POLITECNICO DI TORINO

Master of Science in Automotive Engineering

Final Project

Finished Vehicle Logistic and Transportation: Market Analysis and Application of Optimization Processes

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"E adesso prova a leggermi le stelle
e a dirmi cosa arriverà dal mare
se sono sogni da fotografia
o da buttare via
C'è questo maestrale
e tutta questa musica
che non mi lascia andare
non si dimentica
ma se veddemu
in tu mezo du mä
suvia a' n'unda
che nu pö turnà
sempre anà, anà, anà"

Cristiano De Andrè, Sempre Anà

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Introduction

This paper is the result of an internship experience in a Logistics company mainly involved in the road transport of vehicles in Italy and Europe: this company is "i-FAST Automotive Logistics" based in Turin. Before proceeding, I would like to thank all those who have allowed me to live an exciting and rewarding work experience, both from a professional and human point of view. In particular, during these 6 months, I had the pleasure to work in the Head Quarter of the company, in contact with the Logistics, Operational, Quality Safety and the Administration Commercial teams. Each of them has a very specific role: from the logistic and commercial management of the network dedicated to the transfer of vehicles, to the relationship with various suppliers up to the control operations concerning the movements and the performances related to them, including all the fiscal, commercial and accounting duties. Moreover, the Team deals with the ordinary and continuous relationships with suppliers and customers regarding the organization and execution of the management of orders, loading of cars and the completion of delivery operations.

The objective of this paper is, in a first phase, to provide an overview of the current situation of the outbound logistics sector through the knowledge learned during the internship experience. Such knowledges, only partially deriving from the university course of study, constitute the base on which the activity of stage has been built. Secondly, through the activities carried out in the company I had the opportunity to test myself in the optimization and engineering of internal processes, which, as will be explained, is necessary to take advantage in a complex sector such as road transport.

The paper is structured on several chapters, each dedicated to a specific topic:

The first chapter focuses on the current condition of the automotive sector and the possible scenarios which, in the short-medium term, could describe the evolution of the sector itself.

In the second chapter it will be possible to turn to the main theme of the thesis after defining all its possible influences from the automotive sector, that is the Outbound Logistics sector, more precisely the transport of finished vehicles by road. Here, it will be analysed, as in the previous chapter, the current situation of the sector and possible trends in Europe.

Finally, in the third chapter, a description of the company at which the present thesis has been prepared is provided. Then, the different activites carried out during the internship will be detailed, describing the various departments involved and results obtained.

In order to best conduct the analyses on the automotive and transport sector, the different driving forces that push for changes and actively influence the automotive and logistics sectors are considered.

To best perform these analyses, it is appropriate to first analyse the current situation of the two sectors and then apply the Porter's Five forces Model. This is a typical tool aimed at positioning the company in the current environment from the point of view of the structure of the value chain and market competition, with the aim of identifying the best strategies to apply considering the current evolution of the European market.

Chapter 1

Automotive Sector

Before analyzing the real subject of this thesis, namely the finished vehicle logistic market, it is necessary to remember that the road transport sector operates and cannot be separated from the more strictly automotive dynamics. For this reason, it is necessary to carry out an holistic analysis first of all on the automotive sector in order to define the influences of the sector.

As it will be possible to understand from the following rows, the current sector is looking for changes to evolve and to minimize the causes of a crisis that has hit the world market in full, especially the aspects that will be analyzed.

The automotive sector is called to change its "modus operandi" and grow in the direction that will allow it to recover from the current world situation. The last two years, given the events that have occurred, including the COVID-19 epidemic, have anticipated the need for changes. In fact, the collapse of sales, and consequently of production, is pushing companies in the automotive sector to seek new strategies. Moreover, in addition to these needs, introduced by the global crisis, we must necessarily remember the evolution of environmental regulations, which are becoming more and more rigid for the development of new vehicle's technologies. Other difficulties that are currently being faced are the lack of finding the appropriate components, the increase in the price of raw material and not least the change in the habits of the population that must be properly studied and analysed to exploit the opportunities that will result.

1.1 The International Scenario

In 2019, 90 million vehicles were produced globally. About 25% of these were produced in Europe, where Germany, France, United Kingdom, Italy and Spain are the main producers, both in terms of number of plants and number of cars manufactured. In Europe, the automotive sector employs almost 14 million people (about 6% of European workforce), considering both direct and indirect employment. Moreover, Europe is the main world investor in Research and Development in the sector, to the detriment of the USA, Japan and China, which invest less than half the amount invested by Europe. The following image shows the number of plants and vehicles produced by the major European countries [3].

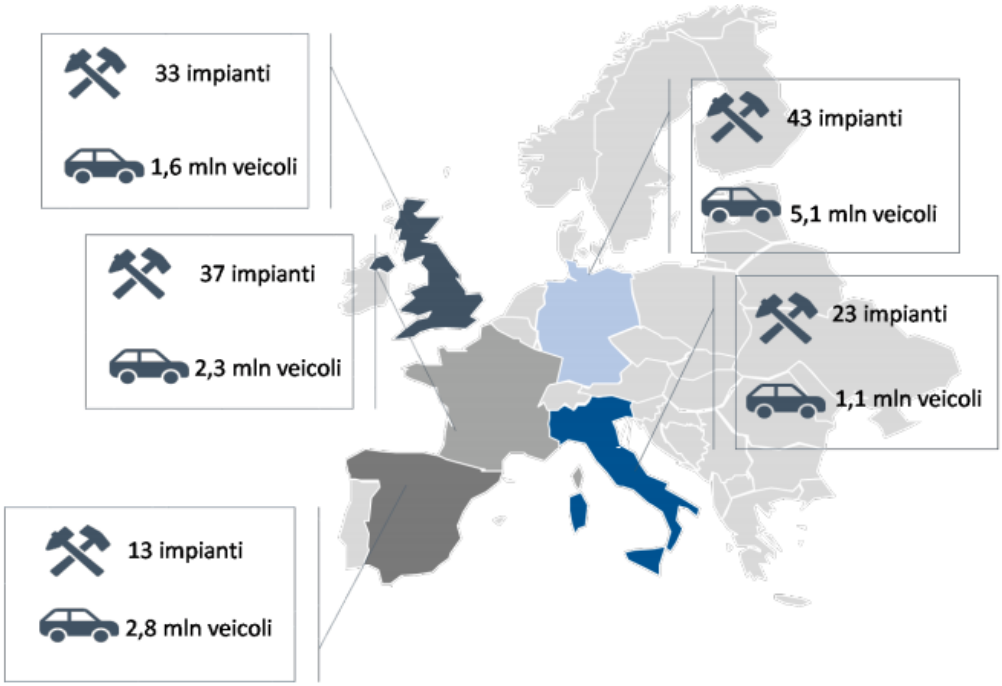

Figure 1.1: Plants and vehicles produced in major European states (2018), (Source: OICA, ACEA 2020)

The automotive sector has always shown great capacity for recovery after crises, as was the case with the 2008-2009 crisis, after which the sector recorded an annual growth rate of 6%. On the contrary, it happened differently in the biennium 2018-2019, which caused a 4% contraction justified by the understanding of the environmental consequences brought by transportation, which put a question mark, not to say a cross, over Diesel motorizations. Moreover, making matters worse was the new conception of the vehicle that is being propagated, namely that the car is a service and not its own good.

It was during this unstable period for the automotive industry that the global Covid-19 pandemic induced an even greater crisis. It caused the prolonged closure of a large number of plants from March 2020, in a period of deep changes that involved large investments in the development of both traditional but less fuel consuming engines and electric batteries. In April last year, the registration of new vehicles in Europe touched historic minimums, previously only seen during the Second World War, with a drop in production of over 20%. According to the OICA, IHS 2020, it will take at least 3 years to recover pre-crisis levels. This analysis was made taking as a reference point, the two-year period 2008-2009, which saw the market losing 15% and recovering the following year. Below there is an image showing the trend of the sector in recent years and a short-term forecast for the post-Covid-19 situation.

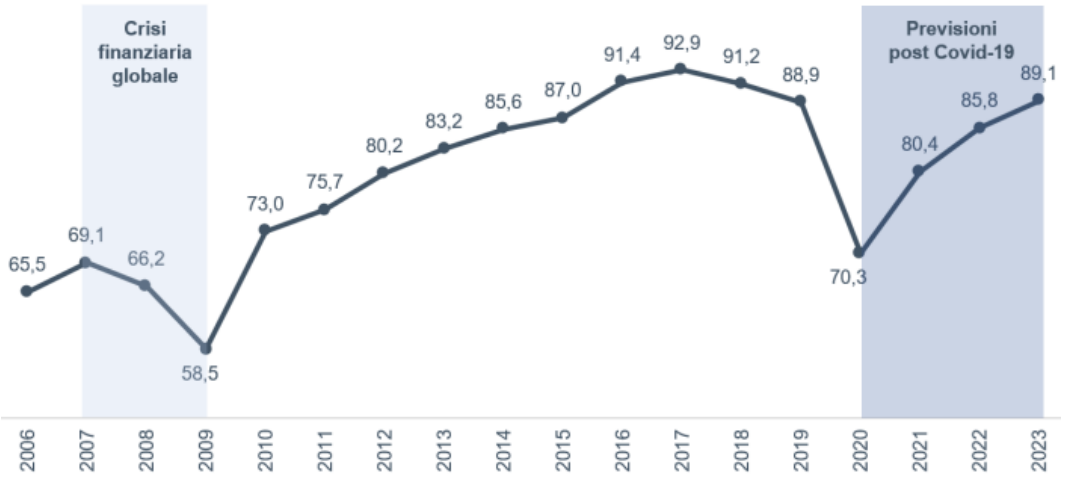

Figure 1.2: Global light vehicle production (mln, 2006-2023F), (Source: OICA, HIS 2020)

As it is easy to think, every single country globally will have different recovery times that will try to be minimized also thanks to the support of the various governments, which have introduced support measures, such as subsidies for the purchase of electric cars, incentives for scrappage and payment extensions with zero financing rates. In addition, several states have followed the example of the United States which, to counter the effect of the lockdown, have allowed online sales of cars by spreading the e-commerce approach to many dealers. As for the situation in Europe, according to the European Automobile Manufacturers Association (ACEA), the loss in production was about 2.4 million vehicles, about 15% of the vehicles produced in 2019.

To have an immediate image of the consequences brought by the global stop of the sector, it is enough to think about the stock performance of car manufacturers. Between March 2020 and last December, all the major players experienced a collapse in their shares, from 15% for Toyota to 62% for Renault, with the ex-FCA group losing around 45%. The most resilient to the crisis were the Japanese manufacturers Toyota and Honda, which had previously oriented their production towards alternative and hybrid injection systems. In contrast, European OEM such as Volkswagen and Renault, which were going through a transition process, were the most impacted.
Below you can see the performance of the stocks of the major OEMs in the pre- and post-Covid-19 period. Assuming as value 100 the value of each of them on 02/01/2020.

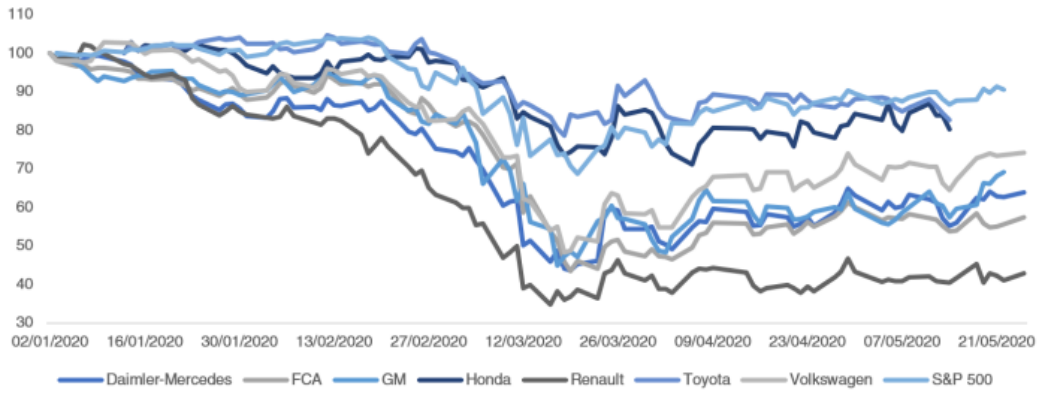

Figure 1.3: Performance of the stocks of the main automobile manufacturers (02/01/2020=100), (Source: Thomson Reuters)

The only positive exception to be noted in this period was the case of Tesla, which in little more than a month recovered almost completely the losses recorded since the beginning of the crisis. This dynamic shows the competitive advantage of positioning a niche market with high added value and innovation such as that of top-of-the-range electric vehicles. On the other hand, electric motors are the technological horizon with which all car manufacturers will have to deal over the next decade. The one to come will be the greatest revolution ever experienced by the automotive sector, which just in the period before the pandemic had already given the impulse to the processes of aggregation and partnership [4].

1.2 Main Driving Forces

The automotive industry is changing radically, the digital revolution and new technologies are changing the concept of the car and people's mobility experience. Consumers have increasingly complex and diversified needs and no longer accept compromises. The future of the car can be summarized with the word CASE, Connected, Autonomous, Shared and Electric. The strategies of the automotive sector must adapt to the change. Innovation, connectivity, population growth and environmental sustainability are the factors on which to focus. Companies that move in this direction will have the best insights on their customers and will be able to take advantage of the changes and market opportunities expected in the coming years. The creation of personalized shopping experiences is the main challenge involving car manufacturers and sales networks. Considering the specific needs of the customer will become a starting point to achieve a unique and memorable customer-experience.

We are in a world where technology has reached levels we could never imagined, everything is now networked and connected. With the introduction of cell phones and the internet, growth has been exponential and will reach unforeseeable levels for our thinking. These are just two of the many pillars pushing for a radical change, from all points of view, on one hand to survive on our planet and on the other to benefit from what humans are able to create. Nowadays, there are many factors pushing for radical change. Let's take in analysis the automotive sector, perhaps one of the most important in the world, which maintains records both from the point of view of the employment of people and therefore from the generation of value. However, at the same time it destroys our world, through the emissions of the products themselves but above all for everything that lies behind (production processes, etc.). We are at the beginning of a new era, a time when change is not an option, it is a necessity. So, what the current challenge is? Will we be able to support them in the most appropriate way and gather the benefits? Today what pushes us to think about the future is the research towards eco-sustainability through new engines that will slowly and surely take the place of conventional engines; this will be implemented by the development of new technologies aimed at finding a new way to power vehicles of any kind, from cars to trucks. The car of the future, as previously mentioned, will be Connected, Automated, Shared and Electric - or "CASE" for short. Each of these individual adjectives, then, will be one of the driving forces driving change in the automotive industry.

- **Electric**: First of all, it must be remembered that the market penetration of electric vehicles is not initially driven by the structure of demand in the market economy but is primarily a matter of policy and regulations aimed at the survival of our planet. Focusing on this point, it is clear that the automotive world will undergo a strong evolution especially in the way of action and therefore in market strategies. The new decade in which we are just entering will allow us to see the first concrete results of what is now only a prediction.

  A possible future scenario will be a world in which car companies will have spent many of their investments in researching new technologies and implementing low cost solutions; thus, making what today can be considered a niche market, become a mass market that will therefore allow to obtain the first concrete results. A world where city centres have developed infrastructures suitable for the electrification of vehicles and autonomous driving, thus reducing CO2 emissions and improving the wellbeing of customers; where citizens have really understood the technological message and left aside prejudices; where new generations will lead the development following the guidelines now established.

  As reported in the previous chapter, the health crisis that hit the whole world last March caused a worldwide economic crisis, mainly affecting the automotive industry at the exact moment when so many sacrifices were being made to develop the above mentioned technologies. This crisis has destroyed the sales sector which, as a consequence, has affected the investments that were being made for technological development. Above all, it has worsened the already poor view of the customer towards the electric car, already considered too expensive and with battery performance not sufficient for personal needs.

  This situation has either destabilized or delayed every possible scenario previously hypothesized. As much as OEMs were focused on the future, confident in the current solid economic situation, they have now necessarily had to slow down their progress. Among the many assumptions that can be made about the evolution of technologies, many depend on this current health situation. If it resolves itself by the end of 2021, which is unthinkable but at the same time why not hope for it, companies will be able to recommit themselves as they were doing before in the direction of change. This change, as mentioned before, will include a new zero-emission mobility and at the same time will try to link it digitally in such a way that it is easier to manage and at the same time satisfies customer demands through personalization

and connection.

However, each of these development steps has a strong dependency on possible future events and technological developments. In terms of electrical usage, it is hoped to achieve major breakthroughs in research and improvement of current performance by 2030. By this year, it is expected that at least 50% of cars sold will be electric. Leading global companies, such as Toyota, have already made significant investments in this area, aimed at developing batteries that can provide levels of range and recharge times/methods comparable to cars with traditional engines. What will company that can't afford these investments do? Will they be forced to create partnerships with more technologically advanced companies, or will they have to stand by and watch? These are other questions that need to be asked. Because if we believe that in the short-term future most cars will be electric, we must also consider the cost of these technologies and the willingness of automakers to offer various models, from city cars to luxury cars, which are attractive but above all accessible to the population. At the same time, to achieve this development it is necessary to implement a new type of infrastructure, suitable for charging these vehicles, which today is not non-existent but almost. To do this, it will require huge investments from the states, are we sure they will be able to afford it? And finally, as mentioned above, it will also be necessary to be able to attract customers to this innovation. This will be another big challenge for car manufacturers who, through important market strategies and advertising moves, will have to be able to raise awareness and engage the customer towards these new products.

- **Autonomous**:Is it fantasy or is it really the next great invention? Probably it really is the next big invention. At the moment only a few cars are using this technology as the main feature of their product (see Tesla), the others for now are only implementing it as a support tool aimed at helping and simplifying the customer's management of the vehicle. In the future, with declarations on autonomous driving lvl.3, 4 and 5, it will take a crucial role in the evolution of driving and public transport. Here the questions to be asked are many and concern the possible influences that this technology will have on the world scenario. Will we be able to manage a traffic system with autonomous vehicles and conventional cars? Will we be able to avoid, if not eliminate, crashes? Will we be able to informatically support all these data transfers at the same time? Will we be able to provide the right infrastructure for transit and refuelling of these vehicles? Will robot-taxis be the ones driving the streets, or will private individuals own these vehicles? Furthermore, this change will not only impact the automotive industry, so many other industries will be affected. One can think of the role that insurance companies will have to play as they will suddenly have to potentially insure large fleets of these vehicles; will gas stations still be used in the same way? And finally hospitals, there is a conviction that these autonomous vehicles will be much safer than the cars we see on the roads today. So, we're going to see fewer crashes obviously, this is going to have an impact on the healthcare business. The reality that's on the horizon in the next 20 years is to have vehicles operating autonomously in geofenced environments. Geofenced essentially implies that the vehicle owns high-definition mapping of the navigational terrain, identifies infrastructure, identifies regulations, and is able to handle a set of limiting cases, which are the most difficult cases for the car to navigate.

  Let's take a step back to report some knowledge about autonomous driving and its development. Autonomous driving refers to cars equipped with driver assistance systems that are able to control the speed and direction of the vehicle in order to avoid hazards. These technologies, called ADAS (Advanced Driver Assistance Systems) can be used in combination with each other in order to provide a certain level of assistance during the journey. Because of this ability to have different systems working together, different levels of autonomous driving have been defined from 0 to 5. For each of them, the International SAE (Society of Automotive Engineers) has classified the different driver assistance devices present in the various levels.

- **Autonomous driving level 0**: as can be deduced, are all cars on which there are no electronic devices capable of providing active assistance to driving. Systems such as ESP and ABS are not considered as driving assistance, as they intervene to prevent critical situations and are now mandatory and present on every newly manufactured vehicle. In these vehicles, it is the driver who must maintain control of the vehicle to avoid dangerous situations.
- **Autonomous driving level 1**: cars in this level are equipped with systems that can intervene on longitudinal or lateral control and operate the brakes, accelerator and steering. The driver must still maintain control of the vehicle by means of the steering wheel and pedals. Systems of this type are the Cruise Control, which allows the driver to set a certain speed to be maintained automatically, or the Lane assistant that deviates the vehicle's trajectory to stay on the path.
- **Autonomous driving level 2**: this level is defined as when the driver can only leave control of the accelerator and steering to the systems installed in particular situations. These systems are able to take control of the brake and accelerator while driving in a queue, up to certain speeds. However, this is only possible under certain conditions, i.e., roads with good asphalt and clear signposts that allow the system to recognize them and, in this case, can also control the steering.
- **Autonomous driving level 3**: this level is defined as highly automated driving. The systems are able to assume responsibility for driving functions and at the same time recognize external environments that are beyond their limits. In these cases, the system deactivates itself by providing a warning to the driver that he/she will have to recover the control of the vehicle. This last part has been found to be a critical issue that has led some OEMs to abandon the idea of using this level.
- **Autonomous driving level 4**: this level of autonomous driving defines cars as independent in traveling in certain situations, such as highways or parking areas. Then allowing the driver to activate this sort of "autopilot" on highways and regain control of the car once they leave them.

– **Autonomous driving level 5**: in this last level of the SAE classification, in which assistance is maximum, there is no intervention by the driver, who becomes to all effects a passenger. On cars equipped with these ADAS systems, steering and pedals can be removed [5].

An image summarizing the various levels of autonomous driving and responsibility for vehicle control is shown below.

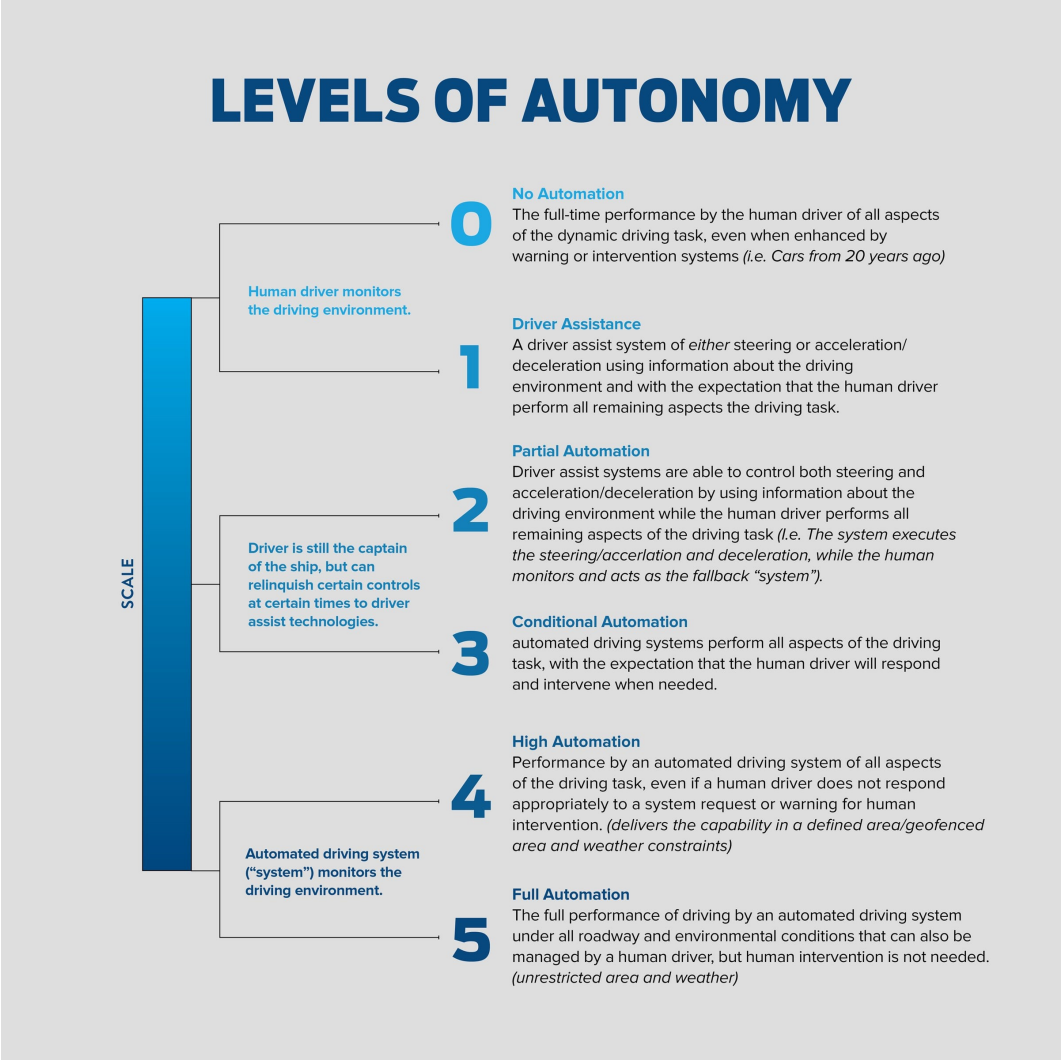

Figure 1.4: Levels of autonomous driving (Source: SAE International)

- **Shared**: another strong influence on the evolution of the automotive sector is due to the new conception of the vehicle, no longer seen as its own vehicle but as something that can be shared between private individuals and can be used "as-needed". Since 2010 more than 100 billion have been invested in shared mobility companies, about 72% of these investments have been made by venture capital and private-equity players, 21% by tech players and only 4% by car manufacturers [6]. This innovative transport solution, that allows users to have access to cars for short periods of time on a strictly need-to-know basis, represents a risk for automakers, who could incur large losses in sales in large cities. This has also been made possible by changes in the habits of the new generations and the technologies available that have made it possible to access this new mode of transport in a much more dynamic and flexible way. Although this new trend can be dangerous for OEMs who want to maintain constant sales levels, it is necessary to emphasize the various benefits that this innovative transport solution brings with it: in addition to being a service that is very convenient for those who do not need to use their vehicles constantly, thus allowing them to save on the costs it implies (insurance, road tax, maintenance, etc.), this service reduces environmental pollution by reducing CO2 emissions simply because it increases the efficiency of vehicle use, thus reducing both urban traffic and the need for parking. In addition, considering the trend of demographic increase expected in the coming years, the consolidation of this innovative solution could allow to avoid urban overcrowding of cities, bringing the benefits previously mentioned [7]. Moreover, in recent years many of these services have introduced the use of electric cars, which perfectly fits the new environmental regulations.

- **Connected**: the connected car is the future, something that it is sure will happen. This is a result of the convergence of several ideas to use the evolving technology of networked communications, known as the Internet of Things (IoT). The role of the connected car in the IoT will be fundamental, as it will merge together key element for the future experience of mobility, such as comfort, convenience, performance, safety and security [8]. This new vision of the vehicles is supported by the latest technologies and innovation that the telematics field brought. First, the advent of the 5G mobile network is the starting point to start thinking of a real environment in which vehicles can be connected together with network and infrastructure. This last kind of connection (V2I) is the new service that will become possible in few years, where the vehicle through a wireless and bidirectional communication will receive and exchange information with all those elements (lane markings, road signs and traffic lights) that rules the mobility in the cities. This will open a new horizon of mobility where the vehicle could understand not just the rules, enabling a wide range of safety benefits, but it will also understand which is the fastest route to reach your destination. However, it is worth remembering that V2I is the base of the autonomous driving technologies of high level, in which the vehicle, as previously said, will be autonomous and the driver will be a real passenger of the car itself. Furthermore, this new data exchange from/to vehicles have allowed different field to introduce new solution and to benefit from these. Just think about the insurance companies, that from few years have introduced new system in the car aimed at obtaining information about the driver style, offering them new deals depending on their way of drive. Finally, it is important to highlight that all the data exchange in networks are not completely safe, for that reasons OEMs are themselves developing in-house solutions aimed at protecting data ownership [9].

1.3 Porter's Five Model

This Tool established by Michael Porter in 1979 is often used by industries to evaluate their competitive position in the current environment from the point of view of the value chain structure and market competition. The model has the objective of identifying the forces, studying their intensity and importance, that operate in the economic environment in order to obtain a complete picture of the competitive position. This finally allows to take strategic decisions and to establish behaviours to adopt in the comparisons of these forces. The forces taken into consideration in this analysis are essentially divided into two directions, horizontal, when referring to competition in the sector, and vertical, when referring to the structure of the value chain.

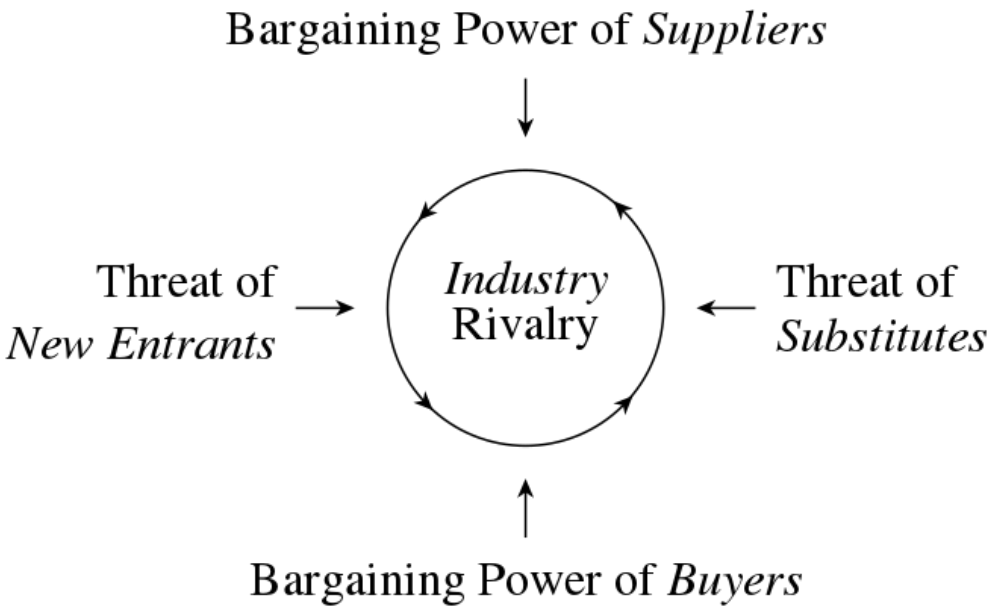

Figure 1.5: Porter's Five Model main forces (Source: Wikipedia)

In order to refine the analysis of the sector under study and extrapolate possible strategic moves aimed at improving it, Porter's Five Model carried out on the Automotive sector gave the results reported below.

- **Bargaining Power of Supplier**: the automotive components business is quite fragmented, in today's market there are many companies for each of the many categories of components. Many suppliers outsource their entire business to a small number of OEMs that purchase most of their manufactured components. In the case that an OEM decides to change

suppliers, this would be devastating to the economy of the previous supplier. This implies that suppliers turn out to be extremely susceptible to the demands and conditions imposed by automakers and therefore have little power over them. For parts suppliers, a key characteristic, is the lifetime of a car. The longer a car remains operational, the greater the need for spare parts. On the other hand, to keep up with the state of the art, new vehicle components are lasting longer and longer, which is great for consumers but not good for parts manufacturers at all, who will see demand for parts decrease at the expense of the ever increasing production capacity.

- **Bargaining Power of Buyers**: the bargaining power of car manufacturers is unchallenged. Consumers can become dissatisfied with many of the products offered by certain automakers and begin to look for alternatives, i.e., foreign cars. On the other hand, while consumers are very price sensitive, they don't have much purchasing power as they never purchase large volumes of cars. This does not decrease the need for the OEM to focus on the customer's need. Only in this way will it be possible to obtain good market share and profits and consequently raise the brand name in a very competitive scenario, especially due to new technologies and existing regulations. However, it should not be forgotten that important customers for car manufacturers are corporations or governments, who purchase large fleets of vehicles, but they too, like private customers, are very price-sensitive. Moreover, the current evolution of technologies and the continuous change of customer needs push car manufacturers to be at the mercy of their customers' approval. All of this identifies a high purchasing power on the part of customers towards automakers, who dedicate their work to satisfy them.

- **Threats of Substitutes**: rather than looking at the threat of someone buying a car from a different brand to ours, it is worth considering the possibility that people will take an alternative means of transport, such as bus, train, plane or ride-sharing to reach their destination. This could be caused because, as mentioned earlier, customers are price sensitive and alternative modes of transportation are almost always cheaper than owning a vehicle and many times are also more eco-friendly. When determining the availability of substitutes, you should also consider time, money, personal preference and convenience in the field of auto travel. Then decide if a car manufacturer represents a great threat as a substitute. In fact, possible substitutes are the new modes of transportation and ownership on the

market, as mentioned earlier in the chapter on driving forces, that will surely revolutionize the years of transportation to come.

- **Threats of New Entrants**: it is true that an ordinary citizen cannot start manufacturing automobiles. The rise of foreign competitors with the required capital, technology, and management skills has begun to mine the market for many OEM. Globalization, the trend of global investment and businesses moving from domestic markets to a global environment, is a massive factor affecting the automotive market. More than ever, it is becoming easier for foreign automakers to enter the domestic market. Cars are highly dependent on consumer trends and tastes. While car companies sell a large proportion of vehicles to businesses and car rental companies (fleet sales), consumer sales are the largest source of revenue.

- **Competitive Rivalry**: Highly competitive industries generally earn low returns because the cost of competition is high. The automotive industry is considered an oligopoly (a market condition in which there are so few sellers where the actions of any one of them physically affect price) that helps minimize the effects of price-based competition. Automakers understand that price-based competition does not necessarily lead to increased market size; historically, they have tried to avoid price-based competition, but more recently, competition has intensified through discounts, low-interest financing, and long-term warranties, which have helped attract customers but have also exerted pressure on vehicle sales profit margins. Every year, car companies update their cars following the "model year" approach derived from the US. This is part of normal operations, but there can be a problem when a company decides to significantly change the design of a car. These changes can cause huge delays that result in higher costs and slower revenue growth. While a new design can pay off significantly in the long run, it's always a risky move in an environment where time is one of the worst enemies due to the exponential evolution of technology and the speed at which customer preferences change [10].

To summarize the descriptions of the previously mentioned forces, reference can be made to the following table:

Table 1.1: Porter's Five Model: Automotive Sector

Horizontal Forces	
Threats of New Entrants	Weak
Threats of Substitutes	Medium
Vertical Forces	
Bargaining Power of Supplier	Weak
Bargaining Power of Buyer	Strong
Competitive Rivalry	Very Strong

1.4 Future Automotive Scenario

The importance of the automotive sector is extremely relevant in the global context. The numbers testify to this, with over 52 billion € in direct sales and over 300,000 direct employees. It is therefore imperative to plan for a solid future that best meets the needs of consumers and employees.

The future vision of the automotive industry depends not only on user demands, but also on environmental conditions, which are strongly controlled and protected by stringent regulations. Most of the market analysis in the automotive world is ready to bet on an electric future, which can reduce CO2 emissions or at least reduce the density of pollution in built-up areas. In Europe, the transport sector accounts for about ¼ of total climate emissions, of which 44% is due to cars alone. In order to comply with the Paris Agreement, according to which global warming must be limited to 1.5 degrees, the European Union will have to impose a stop to the production of polluting cars by 2035 and suspend the circulation of traditional engines from 2050. To keep up with this trend, most European OEMs have allocated significant funds in research and development to upgrade the powertrain of future models. Trivially, there has been a shift from a combustion engine to an electric motor, powered by electricity stored within lithium-ion batteries. The passage of energy from the batteries to the powertrain occurs thanks to the intervention of the Inverter, a device that transforms the direct current of the accumulator into alternating current and sends it to the motor. The electric motor will transform chemical energy into mechanical energy, with an energy efficiency that can reach 90%, about twice as much as a Diesel and three times as much as a petrol engine. This result is the result of several contributions, including the reduction of moving parts (to transform the movement from rotary to linear) and significantly lower heat dissipation.

Car manufacturers have become "assemblers" of components developed by third-party companies, able to secure the appropriate knowledge to provide the best product on the market. In the future, in order to take advantage and remain competitive in the marketplace, OEMs will need to return to manufacturing in their own factories, at least when it comes to expensive components like lithium-ion batteries. Having strong innovations in terms of technology will allow manufacturers to win the competition and share these technologies on different models belonging to different brands. The real competition that will be created between manufacturers will not only concern performance but also autonomy, the real point of interest for customers who use their cars mainly outside the city. The electric car will bring advantages and disadvantages for the user. The first advantage is the reduction in CO2 emissions, practically absent if energy from renewable sources is used. Secondly, the feel while driving, with lightning fast accelerations and the possibility to drive with only one pedal, thanks to regenerative braking, allowing a less stressful driving in the city. Moreover, with an electric car you will have a net saving in kilometres and, in city use, you can take advantage of incentives for circulation and parking. On the other hand, the autonomy of electric cars is less and obliges you to stop for long periods to recharge the vehicle during long journeys. Price also plays a key role and, at present, makes the purchase of an electric car possible for a "premium" consumer base. The biggest challenge that manufacturers will have to face will be to increase autonomy, reducing costs, thus making the purchase of an electric car accessible to everyone.

1.4.1 The formation of partnerships for the exchange of know-how

Faced with a drastically modified social and economic context and a highly competitive global market, the automotive industry must redefine its strategy but is struggling to find the right positioning [11]. Starting from 2018 the number of partnerships in the automotive industry has increased exponentially, this phenomenon is related to the need to create collaborations aimed at exchanging know-how related to the new emerging technologies of autonomous driving and electric cars and to support the huge costs to be faced to bring these technologies on mass distribution vehicles. The examples to mention are really many, the most appropriate to mention is the one between PSA and FCA that led to the birth of the new group Stellantis. One of the main reasons for this merger is the one mentioned above, namely the need in the short term to resize the future through the use of electric cars. Thanks to the sharing of the PSA group's know-how regarding electric platforms, it will be possible to shorten the development and industrialization times of electric and plug-in hybrid versions of the FCA group vehicles. At the same time, PSA will also benefit from many of the FCA group's platforms and technologies currently in use. While cooperation with traditional players is necessary, automakers find themselves forced to forge alliances with new players, often far removed from their core business. This cross-industry collaboration marks the starting point for a change of mindset in the industry and for further partnerships that will help overcome key competitive obstacles [12].

1.4.2 Recycling and Disposal of Lithium-Ion Batteries

Speaking of the car of the future and electric mobility, it is necessary to discuss some of the risks associated with such a scenario. While it is true that the electric vehicle remains the best from the point of view of environmental impact, great attention must be paid to all the elements that make up the batteries. It must be ensured that there are no negative side effects in terms of mining and raw materials. To this end, it is correct to talk about circular economy, according to which products used today will become resources for the future. Specifically, the batteries and systems used in electric cars fall into the category of technical materials, so recycling involves precious metals, alloys and polymers that are difficult to find in nature and are useful for being reused in a new product.

Today, more than 80% of the material that makes up a car is completely recyclable. In the future, of course, efforts will be made to exceed 95% reuse of components and materials in order to reduce the impact on the environment as much as possible. If we make a comparison with the recycling of today's cars, it is not correct to say that in the future cars will be a greater load on the environment, rather the management of batteries will be more complicated. In the future, a reuse comparable to that of motor oil is desirable where, through a regeneration process, about 90% is reused as regenerated base oil, diesel or bitumen.

Currently in Italy, COBAT is responsible for organizing the collection of batteries through its agents and ensuring their proper recovery. During the recycling cycle, the batteries are stored and then crushed by hammer mills. A wet filter is used to separate the metal and plastic parts. The aqueous sulfuric acid solution that represents the liquid part of the battery is sent to the neutralization plant. The fine metal part called pastel undergoes a melting and refining process to obtain 99.7% refined lead or lead alloys, while the plastic part is washed and granulated to be put back on sale.

One form of lithium-ion battery reuse could be storage in order to store energy produced from renewable sources. At the end of their useful life, typically 7-8 years, batteries retain about 80% of their efficiency and, therefore, could be safely reused. With the new system of "vehicle to grid" batteries are real accumulators that allow cars to become receiver and, at the same time, source of energy, in order to maximize efficiency and reduce consumption. Precisely this type can be used as an accumulator of energy derived from primary sources.

1.4.3 Fuel cell solution: will hydrogen be the right replacement for Diesel and gasoline?

The use of hydrogen as a power source for the cars of the future has generated so much interest to push the largest European OEMs to develop projects and concepts powered by this technology called Fuel Cell. The reaction generated between hydrogen and air generates electricity and heat giving as a "waste" product water, obviously a substance that does not pollute the environment. The energy is sent directly to the electric motor and only partially stored inside a small battery.

The main pros of this technology are the possibility to exploit a renewable source and essentially clean, have a greater autonomy and a duration of refueling significantly lower than the current electric cars (about 5 minutes to fill the tanks). The other side of the coin sees a high weight compared to traditional cars, a very high cost of hydrogen with the need for about 70 euros for a complete refuelling translated with a range of about 500 km. Still on the Italian territory there is only one refuelling station, so it is almost impossible to refuel the car today, even if by 2025 will be installed 65 new hydrogen charging points.
Hydrogen could be an excellent solution for the future, provided that the availability of refuelling is well distributed on the territory.

1.4.4 How the car of the future will be perceived

The car has changed and will change over the years, and like it, the perception of the consumer during use. In the future, the sensations and emotions perceived will be completely different, everything will be more filtered than in the present. This is the consequence of studies increasingly devoted to on-board comfort, high levels of soundproofing and the convenience of using the car as a mere means of transport. The cockpit will be transformed into a fully customizable living room that, thanks to the contribution of level 5 autonomous driving, will allow all occupants to share the journey through an experience completely different from the current one. Already through the Level 4 autonomous driving system, the driver will be able to distract himself at different times during the journey, perhaps to write an email or read a newspaper. Therefore, a "multitasking" driving will be preferred, where the pleasure at the wheel will be more focused on comfort than on driving dynamics.

What about all those brands that have made history with analogue supercars derived directly from the world of racing? They too will have to adapt their strengths by trying to combine their know-how in driving dynamics with new powertrain and transmission technologies. A perfect example of the change is represented by the Ferrari SF90, the jewel in the crown of the House of Maranello which, in order to meet environmental regulations, has adopted a plug-in hybrid system. Although for some a Ferrari that makes no noise at low speeds might seem blasphemous, the Cavallino's engineers have managed to achieve records in terms of performance, exploiting all the advantages of the electric motor.

Even on the outside, the perception of the cars will change drastically. City cars will have a less customizable look, suitable to accommodate different people with different tastes. This aspect perfectly reflects the concept of car-sharing according to which the car will be a shared means of transport, suitable for those who need to move quickly. Even the supercars will change in design, with a body designed by the wind (as in the case of the Aston Martin Valkyrie) perfectly aerodynamic to compensate for the increase in weight due to the batteries.

If you think about the current cars that have proven faithful to the concepts of a few years ago, consumers will also get used to new shapes and new ways of using cars. In spite of historic car lovers, screens and on-board infotainment will fill the gap left by the absence of sound and engine noise. Almost certainly, comfort and technology will be the key points on which different manufacturers will try to distinguish themselves.

1.4.5 Territorial influences: the infrastructure revolution

As with all technological revolutions, it takes time to see massive results. The benefits associated with electric cars that will populate our future are still too small compared to the sacrifices required. Despite the many incentives allocated by the State, the price of these cars is still too high and, above all, the autonomy is not on the same level as cars with traditional engines (also considering the disadvantage of a recharge that takes 1 hour compared to a refueling of a few minutes). Another big disadvantage is certainly the current condition of Italian infrastructures, still unprepared for the energy demand to recharge the car by the entire population.

If it is true that the State has provided for the insertion of new recharging columns in the main Italian cities, the current recharging stations are beginning to be overloaded. This happens mostly in built-up areas where, if you don't have a box, you have to use a public charging station. The same cannot be said for the charging stations along the crowded European highways: travelling long distances on board an electric car is no longer impossible, but you have to be patient when charging the batteries.

There are new fields of research and development to find new solutions that can solve the crowding for charging, an example is the induction charging. What is certain is that an adequate infrastructure could be an excellent incentive in the purchase of an electric vehicle and not the opposite reasoning.

The discussion is not only related to the charging columns but also to the structures for the production of electricity. It is useless to use electric cars if the energy they use comes from power plants fuelled by diesel or even coal. In Italy, fortunately, the most common power plant is the hydroelectric one. In the future, significantly more energy will be needed if the entire population uses electric cars.

When talking about the roads of the future, it is necessary to refer to technological infrastructures, connected to the network that can allow a dialogue with all vehicles. If it is true that cars will be networked, so they can interface with other vehicles, the infrastructure will also have to adapt. An MIT study states that with new "smart crossings" traffic lights will be superfluous, and twice as many cars will be able to circulate without generating traffic jams. Communication between vehicles and infrastructure will probably take place through a 5G connection and will greatly increase safety, reducing stress during travel.

Chapter 2

Finished Vehicle Logistic Sector

As already mentioned in the previous chapter, the automotive sector represents one of the largest multinational sectors and has great influence on the other main sector, namely the Finished Vehicle Outbound Logistics. Over the years, manufacturers have become increasingly customer-oriented, recognizing the importance of delivery times. It is for this reason that outbound logistics has acquired more and more importance, becoming a subject of great studies and investments aimed at reducing costs and delivery times. The primary function of outbound logistics is to transport vehicles from the production and/or sorting areas to the end customer. Nowadays the car manufacturers often delegate this function to third parties that adopt differentiated policies but in the last few years the number of car manufacturers that instead outsource their delivery service has increased, as they have seen a source of competitive advantage. Automakers spend billions on transporting cars, costs that are then transferred to customers through destination charging.

2.1 The Main Transport Methods

Before identifying the different types of transport, it must be remembered that the management of this transport is not at all easy due to the size of the goods transported and the safety and quality standards that must be taken. In this field, mass consumption goods are not transported, for which the level of complexity is low, but instead vehicles for which each transport is characterized by a certain mix of models and related specifications, thus increasing the level of complexity. There are three main methodologies used to transport cars: by road, by water, or by rail. These three methodologies are often alternated with each other in a single trip to allow the destination to be reached. In case the destination is in a state not connected by land, the car will make the first part of its trip by ship, being then stored and later loaded on a car transporter or on a train that will allow it to reach its final destination. It can also happen, that the car is loaded on two different car transporters, in this case it will have to stop on a yard waiting for the passage of responsibility.

The image below shows an example in which the vehicle is transported by means of different types of transport, initially by ship to reach the destination continent and then by road to the end customer.

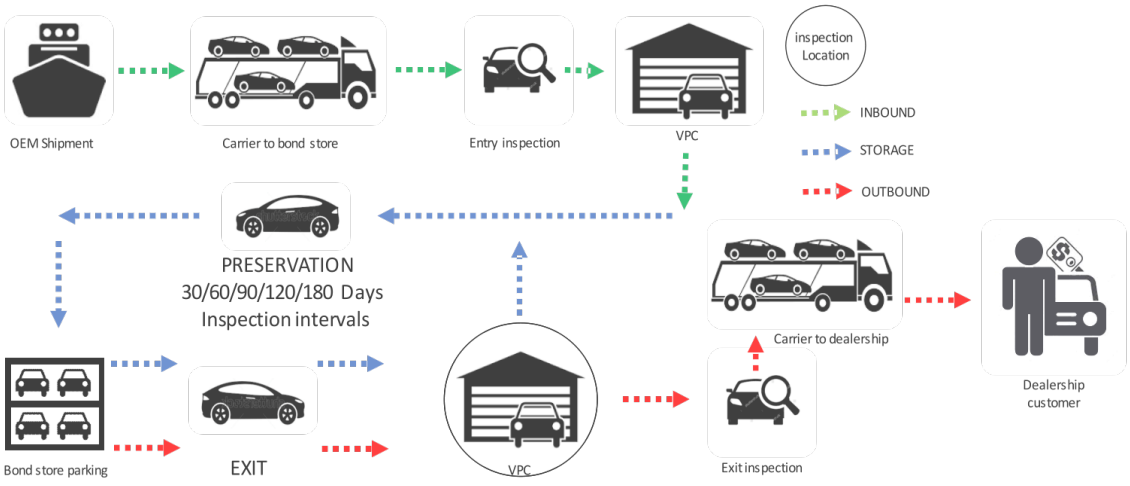

Figure 2.1: Logistic flow of a finished vehicle (Source: Finished Vehicle Logistics)

- **Transport of cars by road**: the initial part of the journey of each car from the production plant to the dealer is necessarily through road transport. These cars are transported by special vehicles, the car transporters. These trucks are different from those used for the transport of goods because of the size and particularity of the transported vehicles, they are composed as always of a tractor but they have different types of trailers depending on the transport mode required. In this context it's normal to understand that we try to ship only loaded car transporters in order to reduce the unit costs of transport, even if it happens that due to timing and geographical locations, the car transporters are shipped not completely loaded. As previously mentioned, trailers can be of different types depending on the transport required and therefore we can distinguish two types of car transporters: open and closed ones.

  - **Open car transporters**: The first type of car transporter has a greater load capacity and consequently lower unit costs, but it has the disadvantage of being uncovered externally and therefore leaving the cars exposed during the trip, being subject to a greater risk of damage. This type of car transporters, depending on the trailer, can transport from 4 to 8 cars at a time, depending on the number of floors of the structure and the type of vehicles loaded. There are also car transporters equipped with state-of-the-art trailers that can load up to 12 cars at a time, but they are rarely used. Trailer structures are platforms with hydraulically operated ramps, which are usually sloped to ensure proper cleaning and to maximize loading capacity. Of course, drivers are responsible for the loading and unloading of the cars as well as any damage the cars may incur during the journey. In addition, it should be said that each car brand establishes procedures for control and/or inspection of vehicles at the time of loading/unloading; these conditions create real manuals of which the transport companies must take note in order to comply with the procedures and avoid penalties or responsibilities in case of damages. The loading/unloading operations last on average from 90 minutes up to 4 hours depending on the batch mix, and on the procedures required for each class of vehicle, from the industrial ones and therefore very high, to the sports ones that must therefore be loaded in such a way as not to damage the bottom surface. The first car to be delivered will consequently be the last to be loaded, moreover the cars must be loaded in such a way as to optimize the

spaces and in a two-level car transporter, naturally the highest cars will be positioned on the upper level.

Figure 2.2: Open truck transporter (Source: i-FAST AL)

– **Closed car transporters**: this second type of car transporter can be preferred for reasons related to the safety of the vehicle, whether it is a super car or a luxury car, or when it is necessary to maintain the secret of the transported vehicle, whether it is a possible concept or a vehicle in phase of launch. As already mentioned, this type of car transporter is mainly used on premium brands or for special transports.

Figure 2.3: Closed truck transporter (Source: i-FAST AL)

- **Transport of cars by water**: this mode of transport is logically used for the transport of cars across the ocean and allows, given the size of the means of transport, the ships, to load the largest number of cars. The largest ships designed to transport cars can load up to 8000 vehicles per trip, but the norm is represented by ships that carry no more than 4000/5000 vehicles. Almost always, given the high costs of this type of transport and given the delivery times required, on the same ship it is possible to find cars from competing car manufacturers.

Figure 2.4: Transport by sea (Source: Grimaldi Group)

- **Transport of cars by rail**: this mode of transport is mainly used for long-distance journeys, where the production plant is located in a foreign country with respect to the car's destination. The advantage of this mode is the greater load capacity, much higher than road transport, and the great reduction in costs and CO2 emissions. The latter advantages highlight the importance that this mode will assume, requiring a more in-depth study for the scheduling of trips and the organization of areas and facilities for loading/unloading, which will have to be situated in areas close to the rails. An image of the structure of these trains is shown below. Each of the wagons, called automatic racks, can carry from 12 to 20 cars. Considering that typically these trains are capable of carrying 800 cars per trip, it means that their overall length is on the order of 1 or more kilometers. This is to highlight even more the high level of complexity of this mode of transportation.

Figure 2.5: Transport by rail (Source: Sifta)

There is, however, a fourth mode of transport for vehicles, even if used less frequently due to its high cost, which is air transport. Air transport is not a traditional form of transport and is used in rare cases only for valid reasons, such as a very special customer who orders a car of inestimable value or for the presentation of a new vehicle. In both cases, however, transport must be preceded by a cost assessment that evaluates its feasibility.

The Hoover diagram is shown below, which justifies and reports the convenience of the various modes of transport by graphing the "cost curve" as a function of the distance to be covered. It is evident that terrestrial transport is convenient for travels of limited distances, while it is necessary and advantageous to use air and sea transport for international travels.

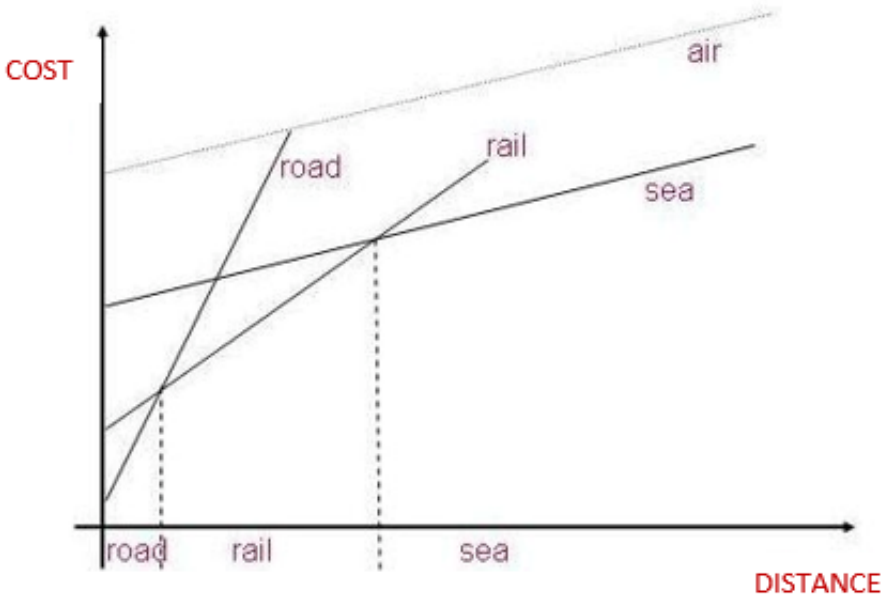

Figure 2.6: Hoover Diagram (Source: Cifi)

Starting from previous descriptions and from the Hoover Diagram it is possible to report the main characteristics of the different transport methodologies for the area of the graph, where the use of each one of these results to be advantageous.

Table 2.1: Characteristics by type of transport

Methodology	**Distance**	**Velocity**	**Cost**
By Road	Short/Medium	Fast	Medium
By Water	Medium/Long	Slow	Low
By Rail	Medium/Long	Slow	Low
By Air	Long	Fast	High

For each of the previously described modalities there are specific procedures for loading cars in order to ensure their safety and integrity. These, such as the imposed limits of loadable cars and the methods of securing, must be respected in every single transport. Moreover, in this sector, given the high costs and volumes, it is necessary to have the correct integration between logistics and scheduling to optimize the trips between the producer and the customer.

2.2 Industry Issues

Before analysing the current European situation regarding the finished vehicles transport market, it is necessary to dwell on what are the problems of the most used methodology, namely the transport of vehicles by road.

As reported by the Eurostat data of 2019, the road freight transport results to be in percentage, the most used methodology, with a value of 88.1% in Italy and 77.4 in Europe [13]. This type of transportation is not without its difficulties. The adversities that are presented to manage for Logistics companies are multiple and each in its own way has a direct and/or indirect influence on transport costs and consequently on the profitability of the sector itself.

First of all, it is worth mentioning the problem of empty kilometres, probably one of the most relevant, this problem is due to the incorrect scheduling of trips that causes the return from some destinations with empty trucks, this implies the presence of travel costs but the lack of profit. Secondly, there are also the problems of waiting times, shortage of drivers and European cabotage, and last but not least the influence of the transport sector on the ecological topic and the new regulations and consequent changes that will be made mandatory in the coming years. Each of these will be analysed in detail below with statistical values that will help to understand their importance.

2.2.1 Empty Travels

The problem of empty trips is really one of the biggest problems for the transportation industry, according to statistical data collected by ATRI, the American Transportation Research Institute, transportation companies travelled a total of more than 17 billion miles in 2019, of which about 20.1% were empty miles (a worsening compared to 2018, where the percentage was equal to 16.6%). Considering a cost per mile of about 1.65$, companies spent about 5.64 billion $ on empty miles in 2019. Similarly, according to data collected by Eurostat, most European Union member states record between 15% and 30% of trips made without a load. It should be noted that these data do not consider trips for which the car transporters were not fully loaded, as they were not completely empty. However, it should not be forgotten that journeys made by car transporters that are not fully loaded also represent a problem similar to that of empty kilometres, with great losses in efficiency and increases in unit costs [14]. The problem of empty journeys not only represents a waste of energy and a cost both for companies and for the final customer, but it also represents an useless worsening of atmospheric pollution. This problem will be one of the main focuses of interest for the development of new platforms aimed at optimizing trip planning and consequently reducing empty trips.

2.2.2 Stopping/Waiting Times

In the transport activity, time is the "enemy number one" because it is never enough, and moreover it is always necessary to respect the rules related to the weekly working hours, which regulate the amount of continuous driving, the frequency of breaks and the total weekly working hours. When we talk about downtime, i.e., stop/waiting times, they can be due either to traffic problems caused by road infrastructures or to waits at loading/unloading places that directly affect all the variables related to working time. In Europe, according to a survey conducted by Vehco, a provider of fleet management solutions, more than half of the transporters surveyed (about 53%) reported that their drivers on average spend 3 or more hours per week waiting (assuming a 40-hour week), with 22% stating that their drivers spend more than 5 hours per week waiting. In addition, according to one transporter quoted in the publication, "If we didn't have wait times, it would save about 10000€ per month." To sum up, for a transport company the waiting time is a cost: a stopped car and driver affect productivity (just think about the Just In Time approach). Not to mention the problem of driving and rest times that are likely to be exceeded by a stop too long and force additional

costs, including the indemnity of about 40 € per hour for each delay in delivery of more than 2 hours [14].

2.2.3 Driver Shortage

Another issue that deserves attention is the lack of newly qualified drivers. This problem has been known for several years for its negative trend, but according to a recent survey by the IRU, the International Road Transport Union, in 2021 the shortage of drivers will increase by 25% compared to 2020 values. The current analysis shows that the situation of drivers for the current year is worse due to several factors: first of all, during the past year many senior drivers have stopped working to avoid contracting Covid-19, in addition, training centers have remained closed and others have left the profession due to the challenges and barriers imposed on their work. The IRU report also highlighted the difficulties in this field also in countries important for the European transport sector, such as Poland and Romania, that results to be the two European countries most affected by the shortage of drivers. In Poland the shortage of drivers is estimated at 22% and is expected to rise by a total of 15 points by the end of this year. In Romania the situation is even more critical as the shortage of drivers is expected to reach values above 60% by the end of the year. In Italy, according to Conftrasporto, the transport market is suffering a shortage of 15000 professional drivers, also in view of the low turnover due to the lack of vocation among young people. According to the "Contract Logistics" Observatory of the Politecnico di Milano, in the last two years 49% of contracting companies have had difficulty in finding necessary transport services, especially during peak periods, while 63% of transport companies have experienced difficulties in finding drivers. The recruitment of drivers, especially young ones, has been difficult for at least a decade and is not helped by the low attractiveness that this profession has today. This is due to a combination of factors: such as long workdays, long periods away from their place of residence, or even a low growth of wages that "remove" the interest in this activity. Moreover, this trend is worsened by the evolution toward automated vehicles that diminishes the attraction of work for those who pay attention to career longevity.

2.2.4 Cabotage

The practice of cabotage consists in carrying out internal transport in a European Union country that is different from the country where the transport company is established. Until a few years ago, this practice was only carried out in countries bordering on the country of origin. In recent years, this practice has changed, especially for transporters from Poland, Lithuania, Romania and Spain. The trend of this practice is not constant for all European countries, as it is driven by socio-economic reasons. Overall, in 2019 this trend increased by 17%, with the highest values recorded in Eastern countries at the expense of Western countries, including Italy, which recorded the largest decreases [15]. This practice has allowed the new EU member countries to enjoy great opportunities for new business, while Western European countries have had to suffer a strong pressure on transport costs, caused by the heterogeneous socio-economic conditions, such as lower wages and tax benefits present in Eastern countries.

2.2.5 Ecological Impact

Concerning the ecological problem of CO2 emissions, the transport sector in Italy follows the European trend, and is therefore responsible for about 25% of greenhouse gas emissions. According to a report of ISPRA, Institute for Environmental Protection and Research, about 92.6% of emissions in 2020 were produced by road vehicles, divided into 69% due to cars, 25% of freight transport, 3% from buses and the same from motorcycles. Given the current awareness of this problem, which has become unsustainable for our survival, in the future it is expected to reduce these emissions through the introduction of new technologies and forms of propulsion, as well as through the prioritization of other modes of transport with reduced consumption, such as intermodal transport with rail and/or maritime transport. In view of the differences between trucks and cars in terms of their equipment, technical characteristics, the distances they cover and their dimensions, the European Commission has defined regulations on CO2 emissions that differ from those for cars and light commercial vehicles. The CO2 reduction targets for the period 2025-2030 oblige all truck manufacturers to invest in alternative powertrains, since according to ACEA data for 2020, approximately 98.3% of all trucks circulating in Europe are diesel-powered, while electric trucks account for just 0.1% and LNG-powered trucks for 0.4%. Therefore, will be necessary to quickly create a network of recharging infrastructures for trucks, which is currently completely absent, in addition to the introduction of significant incentives to make the choice of electric trucks competitive, promoting

fleet renewal.

2.2.6 Paper Documents

Another problem relates to the excessive amounts of documents still in paper format. IDC research shows that 55% of the documents used in companies are still created and kept on paper and that paper management takes an average of 3.6 hours per week per worker [16]. In addition to the time it takes to manage paper documents, it is important to note the impact they have on costs. This includes printing costs, storage costs and the need for physical space, not to forget the environmental impact. Not least, there are also risks related to corporate privacy, which may be compromised if someone has access to prohibited documents and has the possibility to make copies. This problem is still widespread today due to the bureaucratic necessity of signing certain documents, to the too-small companies that are present in the Italian scenario and to the well-established habits of workers that show an aversion to change.

2.3 European Freight

The transportation sector is of fundamental importance for the economic growth and quality of life in European countries. It is widely recognized that innovations and targeted research activities are key factors in promoting the global competitiveness of the freight transport sector. Innovation and related research activities are focused on the future, the challenges, market drivers, and technologies that will become effective in the future.

In particular, having a long-term perspective in the transportation sector is crucial because of the implications of current decisions on future performance and the nature of investments such as transportation infrastructure that require advance planning and careful decisions about future requirements. In addition, it is important for the EU as an entity to identify and assess its competitive advantages and to examine how it positions itself to maintain its existing competitive advantages or to improve them on a global basis to benefit member states.

In general, the European transportation sector faces several challenges for which innovation can play an important role. The current economic recession is forcing a reduction in demand for transportation, thereby increasing the costs incurred by companies. Innovations that improve the cost efficiency and productivity of the transport sector can reduce the impact of the current economic situation. In terms of environmental challenges, national and international regulations such as reducing emissions from the transportation sector have created potential markets for green innovations such as electric vehicles.

Current threats to the trucking industry in Europe are as follows:

- Environmental constraints: the EU has set a target to reduce greenhouse gas emissions by 80-95% from 1990 levels by 2050, and 60% of this reduction should come from the transport sector.
- Competition from rapidly developing global transport markets: EU companies are global leaders in many transport sectors. However, other countries have launched coordinated and ambitious plans to promote certain transport sectors, causing the EU to lose competitiveness and facing the relocation of important companies to more competitive markets.
- Resource scarcity: the EU's transportation sector depends on oil and petroleum products for 96% of its energy needs. As oil will become scarcer in the future, transportation will need to decarbonize to avoid rising oil prices.
- Freight security.
- Congestion: some transportation infrastructure faces major delays that are a barrier to transportation and lead to economic losses for businesses [17].

Innovation in the form of new technologies or more efficient use of existing resources will be key to addressing these threats. In most modes of transport, European industry has a global competitive position to defend, and there is a clear sense that the best way to do this is to invest in research and innovation. The key challenge for European transport policy is double: Ensuring the competitiveness of European industry and at the same time reducing the social (especially environmental) impacts of the transport sector. These two objectives are not contradictory in nature: if legislation and regulation are designed correctly at European and international level, then addressing social challenges will pay off in terms of competitiveness.

Unfortunately, the current European situation in this sector is continuing to experience its own difficulties that were even more highlighted by the Covid-19 health crisis that later turned into an economic crisis. Among the problems mentioned above in chapter 4.2, cabotage is one of the main problems that together with the increase in travel costs, such as fuel and freeway tolls, are worsening the economic condition of many companies. According to some forecasts, the volumes that can be transported in Europe will decrease in contrast to the increasing number of companies willing to transport. This counter-trend between supply

and demand is leading to an increasing price war. Companies nowadays prefer to minimize their margins rather than take a commission for a load in order to have some work. Another cause of this problem is the high level of fragmentation in the industry which, together with the above mentioned problems, is causing the closure of many small companies. These companies until a few years ago were able to survive this scenario, but now given the low volumes, rising costs, health crisis and reduced margins they are forced to pull out of the industry.

2.3.1 Unfair Competition

The presence of these small companies in Italy is caused by the fragmentation of companies and the preference of market operators to use outsourcing strategies to carry out transport services. This phenomenon is very present in the more structured companies that are recurring to strategies of delocalization and consequently of occupational reduction. The freight market is therefore currently characterized by a process of subcontracting due to the lower cost of foreign labor. Reference can be made here to the practice of cabotage, whereby foreign companies are allowed to carry out transport and activities in European territories other than the state to which the company belongs, even if they respect minimum wages. All of this is reflected in a decrease in protection also by means of unfair strategies and irregular work, through phenomena of subcontracting that do not respect European regulations regarding minimum wage terms. In fact, companies that perform the detachment of their workers should follow what is said by the amending Directive (EU) 2018/957 that updates and amends Directive 96/71/EC and establishes mandatory provisions regarding working conditions and health and safety protection of detached workers and aims to ensure fair wages and a level playing field between companies that detach workers and local companies in the host state, while maintaining the principle of free movement of services. Unfortunately, it is not always respected, leading to illegality and the use of strategies that harm competition and endanger employment in the most virtuous and respectful companies. Moreover, this unfair strategy causes the impossibility of the small companies to expand, given the lack of work, and the consequent impossibility to the reduction of the costs tied to the economy of scale.

2.4 Porter's Five Model

In this context, as in the previous chapter, it is very useful to use Porter's Five Model in order to identify the intensity of the forces that govern the structure of the sector from the point of view of competition and its positioning within the value chain.

- **Bargaining Power of Supplier**: the most important suppliers in this sector are the truck manufacturers and all the companies that provide maintenance and essential elements for the running of the vehicles themselves. In addition, these companies are highly dependent on fuel suppliers, which is why some companies have their own internal fueling stations to reduce fuel prices. Spare parts companies also play a key role, so companies enter into maintenance contracts to receive the best possible treatment. However, given the high need from transport companies, the bargaining power of supplier is medium.

- **Bargaining Power of Buyers**: suppliers have a medium bargaining power over the logistic industry, such as i-FAST AL. Those working in this industry are OEMs who need to deliver their vehicles in the distribution network. Their power is determined by the amount of transportation service companies available to travel their routes. Naturally, the greater the number of logistics companies that meet the various requirements imposed by the OEM, the greater the power of the latter in the negotiation phase, where a downward strategy can be adopted to minimize expenses and consequently reduce the profit of the logistics companies. However, customers can in turn enter the market and become a competitor in the industry by providing services according to their own capacity. This last example represents in full what happened in 2006 with the creation of i-FAST by the ex-FIAT group. In this sector, buyers have a medium bargaining power, due to the low switching costs and the low level of differentiation of the services offered on the market. The customer expects to receive delivery quickly, with more flexibility and transparency at a lower price. Since buyers are intermediaries, and not necessarily the final customer, they have the power to switch given the large number of low cost providers available.

- **Threats of Substitutes**: the threat of the substitutes is low. The logistics industry is a fast growing one and offers a variety of services at different price ranges. Logistics range from warehousing, supply chain to transportation. The only substitutes are offered for transportation modality, but they have

extra costs attached to them. Hence the customers don't have much alternate options for the services provided by the logistics industry.

- **Threats of New Entrants**: although it may seem that the barriers to entry are high, given the capital and organization required, they have actually been reduced by globalization which has allowed many new foreign companies to enter the Italian market. This has also been facilitated by technology providing new platforms for new business models and new regulations on cabotage practices. New companies are also using the latest technology to have an up-to-date benchmark of road freight shipping companies and allowing them to match market demands with their available capacity. In addition, the current economic structure of the industry allows small groups to create transport ownership and survive in a very fragmented environment.
- **Competitive Rivalry**: the internal competition in this sector is extremely high. Due to the low differentiation, the companies are competing just with the prices and quality of services. The intense rivalry and the current market, justified the presence of a strong price war that lead companies to accept jobs at a so lower price that only saturates the expenses.

To summarize the descriptions of the previously mentioned forces, reference can be made to the following table:

Table 2.2: Porter's Five Model: Autotrasport Sector

Horizontal Forces	
Threats of New Entrants	Medium
Threats of Substitutes	Weak
Vertical Forces	
Bargaining Power of Supplier	Medium
Bargaining Power of Buyer	Medium
Competitive Rivalry	Very Strong

2.5 Future Scenario

Many of the future challenges for the road transport industry come from factors that are external to transport itself. Each will have some impact on the industry and on decisions at the European level. Below is a picture that shows, following the PEST analysis, what the influencing factors will be.

Public Policies	➢ Business and consumer motivation
Environment and Economy	➢ Climate change
	➢ Economic growth
	➢ Energy and resources
	➢ Environment and ecology
	➢ Mobility and transport costs
	➢ Globalisation
Society	➢ Demographic change
	➢ Increasing urbanisation
	➢ Changing society and consumer trends
Technology	➢ Technology development
	➢ Information and Communication Technologies (ICT)

Figure 2.7: PEST Analysis (Source: Road Transport Scenario 2030+ [18])

2.5.1 Public Policies

Public policy, legislation, regulations, and resulting standards strongly influence the evolution of the industry. The policies adopted have an influence on businesses and consumers who define their decisions about the future from them. Depending on how these policies are applied, they may or may not favor future developments. Taking an example related to a very present problem in the industry, namely the shortage of drivers, through an active approach by policies through financial incentives or through the establishment of training tools, it would be possible to reduce this problem by trying to create a pool of potential workers. In addition, the importance of policies will be necessary with regard to the electrification of the trucking industry, now a necessary step to be taken in the short to medium term. The road transport sector is an integral and vital part of the Italian and European economies, and because of its complexity there are a wide range of policies and regulations. They define not only the movement of goods, but also taxation,

employment, working conditions, ecological impact, road safety and standards. In the short term future, Europe, given global agreements on climate change, will certainly establish policies with incentives to renew fleets and impose higher fuel taxes and restrictions on the vehicles that can be used according to their emission class. In addition, noise and air pollution reduction targets will be imposed in urban centers. In addition, new standards will be set for the size and weight of new transport vehicles, which are likely to be higher than the current ones in order to offer greater load capacity. In addition to greater load capacity, the new vehicles will have improved aerodynamics aimed at reducing fuel consumption and improving performance and safety [18].

2.5.2 Training Needs

In an increasingly competitive market, in which the level of technological innovation will also increase complexity, it will be necessary to improve transversal skills within the company. Fortunately, this past year the Ministry of Infrastructure and Transport has made available 5 million euros for professional training in the sector of road transport companies on behalf of third parties. In addition to the need for training, it will also be necessary to solve the problem of the shortage of drivers, which after the pandemic crisis has become even worse. In recent years, many companies relied on truck drivers from the East to solve this problem, but this is not the right solution for the future scenario. Here, too, support will be needed from the government, which will have to restart this "jammed mechanism". First of all, it will be necessary to offer training tools to enter the profession free of charge and to expand the pool of potential workers, and it will also be necessary to provide welfare to increase the salary of the workers themselves and reduce the cost of the necessary licenses.

2.5.3 Environmental Situation

The changes in the economic system induced by the new environmental regulations will induce immediate changes in transport strategies, modifying destinations and volumes of European routes. In addition, the modes of transport themselves will be reorganized, with preference given to those with less environmental pollution, such as transport by rail or sea. As far as rail transport is concerned, it will in any case be necessary to upgrade the current infrastructures and rethink the organization of plants and their physical location. In order to face the future, it will also be necessary to focus on the need to apply new fuel and propulsion technologies to the road transport sector in order to maintain its competitiveness; for this purpose, the support that governments will provide through the introduction of incentives aimed at the purchase of new vehicles and the disposal of those currently present will be fundamental. No less important is the aspect concerning new materials (i.e. ultralight materials) which will be another area of interest on which it will be necessary to focus for the correct balance between new propulsion methods and vehicle weight. Also infrastructures will need a radical change, as mentioned in the AUTOMOTIVE SCENARIO chapter, current infrastructures are not prepared for a change on a global scale, indeed they are not able to allow the correct present working modalities, therefore it will be necessary to completely rethink their structure and organization in order to support the electric revolution. It is also essential that the changes to come will not only be limited to the reduction of air pollution but will also focus on the reduction of noise pollution and the sustainable use of natural resources. With the new environmental regulations it will also be possible to see a greater consideration of the use of space, there will be a clear separation between (sub)urban and rural areas, but also within urban areas, ecological and non-ecological areas will be divided. Consequently, space in metropolitan/urban areas will become limited. Therefore, city centers will experience lower levels of industrial and commuter transport in order to improve air quality. Noise pollution, however, will be a continuing problem even though electrification activities will provide for its reduction.

2.5.4 Digitalization and Logistic 4.0

As mentioned in previous chapters, one of the most incisive problems in the road transport sector is the excessive amount of documents still present in paper format, which causes a strong slowdown in the transit of information within the company and negatively affects costs. In the future, the process of automation and digitalization towards logistics 4.0 will be fundamental, implementing processes that make use of Big Data and artificial intelligence. This solution is related to the field of information, although companies collect significant amounts of data every day, the majority of it is still paper-based and manually managed. Managing this data with technological solutions would not only allow them to collect more of it, but to be able to analyze it instantaneously to make real-time data decisions with sustainable and environmentally friendly processes. Digitization of logistics and supply chain ensures transportation traceability by providing real-time visibility of loading/unloading activities and ensuring the ability to take timely action. This process of evolution is strictly necessary in order to increase the efficiency and quality of the distribution process obtaining improvements through the reduction of waste (e.g. empty kilometers, matching capacity and demand, etc.,). However, it will be necessary not only to invest in new technologies, but above all to agree to change not only the tools, but also the business models used for logistics work. For this to happen, it will be necessary to improve IT skills and invest in their development, as they will become increasingly important [19].

Chapter 3

Internship Activities

3.1 The Company: i-FAST AL

As it has been possible to deduce from the previous chapters, logistics is a very wide subject and not easy to manage for companies. Transport logistics has a double impact on companies, both on operational and economic performance. In particular, logistics and transport costs can have a negative impact, since they represent a significant share of the costs sustained by companies. Over the years, manufacturers have become increasingly customer-oriented, recognizing the importance of delivery times. It is for this reason that outbound logistics has gained more and more importance, becoming a subject of great studies and investments aimed at reducing costs and delivery times. The primary function of outbound logistics is to transport vehicles from the production and/or distribution areas to the final customer and/or dealer.

In this context of reference is placed "i-FAST Automotive Logistics" which is active in providing services in the field of logistics and transport.

With several offices in Italy and one in Poland, i-FAST AL is a company born in 2006 as a FIAT group enterprise, since that moment it has been an integral part of the FIAT group over the years and through the various fusions, first with the creation of the FCA group, born in the 2014 with the merging between FIAT and the American Chrysler Group and lastly during the current merger of FCA with PSA in the new-born STELLANTIS.

Today, i-FAST AL is one of the top 5 Transport Companies in Italy. What's more, the following assets have allowed i-FAST AL to manage contracts from the largest European car manufacturers, such as Ford and Toyota, and to carry out assignments in many countries outside of Italy on the European territory.

- 4+1 Truck terminals + Head Quarter
- 61 million € turnover 2020
- > 575000 vehicles shipped in one year
- 200 owned trucks
- 400 non-owned trucks

3.2 The Network

i-FAST is a transport company and an integral part of the new-born Stellantis group, it is important to identify the main distribution points of the ex-FCA group in Italy and abroad. There are three main types: plants, ports and compound. The plants from which the various models currently on the market are produced are reported below:

- Melfi, in northern Basilicata, where the Fiat 500X and the Jeep Renegade and Compass are produced
- Pomigliano D'Arco, in Campania, which produces the Fiat Panda
- Val di Sangro, in Sevel, in Abruzzo, which produces the Ducato, Fiat commercial vehicles
- Cassino, in the southern Lazio region, where the three Alfa Romeo models are produced: Giulietta, Giulia and Stelvio
- Tychy, in the south of Poland, where the Fiat 500 is produced
- Bursa, in Turkey, which produces the Fiat Tipo, the Doblò and the Fiorino
- Kragujevac, in Serbia, where the Fiat 500L is produced [1].

Each production plant has a storage area, the yards, which can be either adjacent to the plant itself or just a few kilometres away. In these areas, completed vehicles are stored while waiting to be picked up for delivery to distribution points. This

same type of area is also present in port areas, for the same purpose. Among the most used ports in Italy for vehicle distribution are Salerno, Civitavecchia, Savona and Livorno. Instead, in Europe it is worth mentioning the port of Anversa, in northern Belgium.

In the following image it is possible to notice the geographical positions of the i-FAST sites, as well as the different ports mentioned above and key compounds, in Italy and Europe.

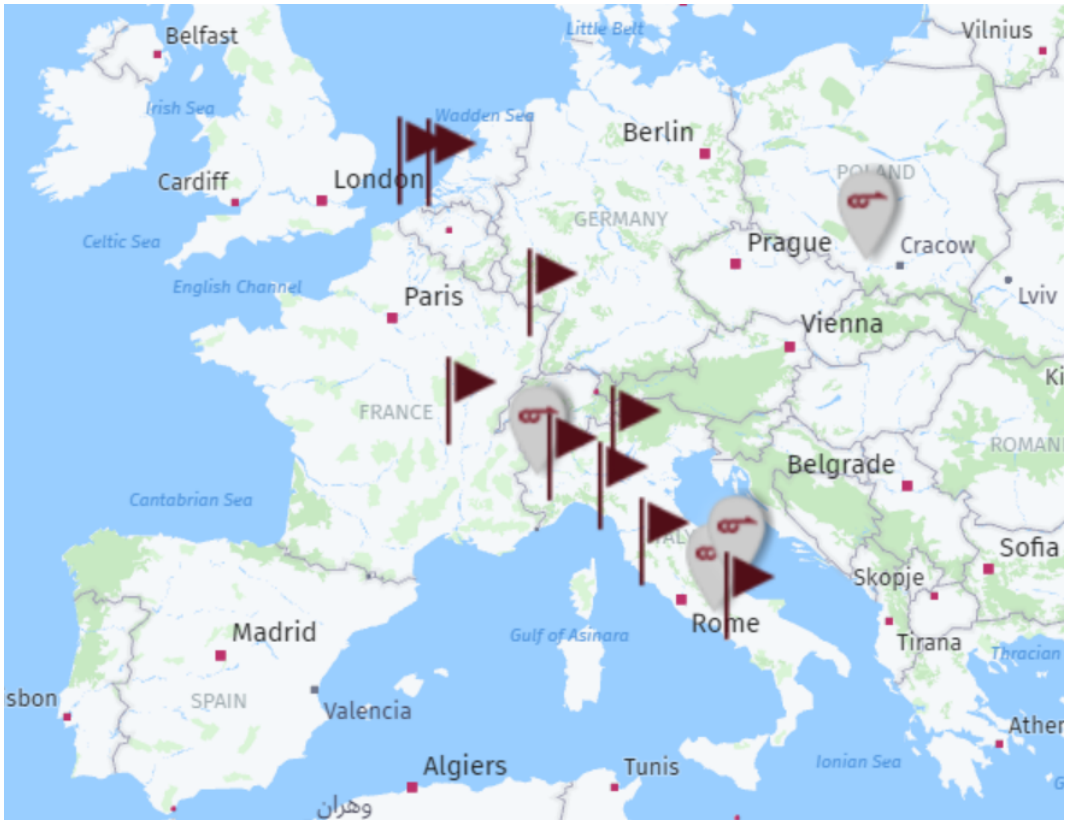

Figure 3.1: Main geographical focus point (Source: i-FAST AL)

3.3 The Industry

Finished vehicle logistics refers to all activities that take place after a new vehicle leaves the factory up to the point where it reaches the customer. The main activities involved in this process include storage, post-production modifications and/or pre-delivery inspections, and finally the delivery of the vehicle to the dealer.

Finished vehicle logistics is a highly specialized area of the transportation industry, requiring meticulous and dedicated storage, workshops, and transportation. Qualified drivers are also required to ensure a smooth delivery without product damage.As a major employer, the finished vehicle logistics sector plays an important role in contributing to the economic success of the European Union. To provide numbers that give an immediate visualization of the importance of the industry, consider that the members of ECG alone (of which i-FAST AL has been a member since 2007), The Association of European Vehicle Logistics, have an aggregate turnover of approximately 23 billion € and their economic impact on the industry's member companies is estimated to be 60 billion €. More than 145,000 Europeans are directly employed in the vehicle logistics industry and another 300,000 are indirectly employed in this sector [2].

Of course, as in every commercial sector, at the basis of transactions and operational movements, there are a series of international rules and/or contractual agreements of which the Commercial Administration team of each company has the task of monitoring their compliance, by the customer and all the actors of the commercial exchange. Among the various regulations, those that manage the Company-Client and/or Company-Carrier and/or Supplier-Company relationship and determine the various billing terms and all the various details of the agreement, financial, quantitative and qualitative, are of extreme importance. Among the others, those arising from the CCNL in force for road transporters are fundamental, defining the working methods in terms of safety and compliance with the hourly regimes as well as the specific qualifications of the people authorized to drive and to perform auxiliary transport operations, such as the loading/unloading of vehicles from the truck. Therefore, operating a strict control for the purposes of administrative, civil and penal responsibilities. In addition to these, there are regulations defining all the dimensional limits of road transport, which differ from country to country. For that reason, it is extremely important to take note of them so as to be able to transit through the different European states without incurring penalties.

3.4 Core activities

During my experience as an intern at i-FAST AL, I had the opportunity to contribute to the execution of various tasks involving different departments. During this experience, I was able to collaborate with highly professional managers and professionals, contributing to problem solving and performance monitoring procedures. Not least, I had the opportunity to approach the administrative and contractual functions in the sourcing process of new international suppliers. This last task has been one of the main tasks during my permanence in the company. As previously written, the working environment in which I have interfaced has allowed me to grow both personally and emotionally, thanks to the people who have supported me and helped me with every mistake and / or request. Next, the various activities carried out will be classified into different clusters (each one specific of the department involved) and for each of them the various tasks will be reported, starting from the analysis of the problem, explaining the methodology used and finally analysing the results.

- **Commercial and Administrative activities**: these activities are mainly oriented to the management of customer and supplier relations. First with the Sourcing process, a necessary step to introduce a new supplier in the company network, and lately through the continuous commercial contact to properly manage the business between companies. This theme has been one of the cores of the activities carried out within i-FAST AL and, as it will be described later, I had the opportunity to test myself in relationship with international suppliers, exchanging information and defining possible collaborations.

- **KPI analysis**: in a context such as that of road haulage, internal analyses and practices aimed at controlling company performance are fundamental. As will later be explained in the dedicated chapter, the controls carried out are many and each with specific objectives to be achieved. Finally, this activity aims at understanding possible problems and criticalities that need to be solved through appropriate operational activities.

- **Engineering of processes**: last but not least, internal process engineering, such as KPI Analysis, is necessary to streamline activities within the company and to facilitate the flow of information and actions. This cluster of activities covers several tasks, starting from the re-engineering of analysis methods to the definition of new processes by applying new algorithms or procedures.

3.5 Sourcing Process

The activity of scouting new suppliers and integrating them into the company's mechanisms was the main activity of my internship job, which extended throughout its entire duration. Before introducing the various phases of which this activity is composed, it is opportune to give a complete vision of the regulations on the modalities of transport so as to understand in full the necessity to have suppliers (Tier_{N+1}) that work in subordination on behalf of the company.

The road transport sector, as previously reported, is regulated by a large number of laws, among which, we find those related to the Sub-Carriage Regulations. These are defined by Art.6-ter of Decreto Legislativo of 21 novembre 2005, n.286; who cites: "1. Il vettore incaricato della prestazione di un servizio di trasporto può avvalersi di sub-vettori nel caso in cui le parti concordino, alla stipulazione del contratto o nel corso dell'esecuzione dello stesso, di ricorrere alla sub-vettura. Il vettore assume gli oneri e le responsabilità gravanti sul committente connessi alla verifica della regolarità del sub-vettore, rispondendone direttamente ai sensi e per gli effetti del comma 4-ter dell'articolo 83-bis del decreto-legge 25 giugno 2008, n. 112, convertito, con modificazioni, dalla legge 6 agosto 2008, n. 133, e successive modificazioni. 3. Il sub-vettore non può a sua volta affidare ad altro vettore lo svolgimento della prestazione di trasporto. In caso di violazione di tale divieto il relativo contratto è nullo, fatto salvo il pagamento del compenso pattuito per le prestazioni già eseguite. In tal caso il sub-vettore successivo al primo ha diritto a percepire il compenso già previsto per il primo sub-vettore il quale, in caso di giudizio, è tenuto a esibire la propria fattura a semplice richiesta. Inoltre, nel caso di inadempimento degli obblighi fiscali, retributivi, contributivi e assicurativi, il sub-vettore che affida lo svolgimento della prestazione di trasporto assume gli oneri e le responsabilità connessi alla verifica della regolarità, rispondendone direttamente ai sensi".

The above reiterates the possibility of assigning work to a single intermediary, the carrier, who has a direct link with the company through the stipulation of a contract. He, in turn, cannot delegate the work to his own carrier, but must execute it on his own account.

With reference to what has just been said about the regulations on sub-carriage transport, it is necessary to mention the present contract modalities of the road transport sector:

- **STANDARD**: they are contracts that are stipulated after the winning of a tender opened by the OEM, with the approval of the terms of the same. In view of a real Sourcing process, the Vehicle Manufacturing Company prepares on the basis of their operational scheduling a quantity of cars and the related list of routes to organize the transports from the production plant/s to the different sorting points. All the information related to the volumes and the respective routes to be covered will be introduced inside the RFQ (Request For Quotation), which will be finally sent, together with all the fiscal and bureaucratic terms, to the several potential suppliers previously selected by the manufacturer. Then, each of the service providers will quote the various routes, depending on their commercial interest, and guarantee the conditions required in the contract. At the end of this process, the manufacturing company will discard those who are not considered cost-effective or who are unable to meet the required conditions. Finally, the negotiation process begins so that the various prices introduced in the RFQs can be negotiated to reduce them. At the end of the Tender, a service provider or more, depending on the "won" routes, will be named and they will enter into a Standard type contract with the OEM of variable duration, about 1-2 years, for the specific routes.

- **SPOT**: this type of contract is not different from the previous one, as it also requires a long sourcing procedure, which will be the topic of this paragraph. The only difference between this type of contract and the previous one is in the terms obtained at the end of the stipulation. With this type of contract, the third party company will be able to receive, with variable frequency, load availability on single routes at a price proposed by the requesting company. It will then be the responsibility of the third party company to accept or not the proposed offer and therefore to execute the transport.

Coming back to the Sourcing activity, as previously said, it has been an activity composed of different phases, each one necessary for its correct execution. In primis, it has been necessary to generate a survey through which it has been collected information of various suppliers in order then to proceed through one phase of analysis and benchmark to the selection of those who resulted appropriate to the assignments, seen their operating abilities and the assets availability. Then, after an initial filtering phase, we proceeded to set up meetings, which, due to sanitary issues and physical distance between the parties, were done via online calls. And finally, after several ethical and fiscal procedures, which verified the stability of the selected suppliers, the actual contract was stipulated, which created a link between i-FAST AL and the selected carriers.

3.5.1 Survey Generation

When I arrived at the company, one of the first tasks for which I was assigned was the review of the existing Survey. This activity allowed me to understand from the beginning what are the most important aspects that allow to define the level of a company in this sector, such as the various assets, the logistic capabilities, and the development of IT management systems that it has. In addition to reviewing the various questions, I had the flexibility to revise the format of the survey, which had previously been developed in Excel. My choice was to reproduce the survey on Google Forms, in order to facilitate both the transmission of the survey, by sending a simple link, and the collection of responses, which were collected on Google servers and automatically reported on Google Sheets, with the possibility to extrapolate the .csv to follow with the implementation on Excel. As for the various questions that make up the survey, they are classified into different clusters in order to collect information that have a certain level of representativeness of the responding company. Below are the different clusters into which the questions have been divided:

- **Company Profile**: the questions in this section are mainly related to the company's financial information and to its operating network, both from the point of view of the territorial areas in which it is present in Europe and related to their work experience with OEM. In addition, some questions relating to performance from an operational point of view, such as the percentage of damages on the volume transported, have been included here.

- **Service Level**: the questions in this section relate to the ability of the carrier to control its operational performance, such as how costs are allocated to the various components and whether various KPIs are controlled.
- **Enable**: This cluster of questions is one of the most important, as the questions here are necessary to understand what assets the carrier has, both in terms of quantity, such as the number of owned car transporters and whether or not the carrier owns in-house refuelling stations and/or its own repair shops, and in terms of quantity, such as the environmental class to which the vehicles belong and the typology of the vehicles.
- **Execute**: the information requested relates to the operational methods with which the carrier transmits its orders, considering the level of integration of IT systems, and the methods of control of moving trucks, through the integration of GPS systems on board.
- **Manage**: finally, in the last cluster, information is requested about the carrier's short- to medium-term goals and training update routines for their employees and/or drivers.

Through these various clusters it is therefore possible to have a complete view, from all points of view that deserve interest, of the carrier in question.

3.5.2 Suppliers Selection Process

Being i-FAST AL a well-established reality in the logistics sector of the transport of finished cars and being well known in Europe, several companies have often tried to get in touch to offer their availability. For this reason, I had the opportunity to look in the market for suppliers both international and Italian to contact, who had previously expressed their willingness to work together. Of course, as will be explained later, there are economic parameters that define those who will be defined as suitable for possible collaboration.

3.5.3 Analysis of results

Once the responses of the various carriers previously selected through the above procedure were received, those responses were collected on an Excel document. In anticipation of this, an evaluation table was specifically constructed, where for certain questions, considered representative of the carrier's capabilities, a weight was assigned. The process of assigning a weight to each question was a long and meticulous process that required three different meetings in which the main figures of each department of the "i-FAST AL" team were present in order to validate the influence of each of the different questions on the final score. Below is the image with the scoring table. (Questions were covered as a matter of internal policy). After assigning a weight for each question, a multiplier was assigned in turn for each possible answer depending on the possible choices available or depending on the ranges in which the given answer falls. In this way, through the use of several automated Excel sheets, it was possible to automatically obtain the overall score of the vector at the time of the introduction of the given answers. Below are reported several questions and relative cluster that have been used to build the Supplier Score (since it is not possible to also report the associated score, the number of "plus symbols" reported at the end of each could be representative of the importance of the question):

- **Company Profile**:
  - What was your global turnover in 2020? (++)
  - With how many OEM's do you have a contract for regular flows? (++)
  - In which areas of the italian region are you in? (+++)
  - In which European countries do you transport and which percentage of the total volume? (+++)
  - What is the percentage of damage to the total transported in the last year? (+++)
- **KPI Monitoring**:
  - How many of the following KPI (Damages, POD, empty kms, lead time and/or others) do you monitor? (+++)
- **Assets and Certifications**:
  - Number of owned and not owned trucks (++)
  - Percentage of open trucks (+)

  - Average life of owned trucks and equipment (++)
  - Which of the following certifications (ISO 9001, AEO, ISO 14001) do you have? (++)

- **Manage and Future Programs**:
  - With which frequency are you training your drivers? (++)
  - What percentage of your fleet (on average) do you renew every year? (+)

As mentioned above, it was also necessary to introduce various constraints, different for Italian and foreign carriers, in order to choose those who were suitable. These constraints were different and based on different variables: firstly, a limiting score was defined, equal to 50% and 45% respectively for foreign and Italian carriers, below which carriers were excluded; secondly, minimums were defined with regard to annual turnover, the number of car transporters and their environmental class. The latter were necessary to exclude those who, despite having a non-limiting score, did not meet the contractual requirements necessary to be taken into consideration.

Moreover, the information obtained from this Survey has allowed to carry out an internal Benchmark analysis with respect to the trend of Italian and European transport providers. This analysis allowed to have a correct understanding of the company situation in terms of assets and innovation.

During the contact phase with the different carriers, it was necessary to request various fiscal and financial documents in order to perform internal procedures. These are mandatory and necessary procedures that will determine the possibility of establishing a commercial relationship with the carrier in question. These procedures, established by the ex-FCA group, are aimed at the ethical and financial control of the companies in order to minimize the risk of involvement in administrative and/or penal processes.

3.5.4 Commercial Contact

The suppliers that were able to satisfy the requests and were interesting for the answers given, have been invited for a virtual contact, through Google Meet, in order to better define the possibilities of collaboration. During these meetings it was possible to review the answers given to the Survey to verify their correctness and it was also possible to discuss crucial and more detailed topics to determine the possibility of collaboration, such as the compatibility of the carrier's network with that of the company, the operational capacity and the corporate structure.

3.5.5 Commercial Contract

At the end of the previous step, it was possible to perform a further filtering of the remaining suppliers, taking into consideration the discussions that had taken place, the results of the previously started internal procedures and the level of professionality shown during the meetings. For the remaining suppliers, it was possible to stipulate a SPOT contract, i.e. aimed at transporting extra-capacity load, for which the company i-FAST AL is not able to take charge. For privacy reasons the names of the companies with which this phase has been carried out have been omitted. Therefore, it is appropriate to report their nationality in order to explain from a strategic point of view what have been the motivations that have led to this final selection.

- **Network Compatibility**: first of all it was necessary to verify the compatibility between the coverage areas of the different companies, this means making sure that the various loading/unloading points of the routes covered by each company are close to each other. This will then allow the availability of vehicles in areas that are crucial to the performance of trips, minimizing empty kilometers and costs related to them. Of course, since we deal with international suppliers, it was important to ensure their coverage in Italy, where i-FAST AL, as a Stellantis supplier, carries out a large percentage of its transport volumes, and also in European countries such as France, Belgium and Germany, which are fundamental for European contacts.

- **Fleet Sustainability**: as mentioned in previous chapters, sustainability is a core topic for today's and tomorrow's businesses. In this respect, only suppliers with more or less sustainable fleets have been taken into consideration. This means fleets that have at least EURO 5 trucks, in order to comply with the current regulations, and those that are completely EURO 6 or, even better, with the availability of LNG or latest generation vehicles.

- **Truck Type Availability**: another fundamental characteristic for the selection of final suppliers was their availability of open car transporters. In an international scenario, it's easy to deal with suppliers who not only transport finished cars but also common goods. For this reason, it has been necessary to look for suppliers who had a good percentage, if not all, of open car transporters in their fleet, which also guarantees their experience in all the related activities, such as loading and unloading of vehicles from trucks.

- **IT Development**: the level of IT development was another constraint that made it possible to choose between various suppliers. Nowadays, as explained in the previous chapters, the evolution of the sector will take place through the technological development of company systems, which will allow transit of information in instaneous way enabling actions to be taken in real time. This in fact turns out to be fundamental in order to execute at best the several operations during the travels and to manage from the operating point of view the orders and the several contacts with the drivers.

- **Continuous Improvement Program**: finally, the approach of each supplier towards the future was interesting to choose only those who had the intention to respect and follow the future development in the best possible way, ensuring the willingness to renew their fleet and their IT systems while remaining compliant with the state of the art.

For these suppliers, as mentioned above, a SPOT contract has been stipulated, which is the first step in order to establish a satisfactory collaboration. Seen from an external point of view, the SPOT contract is a sort of "test" that, if passed correctly, will allow the supplier to be included in the list of those who can participate in the tenders, with the final objective of obtaining a STANDARD contract.

3.6 KPI Analysis

Another fundamental activity on which my internship work was based is the analysis of the various KPIs that evaluate the company's working conditions. In order to correctly measure the performance of a process, it is necessary to identify key indicators, the so-called KPIs (Key Performance Indicators), which are able to represent the process in those aspects on which the company can intervene and create value. International organizations define KPIs as: "A set of quantifiable measures that a company uses to measure its performance over time", Investopedia's definition, or "A way of measuring the effectiveness of an organization and its progress towards achieving its goals.", Macmillan's Dictionary definition of KPIs. However, what is clear is the strong link between KPI analysis and the continuous improvement of the various processes that make up a company. The last need is also confirmed in the ISO 9001:2015 standard, which requires in one of its requirements to set business and quality objectives: "The approach by processes and the initial analysis of these must necessarily be correlated to a series of measurable KPIs in order to verify the effectiveness of the processes themselves".

During my internship, I had the opportunity to really understand the importance of KPIs in the modern market, where in an industry with no possibility of differentiation in services, the optimization of processes with the subsequent reduction of costs is one of the main sources of profit without changing the price of the service, already at a minimum due to the strong competition in the sector.

Among the various KPIs on which we focus in the sector under analysis, several clusters can be listed:

- Financial: EBIT, ROA, ROE, ROCE
- Service level: lead time, % damage
- Fleet productivity: €/km, consumption, empty km
- Fleet maintenance costs: maintenance, % repairs
- Safety & Workers: absenteeism, % injuries

3.6.1 €/km

In the finished vehicle transport sector, the fundamental parameter that defines the efficiency of the company's operations is represented by the €/km. This parameter makes it possible to analyse the company's performance from an internal point of view and then to break it down into its various components, such as drivers, fuel, highway, maintenance, overheads and others. At the same time, this value makes it possible to define the company's competitiveness in the market through benchmark analyses aimed at forecasting the profits that can be obtained from the various contracts stipulated.

In order to have reliable values that can be used as a reference, we can cite the values defined by Decreto Direttoriale 206 of 27 Novembre 2020 on the "costi indicativi di riferimento dell'attività di autotrasporto merci". In this document the minimum and maximum costs for four different categories of vehicle have been reported according to GVM (Gross Vehicle Mass).

GVM stands for Gross Vehicle Mass and indicates the total permissible weight of a rigid vehicle. The mass of the vehicle is given by the following contributions:

$$mechanicalparts + body + sparetire + driver + supplies + equipment \quad (3.1)$$

So, the total weight is given by the weight of the transported goods. The upper limit for GVM of heavy vehicles are generally two: one imposed by the European Community regulations, stating that heavy vehicles cannot weight more than 40 tons, the other is the technical limit of the structure of the vehicle, beyond which the reliability of the vehicle itself is not ensured.

Below are the various classes according to the GVM.

Table 3.1: GVM Categories

Categories	**Gross Vehicle Mass**
Category 1	GVM< 3,5 tons
Category 2	3,5 tons <GVM< 12 tons
Category 3	12 tons <GVM< 26 tons
Category 4	GVM> 26 tons

Considering that i-FAST AL deals only with the transport of cars, the values for the 3rd weight category can be referred to. The values provided are calculated on the basis of 100,000 km travelled in a year and follow the regulations on minimum wages for drivers. The cost split is performed on the different clusters, vehicle-related or not. In turn, the vehicle-related costs are divided into costs related to the purchase of a new truck, costs related to maintenance and insurance documents, such as tax, etc. The other costs are in turn divided in costs of overheads, salaries and consumptions.

In the image below is reported the subdivision of the costs in order to give a first comparison on their influence.

		Categoria							
		A		B		C		D	
	Costo km unitario	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Veicolo	**Acquisto**								
	Acquisto - veicolo	0,025 €	0,163 €	0,046 €	0,227 €	0,090 €	0,495 €	0,187 €	0,598 €
	Acquisto - rimorchio	0,003 €	0,023 €	0,007 €	0,058 €	0,011 €	0,102 €	0,034 €	0,102 €
	Acquisto - semirimorchio	0,006 €	0,008 €	0,012 €	0,038 €	0,014 €	0,088 €	0,017 €	0,088 €
	Manutenzione								
	Manutenzione - veicolo	0,015 €	0,085 €	0,026 €	0,085 €	0,035 €	0,085 €	0,042 €	0,105 €
	Manutenzione - rimorchio	0,001 €	0,003 €	0,004 €	0,005 €	0,006 €	0,010 €	0,010 €	0,020 €
	Manutenzione - semirimorchio	0,003 €	0,003 €	0,004 €	0,005 €	0,006 €	0,010 €	0,010 €	0,020 €
	Revisioni	0,000 €	0,000 €	0,000 €	0,001 €	0,000 €	0,001 €	0,000 €	0,001 €
	Pneumatici								
	Pneumatici - veicolo	0,005 €	0,027 €	0,014 €	0,069 €	0,072 €	0,132 €	0,080 €	0,132 €
	Pneumatici - rimorchio	0,004 €	0,006 €	0,026 €	0,079 €	0,052 €	0,129 €	0,052 €	0,091 €
	Pneumatici - semirimorchio	0,017 €	0,052 €	0,026 €	0,096 €	0,034 €	0,135 €	0,052 €	0,140 €
	Bollo								
	Bollo - veicolo	0,000 €	0,013 €	0,000 €	0,006 €	0,001 €	0,007 €	0,000 €	0,010 €
	Bollo - massa rimorchiabile	0,000 €	0,010 €	0,000 €	0,009 €	0,001 €	0,010 €	0,000 €	0,010 €
	Assicurazioni	0,005 €	0,025 €	0,005 €	0,027 €	0,010 €	0,035 €	0,014 €	0,040 €
	Ammortamento								
	Ammortamento - veicolo	0,010 €	0,068 €	0,019 €	0,094 €	0,037 €	0,205 €	0,077 €	0,247 €
	Ammortamento - rimorchio	0,001 €	0,008 €	0,002 €	0,020 €	0,004 €	0,035 €	0,012 €	0,035 €
	Ammortamento - semirimorchio	0,002 €	0,003 €	0,004 €	0,013 €	0,005 €	0,030 €	0,006 €	0,030 €
Altri costi	**Stipendio**	0,350 €	0,386 €	0,362 €	0,397 €	0,372 €	0,410 €	0,372 €	0,410 €
	Trasferte	0,008 €	0,070 €	0,008 €	0,070 €	0,008 €	0,070 €	0,008 €	0,070 €
	Straordinari	0,000 €	0,028 €	0,000 €	0,029 €	0,000 €	0,030 €	0,000 €	0,030 €
	Energia	0,112 €	0,164 €	0,269 €	0,228 €	0,294 €	0,320 €	0,333 €	0,410 €
Pedaggiamento		0,169 €							

Figure 3.2: Tables of costs CCNL (Source: Ministero Interno Trasporti)

As it is easy to deduce, the optimization of €/km is one of the activities of primary importance to improve the company's profitability. However, cost reduction and stabilization is one of the critical aspects in the trucking industry due to variations in demands and variables that affect operational activities. The primary method of minimizing costs is to analyse operational performance through the use of KPIs.

3.6.2 Empty Kilometers

As explained in the previous chapter, empty kilometers represent the most critical issue in this sector and represent the distance that is covered with the unloaded truck typically between an unloading and the next reloading point. This distance has a cost and an environmental impact, due to the various consumptions and the time for which the driver is paid, but they have no profit since no customer is paying for a car transport. The responsibility of minimizing their incidence is in the hands of the Operations department, whose main function is to organize trips to minimize these inefficiencies, although from a practical point of view it can be said that even with a great organizational effort, due to the many variables involved, it is practically impossible to bring this value to zero. There are many ways to control these values, both through the support of IT and computational software and through manual procedures. The department that deals with the control of these performances is that of KPIs, with which I have had the opportunity to research and experiment with new methodologies that would allow to evaluate and highlight the values on a weekly and monthly basis of empty kilometers.

One of the problems encountered in the search for empty km is the difficulty in coordinating different IT systems that collect information on routes and their kilometers. The company i-FAST AL relies on an IT system called OTM for the management and storage of all the routes travelled and to be travelled, of course, this software does not detect empty trips as they are not assigned any trip code or tariff. One of the first activities I carried out was to extrapolate the trips on a monthly basis and look for an algorithm that would allow to group the different trips made for each vehicle and on the basis of this define which could be the empty trips. Although it seems a simple process, it is not at all, since it is necessary to consider the many variables that can affect and manipulate the right travel history, such as simply a delay in loading the same or even an error in some parameter. This has made this approach unfeasible, even though with a lot of effort we thought we could find the solution.

Another approach that instead brought results, reliable but not perfectly precise, was to identify manually, week by week on the basis of the trips made by each driver, which were the routes travelled without a load. At the end of this procedure, it was possible to obtain a list with all the routes actually covered empty by the various drivers. After that, we proceeded in two ways: initially, these trips were loaded into the company's OTM system, defining for them a specific parameter that would allow correct identification and extrapolation on a weekly and monthly basis, but since this process was time-consuming although useful, it was decided to collect this information in an Excel document. In this document, it was possible to create several sheets each dedicated to a single week, where for each route was identified both the repetition and the distance associated with it. This made it easier and faster to obtain important information about the total distance travelled empty, its percentage on the total kilometers travelled and the most frequent empty routes. The results obtained, as well as giving numerical information on the KPI empty kilometers, have allowed us to have a basis for studying how to optimize the most frequent empty routes.

3.6.3 % POD (Proof of Delivery)

Another analysis is used instead to calculate the percentage of POD, proof of delivery. The POD can be transmitted in various ways and is an event that defines the closure of a journey and the successful delivery. Unfortunately, this signal is not always transmitted in time and in the correct way. An analysis that I have had the opportunity to deal with is aimed at calculating this POD percentage through the use of spreadsheets and by means of data extracted from company computer systems. This analysis is carried out as a comparison between the various trips processed by otm, and therefore carried out by the drivers, and the events instead transmitted to TomTom. By comparing this data, it was possible to understand in how many cases the POD was correctly issued, and therefore made it possible to calculate the percentage of POD itself. It is important to monitor this value both on a weekly and monthly basis, and both for the company's own fleet and for suppliers working on behalf of the company itself. The primary objective for which this activity is carried out is for the minimization of the penalties to be paid to customers, since in the stipulated contracts there are minimum values relative to the receipt on time of the POD.

3.7 Engineering Process

Among the other activities carried out of greater importance, there have been those aimed at optimizing existing processes. All activities nowadays focus on the use of the Kaizen approach, a famous methodology first coined in the 80s by Toyota, which is focused on continuous improvement. In an industry like road transport, where companies have few parameters that allow them to differentiate their offerings from those of other companies, it is therefore of primary importance to work internally on the various processes in order to optimize and benefit from them, both from the point of view of management and especially of profitability. During this period of training, I had the opportunity to experience with my own hands for the first time the application of this theory, which until then had only been a matter of study for me. Next, are listed the various processes for which I was responsible for applying myself to the search for new engineering solutions that would improve the results.

3.7.1 Reorder Point Internal Fuel Gas Station

In the road transport sector, another critical point is the price of diesel fuel, given the large consumption due to the amount of travel and the corresponding kilometers traveled, which in recent periods is having a growing trend affecting in a negative way the costs. For this reason, i-FAST AL is equipped with several internal refueling stations that allow to have advantageous prices for diesel fuel, given the orders of larger quantities, which ensure a saving from the point of view of costs. Although this asset can guarantee advantages from an economic point of view, it also requires adequate management as the availability of an internal station must not negatively affect other parameters, such as the possibility of queues, and consequently delays in deliveries, and the risk of stock-outs. Just this last point has been to the base of a study of optimization action to the definition of a Reorder Point that guarantees to avoid the condition of stock-out.

Starting from the data collected at the different internal refueling stations, an analysis was made in order to determine which was the most appropriate reorder points (R). Several parameters were fundamental to the execution of this task, such as the time required for the arrival of the tanks and the time required to release the order request. In addition, a clearance of a certain amount of liters was also considered, which is due to the difference between the automated measurement, of the distributor, and the measurement made by hand, by means of

a stick performed on a monthly basis. This difference is due to the properties of diesel fuel, which expands its volume under different temperature conditions, releasing gases that introduce uncertainties into the physical measurements.

Starting from the real data of the period between the beginning of the year and April, it was possible first of all to collect a database of data for each day of the week and also to define the limit cases, which are represented by the days of the week with greater demand for supply, where the risk of stock-out is greater. After that it has been studied the statistics, through the use of the formulas of the Gaussian distribution of normal type, of all the trends of the various days of the week for each of the 2 stations of refueling. Then, for each day it was possible to define the mean and the standard deviation. It must be remembered that before starting this statistical procedure, the values defined as Outliers have been eliminated, i.e. those that differ greatly from the normal trend and are due to rare exceptions. Subsequently, there have been created on Excel, through the use of inverse formulas, batches of weekly random data on which it has been possible to carry out tests on the evolution of the level of inventory that has carried to the definition of the Reorder points. Of course, before carrying out the analysis on random data (which were generated using as fundamental parameters the average and the standard deviation extracted from the real data), the same analysis was carried out on the real data to highlight the current risk of stock out. Then for each station, the control was performed on 3 different random extractions, where each of them was composed of data representative of 14 weeks.

In conclusion, considering the various constraints, such as the fixed quantity of replenishment, the Lead time for delivery and the uncertainty on the measurement of the quantity present in the tank, it was possible to define the new value of the Reorder Point (increased compared to the one currently in use) to avoid the stock-out of the tanks.

3.7.2 Digitalization of Service Envelopes

The service envelopes are the driver's travel document and represent the weekly record of his activities through the various documents it contains. The various documents that define the driver's various activities are as follows:

- Bills of transport: fiscal documents that certify the passage of responsibility of a vehicle and are received by the driver at the time of taking charge (loading) of the vehicle(s), defining the driver's taking charge.
- Damage card: these documents are present only in the event that during the inspection in the loading/unloading phase, damage to the vehicle is detected. Their use is necessary to determine the responsibility of the damages and for the subsequent compensation by the company or the dealer.
- Driver card: on the outside of the service envelope there is a table where the driver during the week enters all the chronology of his movements with related basic information, such as mileage of the vehicle, number of cars on the car transporter, date and time of the various movements and finally there is a note space for further important information.

All these documents are collected by the driver during his journey and at the end of it are handed to the competent unit, which then sends them to the i-FAST headquarters to be collected in the central archive. This represents another problem in trucking, namely the presence of a lot of paper material, which, not being managed by IT software, can cause slowdowns in data management and, when necessary, slows down the search for information already archived.

My task in view of this was to look for a solution to digitize the documents mentioned above. As is easy to understand, if this information were present on an online server, it would facilitate both its management and archiving. Initially, the idea was to introduce an application that would allow the driver to create a history of his movements, thanks to a connection between the mobile application and the GPS of the truck, and to receive and exchange all the information of the various documents through the use of the well-established QR CODE technology. Unfortunately, this solution was immediately discarded given the current situation of companies that do not allow to develop on a large scale the use of new forms of sharing for documents and also given some bureaucratic regulations that require that some of these documents are still in paper form. The second solution was to digitize paper documents through the use of existing applications that allow

for high-definition scanning of documents and then sharing them via WhatsApp or uploading them to the various clouds online. This process has been done by means of the Microsoft Lens application which allows to scan documents in a user-friendly manner while maintaining high image quality. After scanning, these documents are uploaded by each driver to his personal folder. In order to facilitate the management of this data, it was therefore necessary to generate a hierarchical structure on Google Drive where to each driver was assigned his own folder in order to collect data in an organized manner and to facilitate control by the relevant personnel. This activity, although in the introduction phase, is important for the reduction of control and research times.

Conclusions

In this thesis, carried out in parallel with my activities at i-FAST AL, an overview of the automotive and road transport sector in the current European scenario has been provided, identifying its problems and possible developments. After introducing the company in its working context, it was possible to carry out an analysis of the current situation of the automotive sector, as its evolution will have strong influences on the transport sector. Through the activities carried out and the knowledge obtained, it has been possible to analyze the road transport sector and to identify which are its main problems. For this last purpose the carried out activities, and explained, have been centered on the optimization of the internal processes, since after a first analysis it has been possible to identify it as one of the possible sources of gain for the companies of the sector.

To this end, the project has been divided into two macro-sections, each of them devoted to a specific objective.

In the first section, the objective has been to explore the automotive and auto transport field. This activity has been carried out by means of bibliographical research of information and through the use of the knowledge obtained in the course of this master's degree. For each of the sectors, the major pressures present today that are pushing for their evolution have been highlighted. Starting from these, it was possible to deduce some insights on their future changes. In addition, this first analysis allowed to identify the points of major focus for my activities in the company.

In the second section, the goal has been to describe the different activities done. Given the need to optimize the company's internal processes, the activities were aimed at process re-engineering and business process management. The first activity had the objective of streamlining and improving existing processes in order to increase internal performance, while the second activity was aimed at the

enlargement and management of the commercial network through contacts with new or existing customers. Both types of activity have been described, starting from an analysis of the problem to the subsequent methodology of action up to the achievement of the results and possible conclusions.

Given the objectives achieved, possible future developments are various and diverse, as the road transport sector is in complete evolution given the European scenarios and future developments. In this regard, from the logistic point of view, the technological revolution for data management and new IT systems is now in progress, which will provide many benefits for internal management activities, thus facilitating many issues that currently exist. This will allow to minimize or even eliminate some of the problems described in this thesis work, allowing to focus the efforts of the company towards other objectives of equal importance.

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