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Automotive web apps: Market Analysis and System integration at Business Integration Partners s.p.a.

In collaboration with BIP s.p.a

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1. INTRODUCTION

This thesis is the result of my internship experience within the company where I worked and for which I am currently employed. The company, called Business Integration Partners (BIP), is an Italian and international management consulting and system integration company with more than 4,000 employees based in Milan (Italy). Before proceeding with the description of the topics that I will discuss in the course of this thesis, I would like to thank all the people who allowed me to approach the reality in which I aspired to work, who made me live a fantastic and gratifying experience of approaching the world of work for the first time and for which I have chosen to remain connected to this day. My thanks therefore go to my reference company partner, my manager and the human resources team who believed in me during the interview phase and at the end of the traineeship for the extension of my contract, and to the team of analysts and consultants with whom I dealt during the period of remote work and who accompanied me on a path of growth that I did not think was possible during the Covid period. I would also like to thank Professor De Marco for his willingness and commitment to support me in the drafting of this document.

The aim of this thesis is to describe the story of how a vehicle monitoring application is developed by a consultancy firm, such as BIP. For policy reasons of company privacy, I will not be allowed to make any references to the client in question. However, it is necessary to underline that the project was born as a result of the car manufacturer's intention to create a diversified business around the life cycle of the electric car, a driving sector that represents a growing and sustained niche in the client's business plan. The reason why the app is only developed for electric cars is dictated by several factors:

1) Electric vehicles, by their very nature, have almost only electronic parts, so monitoring their parameters is easier from the start, both in the code reading phase and in the control phase, since it is often not necessary to provide specific sensors (think of shafts, valves, cylinders, etc.). In agreement with the customer, who assessed the cost of developing the app for thermal or hybrid vehicles as well, and studying the direction of the electric market, it was decided to develop it exclusively for electric cars.
2) The business model is oriented towards the processing of data collected through the app that are used for commercial purposes. The aim is to create a driving experience as "tailor made" as possible for each individual car owner by offering a dedicated service based on the user's habits.

The thesis will therefore begin, in chapter 2, with an overview of the electric car market, necessary to understand the reasons for this choice. In this part I will also try to give my point of view on what can be the limits derived from the mass adoption of this type of cars, in contrast to some very ambitious goals set by the European Union (EU).

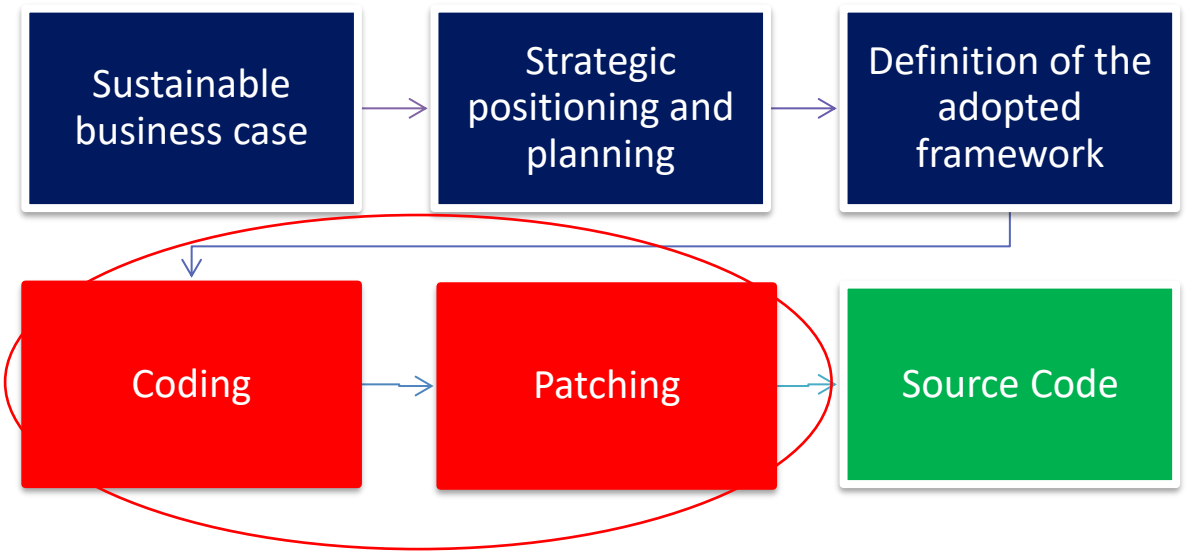
In the central part of the text, chapter 3,4, the main features of app development will be covered; which languages are used and why they are used specifically. This will be the most technical part, related to the system integration work that BIP does for the client and that occupied about half of my time during the internship. The rest of my time was spent on market analysis and strategic positioning, which will be covered in the next chapter.

The final part of the thesis, chapter 5,6, will instead analyze which are the main automotive apps for which BIP has participated in the development and the peculiarities they have from the user's point of view. It will also explain the work that the consultancy company offers in the project definition phase and in the economic and technical aspects. This knowledge, which is only partially derived from university studies, forms the basis on which the internship was built. Secondly, through the activities carried out in the company I was able to try my hand at optimizing and engineering internal processes, which, as will be explained, is necessary to take advantage of in a complex sector such as road transport.

1.1 My Internship

I started my curricular Internship in Milan 16 June 2021. The team I worked for was composed by 12 engineers split in smaller groups each in charge of specific tasks. I decided to apply for BIP because I want to pursue a career in consulting, and it represents an innovative firm with an engineering core business. Further details about the company activity will be described in the chapter 4. The project we worked for was centered on the launch of an automotive web app for the electric sector for an historical Dutch manufacturer. The deliverables of BIP were a sustainable business case and the source code for the web app. When I joined the company the business case was already completed but, in any case, it is the part that the top management of my company discuss with the client. So, for this management activities, regarding the positioning, strategy and macro directions that should be chosen before start working on the source code, I was not involved directly. This because the technical part of the project is driven by analysts, consultants, and senior consultants (with the

supervision of the managers) and the communication, selling and strategy activities are well distributed among managers and the director. I have to position my internship activity at the end of the project path below.



It is however necessary to mention that beside my coding activity, I had the opportunity to take part in all the meeting regarding managerial activities. This means a lot for me in terms of personal growth because I had the chance to see transversally all the parts of the project. My experience as intern ended up in September the 20th, when I officially became Analyst, and the project deliverables was provided in October the 10th.

1.2 The company BIP

BIP was born in 2003 as a spinoff of the engineering management consulting of Deloitte. Now the company operates in many industries (Manufacturing, Energy & Utilities, Financial Services, Telco, Public Sector) with three main functions: system integration, management consulting and company restructuring. Personally I experienced the first two which are related to the development of the final product . We speak about System Integration as the process of connecting different subsystems, also known as components, into one larger system to make everything work in unison. From an IT architecture perspective, System Integration is the process of linking together various IT software and services with the aim of creating cohesion in the management of work processes.

On the other hand, Management Consulting is focused on providing solutions and strategies to improve the positioning and operational health of a business. The companies that decide to rely on management

consulting are often those that, too absorbed by the daily routine of the company, come to lose the objectivity necessary to make the best strategic and operational decisions.

BIP is an international company, based in Italy (Milan). Currently more than 4000 people work distributed in 20 offices in 12 countries. The business areas where BIP operates are 6, called practices.

Offices and Business areas in BIP

Currently and during my internship I work for xTech practice. This section of the company is split into many services: Data, Cloud, Platforms and Solutions. My service area is Platforms, specifically in the Architecture and Engineering field, we design digital platforms (IT, Network, Blockchain, AR/VR, etc.) through high and low-level design.

The career path usually begins with technical roles graded on seniority and skills (analyst ➔ consultant ➔ senior consultant) than there are the managers that are in charge to oversee the work of the technicians and ensure that it is aligned with the required delivery. Above those seniority careers are divided in two separated path Directors and Partners whose roles are respectively direction of operations and commercial.

2. THE ELECTRIFICATION LANDSCAPE

Today, the use of electricity is changing a vehicle's energy storage systems from fossil fuels to electrochemical energy storage systems: the common power supply of petrol or diesel vehicles will in time be abandoned following the roadmap that every country or region has made the commitment to follow . This change is leading to a real revolution in the automotive industry, geared towards the development of an energy vehicle with a more electrified drive train. The orientation of car manufacturers towards the use of electric vehicles as a replacement for the current ones is determined by several factors:

- the rise in oil prices and consequently the price of oil byproducts, which over the years has made using your own car very expensive, especially for small daily trips;
- oil, a fossil fuel consisting of a mixture of hydrocarbons accumulated over the years in reservoirs, has the problem of being a non-renewable energy source;
- petrol and diesel engines emit highly polluting dust such as PM10 into the atmosphere and generate CO2. The pollutants cause an amplification of the ozone hole (resulting in a decrease in the protection of UV rays reaching the earth) and an increase in global warming; WMO, World Meteorological Organization, and UN Environmental Programme are estimating +6.6 *C in 2100 [1]. This situation causes serious consequences for both the environment and the health of the world's population.

At present, environmental awareness is growing in many countries as a result of environmental protection legislation, like Paris Agreement 2015. Political action has been taken to guide and encourage manufacturers to adopt optimal solutions to combat environmental pollution from vehicles. In this regard, target levels of CO2 emissions for car and vans are respectively 90 and 147 g CO2/km for the period 2020-2024 while for the successive period 2025-2030 a further reduction of 15%. The aim is not only the reduction of carbon dioxide to protect global warming but also with the following macro targets:

- CO2 emissions from new cars;

- Noise emissions;

- Harmful emissions such as carbon monoxide, hydrocarbons, nitrogen oxide and particles.

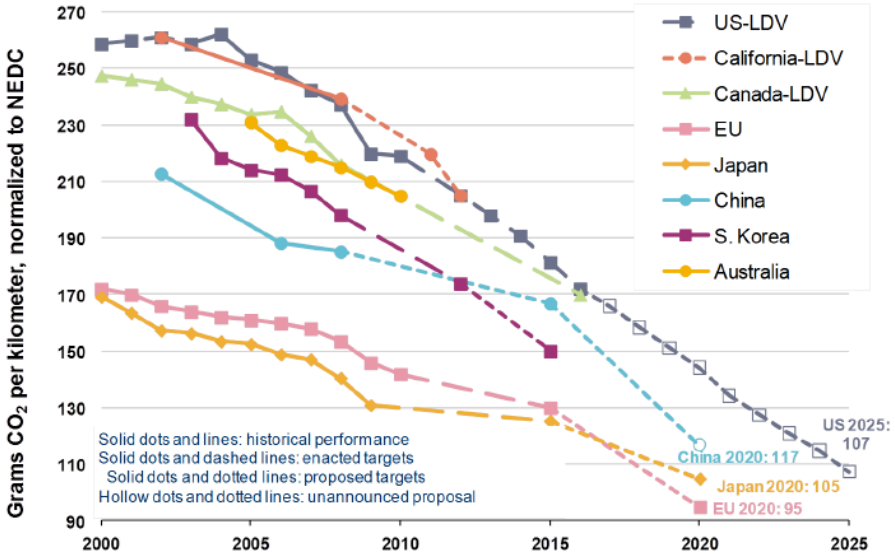


Figure 1 CO2 emissions into the environment of the various states over the years

2.1 Green vehicles: classification and functioning

The direction chosen by most of the western world is the spread of electric vehicles (EVs). An EV is any vehicle whose movement is driven by electricity. The electrically driven vehicle "is a vehicle that converts the chemical energy contained in the batteries into electrical energy and then, via an electric motor, into mechanical energy, which is used to move the vehicle" (ANON., Orizzontenergia). Electric vehicles, having zero polluting emissions, are an ideal solution to solve, at least in part, the problem of air pollution due to road transport.

From an evolutionary point of view, 'green' cars (less polluting cars) can be divided into four categories described by Green vehicles state of the art brochure of EU 2018:

- **Mild Hybrid Vehicles (MHEVs)**, which have an internal combustion engine combined with an electric generator/motor. However, the electric compartment (motor plus battery) is smaller in size and complexity than in hybrids and, unlike hybrids, does not allow cars to be driven for several kilometres in pure electric mode. The electric motor plays two roles: it recharges the battery during the braking phase and supports the MCI (internal combustion engine) during the starting phase of the vehicle. Due to their low power, Mild vehicles are less fuel-efficient than conventional hybrids and therefore require less powerful batteries. The advantage, however, is the lower additional physical weight.

- **Hybrid vehicles (HEV)**; equipped with a two- or multi-component propulsion system, i.e., it has an electric motor and a heat engine working in synergy with each other.

  There are three main characteristics of a hybrid vehicle:
  - Regenerative braking: When a vehicle brakes or decelerates, kinetic energy is recovered by a generator and stored in the vehicle;
  - Reduced idling time: the MCI can be switched off at every vehicle stop or at low travel speeds, reducing losses;
  - Increased MCI efficiency: the electric motor can assist the MCI by providing mechanical power to the wheels.

  Hybrid cars allow noise pollution to be reduced: noise emissions are significantly lower than those of a conventional vehicle.

  Three distinct families of architectures can be identified:
  - *Hybrid electric vehicle series*: is a hybrid vehicle in which the power required for propulsion is provided solely by an electric motor;
  - *Parallel hybrid electric* vehicle: This is a hybrid vehicle in which the power required for propulsion is provided by an electric motor and an endothermic motor.
  - *Mixed hybrid electric vehicle*: this is a very versatile system that makes it possible to switch from the series to the parallel system and vice versa. The combined use of the endothermic and electric motor

is therefore envisaged, thus making it possible to combine the advantages of both technologies on pain of greater mechanical complication and higher construction costs.

- Plug-in vehicles (PHEVs) are a type of vehicle in which the batteries can be charged without the aid of the internal combustion engine, using an external electrical energy source connected via cables. Such cars have the same characteristics as classic hybrids and can be either series or parallel. Plug-in hybrid technology is currently the best performing technology because it allows you to travel several kilometers without having to use petrol (or diesel), thanks to more powerful batteries. In addition, the larger battery allows 50 to 60 km to be covered using the electric motor alone. These vehicles can be recharged not only during deceleration, but also from public charging stations or from the home network.
The advantages are therefore:

- A few dozen kilometers using only the electric motor;
- Zero emissions when the heat engine is not used;
- Absence of problems related to autonomy;
- No specific maintenance;
- More charging options for the electric motor;

-Electric vehicles are the true zero-emission cars as they are driven exclusively by an electric motor recharged by a high-voltage battery, the key element of such a vehicle, which symbolizes a 'reservoir' of energy to run the motor.

Figure 1 Thermal vehicle vs. electric vehicle

2.2 Operation and characteristics of the electric motor

The electric motor has a mechanically less complex structure than an internal combustion engine, petrol or diesel. It has fewer moving parts and does not emit noise, odor or heat when switched on. In addition, when

driving, its smoothness and superior obedience compared to other fuels can be noticed. In short, the electric motor consists of four components:

- Battery charger: its function is to capture electrical current for storage in the battery.
- Inverter: the fundamental component that transforms electrical current into mechanical current.
- Controller: handles and sends the transformed current for the correct operation of the car.
- Battery: has the function of conserving energy.

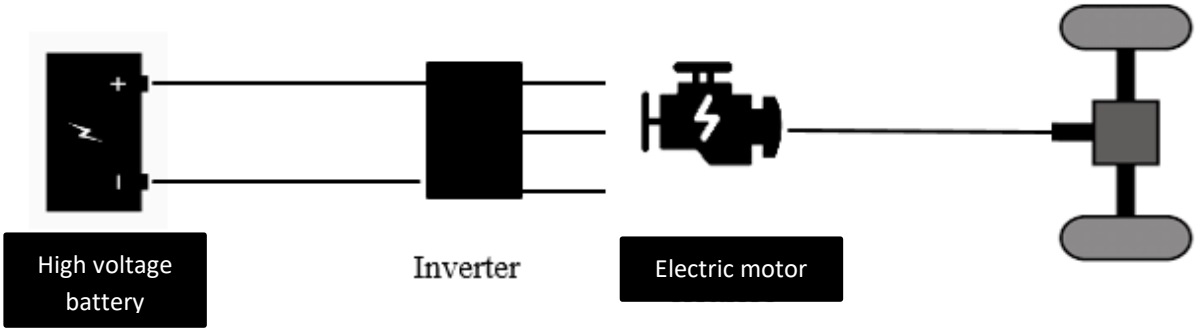


Figure 2: components of an electric motor

While the vehicle is in motion, the battery releases energy to the inverter, which converts the direct current into alternating current and sends it to the motor. The electric motor then uses the electrical energy stored during charging and converts it into mechanical energy to move the vehicle. During deceleration, the motor becomes a generator and recharges the battery.

The engine of electric vehicles is technically less 'complicated' than the combustion engine as it consists of only two main units:

- the stator, a fixed part of a car engine. It consists of a conductor (branch wires) which generate variable magnetic fields opposite those generated by the rotor.
- the rotor, a moving part with a permanent magnetic field.

On the stator, through advanced current management, a variable magnetic field is generated by the windings themselves and the interaction of the magnetic fields2 of the stator and rotor produces the driving torque that allows the car to move.

There are different structures for these two elements:

1) Three-phase asynchronous motor:

The asynchronous motor differs from synchronous motors in that it is a type of alternating current electric motor in which the rotation frequency is a submultiple of the mains frequency, i.e., it is not "synchronous" with it. Today, around 70% of electric motors in operation are of this type. The three-phase asynchronous motor is powered by a three-phase voltage system, i.e., offset by 120°. The supply voltage is 400 V rms, at a frequency f = 50 Hz.

2) Permanent magnet synchronous motor (Brushless)

The synchronous motor is a type of current electric motor whose rotation is synchronized with the electrical frequency. As with the asynchronous motor, a rotating field is generated on the stator (outer) by means of a three-phase supply of three windings (one for each phase). On the rotor (inner) there are permanent magnets which generate the rotor flux which is driven by the stator flux at a speed identical (hence the term synchronous) to that of the stator flux. Permanent magnet synchronous AC motors are also called sinusoidal brushless.
Most electric cars use permanent magnet 'synchronous' electric motors (brushless sinewave) powered by the direct current of lithium batteries because they have to work with varying loads at different speeds and consume less current.

The key element that distinguishes HEVs and EVs from internal combustion cars is the battery, an element that stores and supplies the necessary energy. The batteries currently in use in low-emission, electric-powered vehicles are:

- Nickel-metal-hydride (NiMH) batteries: Endangered, these were the first batteries used in older hybrid cars as an additional power supply to the petrol engine. They have a low range when the vehicle is running on electric power only (3-4km).
- Lead-gel (Pb Gel / Silicon) batteries: initially only lead-acid, this is the oldest technology; it has since been upgraded to lead-gel technology, containing silicon gel to improve performance. The average life of lead-acid batteries is 300-400 complete discharge cycles, and they last about 20 km.
- Lithium (Li) batteries: these are the most modern batteries and will replace those listed above; they have a high energy density and are not subject to the memory effect, making them ideal for electric vehicles. There are different versions:

Lithium-polymer batteries, not to be used in vehicles as they can catch fire and explode (dangerous) in the event of impact:
°Lithium-ion batteries - °Lithium-iron-phosphate batteries are the best around, losing only 5% of their charge capacity each year - *°Lithium-iron-actio-phosphate batteries - °Lithium cobalt oxide* (LiCoO2) *batteries*

2.4 Limits on cobalt use and lithium extraction for battery production

Cobalt, the most expensive battery metal, is used in common lithium batteries with nickel and manganese or aluminum. More than half of the cobalt mined each year comes from mines in the African country of Congo, where child labor is exploited: estimates say that around 15% of Congolese supplies of this metal are extracted by hand, often by children and young people. The government of Congo has set itself the goal of strengthening monitoring of the sector and eliminating forced labor practices by raising the cost of cobalt and undermining companies that produce electric batteries.

In China, battery manufacturers are focusing on alternative materials to cobalt for the cathodes, such as lithium iron phosphate, even if cobalt is difficult to dispense with.

Lithium mining for battery production is not zero impact. It is highly harmful to the environment and puts vegetation at risk. According to the Salares Andinos Plurinational Observatory, which brings together communities, organisations and researchers from the three Latin American countries, lithium extraction produces uncontrolled desertification. According to Ramón Morales Balcázar, a researcher at the Universidad autónoma Metropolitana-Xochimilco in Mexico and a member of the Plurinational Observatory of the Andean Salt Flats, 'lithium cannot be considered an ecological resource because its extraction is producing devastation and land occupation'. Moreover, according to studies by the University of Antofagasta, Chile, two million litres of water are needed for every tonne of ore extracted.

Since lithium-ion batteries are not expected to be phased out any time soon, the first strategy that researchers are implementing to counteract the various problems is to reduce the amount of metals that have to be extracted and used.

Optimising the production of this type of battery has led to important results:

- falling prices: lithium-ion batteries are now 30 times cheaper than when they first entered the market in the early 1990s and their performance has improved. In addition, the cost of a lithium-ion battery for electric vehicles is expected to fall below $100 per kilowatt hour by 2023 (20% less than today);
- development of an efficient lithium battery recycling industry. Guangdong Brunp, based in Foshan, China's largest producer of lithium-ion cells, can recycle 120,000 tonnes of batteries a year, the equivalent of what would be used in more than 200,000 cars, recovering most of the lithium.

  China has further allocated financial and regulatory incentives for battery companies that purchase materials from recycling companies instead of importing newly mined materials.

2.5 Technological innovations

Digital transformation has radically reshaped the automotive sector: increasingly advanced and sophisticated services have changed and will change the car experience.

As drivers' needs become more and more demanding, it is important to find solutions that meet increasingly customised requirements.

The automotive trend also includes innovations in the field of technology and safety:

- autonomous driving, one of the biggest challenges in the automotive industry. Cars are becoming more and more high-tech and will be able to make decisions autonomously through the installation of various safety systems such as autonomous emergency braking and speed regulation.
- permanent connection, every day we are increasingly looking for constant connectivity, even inside the car. This will allow the driver to stay always online, through specific applications. The "Case" car, from the acronym Connected, Autonomous, Shared, Electric is able to allow the owner to control it and keep it in perfect working order remotely.

  Thanks to the connection, it is possible to: identify possible breakdowns in advance, establish customized routine operations based on the actual use of the vehicle, thus avoiding periodic servicing; exchange information on accidents and dangerous situations; book and ask for advice on restaurants, hotels, concerts, tourist attractions, films shown in cinemas or dictate a letter while driving; provide heterogeneous information on the geolocation of the vehicle, driving style, accident dynamics, etc.

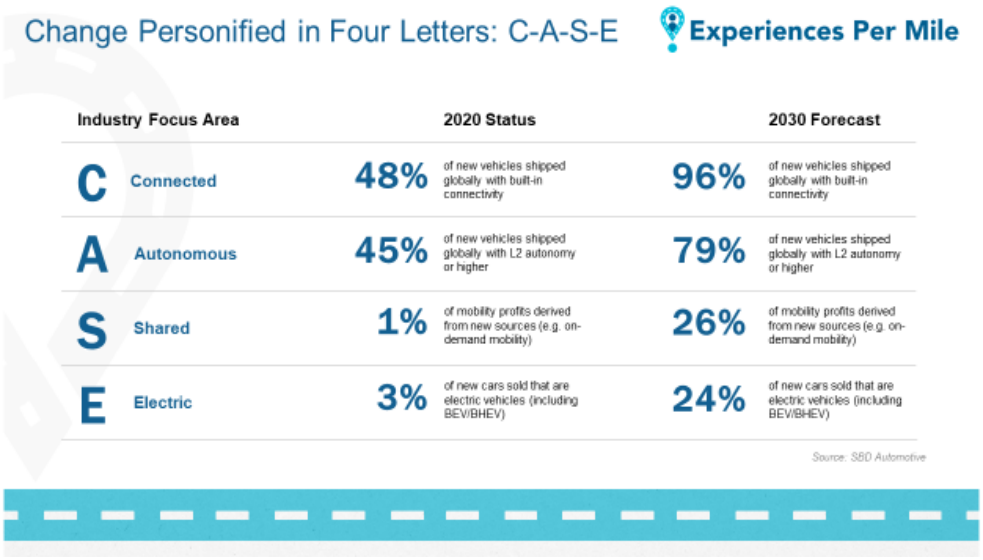


Figure 4 Change Personified in Four Letters: C-A-S-E -Samsung Electronics Co., Ltd

The company BIP, which specializes in both system integration (development of web applications) and management consulting (integration of management with regard to managerial skills that car manufacturers do not directly possess for development), operates directly within projects for the creation of specific applications for the support of electric mobility dedicated to mobile devices for the achievement of objectives related to 'permanent connection'.

This thesis will describe the framework used to create the applications in conjunction with the main web technologies used.

2.6 Advantages and disadvantages of electric vehicles

Buying an electric car offers a number of economic advantages, guaranteed by municipalities and the government, which has proposed a series of incentives that make the purchase of an electric car worthwhile. In particular:

- low consumption: electric cars consume very little, especially when compared to petrol and diesel cars. In fact, the cost of electricity is currently lower than that of traditional fuels.
- possibility of installing a recharging station at home: if you wish to install a recharging station for your electric car at home, you can do so by taking advantage of the tax benefits activated by the government to promote electric mobility. In this way, after an apparently onerous initial investment, the cost of

which is reimbursed through tax deductions, the owner of the electric car can recharge the vehicle directly at home (enjoying the electricity tariff agreed with his manager);

- electric car insurance: it costs less than other cars. It is possible to save between 10% and 30% compared to diesel or petrol cars. The reason for this potential 'discount' is that the calculation of the third-party liability insurance is based on the risk level of the car, and electric cars are safer than other cars in this respect;
- electric car purchase bonus [2]: the Relaunch Decree confirmed a series of tax deductions for those wishing to purchase an electric car. The European incentive are in the years from 2020 to 2022, a super-credits system applies for passenger cars with emissions of less than 50 g CO2/km (NEDC). These vehicles are counted multiple times for the calculation of the average specific emissions of a manufacturer: as 2 vehicles in 2020; as 1.67 vehicles in 2021; as 1.33 vehicles in 2022. A cap on the super-credits is set at 7.5 g/km per car manufacturer over the three years. No super-credits system is in place for vans.

This is a contribution that varies according to the emissions produced by the vehicle. The amount of the subsidy may increase if you decide to scrap your old car at the same time;

- lower maintenance cost (due to its few mechanical components);
- exemption from the payment of stamp duty;

In addition to the economic advantages mentioned above, it is worth remembering that by buying an electric car you can make your own contribution to the environmental cause:

- reduction of environmentally harmful emissions: 'green' cars allow, in urban driving contexts, a reduction in CO2 emissions of 40%-45% compared to similar petrol-engined versions and between 22%-40% compared to diesel-engined ones. Thus, it is possible to say that a 'plug-in car' allows a 30% reduction in emissions compared to cars with an internal combustion engine;
- Reduced noise pollution: green cars are much quieter than conventional ones and allow you to drive in a way that respects the urban environment. In this respect, new generation cars are often equipped with acoustic devices that signal their presence when driving in pedestrian areas.

In addition to these advantages, it is worth remembering that having an electric car allows you to move freely within your city: not only are these vehicles not affected by traffic blocks, but they can also circulate in certain limited traffic zones (ZTL).

Until a few years ago, electric cars seemed like a futuristic means of transport, but today they are already an important and consolidated part of the automotive market. Despite this, the technology still needs to improve some critical points that still do not convince consumers, including:

- limited autonomy: electric cars have a shorter autonomy than diesel and petrol cars, and also than hybrids. This makes it impossible to use them for long journeys, due to the limited presence of electric charging stations on motorways. At the same time, it is worth noting that some European countries, including Norway, have already implemented ambitious policies to achieve a high share of green cars and, consequently, to adapt their motorway infrastructure by equipping it with charging stations;
- recharging times: unfortunately, recharging times for green cars are still often far away and almost incompatible with the hectic pace of life that people often have to face. However, having a wallbox at home can help to partly solve this problem. Alternatively, it is preferable to park your vehicle in a car park equipped with an electric recharging station: in this way you can optimise your parking time and make sure you have a charged car when you need to leave;
- battery safety: today, batteries in green cars are more likely to catch fire. Although this may seem remote, it is worth bearing this in mind in the event of a road accident;
- disposal of batteries: although electric cars pollute less, it should be remembered that the process of disposing of car batteries, if not carried out in the right way, could be an environmentally unfriendly operation.

However, it is worth emphasizing that technology is making giant strides in this sector: while driving an electric car might have been a remote possibility a few years ago, today it is an opportunity that is granted to many. In this sense, the tax benefits provided by the government are a considerable incentive for all those who wish to enjoy the advantages of electric mobility, which, to date, can be considered more superior than the disadvantages.

2.7 Electricity trend: major manufacturers of electric cars

The market for electric cars is booming, and for the moment we can only imagine how great the strategic advantage is in playing a leading role in the sector. At the moment, few manufacturers can claim to have complete control over the entire production chain of electric cars.

2.7.1 Tesla

The leading role in the production of electric cars is taken by Tesla (whose creator is Elon Musk). The Tesla plant in Fremont, California, is one of the most advanced car factories in the world, with half a million square metres dedicated to production. It is the company that was the first to believe in the concept of the electric car, investing a great deal of money and developing its engineering know-how.

The first electric vehicle produced by Tesla was a roadster based on the Lotus Elise. The second vehicle produced was a saloon car, named Model S. Subsequently, according to the latest figures available, Tesla took two models to the podium: Model 3, first with 378,000 units delivered worldwide, and Model Y with 282,000 deliveries made. From a strategic point of view, development in China, where the Giga Factory in Shanghai is located, continues unabated: according to unofficial rumours, it has already produced 500,000 vehicles, bringing the declared target of 900,000 cars produced by 2021 considerably closer.

Volkswagen

Volkswagen seems to be the most optimistic carmaker regarding the transition to fully electric models. The German giant plans to produce 50 all-electric models by 2025. To achieve this, it plans to invest 35 billion euros ($40 billion) in electric car technology, mostly on batteries, by this year. It also plans to sell around 2 to 3 million electric cars per year by 2025, which would account for around 20-25% of the company's sales. With these targets, Volkswagen seems to be the company with the best chance of overtaking Tesla in electric car sales by 2025.

Another positive aspect concerning Volkswagen, as far as this analysis is concerned, is that the company is committed to a transition to fully electric cars, without wasting too much time on plug-in hybrids. The plug-in cars that the Volkswagen group currently sells include 6 plug-in hybrids and 2 fully electric cars, sold in Europe in modest quantities and elsewhere in very small quantities.

The best-selling model is the D-SUV ID.4, with 88,000 vehicles delivered, while ID.3 (which in Italy is third in the EV ranking after 500 and Spring) stops at 60,000 units shipped around the planet.

SAIC Group

In third place is SAIC, which stands for Shanghai Automotive Industry Corporation. This Chinese multinational makes up the country's "Big 5" automotive companies (of which it is currently the leader) and has several partnerships with some of the biggest brands around, including the American General Motors. It has recently made headlines for having acquired the historic British brand MG, re-proposing it in EV sauce. Three electrified

models have arrived for the Italian and European markets, all with typical crossover bodywork: ZS (BEV), EHS (PHEV) and Marvel R (BEV).

BYD Group

BYD, which stands for "Build Your Dreams", is set to knock SAIC off the podium in time. Here too we are dealing with a giant specializing above all in the electric bus sector, with impressive margins for manoeuvre in Europe (Norway and Spain are preparing to open collaboration). The company also has excellent knowledge of batteries, made from iron phosphate, for other technological devices such as smartphones, as well as the ecosystem of connected services. In the automotive sector, the company recently signed a historic agreement with Toyota to produce a low-cost battery-powered car by 2022.

2.8 Electricity trend: market orientation in the sale of electric vehicles

The electric car market is relatively new, developing and still shrouded in uncertainty; in 2021 only 4,1% of new cars where electric. The spread of the electric car is gradually taking place in an environmentally friendly European context. Statistics (European Alternative Fuels Observatory) show that in Europe the countries most interested in electric vehicles are Turkey (93%), Russia (87%), Portugal (82%), Spain and Italy (76%). Among the countries less convinced about adopting electric vehicles are France, Germany, and the United Kingdom.

Using data provided by EV-volumes (EAFO), we are able to offer some insight into the size of the electric vehicle market over the past year. The leader in terms of sales volume is Tesla, with China overtaking Europe in volume with 1,149,000 units sold. The strongest growth was recorded in China with +197%, followed by the United States +166% and Europe +157%. On the global scene, China shows the best performance in electric car sales (in terms of trends and volumes), ahead of Europe and the USA. While outside Europe, 80% of electrified sales will be battery-powered in the first half of 2021, in Europe the share is evenly split between PHEVs and BEVs.

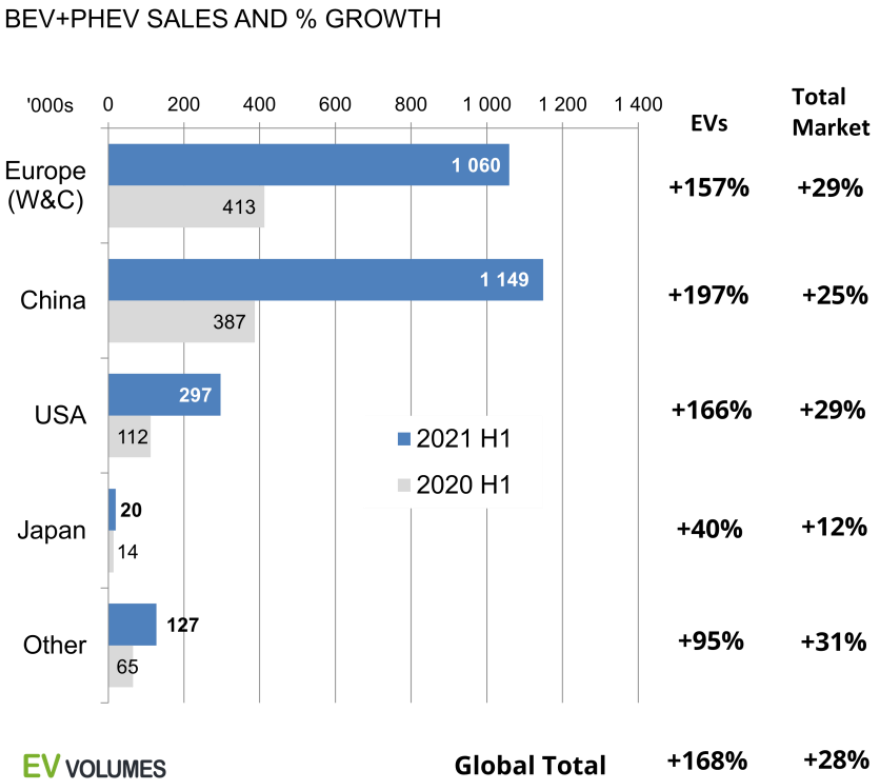


Figure 5 European Alternative Fuels Observatory - Volumes 2020

Looking at sales figures, among the world's best-selling electric and hybrid car brands in the first half of 2021, Tesla is firmly in first place with its four 100% electric models

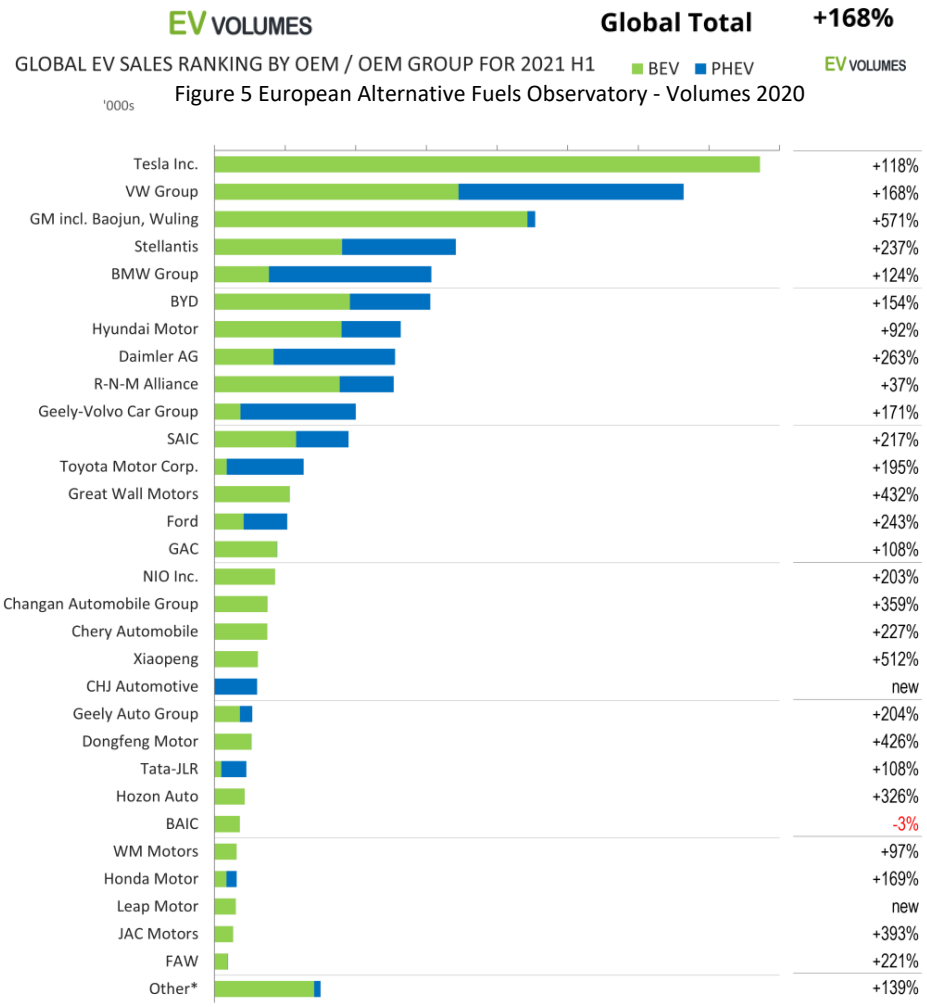


Figure 6 Global EV sales data - EVvolumes.com

and 386,000 cars delivered. In second place is the Volkswagen Group with 332,000 units (172,700 BEVs and 159,400 PHEVs). In third place General Motors-SGMW recorded the best growth in the first half of 2020-2021: +571% and 227,000 units (of which 221,000 BEVs and 180,000 are Mini-EV models sold in China). Stellantis electric and hybrid cars recorded the second-best growth over the period, ranking fourth in terms of volume, ahead of BMW Group which closes the Top 5 of electrified car sales worldwide.

The EV Volumes report on sales in the first half of 2021, compared in the chart below with the previous year, again shows Tesla leading the way with the Model 3 (244,000 cars delivered in H1 2021). The small Chinese Mini EV, on the other hand, is the second best-selling electric car in the world (182,000), ahead of the Tesla Model Y (138,000). The BYD Han and the Volkswagen ID.4 (both at 39,000, but with no 2020 benchmark) are considerably smaller in volume, ahead of the proven Renault ZOE, in sixth place but down 5,000 units.

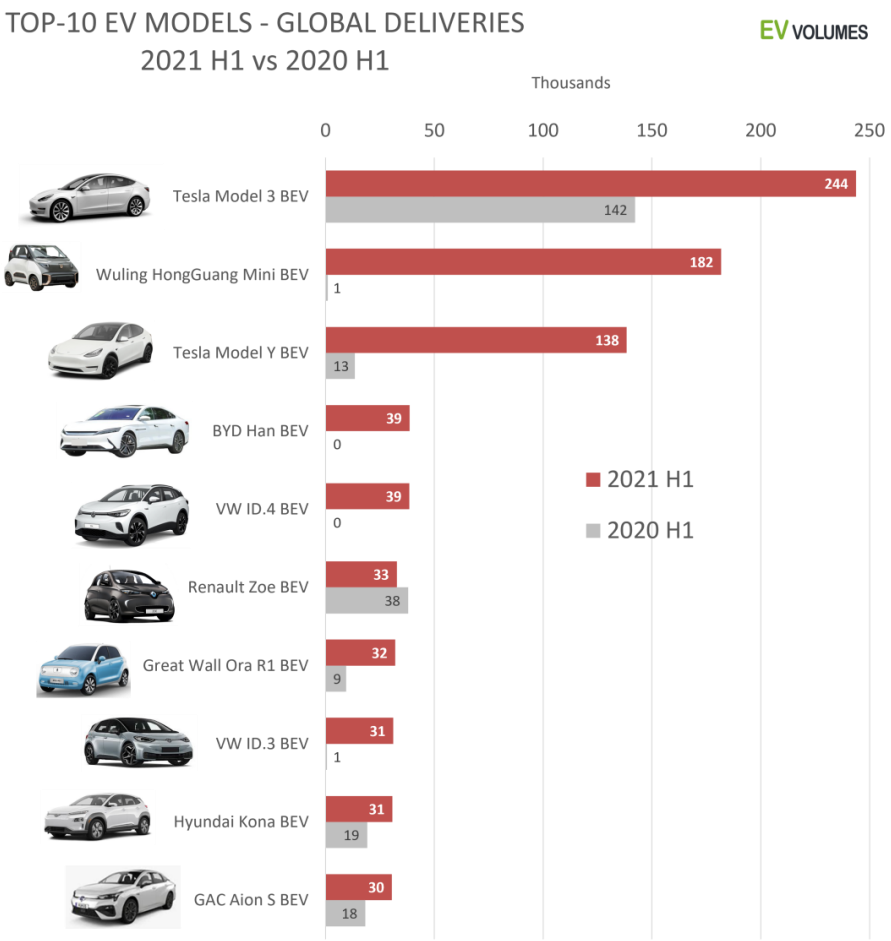


Figure 7 Graph of electric 2car sales in the first half of 2021 vs. year 2020 - EVvolumes.com

3. PROJECT TECHNOLOGIES FOR DEVELOPING A WEB APPLICATION

The development of technology in recent years has made it possible to take advantage of applications that were previously only available on the browser, through the use of smartphones and tablets, whose processor has computing power comparable to that of a PC. With an operating system such as iOS, Android, and Windows Phone, they can support high-definition multimedia files (e.g., photos, videos, audio), read documents in different formats and connect to the web via data networks or Wi-Fi. They also have a touchscreen with a suitable user interface and can be customized or have additional functions added by means of applications downloaded from their respective markets. The strength of smartphones and tablets is their portability, i.e., the fact that they can be taken anywhere thanks to their light weight and small size, thus offering the possibility of using applications at any time. Currently, there are several methodologies for creating a mobile application:

- responsive web design: used to make a web application or a normal website resizable for small screens and adapted for touchscreen use.
- native applications or mobile applications: these run directly on the device like a conventional software application.
- hybrid applications: they encapsulate a website within a native application through the use of a framework (e.g., Apache Cordova). This technology allows development using web technologies, while retaining the advantages of native applications, such as offline operation and hardware access. Like web applications, hybrid applications are made up of a combination of HTML, CSS and JavaScript, the only difference being that they are hosted within native applications, making it possible to access hardware (e.g., accelerometer, camera) and software (e.g., user contacts).

For the development of applications, the company (BIP) has turned to an approach of developing web apps as hybrid apps. Hybrid apps combine the technology of web apps with that of native apps, so that they can be downloaded via a store and installed directly on one's own smartphone or tablet instead of being viewed in the browser. The goal of hybrid applications is not to run on a mobile browser, but to use a WebView contained in the native application.

Figure 8 Representation of hybrid application (BIP)

The main reason for choosing to implement a hybrid application, apart from the simplicity of programming, was the possibility of aiming to make it available on multiple platforms and operating systems. In this way the app spreads more and it impacts positively the number of potential users. This chapter describes the thesis project and illustrates the technologies used to develop web apps for controlling electric cars.

3.1 Web app features

In computer science, a Web Application is defined as an application accessible via the web by means of a network within a computer system or through the Internet, i.e., a client-server type application software with the aim of offering services to the client user. It is therefore based on the concept of the operation of a client that accesses the application by connecting to processing functions on an application server using web browsers as user terminals.

Figure 9 Exemplification of Client-server system via the Internet

A web app can have several recognizable logical structures and organizations on several levels (multi-tier architectures). According to the ISO/OSI protocols, some examples of logical organizations are:

- *Presentation logic*: first level, mostly consisting of the user interface (HTML and CSS, JSP, JSF, JavaScript, etc.), which replaces GUIs (Graphic User Interface), non-web-based software applications.
- *Business logic*: second level consisting of the application engine (back-end, processor of received data), typically present on application servers and consisting of source code in dynamic server-side development language (PHP, ASP, etc.). The back-end application core receives, processes, and satisfies client requests. The fourth level, on the other hand, differentiates a web application from a normal website, as it implements the web service in the form of source code provided to the client.
- *Data layer*: third layer related to the associated database engine (MySQL, MSSql, etc.). It receives and satisfies read/write requests on the database from the application logic. It may reside directly on the DB or together with the application logic on the application server.

Using a web browser as a client is convenient because of cross-platform compatibility, allowing web applications to be maintained and updated without having to install software on thousands of client computers. The client's web browser operates, therefore, by sending its requests, via the HTTP/HTTPS protocol, to the intermediate level or to the dynamic application engine of the web server which interprets and manages the queries to the DBMS engine and, consequently, generates the result in an output directed to the same browser, which interprets it and returns it to the user in the form of the Web. A web application is therefore essentially characterized by the transfer of data or information from one layer to another, i.e., from the front-end to the back-end and vice versa. Moreover, in web applications of a certain size or complexity, like websites and portals, there is often a home page with an initial menu and related submenus for the set of functionalities or services offered to the user. [3]

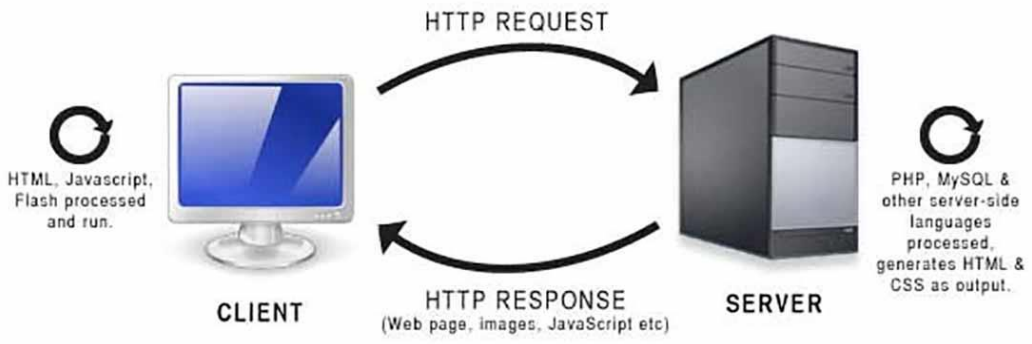


Figure 10 Client-server operation diagram

The development of web applications typically follows the software life cycle, starting with the analysis of requirements.

3.2 Requirements analysis

The application and the web portal require a web server, as the management of the contents must be guaranteed even in the absence of a stable connection and, therefore, offline. Web applications have the disadvantage of being network-dependent as they cannot interact directly with the hardware and software of the device. Moreover, the pages must be dynamic, so as to process the data to be displayed at run-time.

Considering the non-functional requirements, a smartphone or tablet running one of the main mobile systems is needed to use the application. In addition to this, all functions related to the geolocation of the user require that the device used is equipped with geolocation systems, such as GPS, and that these are made accessible to the installed application. On the basis of these requirements, we move on to the design phase that defines how the requirements will be fulfilled, going into the structure to be given to the software system.

3.3 Apache Cordova as a development framework

Apache Cordova is an open-source development framework for mobile devices. It allows standard web technologies such as HTML5, CSS3 and JavaScript to be used for cross-platform development, avoiding any contact with the language of native applications. Applications are then run through standards-compliant APIs to access sensors, data, network status and other native device functionality. To overcome the limitations of mobile browsers, Cordova embeds the HTML5 code within a native WebView on the device using an external interface to access the device's native resources. In practice, the Apache Cordova architecture looks like a Web application container whose graphical interface, the WebView, takes up the entire screen of the device and allows HTML and CSS to be displayed.

To communicate with each other, Cordova and the native components interface via plugins. In this way, native code is called via the JavaScript API. These, along with WebViews, depend on the mobile platform on which they will be used. Plugins are necessary for communication between Cordova and the native components.

Figure 11 Application structure with Apache Cordova

The basic components of an application created with Apache Cordova are:

- config.xml: provides information about the application and specifies parameters on its operation. Adheres to the widget specifications of the W3C (World Wide Web Consortium).
- index.html: web page containing HTML and possibly CSS, Javascript code and multimedia files. It is executed as a Web View.

Two different approaches can be followed for the development of hybrid applications with Apache Cordova:

- **Cross-platform CLI (Command Line Interface) development**: This method implies a general development that is not platform-specific. The CLI is a high-level tool that, by abstracting many of the features of lower-level shell scripts, allows you to build a cross-platform compatible project. CLIs also provide an interface for applying plugins in your application, which is ideal if you want your application to be present on as many operating systems as possible.
- **Dedicated development for one platform**: This approach is advisable, however, in cases where it is necessary to develop an application compatible with a single platform. For example, it can be used to

combine native components with Cordova web-based components. This method is not recommended for the design of applications compatible with several platforms since, in the absence of high-level tools, it could result in the separation of construction cycles and, consequently, the need to modify plugins for each platform. (http://cordova.apache.org/docs/en/latest/guide/overview/)

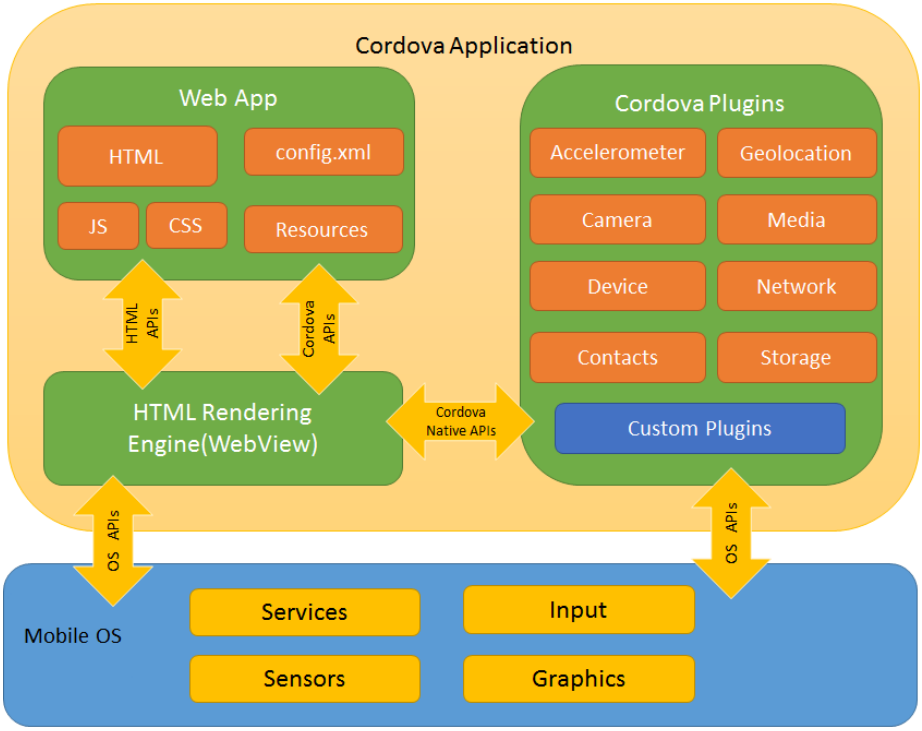


Figure 12 Architecture of Apache Cordova

Apache Cordova currently supports the following mobile platforms: Android, iOS, Blackberry, Bada, Tizen and Windows Phone.

3.4 Cross platform via Adobe Phonegap

Phonegap is a cross-platform mobile framework that enables the creation of hybrid applications. It is an open-source method of accessing a native environment through Web Views embedded in a native application. Its function is to make it possible to develop mobile applications using web technologies such as HTML, CSS and JavaScript, while still being able to use native code when necessary.

In 2001, the rights to Phonegap were acquired by Adobe and the Phonegap framework thus became a free distribution of Apache Cordova. [http://blog.ionic.io/what-is-cordova-phonegap/]

Initially, the differences between Cordova and Phonegap were minimal, but Adobe equipped Phonegap with a set of services inappropriate for an Apache project. One of these is Phonegap Build, which embeds HTML, CSS and JavaScript into the cloud service and creates store-ready applications without having to maintain native SDKs. If you want to create a hybrid application, you can choose either to use Cordova or to enter the Adobe ecosystem using its distribution Phonegap, also a free framework with an open license. Those who want to fix bugs, add tests or write documentation are directed, instead, to work with the open-source Apache Cordova project and not PhoneGap. [4]

The structure of the Phonegap application divided into folders:

- Manifest: folder containing the file AndroidManifest.xml, which allows you to manage the behaviour that the application can have towards the hardware and software of the device and provides this information to the Android system. For example, the Android Manifest contains a description of the application components (tasks, services, receivers, etc.) and the management of the permissions that the application must have to interact with its components.

- Java: folder containing all the java classes that the application needs to run. Android uses a native java language to design native applications. As Javascript code is added to the source code, new classes are created to implement its functions using Cordova plugins.

- Res: folder containing all references to the resources needed by the application. The resources may be images to be inserted or fav-icons, binary files or xml files, for example the config.xml file, a global configuration file of the application through which it is possible to manage the plugins installed and the settings of the platform used.

- Assets: folder containing all the code files written during the implementation of the application. The www folder contains the index.html file.

The www folder includes, in turn, further folders:

cordova-js-src: includes the javascript files relating to the platform, execution of the application and communication with the underlying native application base;
css: contains all the style sheets to be imported into the html file to define the style of the pages. The application has only one style sheet in which all the styles are defined, sorted by class or identifier, and divided into containers, headers, paragraphs, anchors, images, etc.

img: contains all the images inserted in the application screens.

js: contains all the javascript files for the interactivity of the application.

Plugins: includes the JavaScript files of the plugins used in the application.

Res: contains other resources necessary for the operation of the application.

Spec: contains additional special libraries.

The Adobe Phonegap plugins are:

- whitelist: this is installed automatically during the creation of a Phonegap project. It regulates requests to the application's network by allowing or denying access to the web.

- cordova Local-Notifications Plugin: Allows the application to launch push notifications regarding data received from the server (e.g. battery charge level or internal machine temperature).

3.5 HTML for content structure

HTML is a markup language. Markup languages are sets of rules that describe the mechanisms for representing text, using a formatting technique by means of document markup. The sole purpose of the HTML language is to manage the contents of the page by associating a layout within the web page achieved through the use of different tags, ono for each content role that it marks. Tags are markers that describe characteristics such as colour, function, size and position within the page.

The main component of HTML is the element, which is the basic structure that has the function of formatting data or indicating information to the browser. Each element is enclosed within tags, markings consisting of a sequence enclosed between two angle brackets <>.

When writing text or code, tags should be opened and closed, e.g.: <h1>Hello World!< /h1>.

Some tags do not require closing (implicit closing tags), such as the <img> tag, which is used to insert an image at a particular point on the page, or the <link> tag, which is used to include, for example, a style sheet [https://it.wikipedia.org/wiki/HTML].

```
<h1>This is a heading</h1>
<p>this is a paragraph</p>
<div>
    <p>These are links:</p>
    <a href="one.html">One</a>
    <a href="two.html">Two</a>
    <a href="three.html">Three</a>
</div>
<table>
    <th>
        <td>Heading 1</td><td>Heading 2</td><td>Heading 3</td>
    </th>
    <tr>
        <td>Cell 1</td><td>Cell 2</td><td>Cell 3</td>
    </tr>
</table>
```

Example of HTML code structure with related tags

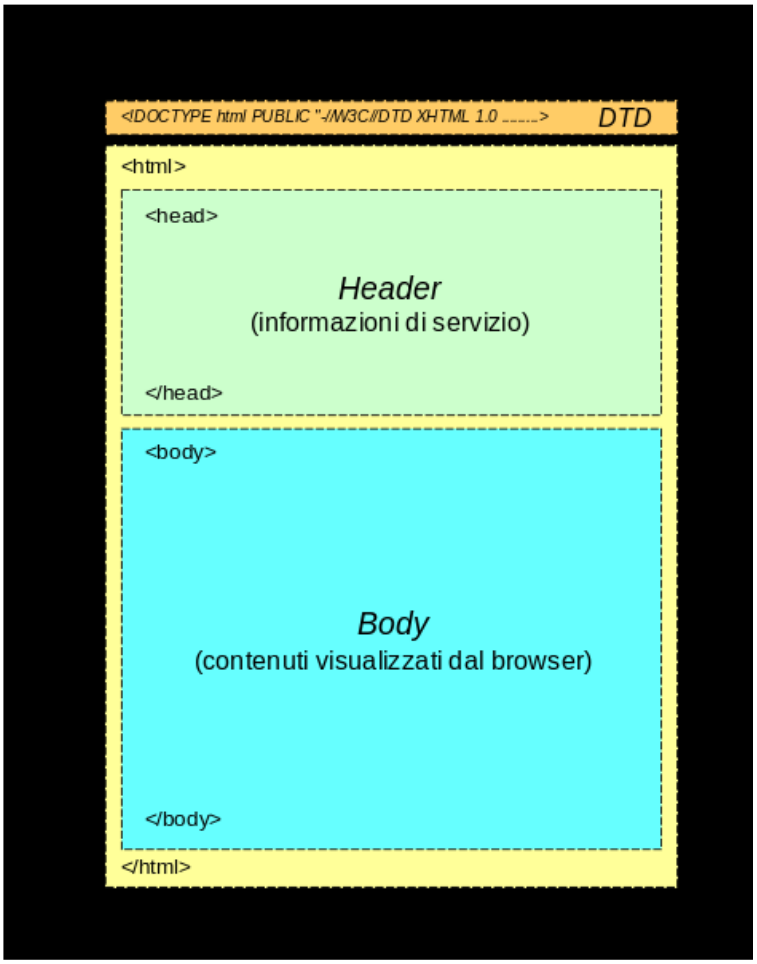


Figure 12 Structure of an HTML document

The initial sequence of characters <!DOCTYPE html PUBLIC "html version"> allows the browser to display the type of document, indicating its syntax and version, thus interpreting, and displaying the document appropriately. The <html> and </html> tags delimit the document, within which there are two distinct sections.

The Header section consists of a header section containing control information not displayed by the browser enclosed within the <head> and </head> tags. The tags contained within it are:

- *Metadata*: useful for addressing useful information to external applications or the browser (e.g. keystroke encoding);
- *Metadata type http-equiv*: useful for checking additional information in the http protocol;
- Links to external service files, scripts, icons displayed in the browser address bar (fav-icon);
- Insertion of executable code (scripts);
- Style information (local CSS);
- Title associated with the page.

The Body section contains the information part i.e. text, images. The delimiter tags are <body> and </body>. The content tags are:

◦ Headings;

° Text structures (indents, paragraphs, etc.);

◦ Text appearance (bold, italic, underlined, etc.);

◦ Lists and lists;

◦ Tables;

◦ Electronic forms (fields that can be filled in by the user);

◦ Hyperlinks and anchors;

◦ Generic document layout;

◦ Insertion of images;

◦ Inserting multimedia content;

◦ Insertion of interactive content (scripts, external applications).

HTML5 is the fifth revision of the HTML specification. It was developed by the Web Hypertext Application Technology Working Group (WHATWG) with the goal of improving the development of web applications.

The markup model has been evolved to change the basics of syntax, the rules for arranging content on the page, and expanded to accommodate new elements.

HTML evolved at the same time as CSS, so JavaScript APIs were also extended to support new features useful in building modern applications:

- save information on the user's device;
- access the application even if there is no web connection;
- communicate bidirectionally with both the server and other applications;
- perform operations in the background;
- driving multimedia streams;
- Driving the navigation history;
- use interaction metaphors such as frag and drop;
- generate 2D graphics in real time;
- generate 3D graphics in real time;
- access and manipulate user-generated information in real time through multimedia sensors such as microphones and webcams.

At the semantic level, new peculiarities have also arisen for the generation of microformats for:

- access the geographical information of the device;
- maintain a database on the user's device;
- generate 3D graphics in real time;

HTML5 offers web developers a language that can be modified both on the content structuring side and on the web application development side [https://www.html.it/pag/19263/da-html-4-ad-html5/].

At the level of the document structure, innovations have been made to support local storage of large amounts of data downloaded from the web browser to allow the use of web-based applications even without an internet connection, in particular [https://it.wikipedia.org/wiki/HTML5]:

- stricter rules for structuring the text into chapters, paragraphs and sections;
- Introduction of control elements for navigation menus;
- Introduction of specific elements for controlling multimedia content such as the <video> tag and the <audio> tag;
- elimination of certain elements that have shown little use;
- extension of a set of attributes aimed at accessibility to all tags;
- support for Canvas, which allows JavaScript to be used for drawing images and bitmap graphics;
- introduced geolocation;
- introduced Web Storage instead of normal cookies;
- standardisation of JavaScript programs;
- replacing the complex doctype string with a simpler <!DOCTYPE html>.

3.6 CSS for the presentation of HTML content

Cascading Style Sheet (CSS) is a style sheet language used to describe the presentation of documents written in markup languages. It is usually coupled with HTML to define the style of web pages. In fact, together with HTML and JavaScript, it is a technology used to create web pages and user interfaces for mobile applications.

Its invention was due to the fact that formatting tags were the only way to define formatting, creating an excessively long document. Formatting tags presented several problems including: the length of the tags, lack of logic in the HTML code which brought additional work to the browser, and different device resolutions. CSS separates the content of the document from the presentation of the document by incorporating aspects such as layout, colours and fonts, increasing the accessibility of the content and flexibility in presentation features. A CSS code can be created dedicated to one HTML document or compatible with several documents. For each HTML element, CSS provides a set of formatting instructions. For example, if all elements within a <p> paragraph must be written in bold, the CSS property "font-weight:bold;" will be set, making formatting with the <bold> tag unnecessary. In this way, by dividing formatting and content, it is possible to present the same markup page with different styles or different rendering methods, such as on-screen, printed or spoken. It can be used to make the format of web pages adaptable to the screen size of the device on which it is displayed (responsive layout). The CSS file included in the markup document by the author can be overwritten by a

different one if desired, but if the document contains no link to a style sheet, the default style of the browser used is adopted.

The CSS style sheet specification defines priorities for rules to be applied when one or more rules are assigned to an element. Properties are calculated and assigned to rules by a 'cascading' method. In addition, the specifications are maintained by the World Wide Web Consortium (W3C).

CSS code can be inserted into an HTML page in three different ways:

- By inserting in the <head> tag a link to an external sheet via the tag:

```
<link rel="stylesheet" type="text/css" href="css/style.css" />
```

- By importing the style sheet into the style tag:

```
<style type="text/css">
    @import url(style.css)
</style>
```

- In line within the elements:

```
<tag style="dichiarazioni CSS">...</tag>
```

Figure 12 Example of CSS

3.7 JavaScript for user interactivity

JavaScript is a dynamic, high-level, object- and event-oriented programming language. Together with HTML and CSS, it is one of the three core technologies of the WWW. It is one of the scripting languages whose specifications were first standardised under the name ECMAScript between 1997 and 1999 by the ECMA (non-profit organisation for standards for information and communication systems). It contains an API for working with text documents, arrays, dates and regular expressions, while it relies on the underlying system in which it is encapsulated to work with I/O. JavaScript is not only used in most websites and is supported by all modern browsers without the need for plugins, but also finds application in non-web-based environments, such as PDF documents and desktop widgets, client-side programming, and thanks to runtime programming environments such as Node.js, it can also be used for server-side programming.

The enormous popularity of JavaScript is due to the emergence of new libraries with the aim of simplifying programming in the browser, the emergence of server-side frameworks and its becoming the main language of mobile devices.
Users of JavaScript are usually programmers with development experience in other programming languages such as Java, C++ or developers who first learned to use its libraries and then moved on to the basic language. Unlike other programming languages that allow the writing of completely stand-alone programs, JavaScript is used for the scripting language, then implemented within another program. The host program must provide a well-defined API that allows specific operations to be referenced by the script. This process is analogous to including libraries in C or Java to perform operations not provided by the language itself.

On the Web, JavaScript is used to write functions embedded in HTML pages, which relate to the browser via interfaces called DOM (Document Object Model). The DOM standards imposed by the W3C are adhered to according to the settings of the various browsers, some may expose different objects to the script and it is often necessary to implement additional controls to ensure compatibility with each browser.

JavaScript user agents are also integrated in applications outside the web, such as Adobe Reader and Adobe Acrobat for PDF files or Microsoft's Windows Script Host for operating system scripting.

Structural aspects of JavaScript

JavaScript is an interpreted language (the code is not compiled). For example, the browser, in the case of client-side JavaScript, executes the code directly on the client and not on the server, with the advantage of not overloading the web server due to client requests. Conversely, in the case of scripts with particularly large

source code, the download time increases considerably. JavaScript also defines the functionality typical of high-level programming languages and allows the use of the object-oriented paradigm.
Other notable features are:

- The use of Unicode, an encoding system that assigns a unique number to each character for writing text.
- The evaluation of regular expressions.
- JavaScript expressions contained in a string can be evaluated using the eval function.

In HTML documents, the code is inserted via the <script> ... </script> tag, which makes it possible both to import the code from a JavaScript file and to write it inside it.

There are two types of restrictions applicable by browser authors:
1. Run scripts in sandboxes in which only web-related actions can be performed and no general programming tasks such as file creation.

2. Binding the scripts by the source policy: the scripts of a website do not have access to the user's personal information.

Most JavaScript-related bugs are related to violations of both points; the only way to ensure that only secure code is executed on a web page is through the Content Security Policy.

JavaScript provides the developer with the following categories of events:

- Events activated by mouse buttons;
- Events triggered by mouse movements;
- Events that can be activated by drag and drop;
- User-activated events with the keypad;
- Events triggered by user changes;
- Focusing events;
- Events that can be triggered by loading objects;
- Events triggered by window movements;
- Events linked to particular buttons;

3.8 Php for database access

PHP (Hypertext Preprocessor) is an interpreted scripting language designed for the creation of dynamic web pages. Created in 1994, it is mainly used in the development of server-side web applications, although it can also be used for command-line scripts or stand-alone applications with a graphical interface.
In web applications, the actions performed by the browser and the web server are as follows:

1. A request is made to the remote server via the HTTP transport protocol;
2. The web server receives the request and interprets it;
3. The Web server returns a response to the client.

In this process, PHP processes the data received via the HTTP request and returns a response to the client. PHP is also used for command line scripts or for creating client-side graphical user interfaces (GUIs).

In practice, PHP mainly acts as a filter, taking an input from a file containing PHP instructions and providing another data stream as output. Often the output can be HTML, JSON, XML or binary data such as images or audio formats.

3.8.1 Features of PHP

PHP has a number of advantages, including cross-platform operation, compatibility with most of the servers in use today, and support for a wide range of databases.

It is a server-side scripting language whose main functionalities are:

- Response to HTTP requests: these can be of two types: GET or POST. GET is the method by which information is requested, while POST allows data to be sent, both referring to a Web server. The PHP language takes care of processing the data received via GET or POST and sending the response to the client.
- Dynamic pages: can generate dynamic page content, i.e. pages where the content is generated by the server on the spot. A dynamic page may consist of PHP code together with markup language.
- Server operation: PHP can create, open, read, write, delete and close files on the server.
- Collecting data from forms: PHP can be used to collect data from forms and insert or compare them in a database.

- Sessions: read/write access to browser cookies and support for server sessions. Cookies are used to keep track of information from a website on the user's client. Sessions, on the other hand, are created to store user information on the server rather than the client. A typical example of a session is keeping user information on the web application after logging in to access content restricted to registered users, so that operations can be performed until logout, i.e. closing the session.
- Database operations: PHP is able to interface with MySQL, PostgreSQL, MariaDB, Oracle, Microsoft SQL Server and others via libraries, being able to perform actions on them (manipulating images, making remote connections).

3.9 Testing phase

Testing is a phase in the software life cycle and aims to detect errors and malfunctions in the application so that they do not occur after the software is released. However, it is not possible to reduce the probability of encountering malfunctions to zero because the combinations of valid input values are so numerous that they cannot be easily reproduced. It is possible, however, to make this probability small enough to be acceptable to the user.

The principle behind PHP Unit is quite simple. After writing a test case for the evaluation of a module, e.g. a class method, all you need to do is to check that it produces output that matches the expected value. If the output matches the expected value, then no problems will be encountered. If not, PHP Unit will provide instructions on how to address the error.

In PHP Unit there are many functions for comparing the output with the expected value, these are called assertions.

3.9.1 Test for downloading a file

The purpose of the following test is to check that a file is downloaded correctly. Two specific cases are evaluated: the first refers to the case in which the user tries to download an expired file; the second to that of a valid file.

According to PHP Unit, in order to write a test suite, a new class must be created with the same name as the one to be tested, followed by "Test" and extending the main framework class PHP Unit,_Framework,_TestCase.

4 BUSINESS INTEGRATION PARTNERS ACTIVITY

4.1 Management consulting: strategic positioning consultancy

The project on which the Business Integration Partner worked, as mentioned above, was to develop a web application to support electric mobility that could display the data received from the electric car and operate certain commands.

Before proceeding with the implementation of the project, the company took care, at the request of the client, to provide strategic advice (management consulting) by means of an analysis of the expected business benefits, expected counter-benefits, costs (summary of current operating costs, project maintenance costs and respective financing plans) and expected risks (assessment and summary of all the main risks related to the project, their likely impact and plans in case they materialize), timeframes in order to verify the ongoing feasibility of the project. To obtain this useful information, it used the business case, a model describing the reasons, justifications, and reasons for undertaking the project. The business case was maintained throughout the project and constantly updated with information on costs, risks and benefits as they became available in order to ensure that the project maintained its justification and ensured that business needs were met and the expected benefits were realized. As the project proved to be beneficial and profitable, we moved on, on the basis of Porter's model, to a market analysis, identifying potential forces which, if not monitored, could lead to the company's loss of competitiveness. In particular, the following were analyzed:

- *Direct competitors*: players who, by offering the same type of product on the market, could limit the profit potential;
- *suppliers*: actors potentially able to exercise their bargaining power and retain more of the value by raising prices, limiting the quality of services or shifting costs to other actors in the sector;
- *customers*: actors able to exercise their bargaining power and capture more value by forcing down prices by demanding higher quality or better services and generally leading actors in an industry to fight against each other;
- *producers of substitute goods*: subjects able to put on the market products different from those of the reference company, but satisfying the same need of the customer/consumer thanks to a better quality/price ratio. If one does not deviate from the alternatives through product performance, marketing will lose profit and, consequently, potential growth;
- *Existing competitors:* Existing players who are able to limit the profitability of an industry by introducing price discounts, introducing new products, advertising campaigns and service improvements.

After the competitive strategy analysis phases, the project moved on to the implementation phase.

4.2 System integration: implementation of the development project

After the management consulting approval phase led by the company's management, we moved on to the technical development phase of the web application (system integration phase).

For the subsequent development of the hybrid application, it was deemed appropriate to use the Adobe PhoneGap framework, through which it was possible to develop the application using web technologies, including HTML markup language, CSS style sheets and JavaScript programming language for user interaction. Plugins provided by Apache Cordova and Adobe PhoneGap and the various JavaScript APIs were used to interface with the software and hardware of the devices.

The APIs used in the development of the project are: Google Maps API, Google Charts, jQuery, Ajax and JSON. Thanks to these libraries, it was possible to develop an application capable of making the most of the services offered by Google, using a simple, clean and functional code thanks to jQuery and Ajax. During the development of the project, direct interaction with the electric car was not possible, so its behaviour was simulated using a local server. WAMP server was used for this functionality, which allows the creation of web applications with Apache2, PHP and mySQL databases.

As previously mentioned, the application has been developed for the Android operating system.

In order to achieve fast and optimal programming, we relied on an IDE (Integrated Development Environment), i.e. software which, with its functions, helps the developer in the creation of source code, pointing out errors and giving the possibility of debugging without the need to send command lines from the terminal. Among the IDEs available, including NetBeans, Eclipse, etc., Android Studio was used. The latter was created and designed precisely to simplify Android programming, providing tools and functionalities suitable for both native and hybrid application projects.

The Android Studio editor allows you to import hybrid applications, i.e. use web technologies such as HTML, CSS, JavaScript in addition to the native Android language. Being a new editor, these languages are handled in a basic way, especially for CSS stylesheets and JavaScript, so it was essential to download extensions that would make the code readable under different colors and report errors or autocomplete code.

The decision to use this development IDE was based on the possibility of being able to emulate the application on a wide range of Android devices, observing the behavior of the graphics on displays of various resolutions and the user interactivity with different versions of the operating system. During emulation, it was possible to check the behavior of the application and errors through the Android Device Monitor.

During the development of the graphics, it was decided to run the application on the Google Chrome browser platform. Thanks to its inspection tool, it was also possible to try out adjustments and combinations of HTML and CSS to improve the graphics.
The choice of the Adobe PhoneGap framework for the development of applications is due to the need to create a hybrid application, so that it can take advantage of the features of a native application using web languages. PhoneGap was preferred to Apache Cordova as it was the first version of the project and provides users with software to facilitate the execution of the project on their device by downloading the PhoneGap application from the store: PhoneGap Desktop, which allows the application to be created without going through the command lines of the terminal. This allows the application to be created without having to go through the terminal command lines. From the terminal, it runs on the mobile device thanks to the application, which connects with the IP address of the server, downloads the application, and runs it. However, using Android Studio as a development IDE and having emulation available on multiple devices, this feature of PhoneGap was not used.

4.3 The graphical interfaces of the developed web app

When the app is opened, the user login page appears it consists of a form that accepts two inputs, one text and one password, and a form submit input. By clicking "Login", the data collected from the form are compared with those in the database. If the operation is successful, the login is performed by setting the data in a local session and the page is redirected to the home page.

Next, the new user registration page appears: this consists of a form that accepts text input of the user's data (name, surname, date of birth, address, city, number plate, email, username, password) and a form submit input. By clicking on "Registration", the data collected from the form are compared with those in the database. If successful, a new record is inserted into the database.

Then, the main page (Home) of the developed application appears through which it is possible to display the battery charge level, the temperatures inside and outside the car and it is possible to navigate the pages through the menu.

In particular, the Parking page contains a map showing where one's car is parked. The coordinates are passed by the server and displayed thanks to the Google Maps API.

On the "Controls" page, you can view the car's indoor and outdoor temperatures and select the air conditioning temperature.

The "Fuel consumption" page shows graphs of the car's performance and fuel consumption. The data is passed from the server to create the graphs using the Google Charts API. The graphs present concern the percentage of battery used for each braking.

On the 'profile' page, all user data are displayed, and it is possible to log out by disconnecting the local session created during login.

In the development of the application, as already mentioned, the Google Maps API was used to display maps of the place where one's car was parked. The API provides a wide variety of functionalities such as the choice of map type (road, satellite), graphical representations on the map (placeholders, information windows, symbols, etc.), services such as glocalization, direction finding.

In order to be able to use the library, it was first necessary to create a personal key (API key) indicating the type of project. The key obtained was inserted into the link to the Google Maps API to make it private and not usable by third parties. Once the link containing the generated API key had been created and imported into the project, the full potential of the Google Maps API could be exploited. The import into the project took place via the <script></script> tag, which made it possible to display the link to the library with the personal key.

4.4 Features and functionality of electric car applications

According to a study conducted in the United States, 70% of users who do not use an electric vehicle would not buy one due to the fear that it would lack autonomy and recharging opportunities. Apps supporting electric mobility help to reassure the user and provide an incentive to buy electric vehicles.
However, it is not always easy to find an app that meets one's needs quickly due to agreements with manufacturers, providers for the integration of charging stations, etc. In addition, there is also the risk that an app may become less popular within a few days due to a function update. In addition, there is also the risk that in a few days an app may become less used due to a function update.

The mobility-supporting applications developed by the Business Integration Partner (BIP) have the function of:

- planning and optimizing a trip by planning stops according to the initial autonomy of the battery, the characteristics of the car, estimated consumption along the route, indications of recharging stations, proposals for better rates for the purchase of products sold along the route, etc.;
- to secure most agreements with charging station operators based on the relevant charging power and connector types available;
- ensure frequent updates with the latest electric and plug-in car models so that you can filter the columns according to your needs;
- possibility of paying for the top-up directly via the App (so you don't need to use the operator's RFID card) with various guaranteed payment methods (PayPal, Credit Card, Debit Card, etc.);
- ensure the integrated GPS function to reach the charging station via a navigator without having to change applications;
- ensure a good web and telephone support service in case of failure of the charging station or in case the charging is not delivered.

Each application developed deals with offering the user different functions to meet different needs:

- Route planning support apps: these have the task of finding all available routes to a destination by indicating the optimal route (in terms of time and kilometers) and offering users route information (in the more in-depth webapps they also display the fuel cost for the planned kilometers and allow storing the trips made).
In order to contribute to the reduction of 'driving anxiety' that affects electric vehicle users, route planning applications also allow users to calculate an estimate of the battery life based on the kilometers to be driven as they monitor the charge level and battery status in real time, thus allowing them to view service stations along the route and, if necessary, book them securely. Authentication at the charging station can take place via Near Field Communication (NFC).
There are websites that allow you to locate charging stations (available, occupied, under maintenance or under construction) within the territory by entering the city of interest and a defined radius of km. Two typical examples of websites for searching for charging stations in the Italian territory are: *Enel Drive* and *Colonnine Elettriche.*

- Parking display apps: developed for drivers who work or commute in large cities. They are divided according to their functionality into:

- Car park search: allows you to view all available car parks in the entered location or around your location, indicating directions to get there, the number of free spaces, allows you to consult opening and closing times and payment methods and prices;
- Parking timers: they remind you when the parking meter expires;
- Search for parked car: this allows the user to help find their car after parking it in an unusual place or location. This is possible by entering photographs of the car park, the street, as well as the possibility of geolocating the car if there is a GPS detector in it.

- Traffic saving apps: avoid traffic jams by signalling queues or delays. They also allow you to report roadblocks and speed cameras.

- Fuel cost disclosure apps: they allow you to indicate the daily value of fuel, reporting the cheapest one among the prices of the distributors closest to your location.

- Apps for **measuring car performance**: they allow you to measure acceleration, horsepower, force of gravity on the sides and on the brakes, entering them and storing them in tables.

- Eco-driving support apps: allow you to understand the environmental impact of your driving by entering car data.

The driving system defined as Eco driving is able to maximize the energy and efficiency of an electric vehicle through driving style by minimizing energy consumption by recovering as much kinetic energy as possible through inertia and braking.

Mobile devices (e.g. smartphones, tablets) are platforms capable of collecting data and obtaining answers and information in real time by interfacing with the electric vehicle. This approach makes it possible both to reduce the cost of integrated equipment and to offer data fusion between the data coming from the vehicle and the data sensed by the smartphone sensors thanks to the connectivity of the network and the advantages of Internet browsing. The term to describe this type of approach is 'bring your own device (BYOD)'.

4.5 Examples of web apps developed in cooperation with BIP

In the following, we will describe the characteristics of the best specific applications for electric cars currently in use concerning the same type of applications studied and developed by the company Business Integration Partner (BIP).

Plugshare

2. Nextcharge

3. Google Maps

4. Chargemap - Charging stations

5. JuicePass by EnelX

6. BeCharge

7. Evway

8. PlugSurfing

9. Power Cruise control

10. Open Charge Map

PlugShare is a free application that can be downloaded from the Play Store or the App Store. It currently offers a world map containing more than 300000 charging stations from major networks around the world, collects information from major networks in Europe (RWE, Clever, Endesa, Enel) and North America (Tesla SuperCharger, ChargePoint, Blink, SemaCharge, GE WattStation, Aerovironment, eVgo) and is the largest community of electric vehicle users in the world. Users have contributed more than 100000 reviews of petrol stations and 30000 photos to make using electric vehicles easier. PlugShare is the official electric charging station locator for the No Charge to Charge Program(sm) for Nissan LEAF and the MyFord Mobile smartphone application. Through this application you can:

- locate public charging stations for your electric vehicle;

- view ratings on PlugScore™, technology built into the app to play reviews, availability, photos of the car park where they are installed and descriptions of the charging stations;
- filter the chargers compatible with your electric vehicle;
- insert new charging stations;
- monitor in-app payments.

PlugShare is thus one of the most comprehensive apps in this field of services.

Next Charge: is an independent, simple and intuitive application available for free download on iPhone and Android smartphones. Once installed on the phone, it displays a map showing the nearest charging stations. The main features of this app are:

- search for electric columns;
- real-time availability status;
- distance and travel time to the column;
- booking and recharging from the App at the time of recharging through the main circuits active in Italy;
- registration by account;
- Obligation to top up at least once a year (otherwise the balance will be lost) following a minimum deposit of €20. NextCharge allows you to constantly monitor your remaining credit balance and to stop recharging even from a distance from your vehicle;
- possibility to leave comments, opinions, photos of the columns and star ratings.

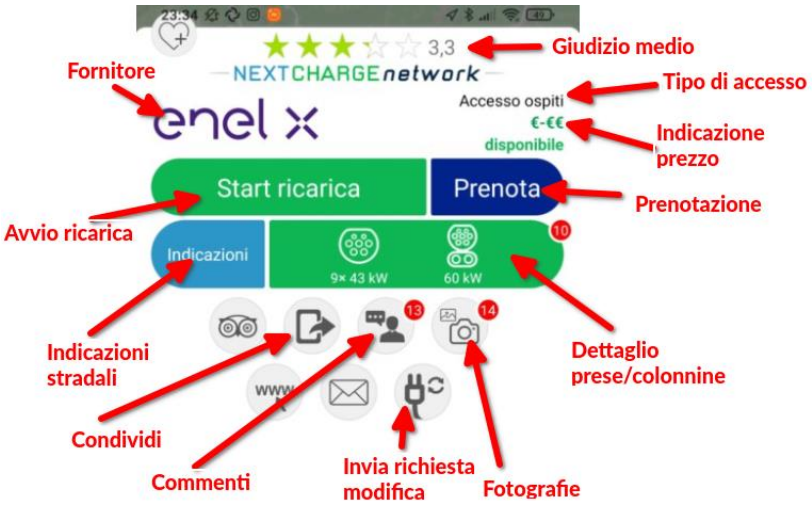


Figure 33 Graphical interface of the Next Charge application

ChargeMap is an app for electric cars available on the App Store and Google Play Store that has an extensive map of charging stations (over 270,000 across Europe). The main functionalities of ChargeMap are:

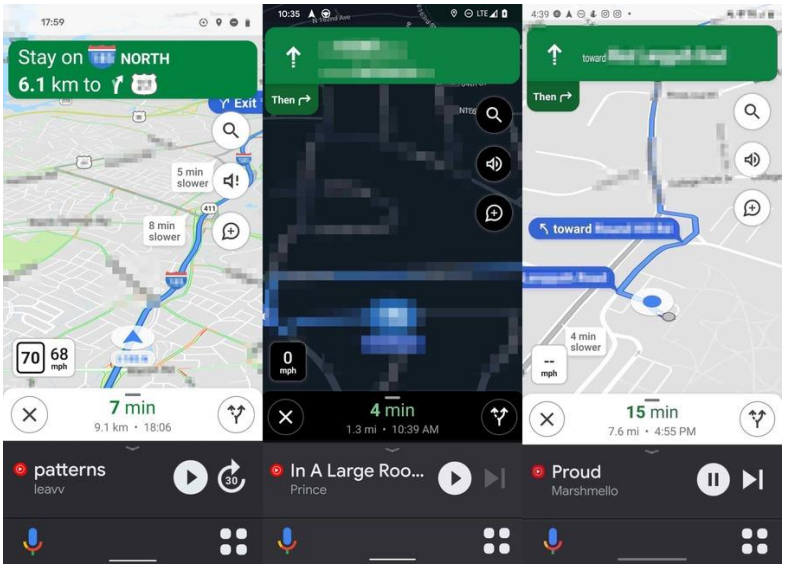
- find charging points along your route, free charging stations, with better scores for connector types, preferred networks, nearby services, etc;
- check the availability of a charging point in real time;
- leave comments, post photos and 'check in';
- share new charging points with the community;
- be present in the ranking of the most active users.

The application also helps to plan the ideal route according to the car model in order to leave and arrive at the destination with the desired battery level.

The reliability of the service of this app is due to the large community of more than 900,000 e-car drivers who continuously integrate data on charging stations.

Google Maps is a famous Google navigator application on the list of the best apps for electric cars. Google Maps, used for travelling by car, on foot, by bike, to get directions and information on the best, fastest route, also has functionality for electric vehicles. Through this app, you can keep track of your car's battery level, receive battery alerts and find charging stations based on the type of charger, payment networks and charging speed.

Figure 14 Graphical interface of the Google Maps application



Juicepass by Enel X is the proprietary application of Enel X , the leading energy player in our country, which boasts around 12,000 charging points (110,000 across Europe), which can be downloaded free of charge and with which customers can manage charging services and other aspects of electric mobility in the city, on suburban roads and at strategic points such as supermarkets, car parks and shopping centres. It is also compatible with charging points at home and in the office. Heir to X Recharge, this is an application that allows you to search for charging stations compatible with the service, book the columns and reach them as quickly as possible. Compatible with iOS and Android operating systems, JuicePass offers customers the possibility of:

- start, stop and even postpone or set the duration of the charge directly from the app by starting the charge and then connecting the connector to the socket. Charging is then interrupted from the smartphone, on which the technical data for that charge will be displayed;
- configure more than one electric car for customised charging and monitor the battery percentage and kilometres added in real time;
- monitor the energy delivered and the charging power;
- receive notifications about activation in an area chosen by the user;
- consult the consumption history;
- pay for your top-up sessions after entering your preferred top-up mode by choosing between pay-as-you-go and pay-per-month plans;
- You do not have to create an account, as you can also access the application as a guest.

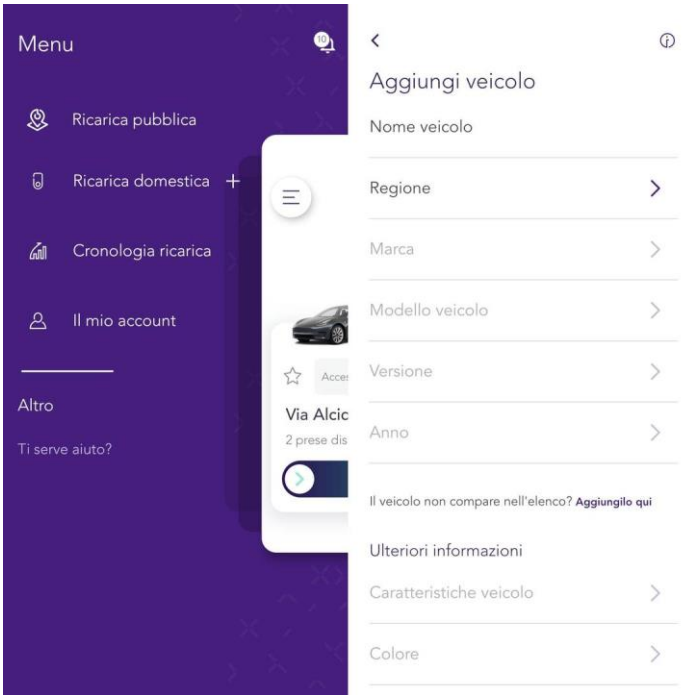


Figure 15 Graphical interface of the Enel X Juicepass application

Becharge is a free application available for iOS and Android that allows you to recharge your electric vehicle in the Be Charge Srl network of charging stations. You need to download the app (for Apple 35.4 MB, for Android 9.6 MB), register for the service and enter your payment method. The service allows you to:

- Search on the map for the nearest charging stations belonging to the Be Charge Srl network with a 100% clean energy source;
- find out how much CO2 has been saved for the planet with each recharge;
- filtering the inlets by availability, 24-hour accessibility, management by Be Charge or interoperable, power and socket type. Inlets that are not marked with the Be Charge logo indicate an external provider that still allows payment via the app;
- display the availability status of charging stations, power, distance and travel time;
- book the socket of the desired charging station and view the route to it;
- consult the history of refills carried out, data and useful statistics;
- check charging status, Kwh delivered.

Evway is an application with 190,000 accessible charging points across Europe that provides comprehensive and up-to-date information in real time to enable a profitable charging experience. It has specific maps for cars, eBikes and electric scooters. Its functionalities consist of:

- Geolocalise all charging points for electric vehicles in Europe;
- provide details of hospitality facilities and commercial activities offering the recharging service, suggesting how to make the most of the recharging stop and accompanying you to your destination thanks to the assisted navigation function;
- allow you to find the nearest charging points to your location on the map, including hotels, restaurants and all accommodation facilities offering charging services to customers;
- offer an 'eMX' navigation system, which is convenient for touring;
- indicate availability (green dot) or not (red dot) of the column;
- display, for each charging station, a panel with useful information such as type of sockets, power output, distance, availability;
- recharge via the keyfob, an RFiD key fob that is brought close to the column to unlock and then connect the car. The cost of the recharge will then be charged to one's account where the credit is in Ladybirds,

the application's virtual currency that can be purchased by credit card, PayPal, Google Pay and Apple Pay.

PlugSurfing: is an application classified as the most accurate database of charging points in Europe and provides the activity status of charging stations in real time. Through it, you can view the charging point in operation, information about it and add comments. The application has the following functionalities:

- possibility to search for available stations around your location or in a specific area;
- possibility of filtering stations according to charging speed or the specifications of your car;
- possibility of obtaining charging prices for each station;
- possibility of starting the charging session via the application;
- possibility to pay through the application by credit or prepaid card;
- possibility of tracking user activity in their car;
- possibility of having a monthly turnover of charging costs;
- possibility of calling the technical support service directly;
- possibility of taking photos and videos of the charging stations;
- possibility to charge your car through the app itself, replacing RFID prepaid charging cards. Payment with PlugSurfing is currently only available in Germany, the Netherlands, Austria, Belgium and Luxembourg and will soon be extended across Europe;
- possibility of receiving data from the Internet, displaying network connections, changing the network connection mode.

Figure 16 Graphical interface of the PlugSurfing application

Power Cruise control is an application that allows you to calculate your car's energy consumption in great detail, plan your electric car journeys and keep an eye on various parameters such as the health of the battery. It works in symbiosis with the OBD modules, with which it exchanges information via Bluetooth to provide the smartphone with the data needed to calculate the (theoretical) energy requirements needed to reach a given destination. It is then up to the user to decide which charging stations to stop at and which Power Cruise Control directions to follow for both charging breaks and cruising speed. The app has not been released for iOS devices but is available for Android smartphones on Google Play Store.

Open Charge Map is a free application useful for finding charging stations almost everywhere, without restrictions due to operators or anything else. Despite the fact that it is not available in Italian (only in English), it is a complete application with a large map of the stations reported and uploaded by the users themselves, which gives the possibility to reach them following the directions of the navigator and to mark them as favourites. However, it does not offer the possibility of booking a station or paying directly in-app.

There are other types of applications that are not developed by the Business Integration Partner (BIP) company but may be useful for owners of electric cars, for example:

- **Apps for storing vehicle and licence data**: these applications help the user to keep track of the licence point balance and validity, vehicle data, and the status of pending DMV paperwork. The iPatente application, in addition to the functions described above, provides important information about the car, such as the environmental class, driving licence for novice drivers, RCA insurance and its expiry date. It also offers the function of vehicle logbook, diary on the mechanical checks of the vehicle (#OnTheRoad) and management of insurance and vignettes.

- **Fines management apps**: they allow you to find out the deadlines for fines and any information about the fine while having a team of lawyers who specialise in appealing the fine and provide help in analysing the report.

- **Speed control apps**: they facilitate the location of speed cameras or motorway sections controlled by the 'Tutor' system, keeping track of the average speed and suggesting the maximum speed that can be reached.

The dual 'power' of web applications

The web applications created are doubly effective in that they allow the electric car user to have access to data such as news or audio on the move, maps, traffic alerts, weather forecasts and various other real-time information and, at the same time, offer convenient and innovative information to the outside world. For example, they allow insurance companies to access vehicle data such as mileage and driver skills such as acceleration, cornering and braking for the purpose of determining insurance rates.

Applications could also collect and share with other specific companies important information such as system and component data from the vehicle itself for maintenance and warranty purposes. This data, collected and stored, can improve driver safety and experience, provide information to the automotive industry to improve vehicle production by offering safer vehicles, but also increase vehicle reliability and durability by providing comfort to the owner.

Data is collected by applications via GPS and, by acquiring detailed information about the data in real time, it is extracted and combined together to provide services. These services enable telematics service providers, car insurance companies and car leasing agencies to predict the 'movement' of cars. In this way, web applications can feed into different business models and help companies understand the supply-demand for their products and services. It is, therefore, a predictive analysis with the objective of helping to predetermine the characteristics or behaviour of a car in certain environments and situations.

Data are usually highly organised by having a formal structure and can be stored, processed in a relational database management system (RDBMS) and finally retrieved without problems by simple search engine algorithms.

The deployment of 5G has increased the revenue opportunity for carmakers as it allows manufacturers to create lasting connections with customers by offering additional functionalities such as remote diagnostics, predictive maintenance and online service planning, which would not be possible without integrated connectivity.

5. BUILDING AUTOMOTIVE SCENARIO

In this final chapter of my thesis I would like to devote myself to the personal activity of constructing a plausible scenario for 2030 by giving my view on how the automotive world will change from the manufacturers' point of view, as well as from the dealers' point of view. This kind of activity is often requested by consultancies because it helps, together with large amounts of data on macroeconomic trends, to set the strategic plans of manufacturers. I personally believe that the next 10 years will see an even more radical change than the past decade, both for technological and cultural reasons.

"84% of drivers are willing to stop buying the car" by Deloitte UK. The transformation of automotive industry was so fast in the last years that to make hypothesis for the future (5-10 years) it is necessary the ability to build a completely new scenario. Commercialization is a natural follower of this transformation. Building a scenario means have a broad view on the macro forces that drives a specific industry in the next generation, and to do so we have 3 possible ways.

1) *Nothing changes*

2) *There are the same players with some changes*

3) *Disruptive technologies that upset the market*

In my prospective OEMs are going to face a scenario between number 2 and 3. What are the thesis supporting my hypothesis? There are two macro trends we must be aware of.

-First of all there is the legislation trend. Most countries are pushing for cleaner and safer cars, in other words electrified EV and autonomous AV. The reporters who track autonomous initiatives, the engineers who design the components, systems, and applications, and the majority of people do not comprehend what constitutes an AV,EV. These aspects are generating some problems for OEMs because of the speed of these expected changes are not compatible with depreciation of previous investments.

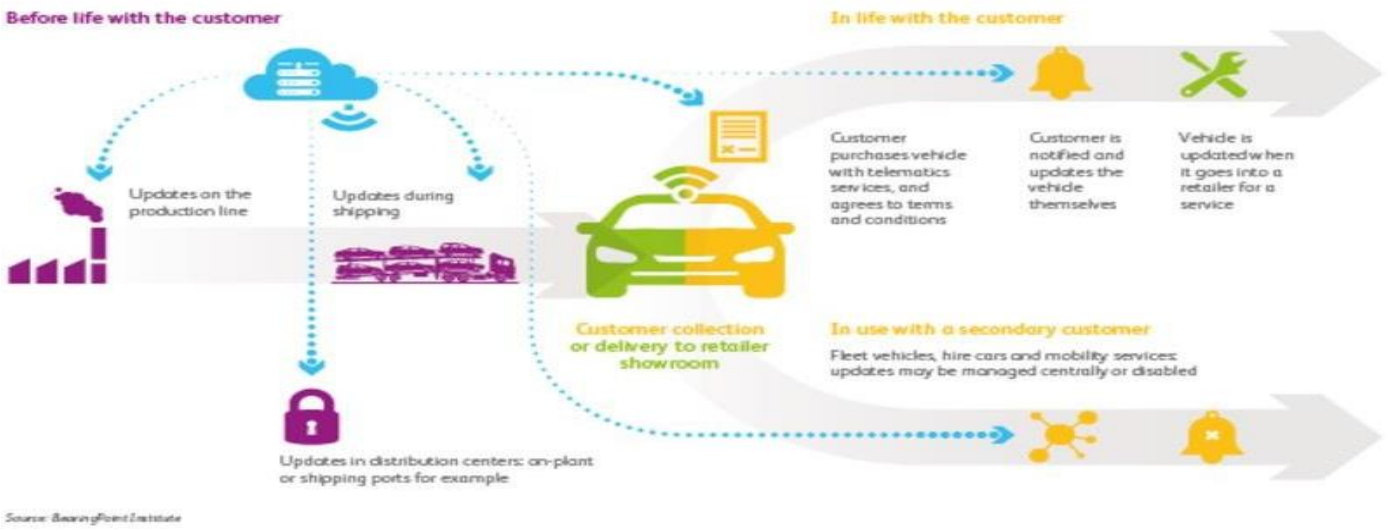
-Second there are a lot of new entry players in the market that have a completely new service, very differentiated to classic target segment of OEMs and that are eating a slice of shares of the historical manufacturers because they provide an efficient alternative (often cheaper). Examples are car sharing, carpooling, taxi bus, and many others.

5.1 WHAT GUIDES TRANSFORMATION

The process of transformation for the manufacturers is of course aligned with this wind of change. For sure it will follow some guidelines of digital transformation. Among lectures we spoke about societal and market rules that are adding always more contents. Price + quality + Variety + Speed + Innovation + Sustainability + Globalisation + Connectivity. If the scenario of AV and EV will be achieved, cars will be no more the product we know, but a completely new kind of experience. To be as synthetic as possible, the car will be a mobile room where person get in and get out and in the meanwhile travel exist. Inside the cabin people can do everything they want: work, entertainment, relax. In general we can assume that cars will be places full of digital contents; the crucial point is that the experience must be fully connected.

Commercialization should be as easy and accessible as possible to gain customer advantage. Theoretically the commercialisation service of the future will make possible to buy a car (and all the related services) from your sofa with your smartphone. Another important aspect is that connectivity of the car makes possible to download updated features of the vehicle with internet; actually Tesla is tracing the future in this way because the customer experience of Musk's company exhibits a very easy approach. Tesla vehicles regularly receive software updates over the Internet that add new features and improve existing functions over Wi-Fi. Whenever an update is available, you will receive a notification on the vehicle's touchscreen display, asking you whether to proceed with the installation now or later.

Another crucial aspect is data. In the future cars will be plenty of multimedia, and every customers will be associated to a specific kind of profile relative to the data consumed during his travels. This allow commercialization sector to use this data in a proactive way, providing to customers a completely customized and automated set of digital products to be experienced in their travels; exactly as social networks are structured today. With most probability expectations on cars will not be evaluated on the ability to reach performance targets, but it will be crucial the comfort and the connectivity.



Vehicle timeline: SOTA updates can be divided as "before" or "in life" with the customer

McKinsey report of the future of Automotive industry in 2018 starts with the following sentence "customers care less about horsepower and are more focused on digital/connection services offered in a car".

The control of the commercialization process is a question mark. We know that Global Sales Plan is what guides commercialization, through different channels (mainly dealers). In accordance with the built scenario the role of dealers will be drastically reviewed. As a consequence the commercialization services will be developed by IT and Tech under the guidelines of manufacturers while dealers will face a significant reduction and their role will be mainly the exposure of vehicles and their features.

For example it will be possible to configure a car on the website of car maker (it is possible nowadays for most companies) and select all the features and service associated. Most of the problems will be answerer on specific FAQ section. Once selected the vehicle type the site/app will give you instruction for the place where you can make the eventual test drive and the purchase will be possible directly through certified mail. After sale services will be provided by online updates and when it will be required a physical intervention it will be possible to choose among a network of authorized garages selecting personal preferences (vicinity, price, rating from other customers, ...).

The key for a winning commercialization to the next generation will be the ease of access to purchase and the trust basis.

5 .2 How should car makers plan?

The industry's primary focus should be on its customers and the products it makes for them. Here are three major trends that will dominate the products and solutions of the new era.

ONE - THE NEW CUSTOMER

The car user of the future will seek the best solution for each task. Depending on the local options, that could mean a ride-hailing service, taxi, rental car, car-sharing service, public transport - or, of course, their own car. This new trend could Accelerate the shift away from traditional ownership. Some people will cease to own a car due to the expense, as tighter regulation increases the cost of powertrains, taxes rise for political reasons, and raw material prices go up. Others will be put off buying a car because of urbanization: Driving in cities involves extra costs such as parking and is generally no longer a pleasure. As populations age, a growing number of people will just need ways to stay mobile - in some cases because they can no longer drive themselves and they will not care whether they get around by way of traditional driving.

In these cases, flexible pay-per-use models will provide an alternative. We think that in Germany and the United States spending on car-based individual mobility services will double by 2040, while in China it could triple. To cope with these new patterns of demand, brands need to become leaders in specific use cases to regain importance. So automakers will have to design cars with these changes in mind. Vehicles will need to be damage-resistant and low-maintenance or that they can easily be used by multiple users. This usage pattern could drive demand for frugal vehicle concepts that are suited for multiple users - a bit like the aircraft interior of a discount airline.

TWO - NEW TECHNOLOGY, NEW CARS

As customers demand new functions in cars, new technology will push other changes. the very best example is Electrification of Automotive. The biggest Challenge in Electric cars are its range and Charging time, new concept of solid-state batteries for Automotive are the new hope for higher range as well as Rapid charging.

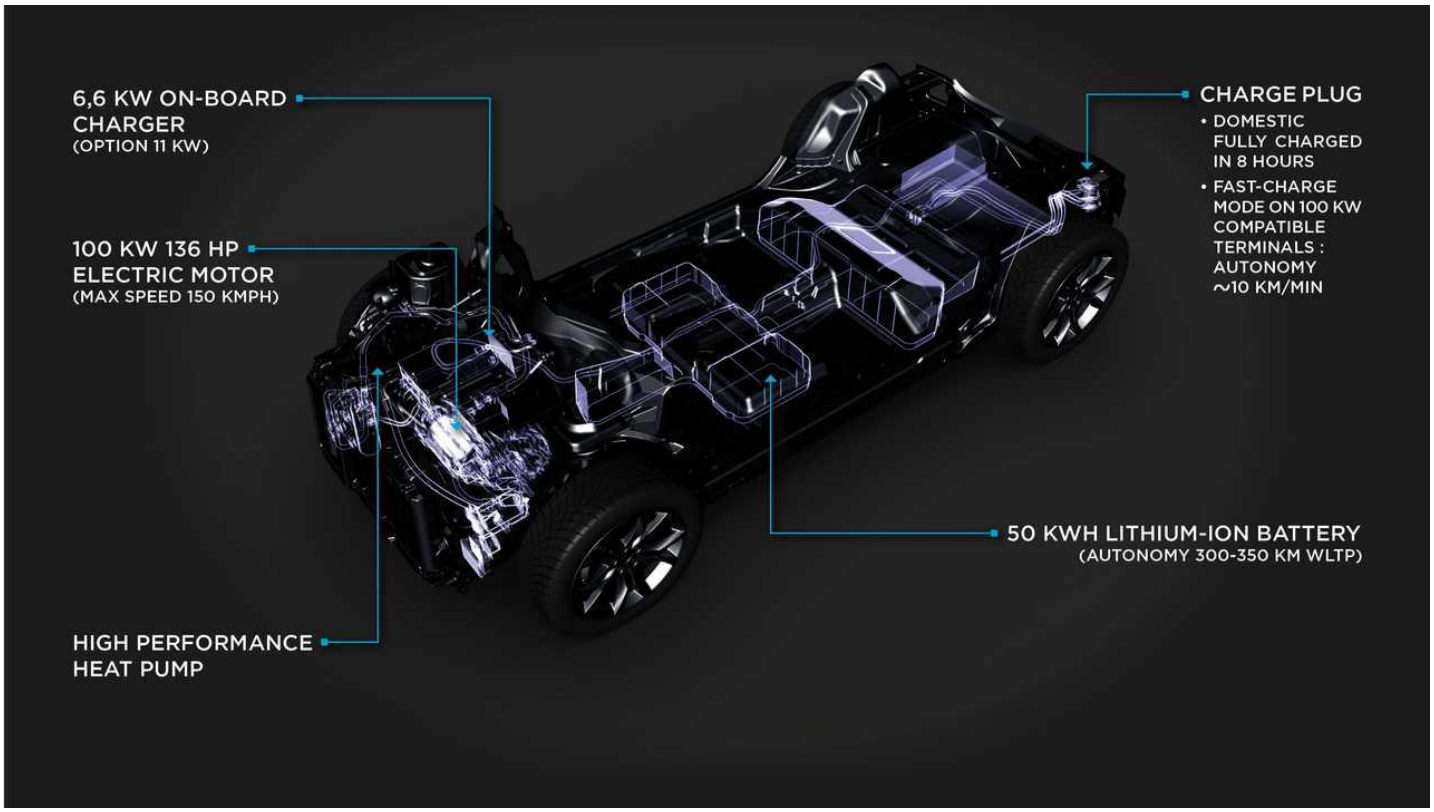


Figure 17 example of modular platform

Additionally, Modular design will enable automakers to continue to manufacture large numbers of variants around a single platform and in a single plant, increasing flexibility and reducing overcapacity. The same principle will apply to infotainment systems, for which the industry will increasingly use standard displays, operating systems, software layers, and input devices [6]. Electronic systems - and mobile communications in particular - will enable drivers to spend less time driving while in their cars and more time doing other things. Technology shifts can also be expected in safety, with progress in braking, steering, crash protection, and advanced driver-assistance systems. In all these areas, automakers will have to build up competence in technologies where other industries have already set the standards. However, many components of the new systems will be made by market-leading specialists. These leaders will supply automakers, which will find it more economical to buy into these specialist technologies than to develop them in-house [7].

One area where the traditional auto industry lacks skills is software, and much of the new technology that will go into cars is first being developed outside the automotive world, in particular by digital companies. The fastest - in some cases the only - way for automakers to develop their own mobility services and electrically powered, self-driving vehicles is through strategic partnering with specialist technology firms. Those companies that fail to do so are likely to lag rivals in developing sophisticated products such as self-driving cars and end up falling far behind the pack.

Another reason to form alliances is to share the huge cost burdens of developing the next generation of mobility. Automakers need to make big technological leaps in both propulsion - electric vehicles and more-.

efficient internal combustion engines - and in the digital transformation of the driving experience. In particular, the development of fully autonomous driving will be too expensive for a single automaker to do by itself. In the race to develop the car of the future, those that collaborate will win.

Moreover, the total number of traditional jobs required in the industry will be reduced as technologies become less hardware-driven and more standardized.

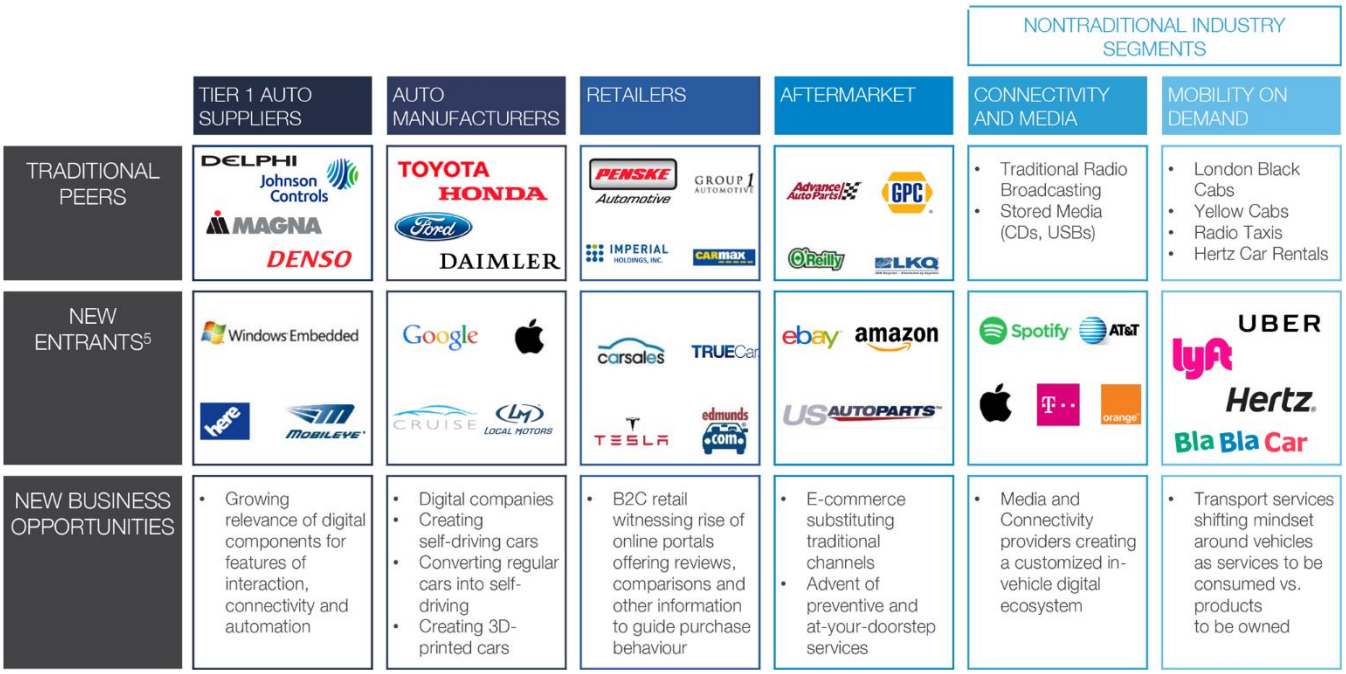


Figure 18 Traditional and new entrant players in 2022. How it will be in 2030?

5.3 What dealers should do to evolve and preserve their role?

Average dealership operating profits plunged from 8.9 percent in 2015 to 1.7 percent in the first half of 2018, while gross profits fell from 3.3 percent to 2.4 percent over the same period. Dealership sentiment is also shifting from optimism to pessimism based on the most recent industry research. Here are some approaches for dealer to hold their role in this digitization era [8]:

1. Dealers should be flexible enough to contribute their work more on after sales which directly deals with the service management

2. Creating a platform ecosystem:

Product feedback system and voice of customer which are supported by stronger customer-relationship-management models and customer insights, retailers have developed tailored product and service propositions that appeal to different customer segments and help drive consolidation of spending with one retailer.

Example: many customers are not strong in the technical aspect of the vehicle. So, during the break down of the vehicle, they approach with the vehicle for service without knowing the cause of damage. The dealership has to manage all kind of possible to understand the failure in the vehicle provide correct way of assistant to the customer.

3. Digitisation of the dealership process

Any assistant from the customer should be available through online mobile application, so that in any emergency, like breakdown of vehicle on roadside or normal service should be available through ticketing tool, call support and chat support, managing easy scanning of customer id upon arrival for ease document preparation.

Example, WhatsApp business application can be implemented to the support service to update any additional parts to be serviced other than mentioned in the quotation before the service. So, that customer is well aware of the service details before making transaction.

4. Second-hand business model:

The dealership can make an agreement only with customer while buying the vehicle, that they sell their vehicle in future to them, while dealership will have an authority to sell the vehicle in second hand.

5. Also Prioritising low-disruption markets

Focus on areas less affected by the emerging trends nonurban and rural locations and will continue to pursue a more traditional dealership model with a much slower pace of innovation, so that they could become customers of dealer groups who have developed parts

5. CONCLUSIONS

My internship and experience within an automotive project unrelated to manufacturing has led me to an expanded view of the automotive industry. I feel it is appropriate to devote the conclusion of my writing to what I think is of value in the change this industry is experiencing today. The first real conclusion is that this is a world that is increasingly taking proximity from American big tech. The type of business is less and less linked to the physical product, whose profitability has been deteriorated over time by several factors (competition, payback time, product scalability) and is moving to a service-centric model, where the added value for companies comes from the sales formula, the services offered to the consumer and the exploitation of the data provided by the latter. The reason a company like BIP can often offer its consulting product stems precisely from OEMs' need to integrate historically unnecessary skills into their business model. This type of thinking is not purely personal, it is supported by several studies. The most important one is that I think is most impactful comes from one of the world's leading strategic consulting firms, BCG, that for large manufacturers, data and connectivity represent the future of profitability in the industry. The adoption of AVs will enable tremendous growth in revenue related to connectivity services. We forecast that revenue will increase from $4 billion in 2017 to $157 billion in 2035. Connectivity revenue will be generated by in-car advertisements and recommendations (such as those currently available in some taxi fleets); digitally enabled services, feature unlocks, and subscriptions (such as GM’s OnStar); and business-to-business data brokerage (in which an OEM sells vehicle-related data to third parties, such as maintenance shops or insurance providers). [5]

In this thesis, carried out in parallel with my activities at BIP, 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 change of the current business model, 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 realize from zero a functional web app, the activities were aimed at process system integration 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. The activity I described most is the one I worked on which is the writing code for the app. 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 app development point of view, the technological revolution for data management and new IT systems is now in progress, which will provide many benefits for internal business 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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ACRONYMS APPENDIX

BIP (Business Integration Partners), EU (European Union), PM (Particulate Matter) WMO (World Meteorological Organization), EV (Electric Vehicle), MHEV (Mild Hybrid), HEV (Hybrid vehicles), MCI-ICE (Internal Combustion Engine), PHEV (Plug-in Hybrid), CASE (Connected Autonomous Shared Electric), SAIC (Shangai Automotive Industry Corporation), BYD (Build Your Dreams), EAFO (European Alternative Fuels Observatory), ISO/OSI (International Standard Organization), GUIs (Graphic User Interface), DB (Data Base), API (Application Programming Interface), CSS (Cascading Stile Sheets), W3C (World Wide Web Consortium), CLI (Command Line Interface), SDK (Software Development Kit), ECMA (European Computer Manufacturers Association), DOM (Document Object Model), PHP (Personal Home Page), OEMs (Original Equipment Manufacturers), SOTA (Software over the air), BCG (Boston Consulting Group).

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