chain.

5.3 Downstream digital architecture before the project

In 2016, before the development of the Bib Track project, Michelin Downstream digital architecture was based on two key information systems. These Information Systems were those used to carry out most of the activities of the downstream supply chain, then they were the hubs of the entire information network starting from order acceptance and ending after the transportation documents printing.

The first key information system, (A), collects, manages and shares with other IS all the product information generated at each stage of the downstream supply Chain from beginning to end. It not only contains such information but makes it possible to consult them. It mainly stores all orders processed for each client, and then makes it possible to retrieve all the key information resulting from these transactions. Thus, the system knows for each CAI ("Codice Articolo Internazionale") how many units are stored in each warehouse based on the order processed up to date. Hence, this information stored can be used to make statistics and evaluate the performance of the warehouses. Since the system (A) collects the data and updates them until delivery, it also interacts with other information systems. This interaction is predominantly based on EAI ("Enterprise Application Integration") messages. With these interfaces with other ISs, it is possible to ensure data integration with multiple systems and then the system (A) can draw information from all the different sources.

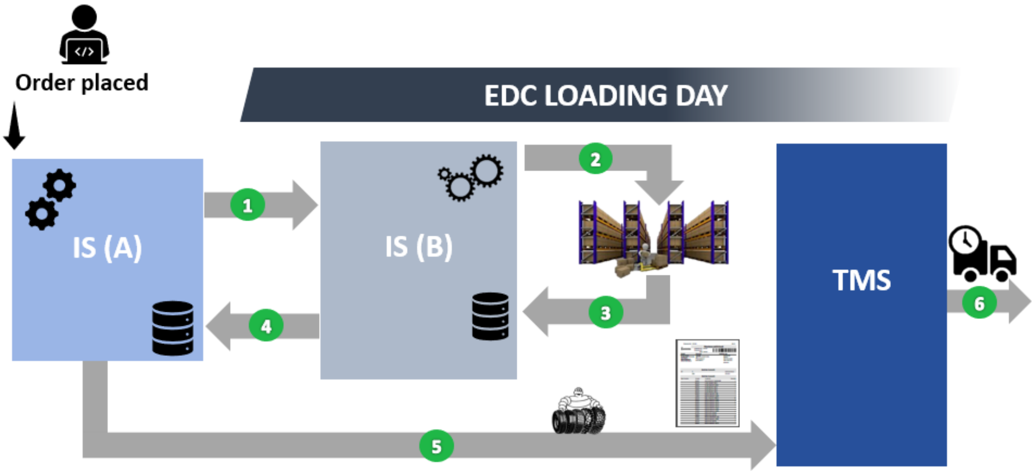
The other key information system, in the downstream architecture is (B). This information system instead, is what is used to support the warehouse operations in terms of loading, unloading, picking and stocking. The company then, predominantly relied on these two information systems to perform all the activities of the downstream part of the SC, from order processing to product shipping and delivery. With this architecture, the order was firstly triggered in (A), in which it was accepted and in case validated. After validation was completed, the order was sent to the system (B). In (B) the order was processed, which means that a picking-list or picking-order of ordered products was generated and then used to perform the picking activity. Once the picking was completed, the end of the picking process was confirmed in (B), and the information sent back to (A). Afterwards, the loading activity could be executed.

At this point, before the truck could leave the warehouse, Michelin was supposed to send an EDI message, containing all the information needed to fulfill all the processed orders, from (A) to the TMS ("Transport Management System") of the supplier of transportation. The supplier in turn, could prepare its fleet and organize the deliveries.

Once the deliveries were organized, the delivery process under Michelin's control effectively ended. Hence, Michelin did not receive any data from the supplier of transportation once relevant data to perform the deliveries were sent to him. Further, Michelin did not have visibility over the way in which the deliveries were performed. The lack of such information generated several inefficiencies for the company, both in terms of customer satisfaction management of the internal resources.

On one hand, the absence of real-time information concerning the delivery produced some sort of uncertainty for the clients who did not receive any kind of notification in case of delays or issues. Every time the delivery had some delays customers could not be promptly warned and this continuously produced a decrease in the customer confidence towards the quality of the delivery service. Additionally, every time the customer required assistance; it obviously contacted the customer service that unfortunately could not have immediate answers to the questions concerning the delivery tracking. On the contrary, the customer service had to contact the equipé of the supplier of transportation in order to give a feedback to the customer afterwards. This unstructured chain of tasks was not doing any better than decreasing the customer satisfaction and stressing the workload of the customer service.

On the other hand, without real-time information, it was almost impossible for Michelin to collect data on the delivery performance and monitor the quality of the delivery service overall. Hence, it could not make analysis to improve the service or to suggest countermeasures in case of issues. Besides, this downstream architecture that does not involve any kind of cooperation or coordination with the carrier was representative of the old business model of the company, for which the carrier was much more a supplier than a partner. The project represents an important step for Michelin to change this management approach as well.



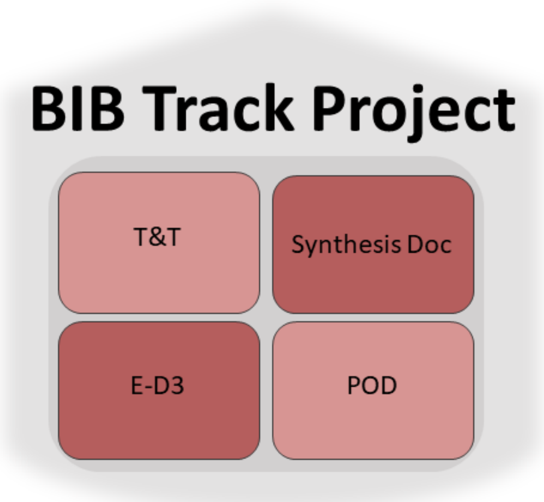
1. *The order is triggered in (A), then after being accepted and validated it is sent to (B).*
2. The order is processed in (B), and a picking list is generated according to the orders.
3. The picking activity is completed and it is validated in (B), which updates its database.
4. Once the picking is validated, the system (B) sends a message to (A) so that it can update its database as well.
5. The loading activity starts and the system (A) sends an EDI message to the TMS of the supplier of transportation, who can organize its fleet.
6. The carrier performs the delivery.

Figure 50 Scheme of the old downstream digital architecture.

5.4 Core Features of the Project

Michelin started the project with the overall objective of improving the customer satisfaction while optimizing internal resources. The development of this project required the introduction of a new provider for Michelin, or better a new partner. This partner had the task to develop a new information system, (C), to collect and manage additional information and generate new flows of data towards the customers, the supplier's TMS and the other internal Information Systems. Then, this system was supposed to be integrated with all the other IS in order to exchange real-time information and, given the volume of data that the project was intended to generate and manage with the system, it had to guarantee a very high level of performance.

The project indeed required a new downstream digital architecture. With this new architecture involving a third key Information System, Michelin wanted to address four main challenges.



The first one concerned the delivery tracking service. All customers with a free subscription to Michelin digital services should have the chance to follow the shipping activity and to be warned on potential delays or issues with the delivery. Hence, they should be given the possibility to know the estimated time of arrival of the items ordered or where is the truck located in a certain moment or what was the last milestone it reached.

The second one concerned the digitalization of transportation documents. To justify the transportation of items from the sender to the recipient, carriers needed to print the "Documento di Transporto" (DDT). The DDT is a fiscal transportation document collecting all the information about the delivery; it contains the number of the document, the starting date of the shipping, fiscal information on the sender and the recipient, and finally the description of the goods delivered in terms of quality, nature and quantity. The second purpose of the project is then to create a digital version of the DDT and to make it available for customers before the actual delivery.

The third main challenge of the project concerned the development of a methodology to collect and store all the documents of "Proof of delivery" (POD). The POD is a method to establish the fact that the recipient received the contents sent by the sender. The POD document is not a fiscal document itself, but it is practically important in all cases in which it could be necessary to legally prove that the client effectively received determined goods sent by the company.

The last big challenge of the project was conceived as a methodology to simplify the customer control on products purchased. When the client makes an order, the client does not see what is the warehouse from which the products ordered are distributed, he only knows whether the products are available or not. Based on the order, the latter may include products distributed by different EDCs and for each shipping, it must be produced a relative DDT document. At delivery, the customer received several DDT documents and he had to check each of them to control the consistency with his order. Michelin then decided to group all DDT documents generated at each transportation moment in just one summary document called the synthesis. Despite the fact that the synthesis is not a fiscal document, it is practically useful for customers to check the correctness of their order and to visualize the overall portfolio of products bought.

5.4.1 T&T

The Track & Trace service proposed by the project has the objective of creating visibility and transparency about the shipping and delivery processes. As mentioned, this transparency can have the double purpose of improving the customer satisfaction and the performance of the delivery service. The tracking concerns all steps of the delivery process. For illustration purposes, it is assumed the case of a one-day delivery service since the architecture would be the same for a two-day delivery. Overall, there are two alternative paths that the order tracking can basically follow: an "*happy*" path and an "*unhappy*" path. What changes between the two is simply whether the delivery involves or not form of "negative events". For instance, forces affecting negatively the scheduling of deliveries, or events that effectively prevent the delivery. Certainly, based on the path, what changes is also the number of interactions with the customers; and consequently, the activity of the customer service. At each interaction, there is a transmission of a determined information to the client that is expressed by a specific event. The list of events has been conceived to differentiate the interaction points and in principle to better monitor the performance of the carrier.

In case of an "*happy*" path, the delivery has been performed as scheduled. In case of a one-day delivery, the customer is expected to digitally interact with Michelin four times along the journey, hence there are four milestones at which the customer information about the delivery progress will be updated. The first interaction point occurs the day before the delivery, immediately after the order of the client has been validated and goods have been loaded in the truck. The event produced is called "Expedition Conforme" (EXPCFM); this is the moment in which the electronic transportation document (also called "E-d3") is sent via mail to the client. As a result of this first interaction, the client will know what it the promised delivery date at which he must expect to receive the products ordered and he will also receive the link at which he can follow the order tracking. Further, it receives a digital version of the transportation documents that he can already check to control the correctness of the order with no need to wait for the delivery. The second interaction occurs at the beginning of the delivery day. When the truck leaves the EDC and moves towards the client location. The event produced is called "Mis en Livraison conforme" (MLVCFM). The carrier's TMS must send to Michelin new IS the information concerning the moment at which the truck starts the journey and the "estimated time arrival" (ETA) to the specific client. Michelin then notify via email that information to the customer. The ETA ("Estimated Time Arrival") is one of the most important information that the carrier must share with customers. The ETA provides the customer with the information of the hour at which the carrier is expected to deliver. Concretely, the ETA is the most valuable information provided to the customers according to the survey conducted by the company. Michelin's customers consider the ETA as a valuable information because based on that information they schedule their commitments with their clients. On the other hand, being capable of estimating such information and making it accurate has proved to be a difficult challenge for the carrier. The algorithm used to provide such information must consider multiple variables and not all of them could be under control.

The third interaction point occurs once the delivery has been successfully completed. The corresponding event is the "Livraison Conforme" (LIVCFM). This milestone is actually more valuable for the company than for the customer. Michelin can in fact exploit such information and then analyze the delivery times to monitor the carrier's delivery performance. Finally, the last interaction point corresponds to the "Proof of Delivery Conforme" event (PODCFM). At this moment the client has signed the POD and the carrier has taken a picture of it and has sent this picture back to the TMS of the supplier, which will send this picture to Michelin's IS afterwards (Figure 51).

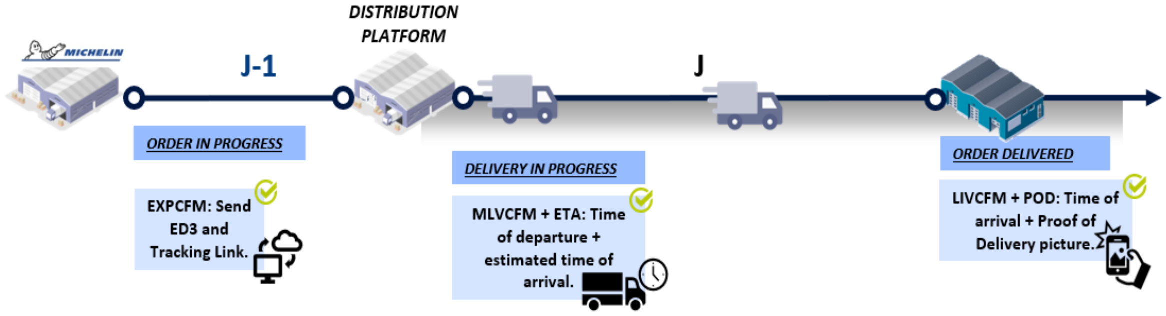


Figure 51 Scheme of the interaction points in the "happy path"

With an "*unhappy*" path, the customer could interact with the company more times than those corresponding to the standard events. Basically, there are additional events that are used to warn the customer when something affects the delivery scheduling. There are not specific and unique codes adopted to make these warnings, instead there are as many events as the possible categories of issues that the shipping and delivery processes can suffer. For instance, warning messages when the estimated time arrival is updated or when unforeseeable events could produce deliveries delayed or delated. Every time it is registered one of these "negative events", the client as well as Michelin must be promptly warned by the carrier. The association between negative events and delivery issues has been much more complicated to adopt. In this case it was not possible to associate a single event to a determined milestone, because there was not a one to one relationship anymore and in addition, there were too many issues that could happen at a casual stage of the delivery.

The T&T service creates added value in the delivery process starting from order processing and ending at the delivery moment. Customers indeed can rely on the delivery tracking to improve the quality of their service towards their clients. The delivery tracking allows Michelin's customers to better schedule their sales and then increase the percentage of order fulfilled. Further, having visibility over the shipping and delivery processes allows the customers to better prepare for receiving the goods they ordered and then save their time.

5.4.2 E-D3

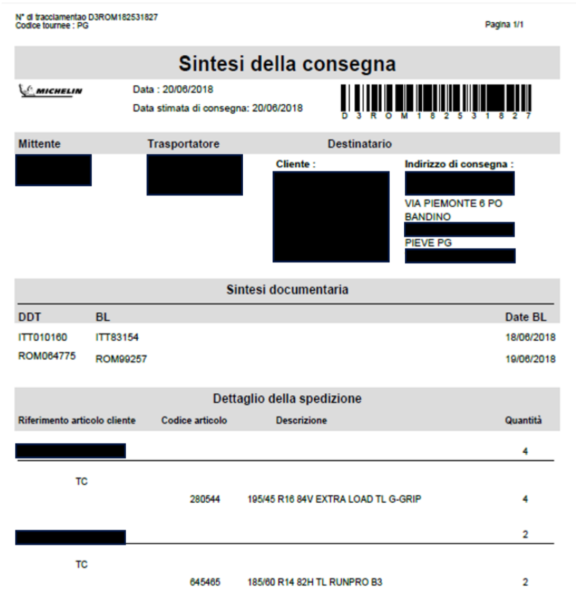
Before the development of the project, Michelin produced the "Documento di Trasporto" (DDT) in its traditional paper format and everyday thousands of pages were printed and delivered together with the products ordered to the customers. The project instead pushes the company to activate a new digital system for deliveries that based on the advantages brought by digitalization could effectively simplify the activities involved in the outbound logistics. In detail, the digitalization of transportation documents allows the company to decouple the phases of delivery of the items ordered and delivery of the transportation documents. With this new structure, the phases are not happening simultaneously anymore and instead the transportation documents can be electronically sent to the customers via mail. Hence, the day preceding the beginning of the shipping, Michelin sends the "E-D3" to its clients. What has not changed following the development of the project is that the delivery of items to the customer cannot start unless the latter has received the relative documents. This is indeed the general rule since the transportation documents have fiscal purposes. The consequence of this rule in the new digital environment is that even though the company does not incur the risk of delivery delays caused by problems related to the printing activity, it totally relies on the performance of its information systems and their capability to generate and exchange high volume of data.

5.4.3 Proof of Delivery

For the logistics industry, the Proof of Delivery is a critical part of the delivery process. The POD consists of a written acknowledgment of having received a determined order from a specific sender, then the document includes all the shipping details, but it is not a fiscal document. Once the buyer receives what he ordered, after checking the status of the package he must sign the POD document to declare the conformity between the package and the order he made. If there is something wrong with the package the buyer has the chance to immediately report it, putting a remark on the POD. This document is essentially used for accountability purposes; hence Michelin needs to collect and store the POD signed at the end of each delivery day. According to the new digital structure proposed by the project, the new Information System (C) must collect the photos of signed POD taken by the carrier after delivery. The photos are sent to the TMS of the carrier and then exchanged with Michelin's IS via EDI messages.

5.4.4 Synthesis Document

After having received the order, the very first activity performed by the buyer is to check whether the items just delivered are coherent to what he ordered. Michelin's customers are mainly medium-large size vendors who usually make orders of several hundred kilograms of products and different categories of them. Also, they make orders quite often to keep up with their demand and so they may easily forget what exactly they ordered in a specific date. For this reason, the results of different surveys conducted over samples of customers showed that one of the first things customers wanted to avoid was to consult too many different documents in which they had to find the information of the products delivered and check the consistency with their order. Based on Michelin's distribution network when the client makes an order, the latter may include products distributed by different EDCs from all Europe. However, for each shipping each EDC must produce one DDT document. At the end, the customer will have to consult as many DDT as the number of EDC from which the items have been delivered, without specifically knowing which warehouse distributed which product. To satisfy this customer need, the project proposed to create the synthesis document. Hence, before delivering to the final customer, the DDT documents generated in all EDCs will be grouped in one document reporting the details contained in each single DDT such as the products ordered, the quantity, the kilograms, the price and the EDC they belonged. Also, to make it easier for customers reading it, those details are grouped by macro category of product such as car tires, motorcycle tires or truck tires.



N° di tracciamentao D3ROM182531827
Codice tournee : PG

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Sintesi della consegna

MICHELIN

Data : 20/06/2018
Data stimata di consegna: 20/06/2018

D3ROM182531827

Mittente	Trasportatore	Destinatario	
		Cliente :	Indirizzo di consegna :
[redacted]	[redacted]	[redacted]	[redacted] VIA PIEMONTE 6 PO BANDINO [redacted] PIEVE PG [redacted]

Sintesi documentaria

DDT	BL	Date BL
ITT010160	ITT83154	18/06/2018
ROM064775	ROM99257	19/06/2018

Dettaglio della spedizione

Riferimento articolo cliente	Codice articolo	Descrizione	Quantità
[redacted]			4
TC			
	280544	195/45 R16 84V EXTRA LOAD TL G-GRIP	4
[redacted]			2
TC			
	645465	185/60 R14 82H TL RUNPRO B3	2

Figure 52 Example of a Synthesis document.

5.5 The new downstream digital architecture

One of the major risks for Michelin in the development of the project has been changing the structure of its downstream digital architecture, according to information provided by the Julien Peignot, European project leader, during an interview.

Introducing a new key information system that was designed to collect huge volumes of data from different sources and to exchange these data with many parties, has been indeed one of the biggest challenges for the company. The most crucial thing, in fact, was never to change the digital structure but to make sure that the velocity at which data and information exchanged in this new architecture was fast enough to not create slowdowns or worse frozen activities. The new structure is designed to include a new flow of information generated during the "*delivery day*" while keeping almost unaltered the digital structure during the phases of order processing and product picking. Hence, the first part of this new architecture does not change compared to the prior architecture. The order is again firstly triggered in (A), then sent to (B). In (B) the order is processed, and a picking-list or picking-order of products is generated and then used to perform the picking activity. After the picking is completed, the system (B) sends back a message to (A) confirming the end of the picking process. Once confirmed the end of the picking process, the truck is loaded to fulfill the orders. The "*delivery day*" indicates the day in which the shipping effectively starts, from the moment in which the truck leaves the EDC. At the "*delivery day*", before that the trucks can leave the warehouse, the system (B) sends an EDI message to the new system (C) containing all the details of the deliveries that will be fulfilled by each specific truck. The system (C) collects this data and in a few minutes, it must digitally generate all the transportation documents including the DDT that will be automatically sent via email to each customer along with the shipping tracking link. Further, it must generate a new EDI message towards the TMS of the carrier so that the carrier can in turn prepare its fleet for the deliveries. At this point, the truck can leave the EDC and start the shipping. From this moment on, the carrier will be tracked by GPS and he will send notification concerning the status of the delivery at each milestone to the TMS of the supplier of transportation.


```
UNA:+.? '
UNB+UNOC:3+MU_UF1:22+TR_BPY:22+190122:1309+0028002'
UNH+1+IFTSTA:D:96A:01B:ETTXXX+0000675347'
BGM+77+0028002+9'
DTM+137:201901221431:203'
NAD+MS+MU_UF1'
NAD+MR+TR_BPY'
CNI+1+429452'
STS+1+113+310'
DTM+7:201901221431:203'
DTM+334:201901221309:203'
UNT+9+1'
UNZ+1+0028002'
```


Figure 53 An example of the structure of EDI files sent by the carrier.

Hence, using a list of events associated to each specific milestone, the carrier communicates the delivery progress and this information will simultaneously be sent via EDI message to Michelin's system (C).

```
UNA:+.? '
UNB+UNOC:3+MU_UF1:22+TR_BPY:22+190122:1309+0028002'
UNH+1+IFTSTA:D:96A:01B:ETTXXX+0000675347'
BGM+77+0028002+9'
DTM+137:201901221431:203'
NAD+MS+MU_UF1'
NAD+MR+TR_BPY'
CNT+1+429452'
STS+1+113+310'
DTM+7:201901221431:203'
DTM+334:201901221309:203'
UNT+9+1'
UNZ+1+0028002'
```

Figure 54 Underlined the data referring to the code of the event associated to a determined milestone of the delivery.

Happy Path

	STATUS	REASON	EXPECTED DATA	EVENT CODE	MEANING OF THE EVENT	TIMING	
AT LOADING PLACE	5	364	5-364	CHGARS	Must be uploaded when the truck is registered at Michelin's gate	REAL TIME UPLOAD	
	5	132	5-132	CHGDEB	Must be uploaded when truck is at the doc		
	5	13	5-213	CHGFIN	Must be uploaded when the truck gates are closed		
	349	**310**	**349-310**	**PCHCFM**	**Must be upload when the driver is living the loading place**		MANDATORY (for upstream flow)
	113	**310**	**113-310**	**MLVCFM**	**Must be loaded when the driver is living the loading place**		MANDATORY
AT UNLOADING	113	364	113-364	LIVARS	Must be uploaded when the truck is registered at delivery place gate		
	113	135	113-135	LIVDEB	Must be uploaded when truck is at the dock		
	113	346	113-346	LIVFIN	Must be upoaded when the truck gates are closed		
	21	**310**	**21-310**	**LIVCFM**	**Must be uploaded when paperwork is done at delivery place**		MANDATORY
	167	**310**	**167-310**	**PODCFM+URL POD**	**Must be uploaded to make POD available on the portal**	POSTERIORI UPLOAD	MANDATORY

Figure 55 List of Events associated to each milestone of the delivery.

One of the most important information that the carrier must share with customers is the ETA ("Estimated Time Arrival"). The ETA provides the customer with the information of the hour at which the carrier is expected to deliver. This time is expressed as a range of two hours for Italy, but it slightly changes in some regions in Europe. The ETA is the most valuable information provided to the customers according to a market research conducted by the company. Based on this information the customer can better prepare to receive the order, and most of all he can optimally schedule his commitments with his clients. At the same time, also the customer will be informed about the status of the delivery since the delivery tracking link that he received before the shipping started, drives him to a specific web page connected to the system (C).

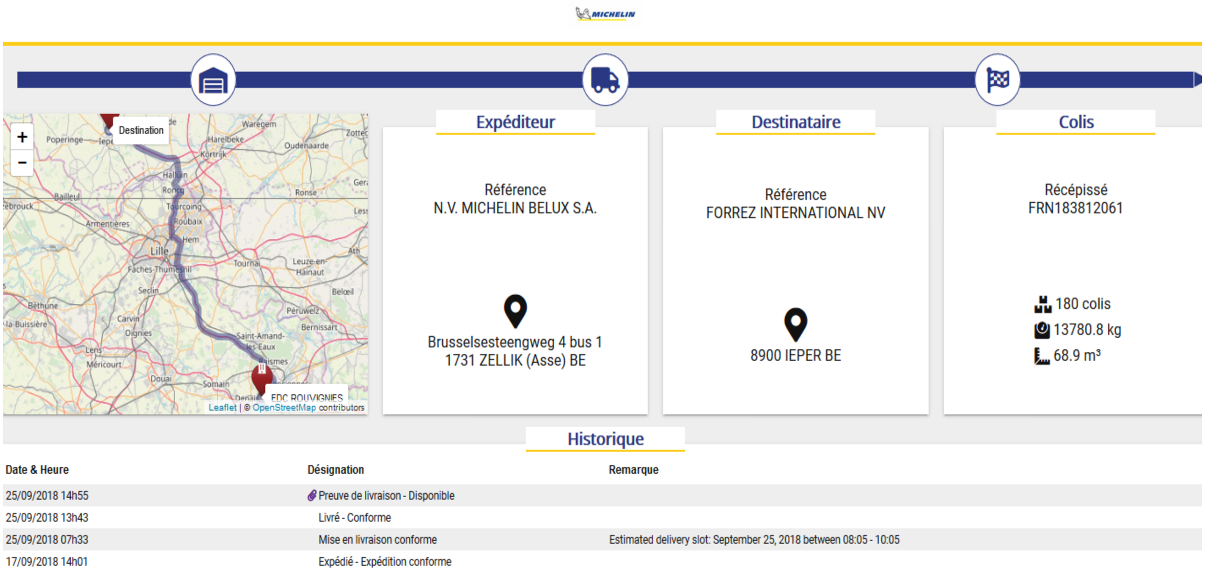
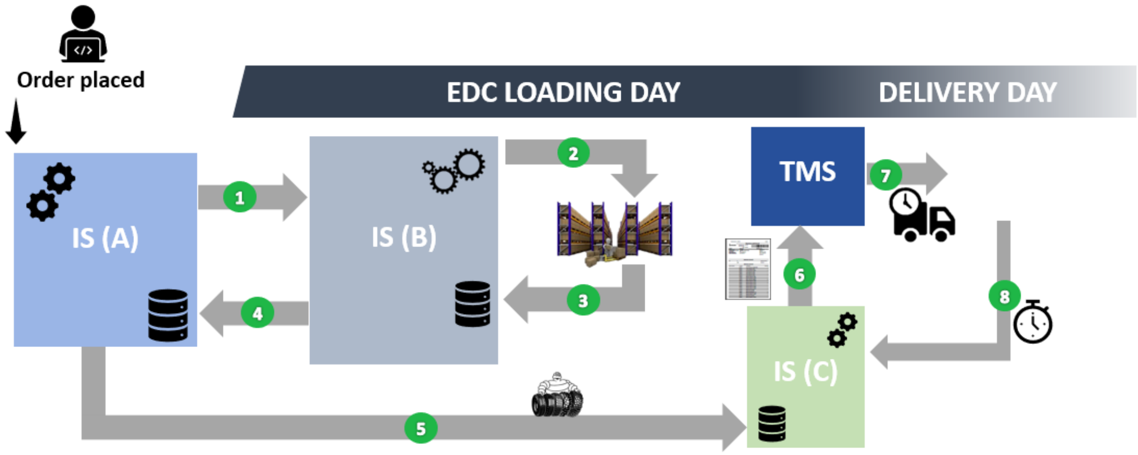


Figure 56 Example of a Delivery Tracking

In this way, the new structure ensures a collaborative environment between the carrier, Michelin and the customer where each of these actors will be constantly updated on the shipping status. Furthermore, the transparency generated by this digital architecture will reduce the workload of the customer service. The customer service will be contacted much less than before, since only customers who will not check the delivery tracking themselves will have the need to contact the customer service and even in this case it would be much easier for the customer service to retrieve the information to share with the customer.



1. *The order is triggered in (A), then after being accepted and validated it is sent to (B).*
2. The order is processed in (B), and a picking list is generated according to the orders.
3. The picking activity is completed and it is validated in (B), which updates its database.
4. Once the picking is validated, the system (B) sends a message to (A) so that it can update its database as well.
5. The loading activity starts and the system (A) sends an EDI message to the system (C), which collects the data in its database of deliveries.
6. The system (C) sends an EDI message to the TMS of the supplier with all the delivery information.
7. The carrier performs the delivery.
8. During the delivery the carrier sends messages on the delivery status to the TMS, and the TMS sends EDI messages back to the system (C).

Figure 57 Scheme of the new downstream digital architecture.

5.6 Cost of the new digital infrastructure supporting the project

The Bib Track project launched in 2017 was representative of a real transformation for Michelin's logistics operations in terms of process digitalization. The project has been proposed to enhance the customer satisfaction on the basis of actual needs emerged during different touchpoints with the customers (0). Consequently, the main driver of the estimated benefits resulting from the development of the project was essentially the positive reaction of Michelin's customers to an innovative and respondent to the needs delivery service. In this way, Michelin intended to demonstrate to his customers its vision on customer-centricity and continuous improvement. The Michelin Group is also one of the largest tire manufacturing of the world, thus, the importance of being competitive in the industry, both in terms of product quality and service quality, is always a key driver for innovation.

Therefore, in the following paragraph, there will not be any reference to the economic benefits of the project. The benefits can be associated to the following objectives:

- To demonstrate Michelin's customer centricity philosophy.
- To be among the first movers in launching this delivery service in the tire manufacturing industry.

The costs of the projects can be instead divided in different categories:

Total Cost of the resources: this total cost concerns the costs of the resources needed to launch the project. Hence, the European project leader, the project managers over the territories, the other managers involved in the project, training sessions etc.

Total Cost of the digital infrastructure to support the project: this cost instead include the cost of Michelin's new IS, thus, the cost needed to develop and integrate the new information system, and then all the costs related to the development of the project features such as E-D3, T&T, Proof of delivery (POD), etc.

In this paragraph it will be described only the part of the total cost of the new digital infrastructure related to the project features, as the cost of Michelin's new IS and total cost of resources could not be disclosed for privacy reasons. Since the project involves features such as delivery tracking, electronic transportation documents, and electronic proof of delivery, the costs needed to develop a solid digital infrastructure can be considered as the greatest part of the overall cost of the project.

However, the costs included in the development of the digital infrastructure must be considered as at European level and more importantly do not include all the extraordinary costs due to the special requests of the single countries belonging to the project.

The first cost component related to the new digital infrastructure is the E-D3 cost. In the first phase of the project, the most important thing was to make it possible the generation of the electronic transportation documents ("E-D3"). As mentioned, (0) the E-D3 is generated by Michelin's new IS after it receives EDI messages from Michelin's other information system that is used to manage the orders. Once the E-D3 is generated, it must be sent to the carrier's TMS and then to the customers who made the order. The development of this part of the project was particularly important, because the generation of the E-D3 is a prerequisite to start the delivery process. Certainly, the E-D3 did not simply have to be generated, it must be received, created and edited in a reasonable time for each delivery planned, roughly one minute per document.

Therefore, the development cost of this feature had to include different components as reported in the table (Table 1).

Table 1 Cost components for the development of the E-D3 feature.

Electronic Transportation Documents E-D3	
Installation on Michelin's new IS	175 k€
Installation of DGSI	145 k€
Creation of interfaces between Michelin's IS	30 k€
Connections with carriers	90 k€
EDI messages flows	70 k€
TOTAL	**515 k€**

In addition to these costs of development, running costs are estimated to be 330 k€ per annum to support the digital architecture while variable costs amount to 0,10 cents per each D3 generated.

Before the development of the project, Michelin did not have the third IS that generated the E-D3 while sending EDI messages to the TMS of the supplier and instead relied on the second IS just to send EDI messages to the carrier since the transportation documents were printed. The running costs for the previous architecture amounted to 170 k€, which was basically the cost associated to EDI message flows between Michelin's IS and the carrier's TMS. Hence, this new feature has a net additional running cost of 150 k€, although it reduces many hidden costs due to higher efficiency and traceability. As a matter of fact, the separation between the physical delivery of items and the digital delivery of documents creates added value in the value chain. This value is not only assumed by customers, who can check the shipping in advance and then better organize their scheduling and sales, but also by the company itself. The digitalization of the transportation documents gave the company the chance to implement new functionalities such as the digital invoicing, the track and trace, and consequently highly increasing the operational efficiency and performance.

The other cost component of the total cost of the digital infrastructure is related to the Track and Trace (T&T) process. The T&T is a new process for the company, then it is not possible to compare it with previous costs undertaken by the company. This cost includes the delivery tracking, mainly in terms of EDI messages exchanges between Michelin and the carrier, the interaction with the clients who can monitor the delivery, and finally the storage of the Proof of Delivery (POD) for fiscal purposes. The budget allocated for the T&T feature amounted to almost 400 k€ for a three-year development.

5.7 The Order Management Process

Other than changing the digital architecture of the company, the new project also forces the company to reconfigure the structure of the order management process. The new digital flow of data created to support the logistics operations must be sustained by new activities that are effectively performed by the carrier and then shared with the customer service, the logistics and the customers during the delivery day.

The following scheme represents the flowchart of the order management process after the development of the project (Figure 58). The previous structure of this process has been already described previously in the paper (4.2.1 Ordering Process). Basically, the process ended at the beginning of the delivery date, after the carrier left the last distribution center, either the EDC or the Distribution Platform, and started the delivery. During the delivery process, both the customer and the company did not have any visibility over its progress. Consequently, every information concerning the status of the delivery had to be directly released by the carrier who was delivering the products. For customers who wanted to know what was the hour at which the delivery was estimated to be fulfilled, the only option was to get in contact with Michelin's customer service, who in turn could get in touch with the carrier. The absence of visibility over the delivery process negatively impacted the level of customer satisfaction because of the customers' uncertainty of order fulfillment. Further, the company could not intervene to mitigate delivery performance scarcity because it did not know neither where nor when to intervene.

With the launch of the project, the old flowchart changes and extends to include new activities performed during the delivery day, while keeping almost unaltered the process in the day before the delivery starts. In the new process, the additional activities are performed by the carriers, who via mobile phone and specific software applications have been trained to send specific codified messages representing delivery milestones that are communicated to the customers via Michelin's information system.

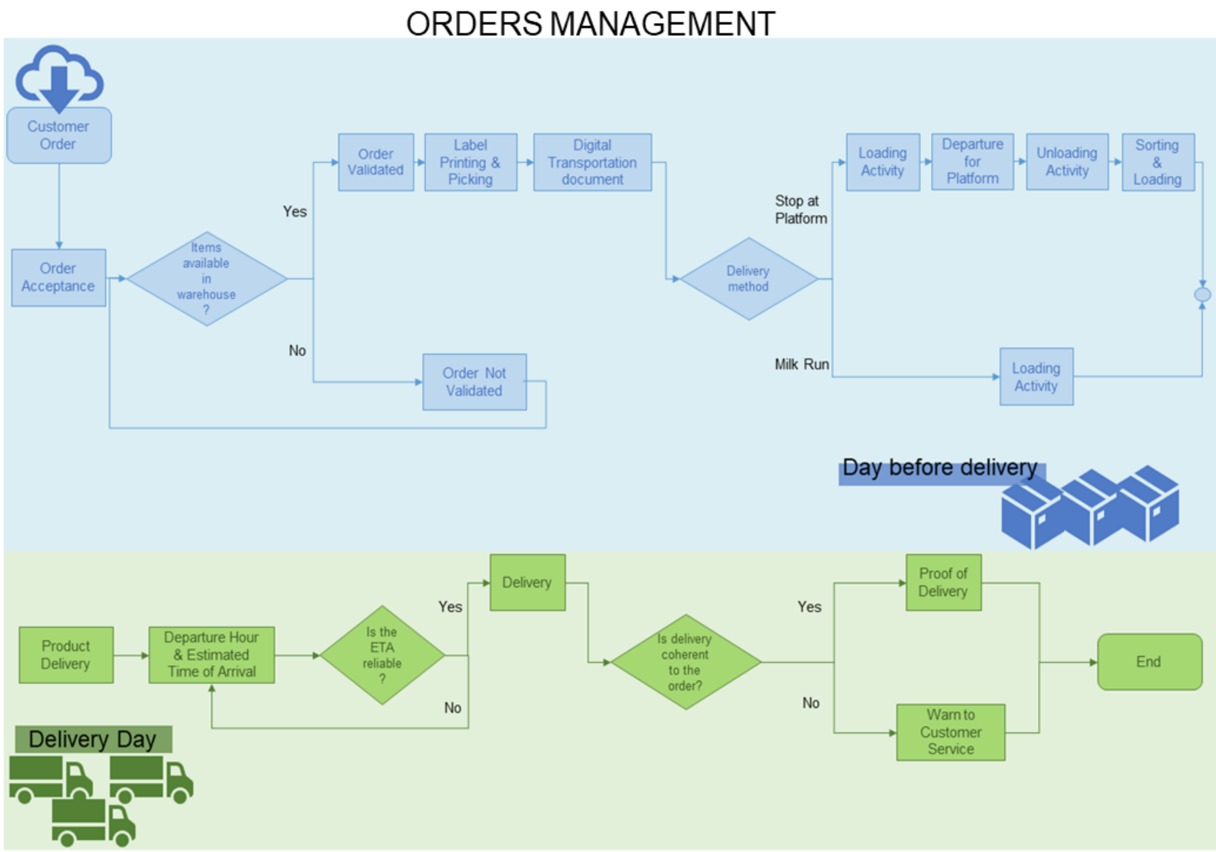


Figure 58 Order management process after the development of the projec

5.8 My role in the project

When I started my internship in Michelin, March 2019, the project has already been running for almost two years. In the meanwhile, in fact, the new information system had already been developed and the structure of Michelin's digital architecture at European level had changed accordingly. However, the development was still far from being finished. In the first phase of the project the main objectives concerned the installation of the new IS, its integration in Michelin's digital architecture and the first evolutions of the project features. When I arrived, none of the core features was hundred percent completed and indeed the new IS was not yet completely deployed by the logistics of Michelin Italiana. Hence, the company did not have the chance to exploit the benefits resulting from the project in terms of traceability of all the activities to achieve before delivering. Consequently, the company was not yet configured to manage and elaborate the data generated and collected by the new information system during the delivery process. All this information was supposed to become the new basis for performance monitoring and decision making and I was entitled to manage this data flow and bring out insights that could drive optimization throughout the delivery process.

The very first days at work, I was sent in France to attend a three-days training session in Lion, about the core principles of the project and the usage of the new Information System. I was explained what would have been my role inside the project, and what skills the company needed to make new progresses and reach its next objectives to effectively launch the project. As mentioned in the previous chapter, the project was intended to achieve two core objectives:

- Enhance the customer satisfaction by improving the customer centricity.
- Optimize the carrier performance by using the same transparency generated to bring visibility to customers on the delivery process.

The company needed someone to actively contribute in achieving the latter. Generally, every optimization process requires four main activities:

- Identify: It concerns a process that is object of the optimization; in this case the delivery process.
- Analyze: It concerns the analysis of the weaknesses of the process in object.
- Implement: Based on the previous analysis, apply the revised process in a new form.
- Monitor: It is about monitoring the new performance of the process and fine-tune until the desired results are reached.

However, if in the past that step guide required a lot of effort and time to be fulfilled, in the new era the digitalization creates an enormous advantage in making optimization activities. Performing the above-mentioned steps to propose optimization plans is much faster than in the past, because it is much easier to collect data and information on a determined activity and observe its patterns, while at the same time it is easier to implement new solutions or mitigate current weaknesses. Also, new technologies along with specific skills and competences can effectively help in decision-making activities to make the business grow.

According to the scope of the project, the optimization of the internal resources concerns the optimization of the distribution process that is performed by the carrier. As a matter of fact, the transparency that the project brings through the delivery tracking can be used to monitor the quality of the service offered by the carrier and then spot and address potential weaknesses of the distribution service.

Therefore, my role inside the project started with the of analysis of the carrier's delivery performance at Italian level in order to favour optimization choices. Hence, my responsibility can be divided into the following macro-activities:

- Analysing the performance of the carrier in terms of quality of the delivery service based on the tracking;
- Creating reports and dashboards of the performance results;
- Suggesting new solutions and improvements to achieve performance targets.

5.8.1 Key Performance indicators (KPI)

Previously in the paper, it has been described how the downstream digital architecture of Michelin has changed according to the development of the Bib Track project. In fact, the new Information System, codified as (C), manages a completely new flow of data that is fuelled by the information that the carrier sends from his TMS during the "*delivery day*". The system (C) collects the data and while making it available for customers, it also stores all this information in its database.

As previously mentioned, the carrier practically sends codified messages to the system (C) at each milestones of the delivery process; and the code of these messages differ based on the milestones they refer. Then, each milestone corresponds to a certain progress of the delivery.

Table 2 List of mandatory events representing delivery milestones.

MANDATORY EVENTS	MEANING
EVENT MLVCFM	It represents the moment in which the truck leaves the last warehouse and starts the delivery to the client.
EVENT ETACFM	It is a message containing the estimated delivery time as a range of two hours.
EVENT LIVCFM	It represents the moment in which the delivery is effectively realized.
EVENT PODCFM	It refers to the moment in which Michelin's IS receives the signed Proof of Delivery by the client.

Such codification of the delivery milestones makes it possible to evaluate the performance of the carrier's distribution service at each progress of the delivery. However, what matters to evaluate in terms of carrier's performance changes based on the event in object. In other words, not all the events are evaluated in the same manner, hence specific KPIs "Key performance Indicators" have been contractually agreed upon with the carrier with reference to the Bib Track project. Based on the different milestone, it is possible to carry out a different performance analysis:

"MLVCFM": By studying the hour at which this milestone is reached for each daily delivery, it is possible to understand whether the trucks always leave the EDC or the platform (in case of two-days delivery) on time. This information is quite important in case it is carried out an analysis on the root-causes of delayed deliveries. Delayed deliveries, in fact, can have many root-causes and a late departure from the EDC can be one of those.

"LIVCFM": By studying the hour at which this milestone is reached for each daily delivery, it is possible to understand whether the trucks deliver on time. Michelin's customers indeed are available to receive the orders only up to a certain hour in the afternoon. Hence, making sure that deliveries are completed before that hour is a priority for the company. Further, with historical data is possible to go deeper in the analysis and generate the monthly statistical distribution of the delivery time or other statistical information.

"PODCFM": In this case what matters the most is the presence of the information, then making sure that at the end of each delivery, every client has signed the POD and the carrier has taken a picture of it. As briefly said, this document does not have a fiscal value, but it can be very precious in case of disputes or claims. The key analysis then concerns in ensuring that hundred percent of the delivery have their signed POD.

"ETA": As briefly said, this information has been the most difficult to share for the carrier. The carrier must make sure that this information is available for customers no later than 8.30 a.m. of the delivery day. The "ETA" is sent as a range of two hours for every daily delivery, the reliability of this information is evaluated by analysing whether the hour at which the delivery occurs ("LIVCFM") is included in the time interval that has been previously defined by the “ETA”. In other words, the analysis consists in verifying that the real time of arrival to the client is included in the estimated time interval of arrival. Giving a reliable “ETA” requires that the carrier had accurately planned its daily distribution for each truck and assumes that no “negative event” could disrupt of more than two hours his schedules.

If each of these events is representing a specific phase of the distribution process, one can practically focus on each stage of the distribution process by setting on it a proper analysis. The only requirement in doing so is the availability of the information. Having hundred percent of the necessary information means that each driver, that is fulfilling a delivery, must update the status of the delivery at each milestone and send via a mobile phone application the new status to the TMS of the carrier, which in turn will communicate the information to Michelin’s IS. For this reason, at the beginning of my activity, I also had to consider the presence of the information shared at each milestone as an important variable affecting the performance reports.

In addition to those standard events, analysing the performance of the carrier also had to include the analysis of the “negative events”. The project defines the “negative events” as all the events for which the carrier could not fulfil the delivery as scheduled. Based on this definition, since there could be too many different cases of delivery not fulfilled as scheduled, generating a “negative event”, it was necessary to list all these potential cases and group them under macro categories. Further, each of these macro categories was identified by a specific code. This association was intended to simplify the analysis of these cases but mostly to simplify the communication between the carrier making the delivery and Michelin’s customer service that would have warned the client of the event.

In the following table, it is reported a shortlist of events associated to the delivery milestones. In the example in object, there are both negative and positive event code describing the status of the delivery (Figure 59).

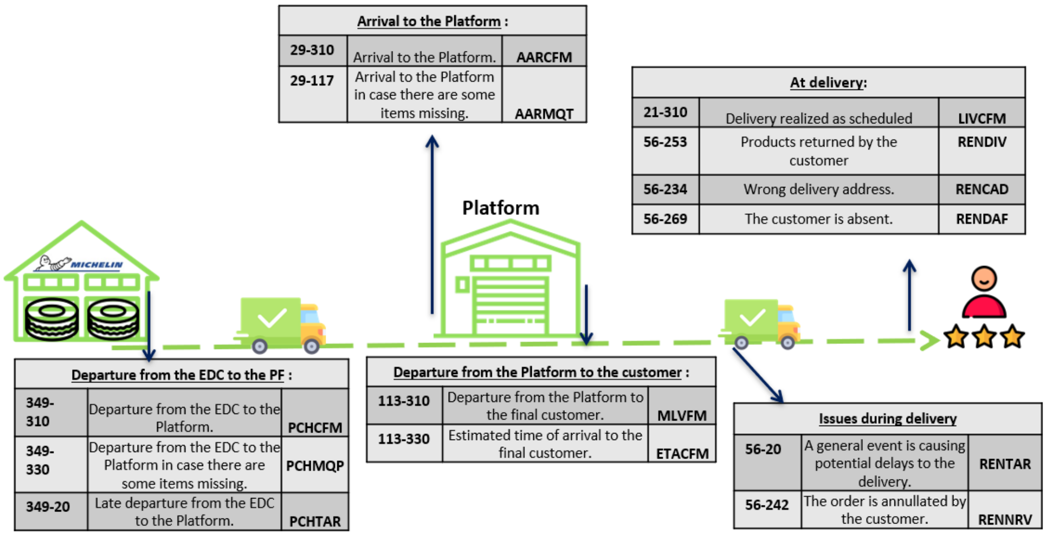


Figure 59 Shortlist of codes associated to the delivery milestones.

Therefore, my first responsibility inside the project has been that of analysing the performance of the carrier's distribution, for each Italian region, based on those events, which are digitally representing the progress and the quality of the delivery process. Also, these analyses would have be important to generate reports, dashboards, charts and everything related to them in order to help managers and executives of both the companies, Michelin and the supplier of transportation, in decision-making activities to implement new solutions.

To achieve this task, I did not have to simply look at already created dashboards or to use already implemented programs because there were not any of these, I had to create my own. I created a new and specific Relational Database Management System (RDBMS), that stores data of all the valuable information concerning the Italian deliveries sourced by Michelin's IS (C).

5.8.2 T&T Database

The transparency that the project was intended to create in the distribution process to benefit Michelin's customers and to boost the carrier's performance required at least for the second purpose being able to manage a high volume of data for internal decision-making activities. Michelin performs almost 2000 deliveries a day only in Italy, then 10.000 deliveries a week. Tracking each milestone of each one of these can generate a fair amount of information.

Once I was explained what the company expected by my activity, I started designing a Database management system (DBMS) that would have helped me in efficiently performing analysis of the current distribution service and at the same time creating reports, dashboards and charts that in turn would then be used to suggest to the management implementations and new solutions aimed at optimizing the carrier's performance.

The database is based on a Relational model, then a Relational Database management system (RDBMS), since data are organized into tables of records and attributes. Accordingly, the database has been entirely programmed in SQL ("Structured Query Language") language. As mentioned, the database has been designed not only to make daily performance analysis but mostly to collect and store specific valuable information and then use historical data to discover patterns, study trends and make statistical analysis.

The very first step in the creation of the database has been understanding what information it was supposed to collect and how to power it. It had to collect all the relevant data of each delivery such as the number of the DDT, the client, the shipping warehouse, the date of shipping, the estimated date of delivery, plus all the information concerning the tracking of the delivery, hence the hour and the date of each milestone.

Since all these the data were firstly collected by Michelin's IS (C), it was reasonable creating a connection that allowed to extract only the mentioned relevant data of each the daily shipping from the system (C) and import these data into the database system. Therefore, from the system (C), an SQL statement is used to extract the data in a CSV file format. With an automatic connection between the query producing the CSV file and the database system, it was possible to import and insert the extracted relevant data in a support table of the database system. Hence, with this architecture, the database system automatically retrieves the relevant data at the end of each day and temporarily stores them in a support table. Lastly, from the support table the information must be added in the real database. This operation is based on an append or update algorithm, written in SQL as well. Hence, based on the comparison between the data contained in the two tables the algorithm updates already existing rows when a specific condition occurs or appends new rows. With this architecture the database has been created and it is daily updated.

The second step instead has been understanding how to manage the data in the database and then how to efficiently manipulate them and execute queries and algorithms to make performance analysis and generate reports and dashboards. This was effectively my second key task inside the project.

To better grasp the idea, let me take the example of the “ETA” algorithm. The “ETA” is one of the relevant information that the carrier shares for each delivery and, based on the structure previously described, the ETAs of all deliveries will be found in the T&T database implemented. However, for performance analysis the mere presence of the information was not enough. In fact, it was interesting to measure not only the presence of the information but also to evaluate its reliability. Then, to measure how many of the daily ETAs were reliable, I had to compare the ETA of each delivery and the time at which the delivery effectively occurred. For this and other similar purposes I predominantly used VBA (“Visual Basic for Application”) (Figure 60).

```
Set db1 = DBEngine.Workspaces(0).Databases(0)
Set dd1 = db1.OpenRecordset("archiviodati", DB_OPEN_


Set dd1 = db1.OpenRecordset(" SELECT archiviodati.*

dd1.MoveFirst
Do Until dd1.EOF

If Len(Trim(dd1!eta_iniziale)) > 0 Then
   'dd1.Edit
   'dd1!eta = "ETACFM"
   'dd1.Update

   eta = dd1!eta_iniziale
   etarray = Split(eta)
   For cont = 0 To UBound(etarray())
    oratemp = etarray(cont)
    timearray = Split(oratemp, ".")
      If UBound(timearray()) > 0 Then
        If orainizio = "" Then
         orainizio = oratemp
        Else
        orafine = oratemp
        End If
      End If
    Next

  'oraeffettiva = dd1!oraevt_livcfm
    If Len(Trim(dd1!oraevt_livcfm)) <> "" Then
```

Figure 60 An extract of the ETA algorithm

VBA and SQL have been widely used on the data contained in the database to fulfil my second task inside the project. The former was mostly necessary for counting, controlling and doing the calculations. The latter, instead, has been used to group, order and practically display the obtained results. In other words, to produce the reports and dashboards. The most valuable thing associated to the T&T database was that it could store hundreds of thousands of records and this meant a lot of information to work on. Since the deliveries were entirely tracked by portioning each one of them in events representing milestones, the analysis that I made concerned many different topics: the reliability of the information provided by the ETA, the statistical distribution of the delivery time, the most common "negative events", the daily presence of the Proof Of Delivery and so on. Most of these reports, in fact, were daily or weekly discussed by the members of project team and the managers of Michelin's supplier of transportation, to take actions on current performances and set guidelines to improve them. Additionally, these analyses were not only intended to pursue the optimization process in logistics but also to make sure that the supplier of transportation was effectively committed to the project. On this matter, the last paragraphs of the paper focus on the critical aspects of the development of the project.

5.8.3 Analysis of delivery performance

With hundreds of thousands of rows collected in the T&T database I had the opportunity to run many quantitative analyses aimed at monitoring the performance of the delivery process from the moment in which the truck left the EDC to the moment in which it effectively delivered to the customers on the Italian territory. These analyses not only supported the development of the project but helped in screening the actual performance of the carrier on a determined time basis. Hence, the importance of this task was also recognized by the management of the company, which could use the results of the analyses in decision-making activities to pursue process optimization and continuous improvement.

As mentioned, the analyses that I carry out as part of my job inside the company involve different aspects of the delivery process; in this paragraph I will focus on two key delivery performance influencing variables:

- The timing of the delivery milestones;
- The quality of the information provided by the ETA ("Estimated-Time-Arrival").

The timing is indeed one of the major aspects to consider in the evaluation of the delivery performance. The importance of the timing in the delivery process relies on the fact that it directly influences the customer satisfaction and then the quality of the service offered.

To make sure that the delivery times are always realized in accordance to the customer needs and within a specific hour, it must be analysed the timing of all the delivery milestones constituting the delivery process. These analyses can screen the timing of the delivery process on a daily, weekly or monthly basis and can be used to identify the potential causes of delays whenever they occur at the delivery moment.

The delivery process can follow two different paths, as shown in the figure below (Figure 61). Hence, the second path in all cases in which the delivery must temporary stop by the platform involves two additional milestones, the departure from the EDC to the platform and the arrival at the platform. The tracking events associated to these delivery milestones have been described in the previous chapters ().

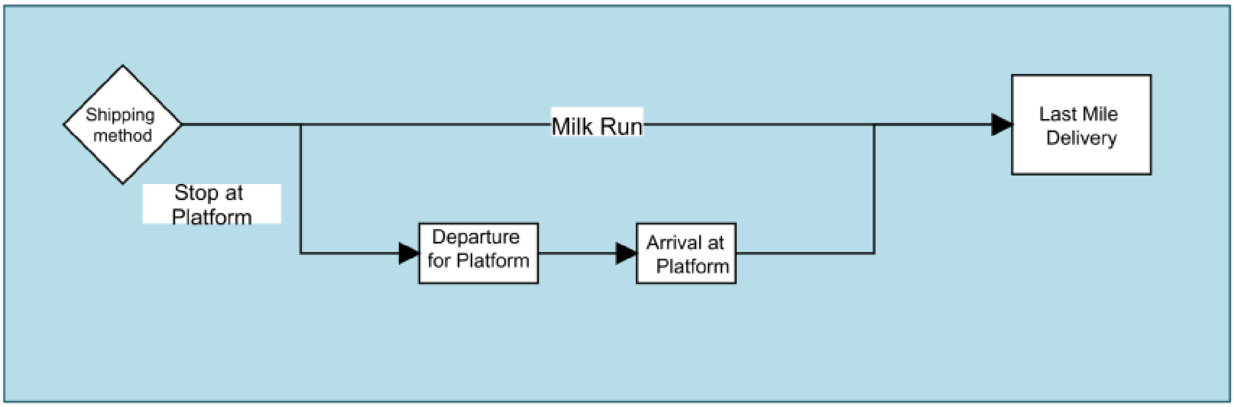


Figure 61 Possible delivery paths.

The following analysis considers only the deliveries involving a temporary stop by the platform. The time frame in object is three months, the second quarter of last year. The number of deliveries tracked N is 58.000.

The analysis is divided into four parts, one for each delivery milestone. The first one concerns the time of departure from the EDC to the platform. This is indeed the moment at which the truck leaves the EDC. Obviously, depending on where is the truck headed, thus, the distance of the platform, it will have a certain priority in the departure. Results of the analysis reveal that during the second quarter of 2019, trucks have been leaving the EDC between 19.00 p.m. and 02.00 a.m. (Figure 62).

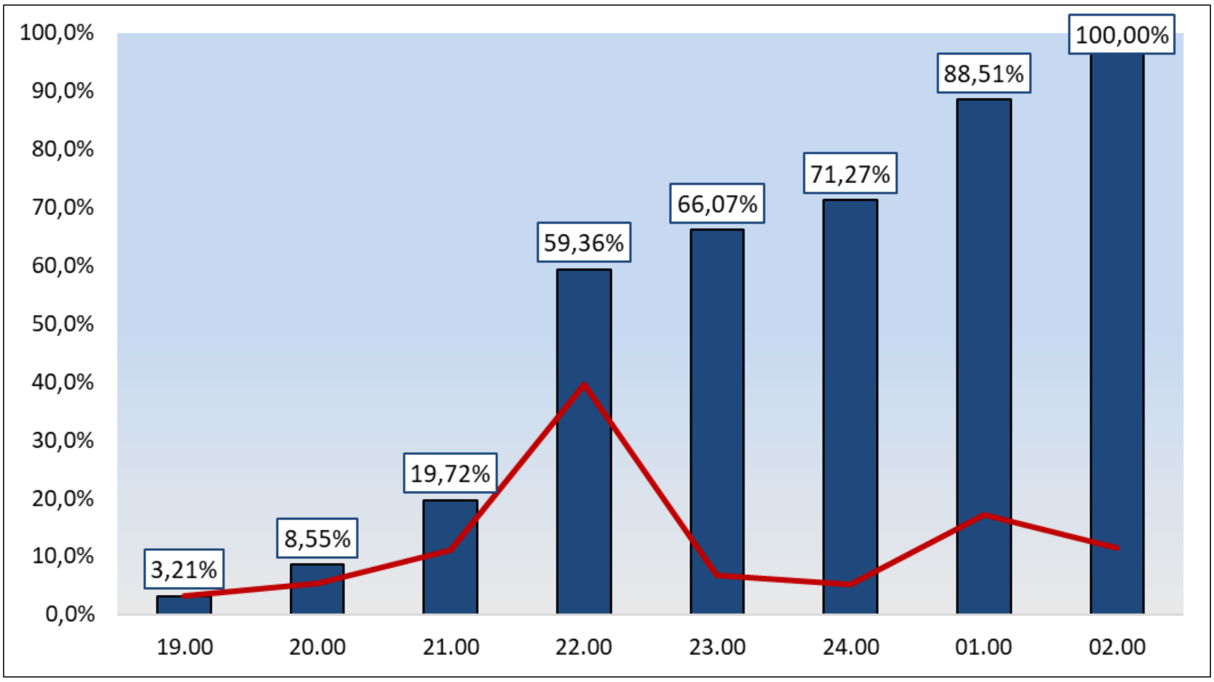


Figure 62 Cumulative Distribution of the departure time for platform, Q2 2019.

Further, by grouping the observations of departures in ranges of one hour it was possible to derive the frequency of the hourly departures and then an approximation of the statistical distribution (Figure 63). The curve shows one absolute peak hour between 21.00 p.m. and 22.00 p.m., in which have been grouped 39,6% of the overall quarterly departures, and one relative maximum point between 24.00 a.m. and 01.00 a.m., in which 17,2% of departures have been observed. The departure time for platforms is a valuable information to monitor the timing of the delivery path from the beginning of the process. Also, the entire delivery process has been organized according to specific restrictions on timing (e.g. platforms are prepared to receive trucks at specific time slots, platforms set up the opening hours based on determined time slots, etc), hence, making sure that the time of departure for each platform is contained in a determined range of hours has a major importance.

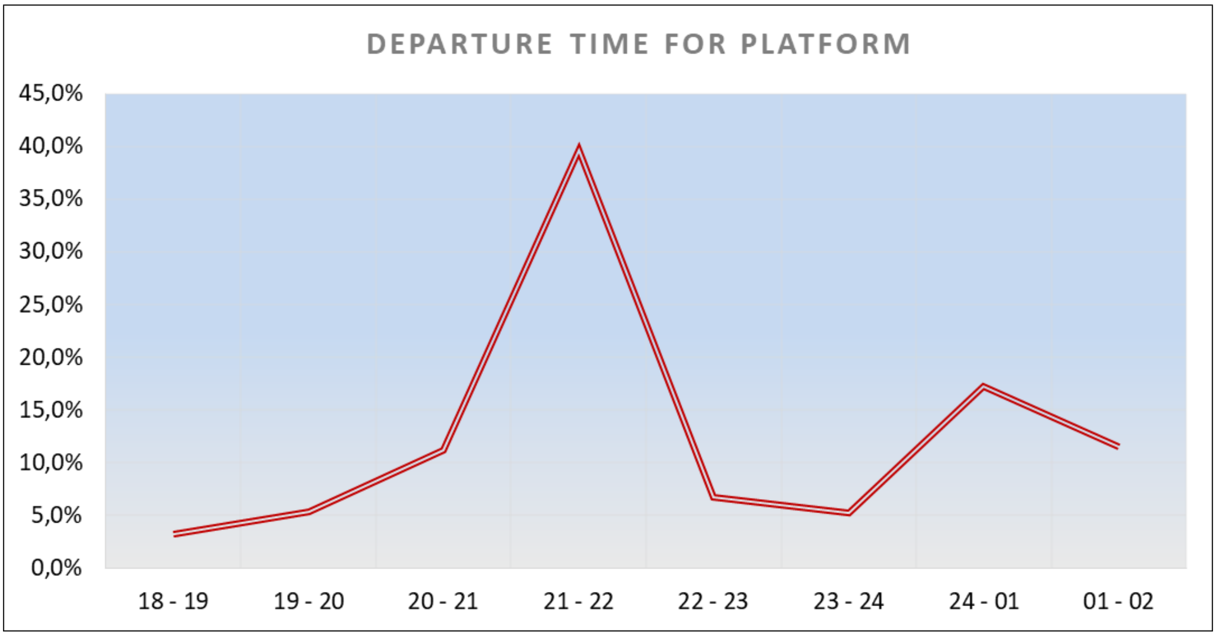


Figure 63 Approximation of the statistical distribution of the hourly departures for platforms, Q2 2019.

The second milestone of the delivery path is the arrival time at platforms. The analysis on the time of departure allows to understand whether the trucks left the EDC on time, while this second analysis allows to understand whether that timing has been preserved until the arrival at the platforms, or something occurred and caused some delays. Based on the same reasoning it could happen that some delays are spotted in the time of departure for the platform, but they do not have any impacts on the time of arrival.

Results of this second analysis suggest that during the second quarter of 2019, trucks have been arriving to the platforms between 22.00 p.m. and 06.00 a.m. (Figure 64)

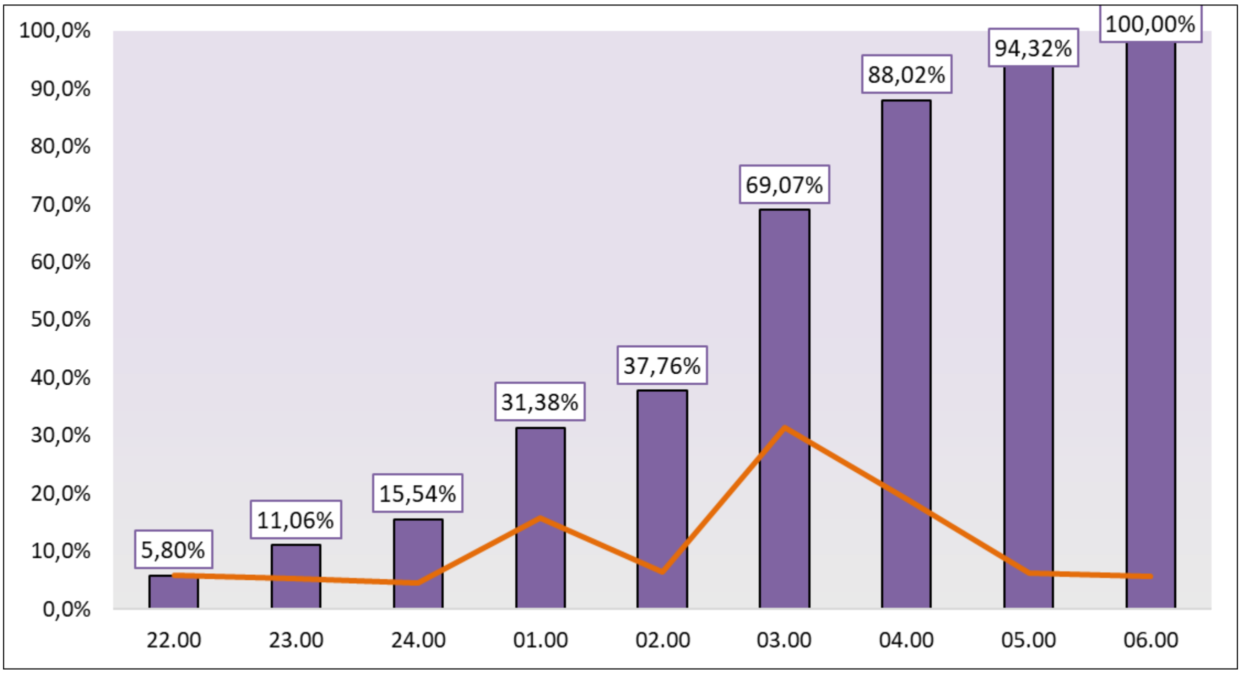


Figure 64 Cumulative Distribution of the arrival time at platforms, Q2 2019.

Even in this case, by grouping the observations of arrival times in ranges of one hour it was possible to derive the frequency of the hourly arrival time and then an approximation of the statistical distribution (Figure 65). Coherently to what the previous analysis showed, the two peaks on the time of departures for platforms are reported in the arrival times at platforms. In this case, the absolute peak was registered between 02.00 a.m. and 03.00 a.m., while the relative peak has been observed between 24.00 a.m. and 01.00 a.m.

The fact that there is consistency between the peaks in the two curves is coherent to the organization of the delivery process. As a matter of fact, given a certain number of trucks leaving the EDC to reach platforms, the logistics schedule their departure and arrival based on specific slots in order to have as much homogeneity as possible during the process. In this way, logistics can optimize the timing and the workforce at the same time.

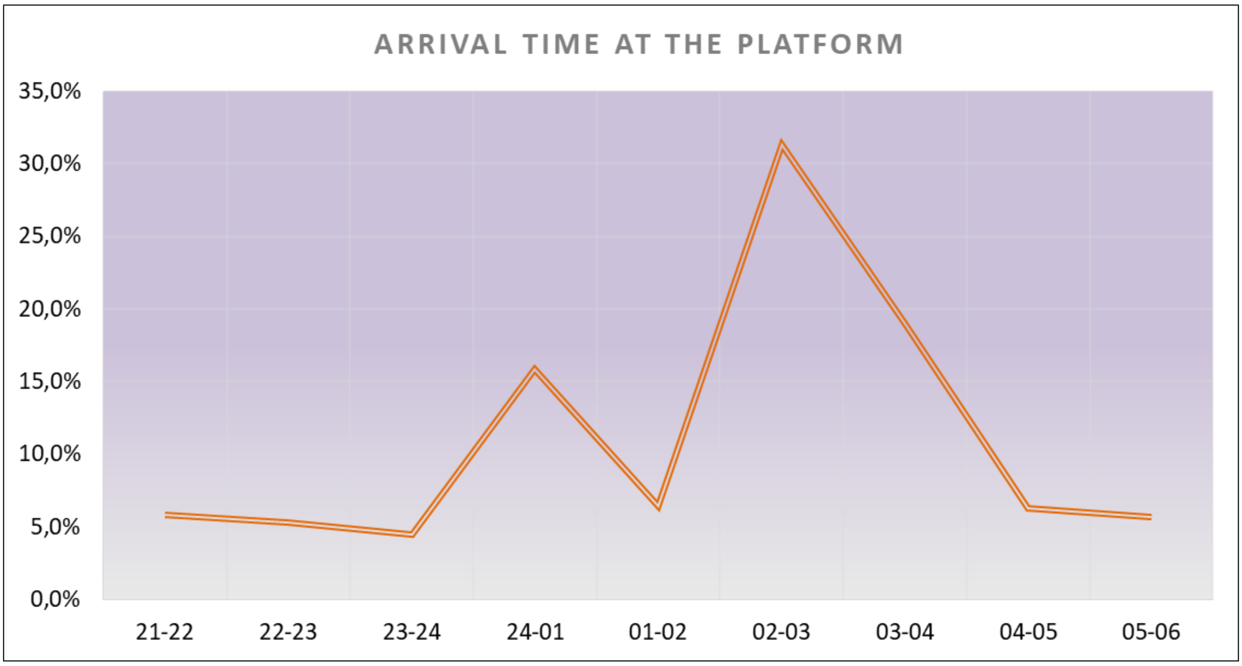


Figure 65 Approximation of the statistical distribution of the hourly arrival times at platforms, Q2 2019.

The third milestone of the delivery process, in case of deliveries temporary stopping at platforms, is the last mile. In the delivery path assumed in this analysis, the last mile is the moment in which the truck leaves the platform and it is headed to the final customer. During this milestone of the delivery process, the carrier also sends the ETA ("Estimated Time Arrival") message to Michelin's IS, which in turn displays the information to the customer.

Results of this third analysis reveal that during the second quarter of 2019, trucks have been leaving the platforms headed to the final customers between 07.00 a.m. and 11.00 a.m. Further, 82.74% of the overall quarterly deliveries started the last mile before 09.00 a.m., while almost 99% of the deliveries started it before 10.00 a.m.

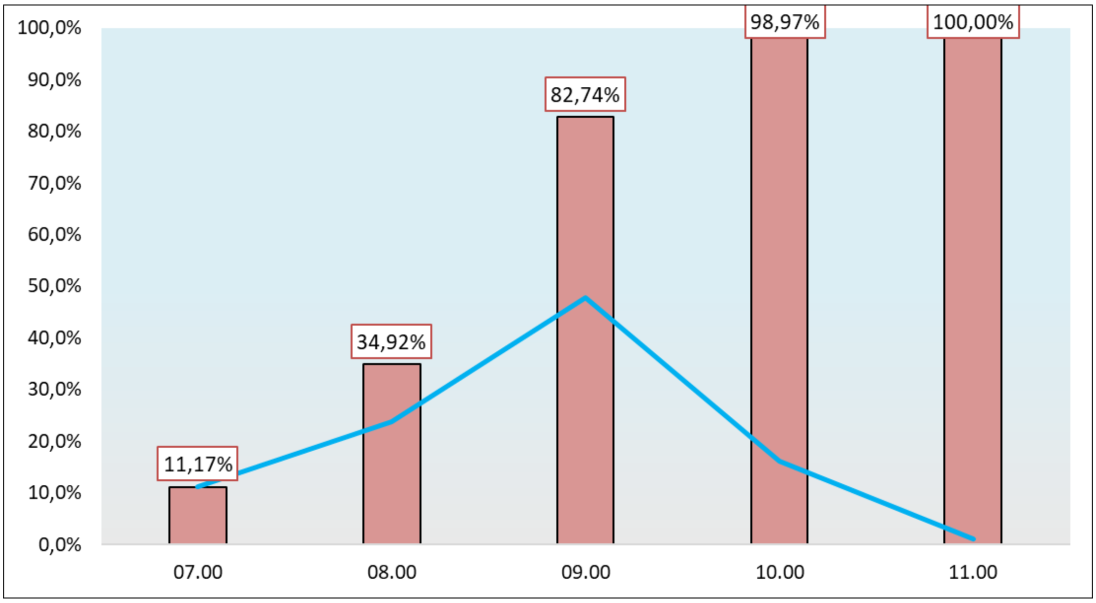


Figure 66 Cumulative Distribution of the starting hour of the last mile delivery, Q2 2019.

Having grouped together the observations of departure times in ranges of one hour it was possible to derive the frequency of the hourly departure time for customers and then an approximation of the statistical distribution (Figure 67). In this case, the curve registered just one maximum peak between 08.00 a.m. and 09.00 a.m., in which 47.8% of the overall quarterly deliveries started the last mile of the delivery.

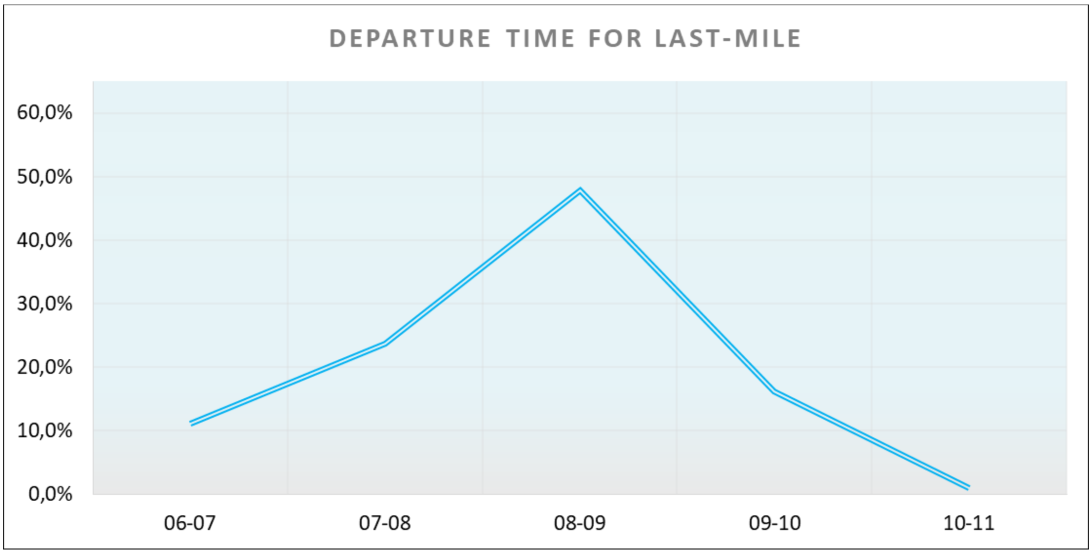


Figure 67 Approximation of the statistical distribution of the hourly departure time for delivery to customers, Q2 2019.

The last milestone of the delivery process is the moment at which the delivery is effectively realized. All the prior analyses are usually used to support the results of the analysis on the delivery time. As mentioned, the milestones of the delivery path, with their timing, are key influencing-variables of the delivery performance because to understand the distribution of the delivery time, it must be figured out the distributions of the timing of the other delivery milestones in order to make sure there has been consistency, compliance with agreed timing and so on. Hence, with a complete screening of the delivery path it is easier to identify root causes of potential issues such as delays occurred during the delivery process.

The results of the analysis reveal that during the second quarter of last year, roughly 60% of the overall deliveries realized before 13.00 p.m., while approximately 35% realized before 18.00 p.m. and only 4.39% realized between 18.00 p.m. and 19.00 p.m. (Figure 68)

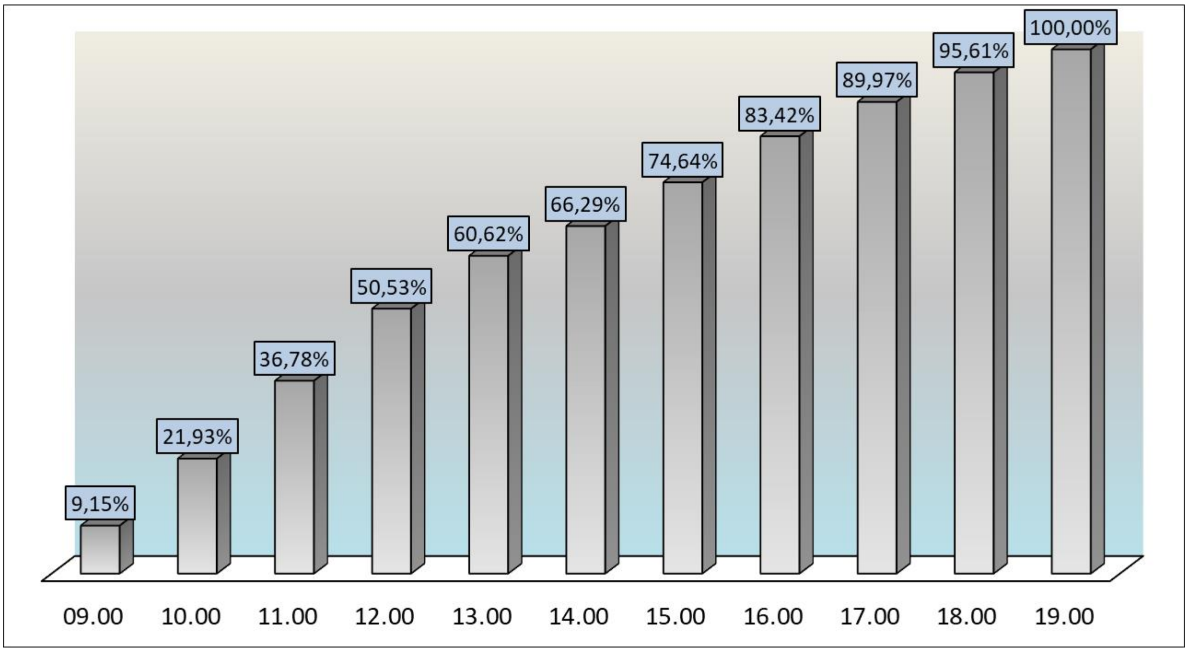


Figure 68 Cumulative Distribution of the delivery hour, Q2 2019.

In the same way as for the other milestones, having grouped together the observations of the delivery hours in ranges of one hour it was possible to derive the frequency of the hourly delivery time and then an approximation of the statistical distribution (Figure 69). The distribution of the delivery hour is not only the result of the delivery schedule and then number of customers that each shipping must fulfil. It is also subject to the preferences of the customers who in turn shape the curve. The deliveries realized in the morning must satisfy the needs of customers who asked for a morning delivery while the delivery realized in the afternoon must satisfy the needs of the customers who preferred a delivery in the daytime. What is important to verify is that the percentage of deliveries realized in the morning or in the evening keep up with the percentage of customers who had the specific request.

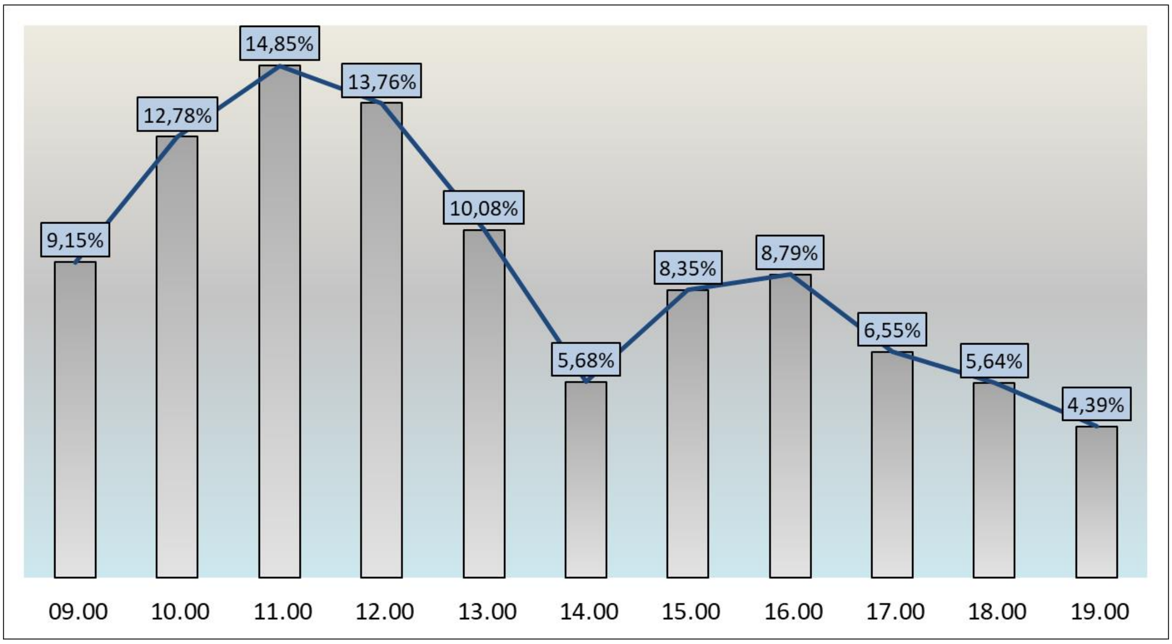


Figure 69 Approximation of the statistical distribution of the delivery hour, Q2 2019.

The other key delivery performance influencing variable whose analysis will be illustrated in this paragraph is the quality of the information provided by the ETA (“Estimated-Time-Arrival”).

The ETA is effectively one of the key information providing value added to customers, as mentioned in the paragraph concerning the analysis of customer needs. The ETA message is sent by the carrier at the moment in which it starts the last mile of the delivery process, thus, in the early morning of the delivery day. The information is expressed as a range of two hours; hence it is always a timeframe in which the carrier expects to deliver and never a specific single hour.

Further, once shared the first ETA, the carrier has the chance to update the information every 30 minutes in case he forecasts variations of the ETA greater than 30 minutes. Hence, based on the delivery progress the customers could receive updates of the ETA in case the first communicated is expected to vary by more than 30 minutes either in the lower bound or in the upper bound of the time interval.

The analysis of the quality of the information provided by the ETA involves different aspects:

The presence of the information: It concerns the number of deliveries that have displayed the ETA message at least once compared to the total number of deliveries.

The reliability of the information: It concerns how many ETA messages have finally turned out to be reliable, hence in how many cases the realized delivery hour was contained in the ETA with respect to the overall number of deliveries.

The average number of updates of the information: It concerns how many times on average the ETA message is updated during the delivery day for each delivery.

The average number of updates has a heavy weigh in the overall evaluation of the KPI. It directly influences the actual reliability of the information provided and in addition the satisfaction of the customer who would receive the information. Basically, the more the updates, the less the value of the information provided. With many updates of the information, indeed, it would be much easier to improve the reliability of the information while at the same time the customers would be unsatisfied of a continuously changing information. For this reason, the monitoring of the average number of updates the ETA has for each delivery was a main analysis conducted daily. The results of the analysis of the progresses carried out over the whole year 2019 reveal that the company has more than halved the average number of updates of the ETA, from 4.11 in January to 1.44 in December (Figure 70).

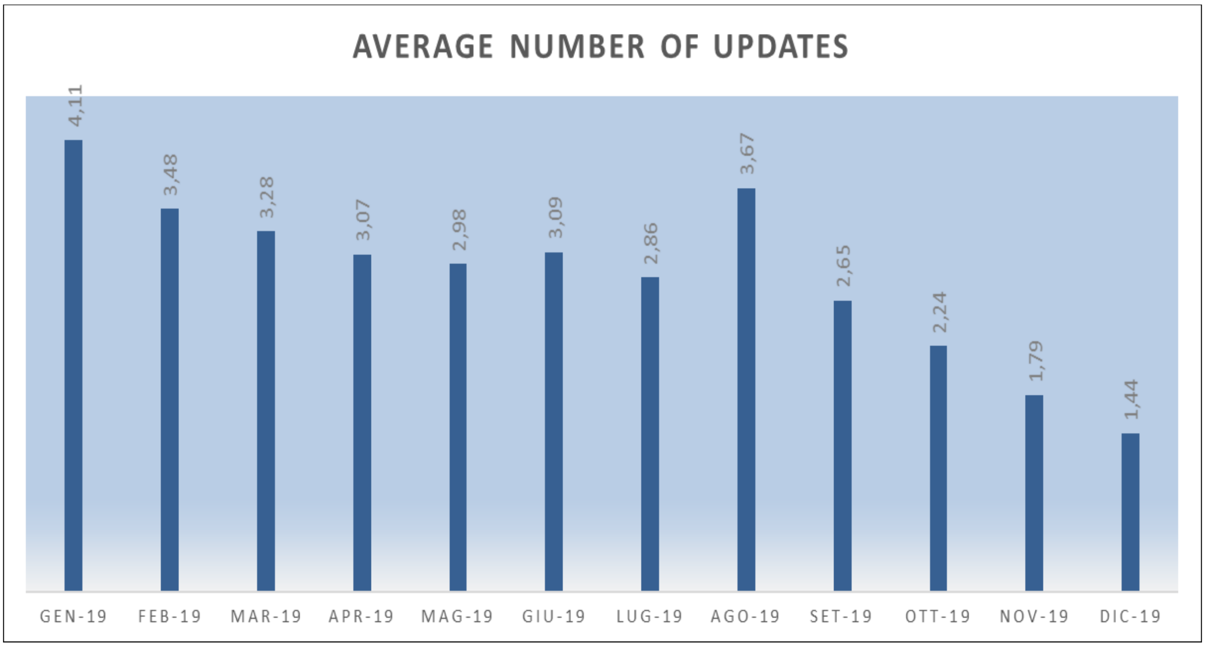


Figure 70 Average Number of updates of the ETA message in 2019.

5.9 Critical aspects of the project

This last paragraph has the main intent of describing the critical aspects related to the development of the project. As mentioned, this project disrupted the way in which Michelin's logistics was structured not only because of the its core features but also because of the completely new attitude that the project required from Michelin towards the supplier and vice versa. On one hand, the digitalization brought by the project into the logistics created a new flow of data intended to improve the performances of the logistics and the customer satisfaction. On the other, instead, the digitalization required that all actors involved in the process had the proper resources and competences to effectively adapt to the disruption it brought and benefit from its innovations. Further, as described in the third chapter of the paper, one of the building blocks for succeeding in the new digital era is to mitigate digital culture scarcity both inside and outside the company. Hence, adapting to the digitalization does not only require skills and talent, but also willingness to positively change and welcome the innovations.

Therefore, the critical aspects that will be described in the following paragraphs can be grouped into three main points:

- The attitude towards change: This is related to the theory of the natural resistance to change. Hence, the natural friction generated against change brought by a disruptive project.

- Relationship with the supplier of transportation: The project is a first attempt into the development of a new ecosystem in which trust ensures transparency between the company and the supplier of transportation. However, building this trust is a long enough process that involves cooperation, coordination and partnership.

- Digital infrastructure: This aspect is related to the importance of being prepared to embrace the digitalization. Thus, this aspect concerns the challenges resulting from the project in terms of digital requirements. One key requirement is having an effective digital architecture, which means having a business structure that is capable of holding new technologies and digital innovations.

5.9.1 The attitude towards change

Over the past 20 years, disruption has become a critical topic in the business community. Many companies have changed their organizational structure in order to adapt to new realities, but these changes always came at a price. There have been famous cases of big companies losing their market leadership, such as Kodak or Blockbuster. Also, there have been entire industries such as traditional taxi or car services disrupted by radical changes in their ecosystem. (Woods, 2018)

Before that lean management and business flexibility became key aspects to face the new dynamic environments, companies were not effective in changing the business practices, the strategic objectives and the overall mindset to accommodate new eras. Compromising the status quo has never been neither an easy nor a fast practice. To understand why it is generally complicated to effectively accommodate disruptive changes experts describe among the other things the concept of organizational inertia.

In physics, the term “inertia” is associated to the “principle of inertia” described by Newton in his first law of motion: «*An object not subject to any net external force moves at a constant velocity. Thus, an object will continue moving at its current velocity until some force causes its speed or direction to change*». The core principle of the Newton’s law seems to be true for businesses as well. Once an organization matures and falls into an established trajectory, it tends to stay on that path. According to the literature, there are both psychological principles and organizational systems that tend to describe the root causes of organizational inertia. In our case, it is fair enough introducing one of the psychological principles that contributes to create barriers to change.

Based on the report developed by the Sterling Woods Group, one key psychological principle at work is the negativity Bias. The negativity Bias, also known as the negativity effect, occurs when things of a negative nature have a greater effect on one's psychological state than neutral or positive things, even in case of equal intensity. Hence, this positive-negative asymmetry impacts the business decision-making processes and inhibit the flexibility to change. Thus, businesses and employees inevitably tend to stick with the status quo as long as the ecosystem in which they operate allows them to do so.

Clearly, the organizational inertia concerns the entire business proactivity to change. However, the same principles could be applied at an inferior level, not in terms of overall business ability to change but in terms of actors involved in a disruptive project radically changing specific work methods.

Therefore, every project oriented to change the status quo must also manage the friction generated by the sum of the resistances to change resulting from the stick up with the status quo approaches of the actors involved. The Bib Track project, as mentioned in the previous paragraphs, disrupted the logistics operations and then required both Michelin and the supplier of transportation to make some radical changes in their activities. The fact that the supplier of transportation was directly involved in the development of the project means that it represented another key resistance force that inevitably contributed to slow down the evolution of the project. Thus, in theory, the greater the number of actors involved in the development of a disruptive project, the greater the resistance force that will be produced against the change.

Consequently, companies must take into account this critical aspect and find a way to offsetting it. Managing resistance to change is not effective if firstly it is not conducted a process of identification of the true nature of that resistance. On this matter, there could be several root causes explaining why employees tend to develop such opposition: impact on current job role, fear of job loss, lack of understanding of the reasons to change. After having understood the true nature of resistance, companies can start dealing with it. Paul R. Lawrence in its article titled "How to deal with resistance to change" describes that one of the main solutions adopted for dealing with resistance to change is « to get people involved to participate in making the change. » Then, employees must be active part of the change rather than simply imposed to follow the change. (Lawrence, 2020)

5.9.2 The relationship with the new partner

The Bib Track project has been a very first step for Michelin's logistics to embrace the digital era. The project, as conceived, brought different innovations into the logistics operations, and these innovations are not all driven by a digital mindset, then do not concern only technological innovations. This reasoning seems to be coherent to what has been described in the third chapter of the paper, in which the paragraph on the building blocks for DSC success explains how embracing digitalization in your business is not only a matter of new technologies.

In detail, among the project ‘s requirements one of the most important one concerns the role of the carrier within the project. The carrier is supposed to be an active part of the project, since it is effectively the main character of the new flow of information that the project wants to generate, not to mention that it is the carrier who basically fuels that flow of data. Therefore, the carrier could not be considered anymore as a supplier, in this case for transportation, its role was designed to be that of a partner. In other words, the project is not only intended to enhance the customer centricity, but it also wants to be a first attempt in creating a collaborative downstream supply chain, structured as a digital ecosystem, in which information flows through all the processes and from all the functions, including the supplier of transportation, in real-time.

The Institute for Supply Management (ISM) defines the supplier partnership as follows: « A commitment over an extended time to work together to the mutual benefit of both parties, sharing relevant information and the risks and rewards of the relationship. These relationships require a clear understanding of expectations, open communication and information exchange, mutual trust and a common direction for the future. » Generally, there are many advantages resulting from partnering with a supplier such as reduced costs, increased efficiency, consolidation of the supply chain, and continual improvements of operations. Despite that, creating this kind of relationship is not an easy process and instead requires time.

In the project, the relationship with the supplier of transportation has been a critical aspect affecting the development of the project itself. The supplier was designed to have a key role, because he was the one supposed to fuel the new flow of data necessary to improve customer satisfaction and his distribution performance. However, this supplier’s empowerment brought accountability as well; thus, the greater the importance and the higher the responsibility. The supplier must feel as a main actor involved in the realization of the project and as a main actor, he must understand what he is contributing to achieve together with the company and not focus on how much he is right or good towards the contract.

In the new ecosystem that the project aimed at creating between the supplier, the company and the customers, it is trust that ensures transparency and makes the collaboration work among the actors involved. According to the literature, trust is mostly created when relationships are based on long-term focus and inspire mutual benefits and common objectives. Hence, partnering with the supplier could be a good strategy to enhance trust between the parties.

In the new digital era, it is more common to talk about “digital trust” with ecosystem partners rather than simply trust between them. The reason is that the new connected ecosystem is created by the data shared by the different ecosystem partners, consequently the “digital trust” concerns the transparency of the data shared. Thus, real data representative of the pure flow of data automatically generated during the processes, and not data that have been manipulated to produce distorted results. As a matter of fact, data security in the new collaborative environment is a real concern. From the study of Pwc (pwc, 2016), it emerged that the unauthorised data extraction or modification within company-internal data flow is one of the top data security concerns (Figure 71).

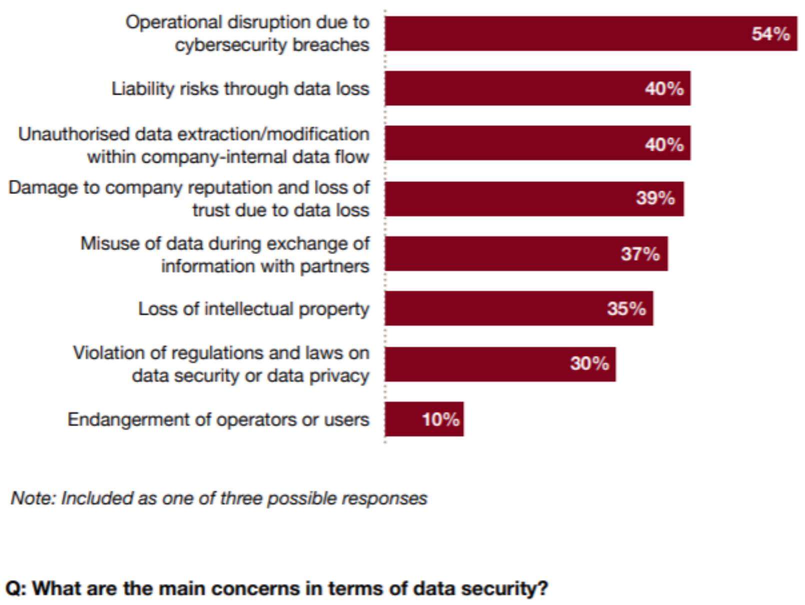


Figure 71 Top data security concerns between ecosystem partners

Building a solid trust between the parties involved is not easy. The core issue is that it is difficult to find the right balance between leveraging on the basis of the contract and motivating on the basis of trust to achieve the same results. The dilemma is then whether to stick with the contract and eventually enforce it to get the promised results or trust the partner that he will be able to achieve those promised results. In the first case, perhaps, it would be possible to get the short-term results faster, but at the same time pulling the supplier away, then negatively affecting the long-term relationship and objectives. While in the second case, despite short-term results are more likely to delay, the long-term relationship would be much better preserved and the same would be also the long-term objectives with it.

Even though Michelin’s approach in the project was much closer to the second approach it took time to establish this relationship more based on cooperation and collaboration and less based on duties and contractual agreements.

5.9.3 The importance of the digital infrastructure to support the project

The last critical aspect of the project concerned the importance of having in place a solid digital infrastructure that allowed to implement all the digital features provided by the project. Researchers define digital infrastructure (DI) as the physical assets required to operate technologies such as digital communication, computing or data storage. In other words, DI is the prerequisite that allows companies to embrace the digitalization and everything that comes with it, such as richer connectivity, powerful technologies, faster communication, data mining and so on.

For the development of the project, building a solid digital infrastructure was one of the first and most important steps. Michelin launched the Bib Track project at European level, thus, involving more than 10 countries and at least more than 10 different suppliers of transportation (several countries have more than one supplier of transportation for the territory), hence, the project was from the beginning intended to involve an extensive network of participants.

To build this new digital ecosystem, including all the suppliers of transportation and the customers on European territory, Michelin relied on a new partner, who had to develop a new IS that was supposed to become the hub of the information network that the project intended to create.

The new IS must manage the flows of information generated during the delivery process and exchanged in the form of EDI messages with the TMS of all the European suppliers of transportation. Therefore, building a digital infrastructure that was solid enough to support heavy, frequent and rapid exchanges of data has been a real challenge.

As described in the fourth paragraph of the first chapter of the paper, in the new digital structure the new IS has key roles:

- It generates and sends to the TMSs the Electronic transportation documents (“E-D3”) necessary to start the delivery process.
- It must collect large amounts of data simultaneously from different sources (TMSs).
- It must send and display information on delivery process to customers of all Europe.

In the first year of development of the project, the supplier of the IS had to put a lot of effort to increase as much as possible the efficiency of the system, mostly in terms of velocity at which information were processed and exchanged in the network.

However, the prerequisite of a solid DI to support the project is not only related to Michelin’s Information Systems. The supplier of transportation also had a key role. As a matter of fact, Michelin’s new IS was one key system involved in the exchanges of data, while the others were the TMSs of Michelin’s suppliers of transportation over the territories. The Transport Management Systems (TMSs) of the carriers must receive the EDI messages containing the “E-D3” generated by Michelin’s IS and must send back EDI messages related to the delivery tracking process. Hence, while Michelin’s IS must be solid enough to collect and display to customers large amounts of data from different sources at the same time, the TMSs of the carriers must be able to correctly send these data on delivery tracking.

Since Michelin’s IS could display, then communicate, to customers only the information it received from the TMSs of the carriers, the activity of the suppliers of transportation essentially represented the input to make the exchange of data possible between the systems.

However, even for the supplier of transportation the exchange of these data by means of EDI messages was not an easy task. What must be taken into account even before the digital infrastructure, indeed, is the organizational structure of the supplier of transportation. Most of the times, in fact, the supplier has in turn many other logistics partners, and just in a very few situations it is a sole company.

The organization and the number of the logistics partners of your supplier is a “must-know” information before committing in any digital project. Certainly, the wider the territory of competence of the supplier, the more the number of logistics partners it may have involved.

Therefore, in a deeper analysis of the information network that the project wanted to establish in which Michelin’s new IS was the hub, the Transport Management System of each supplier of transportation is in reality the hub of the information network between each of the suppliers and their logistics partners (Figure 72). Consequently, the input messages that Michelin’s IS receives from his suppliers of transportation over the European territory are the result of what the carriers are receiving from their respective logistics partners (Figure 73).

The critical aspect of the project is then related to the fact that the information network that it intends to create does not involve only Michelin’s direct suppliers of transportation, but it indirectly involves their logistics partners as well. However, those third parties never took part in the agreement on the development of the project, and then each of Michelin’s direct supplier of transportation must agree the investments, risks, and generally the efforts separately with each of their logistics partners.

This aspect had an important impact in the development of the delivery tracking process as well. In fact, the effort of the different Italian territories has not been homogeneous over time. While certain regions were performing well, others performed badly, and this was a clear sign of the different investments and efforts put in place by the different regions.

Therefore, the scale and the number of actors involved is a key influencing variable for the development of projects aimed at creating an information network in which large amounts of data must flow from different sources and must converge in the same node before ending up together in only one

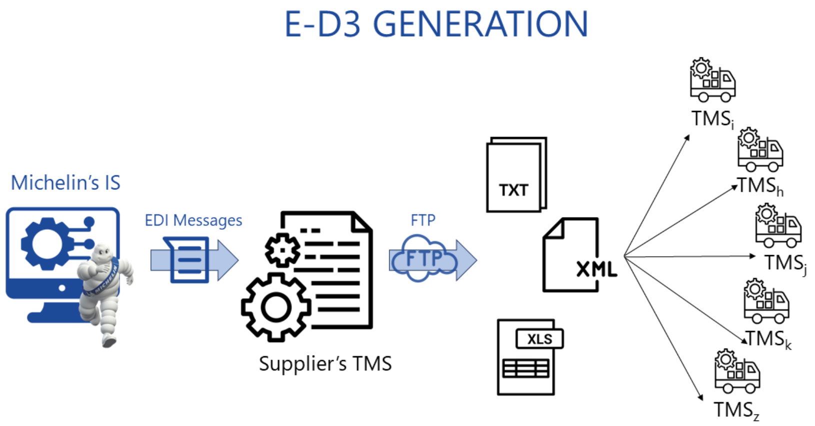


Figure 72 Digital architecture of the supplier of transportation.

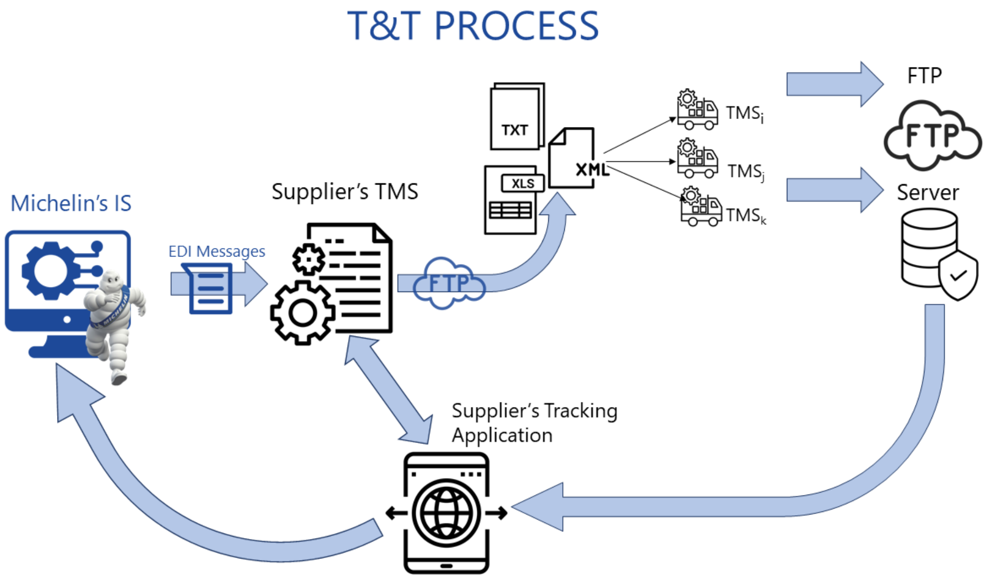


Figure 73 Flow of data in the T&T process.

5.10 Conclusions

Digitalization is disrupting every business industry. Companies worldwide are reconfiguring their supply chains in order to embrace the digital transformation, that entails new and advanced technologies that bring new opportunities for growth but also new challenges. Innovation is taking place in a complex and dynamic environment in which it is up to the companies whether to capture it or let it go, with all the consequences it may bring.

Michelin is one of the largest tire manufacturers worldwide and being a leader in the industry means keep up with new trends, technologies and do the best to match the customer expectations.

The Bib Track project gives a remarkable proof of Michelin's approach towards the digital transformation. The project has been developed on the basis of customers' needs, thus, by listening their requirements and expectations, with the core purpose of maximizing their satisfaction through the features of the project.

It has been described (2.5 Building Blocks for DSC success) what are the building blocks to succeed in the digital transformation. Customer centricity and collaborative supply chain have been mentioned to be two of them. Customer centricity means focus on the entire customer journey and enhance the customer satisfaction at every touchpoint. The key is that the customer journey must not be thought as restricted to the control of the producer, rather, it must include all the actors in the supply chain, including then suppliers, external providers and partners. This is why adopting a collaborative approach throughout the supply chain is another building block for the digital transformation success. The company, the suppliers and the partners must be part of the same ecosystem in which the customer is at the centre; then his satisfaction must be the common objective.

The Bib Track project effectively relied on these new pillars and launched Michelin's logistics towards a new age. The customer centricity is indeed the underlying principle of the project, thus, creating new connection points with the customers by giving them visibility over the delivery process and then providing them required information while at the same time the company can analyze their requests and feedback. The collaborative approach with the partners and providers is another prerequisite for the development of the project, since the transportation activities are outsourced by the company. Then, the new data flow is actually generated by the logistics partner while it must be collected and managed by Michelin in order to make it available to its customers afterwards. Consequently, it is collaboration that ensures digital trust, common objectives and then shared benefits.

The project core features are also consistent with the digital innovations expected from the logistics 4.0 that allow an end-to-end visibility of the logistics process, digitalization of paper documents and a data-driven strategic approach. The Track and Trace feature allows the company to have full visibility over the delivery process, hence, Michelin can deploy this transparency to primary notify and inform its customers and then optimize process performances.

The T&T feature in the outbound logistics creates an important added value in the value chain. Customers will extract most of this added value and will improve their supply chain performance in terms of scheduling, planning and then order fulfilment. Michelin captures part of this value added by optimizing the internal processes mostly in terms of timing. In chapter 4 of the paper, (4.4 KPI of the warehouse), timing is defined as a key-influencing variable of costs and performance for the EDC.

Every activity, from production to distribution to the final customer, is constrained by a specific timing. The reason is that Michelin relies on accurate forecasting activities to match as much as possible the market demand, then pushing hard to have a smooth production process that allows the company to minimize the stock of products. The accuracy of forecasts depends in part on the assumed timing at which the different activities are practically performed; hence, a better timing of those activities can effectively benefit the estimates and improve the flexibility of the production process.

Currently, indeed, data analyses allow to study the realized hours of all the milestones of the delivery process and make statistics to improve the accuracy of planning and scheduling of the different activities. Further, a more precise planning and scheduling can provide significant time savings, which can be cumulated to reduce the overall process timing or at least to benefit critical activities, thus, those with a lower margin of delay.

Therefore, the project gives the company the chance to use the new data flow to improve decision-making activities, monitor the performance of the logistics partner and improve the overall operational efficiency of the delivery process while increasing the customer satisfaction.

In this paper, the Bib Track project has been described based on its core vision and current developments, which are those I have been actively involved. However, the project also provides new evolutions for the near future.

It has been described (4.1 MICHELIN Downstream SC) the structure of Michelin's downstream architecture, characterized by a physical separation between the production facilities that also stock the final products and the distribution centres that instead collect the products from different production facilities to distribute them over the territory of competence.

Next years will see the project extended to the entire downstream supply chain, then including also the distribution phase from the production facilities to the distribution centres. A full visibility over the downstream processes would allow the distribution centres to have a clear traceability of both the inbound and the outbound.

In that case, Michelin could even increase the share of added value captured as a result of this evolution of the project. Not only it would be possible to efficiently combine the inbound and outbound planning that in turn would let the company optimally manage resource allocation, but at the same time it would give the company the transparency needed to know about delays, issues, or any other problem in real-time when they occur. As a result, the distribution centres could develop a greater reactivity against exceptional events and adopt countermeasures to contain them.

To conclude, the Bib Track project has been a real disruption for Michelin's logistics, and it is evidence of a company that is embracing the digital transformation in its processes in order to keep up with technological innovations, pursue new trends and continuously readapts to fulfil the customers' expectations.

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