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Master's Thesis in Automotive Electronic Engineering

SMART DATA ANALYSIS ON LAMBORGHINI CONNECTED VEHICLES

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La determinazione sta nel fare delle cose che altri non fanno.

Abstract

The thesis is the result of work conducted during a period of six months at the Strategy department of Automobili Lamborghini S.p.A. in Sant'Agata Bolognese (BO) and concerns the study and analysis of Big Data relating to Lamborghini's connected cars. The Big Data is a project of Connected Car Project House, that is an inter-departmental team which works toward the definition of the Lamborghini corporate connectivity strategy and its implementation in the product portfolio.
The Data of the connected cars is one of the hottest topics right now in the automotive industry; in fact, all the largest automotive companies are investi,ng a lot in this direction, in order to derive the greatest advantages both from a purely economic point of view, because from these data you can understand a lot the behaviors and habits of each driver, and from a technological point of view because it will increasingly promote the development of 5G that will be an important enabler for the future of connectivity.
The main purpose of the work by Lamborghini prospective is to analyze the data of the connected cars, in particular a data-set referred to connected Huracans that had been already placed on the market, and, starting from that point, derive valuable Key Performance Indicators (KPIs) on which the company could partly base the decisions to be made in the near future.
The key result that we have obtained at the end of this period was the creation of a Dashboard, in which is possible to visualize many parameters and indicators both related to driving habits and the use of the vehicle itself, which has brought great insights on the huge potential and value that is present behind the study of these data.
The final Demo of the project has received great interest, not only from the whole strategy department but also from all the other business areas of Lamborghini, making mostly a great awareness that this will be the road to follow in the coming years.

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Chapter 1

Introduction

Since the introduction of the smartphone, it has become clear that customers are quick to adopt even highly complex and expensive technology if it makes their lives easier. In other words, users value convenience and ease. These core values turned the automobile into the defining technical cultural item of the 20th century. Now it is time to translate these properties into the context of today's – and tomorrow's – technology and society. The automotive industry has the opportunity to shape this fundamental restructuring. When devising strategies and business models, companies should not only consider direct product purchasers but all users and groups affected by transport issues. The automobile has long since changed from a technical to a social commodity: it guarantees our personal mobility and social participation, shapes our cities and landscapes, and structures our temporal and spatial thinking. This is why we have to rethink the whole automotive industry – with the focus on the use rather than the production of vehicles, in order to make the lives of individual users more enjoyable, more efficient and safer.

Furthermore, today's economies are dramatically changing, triggered by development in emerging markets, the accelerated rise of new technologies, sustainability policies, and changing consumer preferences around ownership. Digitization and new business models have revolutionized other industries, and automotive will be no exception. For the automotive sector, these forces are giving rise to four disruptive technology-driven trends:

- **Connected**
- **Autonomous**
- **Redefined**
- **Electrified**

Most industry players and experts agree that these four trends will reinforce and accelerate one another, and there is general consensus that the industry is ripe for disruption. Yet although the widespread sentiment that game-changing disruption is already on the horizon, there is still no integrated perspective on how the automotive industry will look in 10 to 15 years as a result of these trends.

1.1 The Four Automotive Trends: CARE

The analysis of the automotive market reveals the presence of four mega-trends that are shaping the future of the automotive industry. The car of the future in fact will be connected, autonomous, redefined and electrified.

1.1.1 Connected

Connected cars not only provide better experiences for drivers but also open new ways for business to create value. Conventional vehicles will evolve into information-enveloped automobiles that offer drivers and passengers a range of new experiences, increasingly enhanced by artificial intelligence and intuitive interfaces that far surpass today's capabilities.
The key success factor for connectivity services is the clear value proposition the offering has, either to an external customer or to an internal stakeholder. It seems that this value is very often created only by combining data assets and capabilities from various partners.

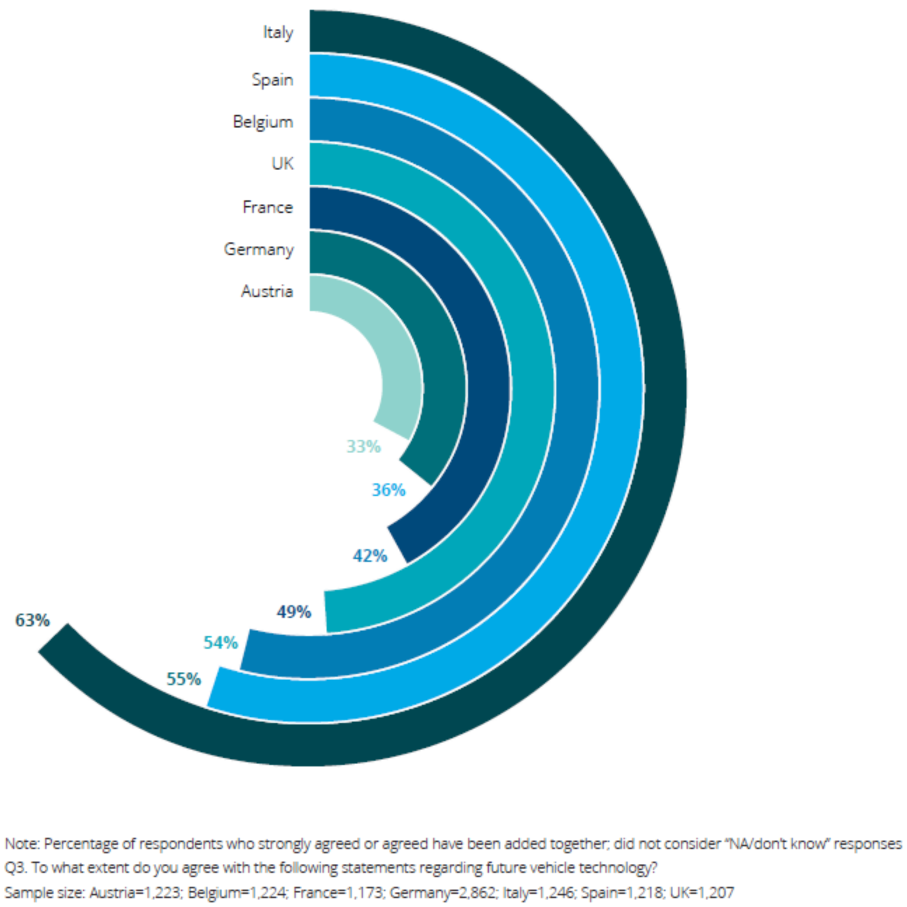

Figure 1.1: Percentage of consumers who feel that increased vehicle connectivity will be beneficial

Connected car benefits are also perceived from European consumers, as it is possible to see in Figure 1.1. What is important to underline is that even the European countries with the smaller percentages still feel that the increase of connectivity will be beneficial.
Moreover, different types of analysis, just to name one, the McKinsey's analysis, have identified five levels of connectivity, each involving incremental degrees of functionality that enrich the consumer experience, as well as a widening potential for new revenue streams, cost savings, passenger safety and security, see Figure 1.3. These levels reflect the potential for connectivity to stretch from today's increasingly common data links between individuals and the hardware of their vehicles to future offerings of preference-based personalization and live dialogue, culminating with cars functioning as virtual chauffeurs. The research suggests that by 2030, 45 percent of new vehicles will reach the third level of connectivity, representing a value pool ranging from $450 billion to $750 billion. The surveys also indicate that 40 percent of today's drivers would be willing to change vehicle brands for their next purchase in return for greater connectivity.

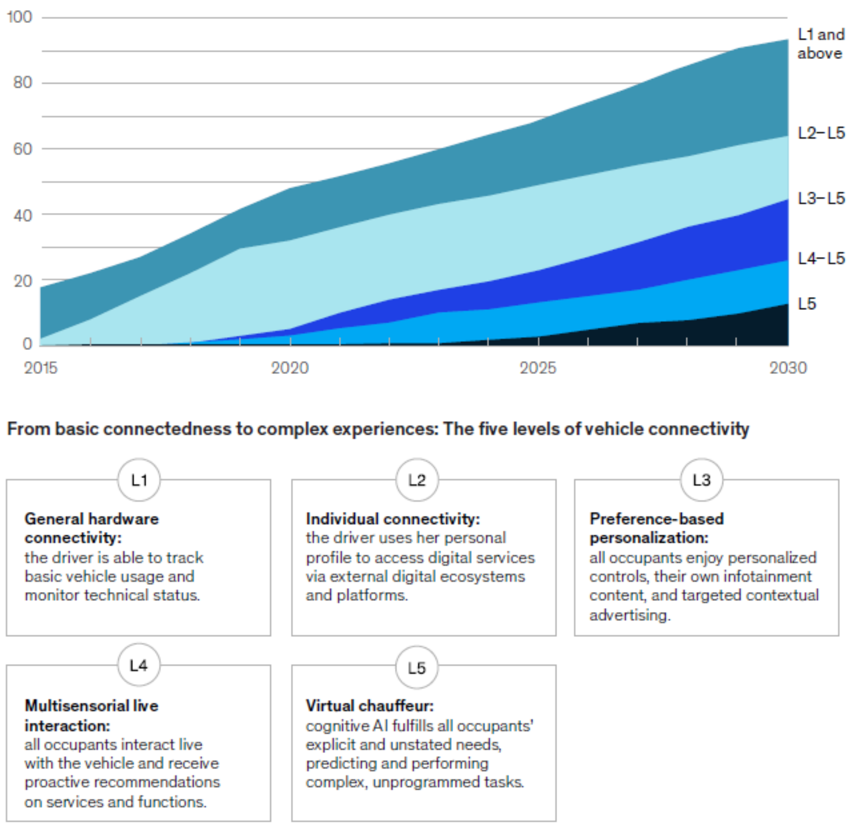

Figure 1.2: By 2030, 45 percent of global new-car sales could be at level 3 or above in connectivity.

Many manufacturers and suppliers already access a wealth of vehicle data to improve or refine their cars and services, and possibilities abound for other players to share information as new ecosystems form.
For these reasons, connectivity can be considered the technology enabler of all the other mega-trends identified, especially with regard to the Big-Data that are col-

lected by connected cars, which will be discussed more in depth in the next chapter.

1.1.2 Autonomous

For investors, executives and enthusiasts alike, autonomous technology and self-driving cars have long been some of the most interesting areas within the future-of-mobility space. And even if, in 2019, progress in AV technology was not as fast as expected, the underlying logic for autonomous driving, especially in cities, remains intact. There is still the belief that electric, shared AVs, also called robo-taxis or shuttles, could address mobility's pain points in cities (such as road congestion, crowded parking spaces, and pollution) while revolutionizing urban mobility, making it more affordable, efficient, user friendly, environment friendly, and available to everyone. If integrated seamlessly in the public-transportation system, it will be an important enabler in reducing today's share of private-car traffic.
Robo-taxi and shuttle mobility in fact, have the potential to disrupt our future mobility behavior and to cannibalize many of the miles people travel each day. This could fulfill daily mobility demands but also may signal the end of mass private-car ownership—at least in high-income urban and suburban areas.
Customer adoption rates for robo-taxis and shuttles will vary by mobility use case: customers will use robo-taxis and shuttles in different mobility use cases, most likely with different frequencies.
The different adoption rates depend on convenience factors, such as finding a parking space (or not) when going to the city center, and cost calculations, which depend on the next best alternative for the respective journey. However, from the survey carried out from Deloitte in 2019, emerged that almost 50 percent of consumers agree that autonomous vehicles will not be safe, Figure 1.3. Therefore the way to autonomous vehicles still seems long.

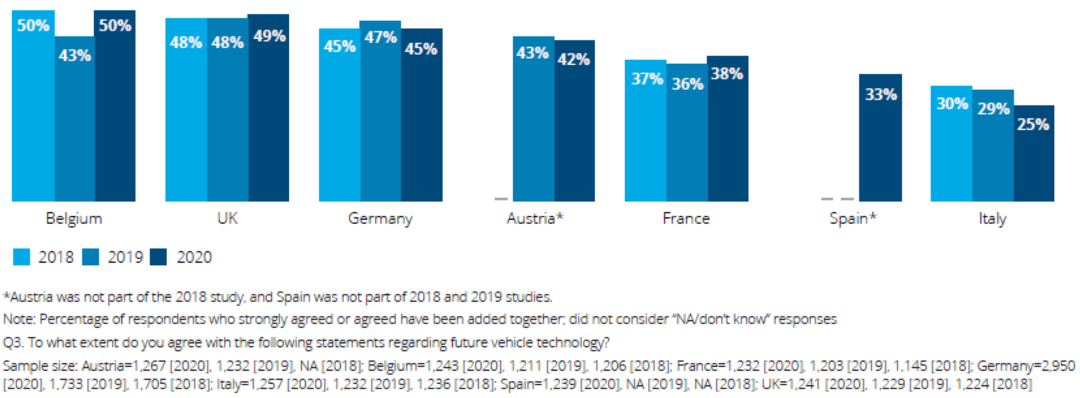

Figure 1.3: Percentage of consumers who agree that autonomous vehicles will not be safe

1.1.3 Redefined

Furthermore, McKinsey's analysis shows that global automotive revenues will nearly double to EUR 5,500 billion in 2030 and will mainly originate from disruptive business models such as mobility as a service (MaaS) or data-enabled services. At the same time, profit pools will shift even more towards new technologies and services, with more than 80 percent of the industry profit pool originating from the megatrends technologies and new business models. Therefore, the European automotive industry will have to secure control points to maintain a profitable position in the future and to participate in the changing revenue and profit pools.

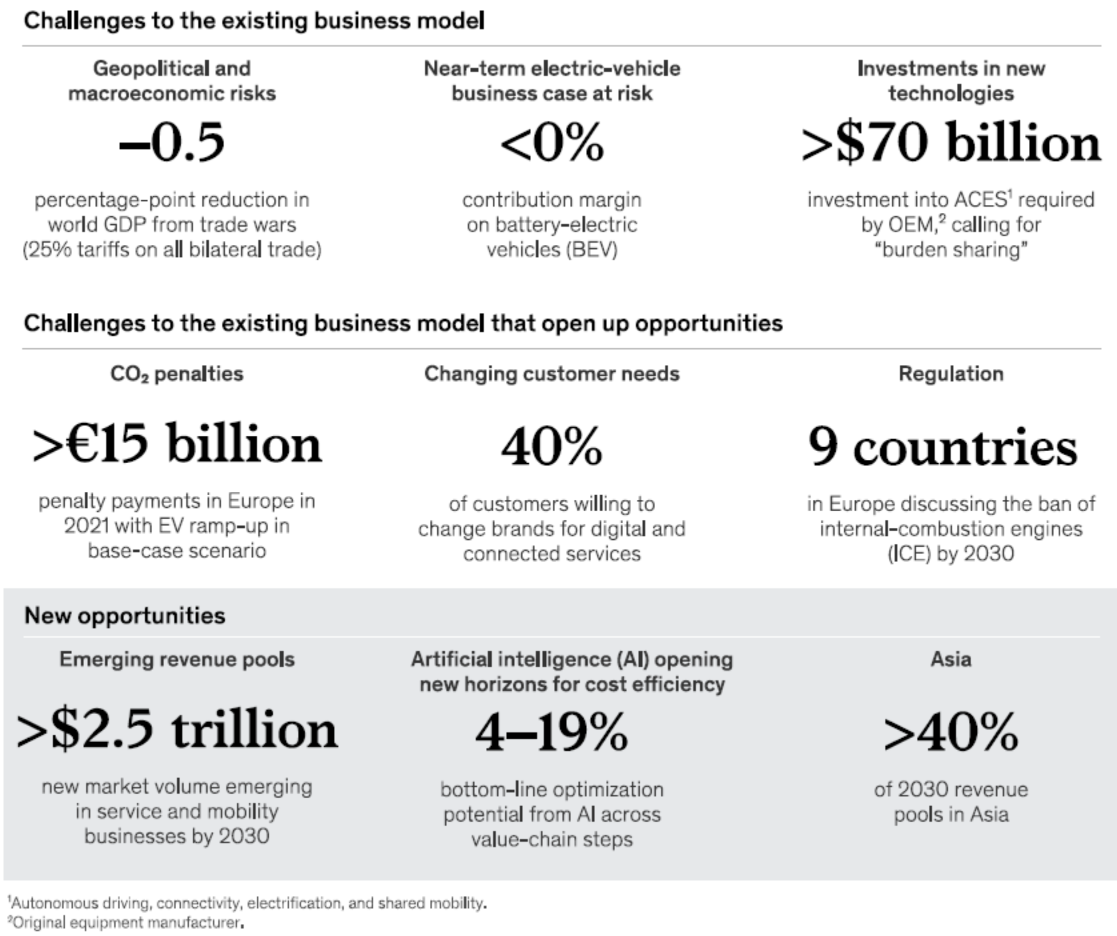

Figure 1.4: While the challenges are significant, they in turn provide great opportunities for players to conquer new markets and further reduce costs.

1.1.4 Electrified

Electrification—certainly gained momentum in 2019. This development was triggered by two trends: tightening regulation—for example, in Europe—and rising customer demand. In fact, as it is possible to see in Figure 1.5 consumers in Europe are willing to switch from an ICE powertrain to an alternative one, preferring an hybrid electric vehicle when considering their next car.

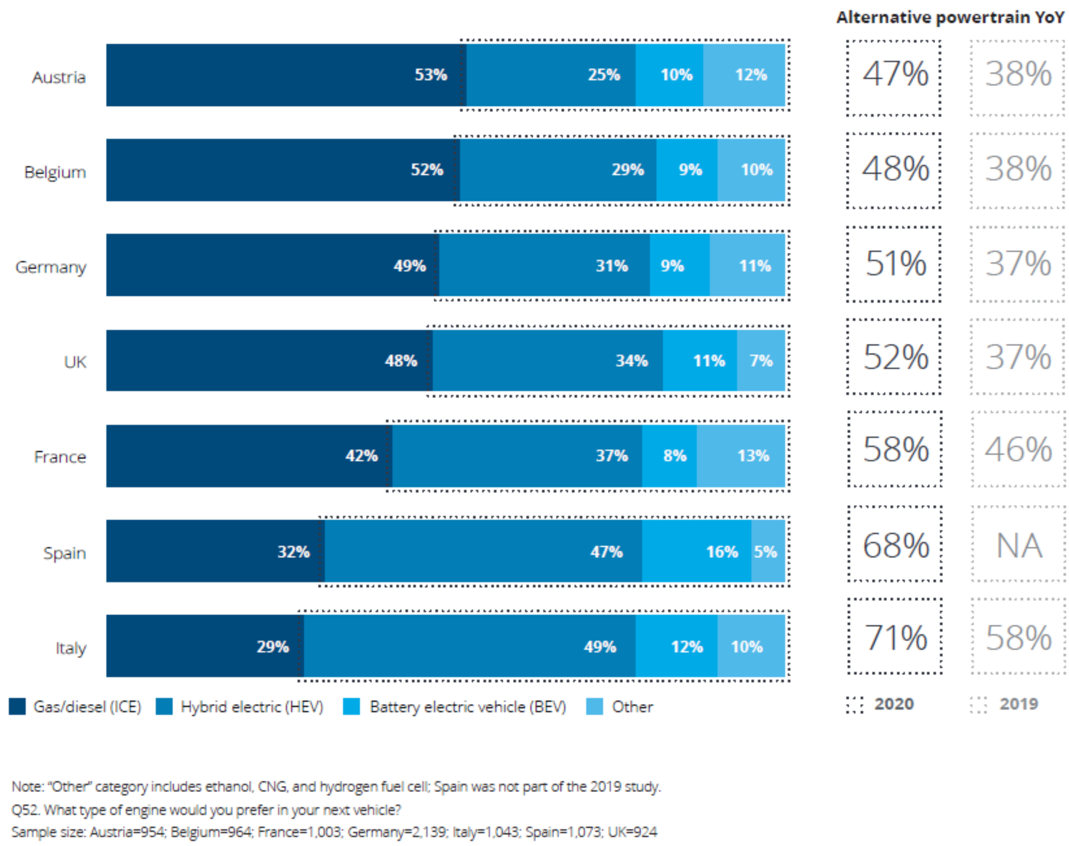

Figure 1.5: Consumer powertrain preferences for their next vehicle (2020)

From the same survey, it emerged that the reasons why consumers consider buying hybrids or BEVs in Europe are in the first place the lower emissions and the lower vehicle operating costs, as shown in Figure 1.6

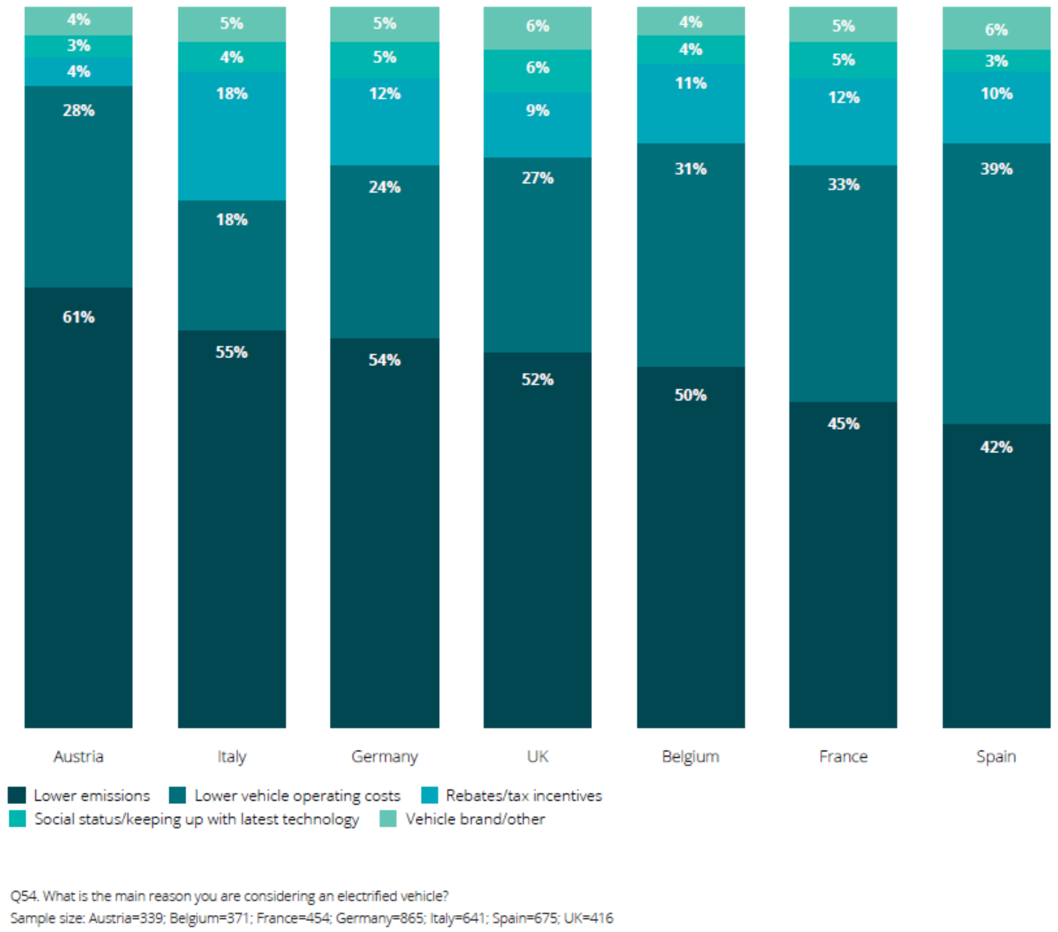

Figure 1.6: Reasons consumers consider hybrids or BEVs

There is no debating that the next five years will be a challenging transition period for automakers and suppliers alike. Consumers, city dynamics, regulators, and competitors will increase pressure on most OEMs to switch more quickly from ICE vehicles to EVs, often with little consideration of EV economics.
Therefore, a clear road map of alternative powertrain is needed, including optimized ICE/alternative fuels, electrified vehicles, hybrids, and fuel-cell vehicles towards the 2050 zero net impact emission target. Furthermore, a use-case based approach to alternative powertrains could help identify the optimal powertrain for each mobility use case with regard to local and total emission performance, mobility cost, customer convenience, and regulatory requirements.
The challenge of making EVs profitable remains, but OEMs and their suppliers are working hard to address it successfully. Advancements in battery technology, economies of scale in EV production, native EV design, and cooperation among OEMs can help bring down costs—which are currently still higher than for comparable internal-combustion-engine (ICE) vehicles.
As starting point, since the business case is more attractive, OEMs are focusing on large and medium-sized cars for the coming years. This is understandable from an economic point of view but will not necessarily help OEMs meet CO_2 targets at scale, as the price point is still too high for many consumers.

Today, in fact, most OEMs do not make a profit from the sale of EVs. These vehicles often cost $12,000 more to produce than comparable vehicles powered by internal combustion engines (ICEs) in the small- to midsize car segment and the small-utility-vehicle segment. What is more, carmakers often struggle to recoup those costs through pricing alone. The result: apart from a few premium models, OEMs stand to lose money on almost every EV sold, which is clearly unsustainable.
During the next five to seven years, as the industry transitions toward electrification but struggles with profitability, automakers should more strongly consider partnering and collaborating with competitors. These alliances will also be most beneficial when they enable higher-volume procurement of the same battery cells and power electronics to take advantage of scale that is otherwise elusive when going it alone.
In fact, some automakers have already announced a range of different global partnerships focused on reducing the cost of designing and producing EVs. According to McKinsey's analysis the impact of two OEMs codeveloping a dedicated EV platform, which could lead to two to three times the volume spread across a similar fixed-cost base-reducing costs by $1,500 to $2,000 per vehicle.
However, accelerating EV profitability will require some bold steps, including the following:

- making tough choices around EV-platform design, including balancing lower material cost with higher capital allocation and maximizing volume where possible
- applying more ambitious cost-reduction approaches to EVs, including design simplification, value-neutral decontenting, and aggressive purchasing strategies
- evaluating new potential partnerships with competitors to share R&D, tooling, and production costs for new EV platforms
- considering more creative use of alternative EV-specific business models that can boost margins

However, infrastructure needs to grow in line with growing EV demand. Fifty percent of potential BEV buyers are concerned about limited range or access to charging stations, as it is shown in Figure 1.7 where a recap of consumers considerations about BEV/PHEV vehicles is reported.

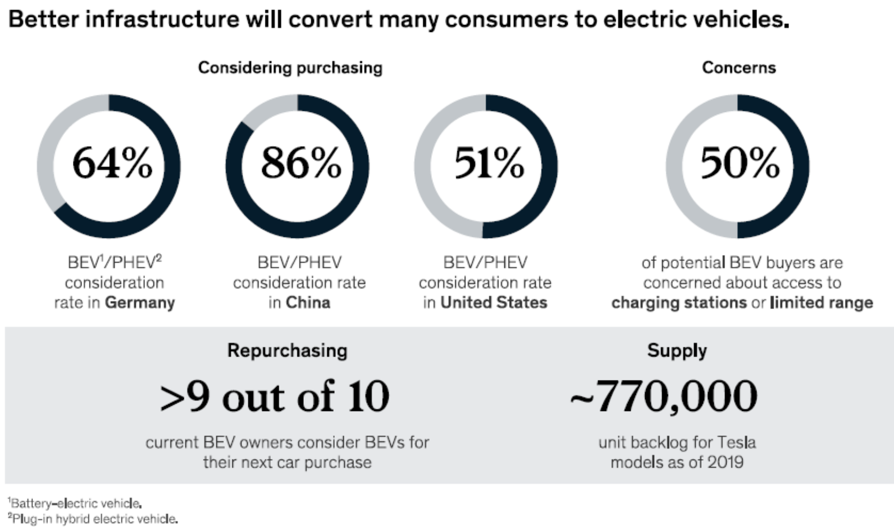

Figure 1.7: Consumers considerations about BEV/PHEV vehicles

Moreover, projections for Europe indicate that automakers would need to sell up to 2.2 million EV units in 2021 alone to meet their fleet CO_2 targets. This is a steep ramp-up of EV sales in less than two years and equivalent to global EV sales in 2018. This is a big task not only for the automotive industry, but also for adjacent industries.

These four are the mega-trends that currently exist in the automotive sector and since the entire thesis work is based on the study of Big-Data, the greatest enabler in this direction is to be connected, so the Connectivity. Being connected is critical to grouping and analyzing data, in fact nowadays it is an area in which OEMs will invest a lot of resources and money, thus, this emerging new trend in connected car data will be analysed in detail in the next chapter.

Chapter 2

The Importance of Big Data

The collection and usage of consumer data first entered public discourse en masse in the early 2000s during the big tech boom as start-ups became multinational powerhouses in record time. Much of this success was derived by providing a novel service to consumers, such as social media outlets or intelligent web searching, in return for unobstructed collection of users' habits and interests data that was like gold to advertisers, product designers, and more.

The automotive industry trailed the big tech data trends by more than a decade due primarily to a lack of always-on connectivity, but also due to the slower pace of tech innovation in the industry. Now that in-car connectivity is nearly ubiquitous, and the industry has pivoted to a more agile software-driven structure, automakers are rapidly exploring new opportunities to capitalize on the potential value of the data collected. In many cases, this takes the form of providing new or enhanced services to the customer, while in some cases, the data may be used for the greater good, such as improving infrastructure and safety. While there are many potential uses for in-car data, automakers must balance the potential value with consumers' demand for privacy, which is becoming increasing mandated by various regulations. With careful consideration of their data usage, automakers can improve their product and service offerings, while respecting privacy rights, and still enhance their bottom line. What is clear to everyone today is that a clear value-add strategy is required for an automaker's data program to be successful. Connected car data was once touted as creating instant profit, yet the reality is quite different. Data by itself generates very little revenue, yet creating true insights and value-add services from the data will put the automaker on the path to success. The implementation of this kind of program may require organizational changes and significant resources to get the program to the market.

The main questions that the management of this data have led to OEMs are multiple and that still today have difficulty finding a real answer are the following:

- **How to define success for my organization?**
- **Are laws threatening opportunities?**
- **How do we catch up to the competition?**

2.1 How to define success for my organization?

The success of a connected car data program comes in many shapes and sizes and will be determined at least in part by the automaker's personality, challenges, and organizational goals. Regional differences also play a large role in defining success due to various regulatory issues, differences in consumer willingness to pay, and different market maturity levels. The best place to start is to ask what your customers need and want, and then determine how those do or do not align to your regional and global goals. Some additional goals may not directly involve your customers and so a second round of goal setting should look at internal needs. However, the automaker should be careful to understand if any of the internal goals could also affect the customer and whether that is in the customer's best interest. Automakers typically define several types of goals, including both internal goals and customer-facing goals. Regardless of what the actual goals are, success cannot be determined without measurement of KPIs. A regular PDCA (Plan, Do, Check, Act) cycle should be incorporated into any new data program. Some of the most common success definitions are shown below:

1. **Champions of the Greater Good:** Many automotive data sets can be leveraged in a way that has an immediate and direct impact on broader social issues. The simplest examples are related to safety, where road ice detection, emergency braking, etc., can be relayed to other cars in the area or (in the case of ice detection) to the highway authorities. Another example is using a car's driving behavior data to detect road designs that are particularly dangerous. These types of data are typically given away to public authorities as a form of corporate social responsibility. While announcing the activities to the public is encouraged, it should not be used as an advertisement, since this will cross a moral boundary for many customers.

2. **Facilitator of 3rd Party Services:** Perhaps the most visible use of connected car data is the enablement of services such as fleet management, usage-based insurance, and listenership tracking. While the 3rd parties will make a clear case for a synergistic relationship, very few of these partnerships yet develop significant consumer uptake or revenue for the automaker. An overabundance of 3rd party offers may also confuse the consumer or taint their perception of the brand.

3. **Warranty cost reduction:** Many automakers begin their automotive data journey by analyzing trend data from specific components, such as batteries or fuel injectors, to predict failures. On paper, this seems like a straightforward concept, yet in practice can require teams of data scientists to turn the mountains of data into reliable insights. By detecting design flaws prior to in-market failures, automakers can dramatically reduce their warranty costs while improving consumer satisfaction, and potentially avoid recalls. The predictive maintenance is one of the much discussed topics today by all the most important OEMs in the world, even Lamborghini is a topic on which it is reasoning and on which in the future it would like to focus.

2.2 Are laws threatening opportunities?

At first glance the answer to this question is YES, however, the various types of legislation should not be viewed as a homogeneous group with similar implications for the automaker. Data privacy legislation for instance should be viewed as an inevitable social initiative that supports human and competitive market rights. Other forms of data legislation such as Right to Repair laws or the EU's upcoming Data Act, are not quite so clear cut, and may lead to a paradigm shift in automotive and other connected device industries.

2.2.1 Data Privacy Legislation

By their nature, data privacy movements will infringe on some of the existing opportunities that automotive data can provide. The development of more restrictive privacy legislation will continue globally until consumers and governments feel that their natural right to data privacy is wellrepresented in law. However, this does not mean that automotive data programs are doomed to fail, nor that they won't provide real value to consumers, automakers, and 3rd parties. Using Europe's GDPR as an example, the legislation is quite restrictive yet creates a framework for the responsible handling of personal data, and only with explicit consent from the customer. This ensures that car owners aren't taken advantage of and provides automakers and 3rd parties with a supportive framework for the creation of value through data analysis and trading. Privacy legislation such as this will certainly add overhead to the development of any form of connected vehicle service yet will result in an organization that works to support their customer's rights, ultimately improving the customer experience. The services that are developed under these privacy frameworks will still create value, but in a manner that is completely transparent and consensual.

2.2.2 Right to Repair

This divisive legislation has seen significant activity in the last 10 years, with the European Commission and individual states in the USA mulling over various ideas about how to democratize vehicle data so that aftermarket repair shops and 3rd parties can gain access without going through the OEM. While both sides of the argument have merit, it is clear that this is a threat to the automakers' traditional perception of being data owners. The advent of 3rd party data marketplaces (and automakers' proactive engagements with them) may have delayed the issuance of new legislation by several years, however new regulations come into effect in 2023, requiring a standardized data interface.

2.2.3 European Commission's Data Act

This legislation, which is still in the proposal phase, could result in the broad reclassification of non-personal connected device data as being a public asset. This could, for instance, allow any third party, including competitors, to analyze all non-personal data that the automaker receives from the vehicle. This act could indeed usher in a new wave of economic development based in data science and data-for-good initiatives yet would strip automakers of many current opportunities and eliminate any advantage currently held.

2.3 How to catch up with the competition?

While many automakers have mature vehicle data programs, some have yet to capitalize on the opportunities presented by connected data. The maturity of an automaker's data programs are typically proportional to the share of vehicles that they sell with embedded modems. Just a few years ago, many high-volume brands didn't offer embedded modems on any of their models, instead opting for smartphone tethering and mirroring solutions. This is partially because these automakers saw embedded connectivity simply as a premium feature that would need to be reserved for their premium lineup where customers would be more likely to purchase the feature. While the practice of 'de-contenting' is common among an automaker's brands, it also artificially constrained the creation of value by ensuring that the connected vehicle fleet was limited to low-volume premium vehicles. Furthermore, because few value-added services were being offered to the customers, subscription rates were typically very low, further compounding the problem. The final twist is that many of these automakers tie the connected services budget to the revenue generated by the subscriptions and add-on services. This organizational design guarantees that the chicken-and-egg problem will never be resolved through natural growth. Now that the problem faced by many automakers has been examined, you will see how an immature or non-existent data program can become competitive in the industry.

1. **The first step is to increase the penetration of embedded connectivity in your fleet.** This is an investment in the company's future. While this will add cost to the BOM, it will improve customer satisfaction and enable the additional use cases that provide both monetary and non-monetary value to the automaker.

2. **Provide the customer with a long (3+ years) complimentary connected service period combined with well-designed, simple features.** The simple, well-designed service will ensure that customers renew their subscriptions. If the internal value created by the platform is large.

3. **Don't try to run before you walk.** Attempting to stand-up too many customer-facing services or data use cases at once will likely lead to none of the services receiving the design attention that they desire, will require a larger initial investment, and may lead to a disjointed data organization. Develop internal data use cases and 3rd party partnerships gradually, ensuring goal achievement of existing initiatives prior to moving on.

4. **Ensure that the connected car data organization starts with a robust governance model with support from top executives and the authority to pull internal 'levers' to meet KPI goals.** For instance, the team should be empowered to explore innovative data use cases to optimize value creation.

These concepts are very much based on the four mega-trends mentioned and analyzed by previous chapter, in particular the trend related to Redefined the automotive revenues with the creation of Business models completely different from before, with nowadays the need to have models such as mobility as service (MaaS) or data-enabled services.

2.4 Who's who in the automotive data industry

The automotive data landscape is divided into the suppliers of data (the automakers) and the suppliers of data services (the data platforms). SBD's analysis reveals that while there are many data platform providers, the majority seem to have slowed their development and client onboarding, leaving just a handful of companies to pursue the large partnerships with OEMs. For some of these companies on the left side of the Data Platforms chart, automotive data processing and brokering is a small portion of their business and therefore they may not intend to pursue more than a basic level of capability and business engagement. Meanwhile the focused companies, such as Wejo and Otonomo are competitively pursuing new business. The Historical Trend arrows show the general movement that SBD has witnessed over the last few years. The automakers on the other hand, are all moving in the same direction, just at different speeds and with different strategies. We expect the cluster of automakers in the middle of the chart to continue moving to the top right to remain competitive.

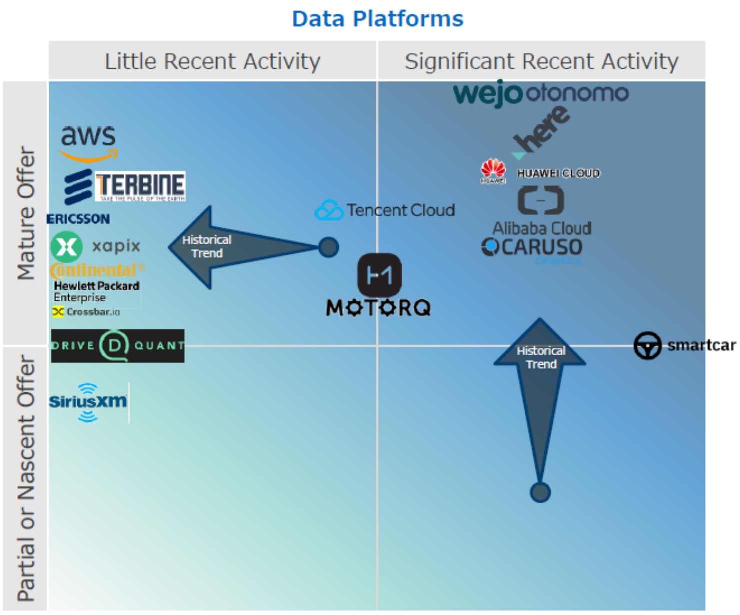

Figure 2.1: Data Platforms

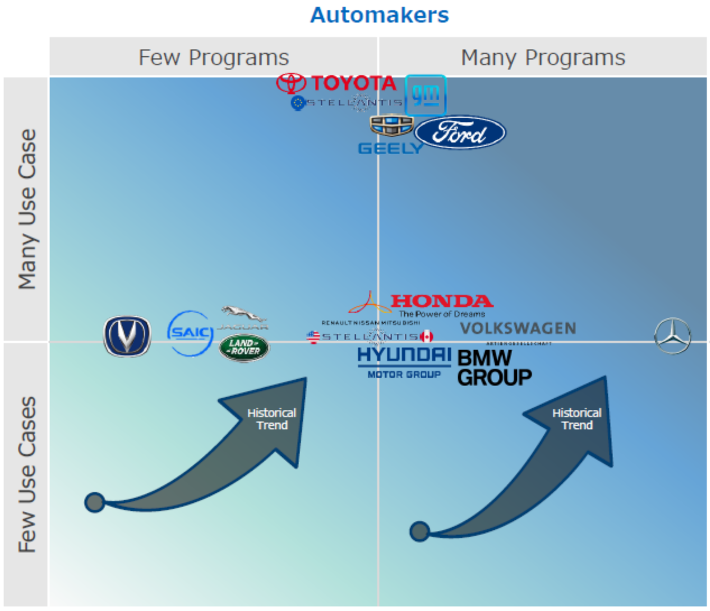

Figure 2.2: Automakers

OEMs can potentially realize enormous benefits from knowing which parts of a vehicle are likely to fail and when. Real-time data sent from vehicle sensors can identify problems early, and predictive analytics can allow companies to get out in front of potential warranty and recall issues. This kind of data can also help OEMs and dealers optimize their parts inventory and technician resourcing strategies. Further, a deeper understanding of how customers use their vehicles can help OEMs design better, more customized customer experiences to improve brand affinity and loyalty. In terms of external revenue opportunities, OEMs and other industry players are exploring a wide variety of data-based products and service offerings, including user-based insurance, mobile commerce, mobility-as-a-service (MaaS), behavioral and geo-based advertising, infotainment, and personal health monitoring. However, many OEMs are already showing their collective vulnerability to new and existing entrants looking for ways to go around them. In the case of user-based insurance, for instance, the addition of a simple plug-in allows insurance companies to gain access to vehicle usage data, thus circumventing the need to interface with OEMs. Vehicle manufacturers may also face an uphill struggle with significant consumer concern over the collection of bio-metric data. For example, recent survey data suggests that 63 percent of US consumers are at least somewhat concerned about bio-metric data being captured and shared with external parties. The complexity and dynamism that characterize the emerging connected vehicle industry has made it difficult to make decisions regarding where to play and how to win; in fact as it is illustrated in the figures 2.3 and 2.4 , it is possible to see what are, at the moment, the main drivers and barriers that are affecting the connected car data.

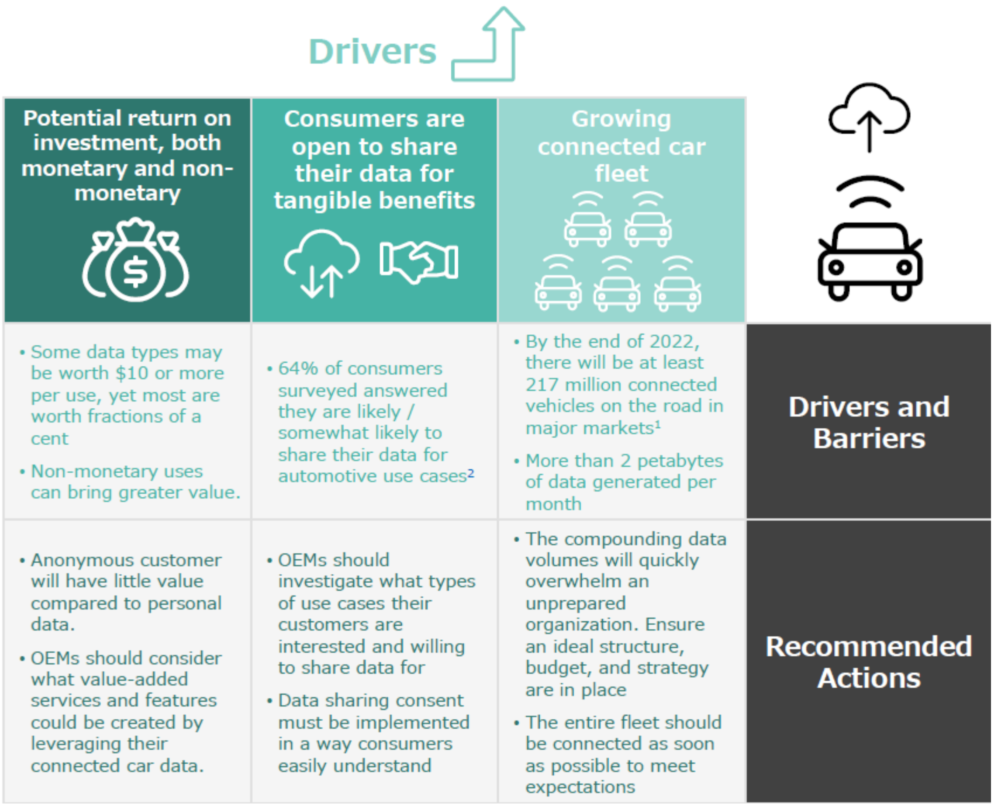

Figure 2.3: Drivers affecting connected car data

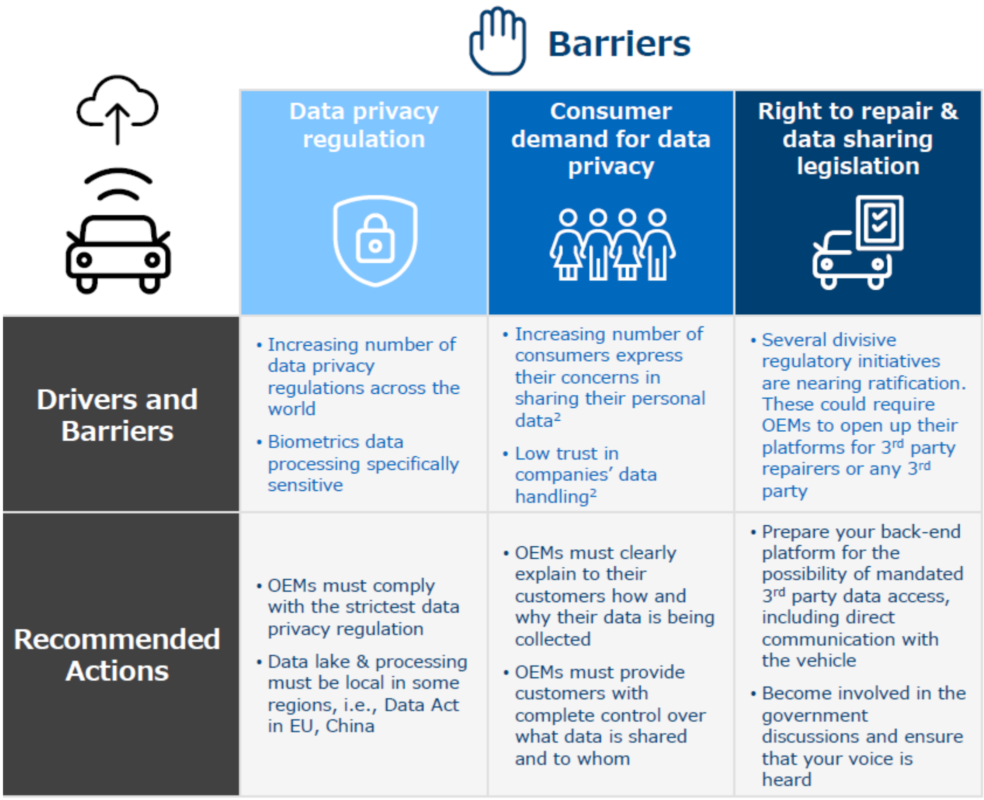

Figure 2.4: Barriers affecting connected car data

Obviously, looking at the two figures, we can well understand that the drivers that influence today and that will influence in the future will be more an exponential growth of connected cars, also there will be in the near future a little change in the mindset of the people, in fact 64% of consumers surveyed answered they are likely to share their data for automotive use cases. However, just when it comes to the management and sharing of customer data, the first barriers are born; in particular, OEMs must clearly explain to their customers how and why their data is being collected and, moreover, they must provide customers with complete control over what data is shared and to whom, otherwise, if there is not this transparency and clarity on the part of OEMs, what is at risk is that customers will have less and less confidence in the management of their personal data. Beyond consumer demand for data privacy, there will also be a huge increasing number of data privacy regulations across the world and for that reason the OEMs will have to comply with the strictest data privacy regulation and for sure, Data Lake processing must be local in some regions: i.e. Data Act in UE, China etc.. Putting these main drivers and barriers on the scale and due to the fact that the compounding data volumes will quickly overwhelm an unprepared organization, we have to ensure the presence of an ideal structure, budget and strategy are in place, otherwise the management of this data will become a real hell.

2.5 Data monetization opportunity

Connected services and data monetization have long been seen as a big opportunity for automotive companies facing an uncertain future. However, the path to success may require new thinking in terms of where to play and how to win. For decades, automotive original equipment manufacturers (OEMs) have been able to find success in the relative comfort of building assets for personal consumption. But outside the industry, companies in areas such as financial services, biotechnology, and social media were hard at work finding new ways to generate revenue and grow shareholder value. Many biotechnology companies, for instance, found their niche as "technology creators," while social media players and other "network orchestrators" created asset-free revenue models based solely on bringing supply and demand together in a market exchange environment.

Although OEMs have introduced countless innovations over the years, they have never really been credited as "technology builders" by the investment community. In fact, their valuations still hover around those of the lowest "asset builder" quadrant. So how can traditional automotive companies start moving up the revenue multiplier ladder? The answer may be found in new business models that promise to leverage the increasing amount of data being generated, captured, and shared by the vehicle itself. Vehicles are now able to capture and share many types of data, including geolocation, vehicle performance, driver behavior, and biometrics data. Though GPS functionality has supported navigation systems for years, smarter applications of the data are adding significant value in the form of real-time traffic updates and road safety alerts. Uses for vehicle health and operational functionality data are also spreading as vehicle manufacturers continue to develop app-based tools to monitor key maintenance statistics. And while the use of advanced biometric data is still in its infancy, new sensors in the cockpit can allow vehicles to

monitor key attributes of their occupants, including stress levels, heart rhythms, alcohol consumption, and fatigue. However, monetizing this tremendous increase in operational and behavioral data is easier said than done—and OEMs have largely been lagging behind market disruptors entering this space. There is also good reason to wonder whether a critical mass of consumers see the increase in vehicle connectivity as a good thing. Recent study results suggest that while 79 percent of consumers in China believe increased connectivity will be beneficial, only 35 percent of German consumers feel the same.
One of the first decisions for companies aiming to monetize vehicle data is where to play in the connected vehicle value chain. Potential roles exist for companies to act as:

- **Generators:** making end products capable of capturing data;
- **Transmitters:** safely delivering the data to a central repository;
- **Manipulators:** aggregating data from different sources into a usable format;
- **Developers:** designing end-user offerings that leverage the data;
- **Providers:** marketing the service offerings to both Business-to-Consumer (B2C) and Business-to-Business (B2B) audiences.

Not every company is well-placed to succeed in each part of this value chain. For new entrants in particular, it can be difficult to create value further down the chain without access to the data being generated further upstream. Here lies one of the central issues that is currently preventing the vehicle data monetization ecosystem from developing to its full potential. Many OEMs have the data, but because they want to control every point in the value chain—even though they are not generally well positioned to do so—they are reluctant to make the data available to anyone else.

2.6 What is Data Monetization and why are automakers trying to monetize vehicle data?

Data monetization is the practice of using data to derive revenue. This business model can take many forms, from the immediate return of selling data directly to 3rd parties for a fee, to the long-term practice of providing value-add services for free in hopes of increasing repeat purchases. OEMs currently have the greatest opportunity to capitalize on data monetization use cases since they have direct access to the full set of vehicle data and access to the customer. Where OEMs aren't able to provide a service, they can choose to sell the data directly to 3rd parties or offer services to the customer in partnership with the 3rd parties. Data privacy legislation is beginning to make it more difficult for OEMs to proactively offer services to their customers without fear of legal action. Some 3rd party hardware vendors are attempting to compete with the OEMs by offering services powered by OBD dongles. The picture 2.8 shows briefly how is made the ecosystem in which the data flows everyday.

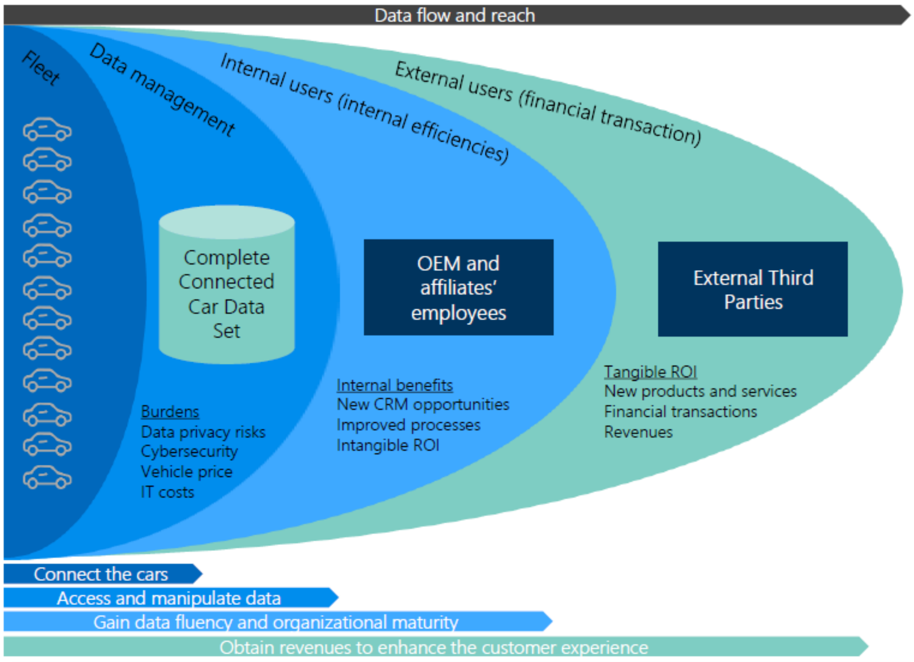

Figure 2.5: Data ecosystem overview

As the automotive industry evolves, automakers are becoming increasingly focused on monetizing vehicle data. Automakers are investing in data monetization for five main reasons:

1. Increased desire for autonomous vehicles, shared mobility, fleet management and usage-based insurance opens new, data reliant business opportunities for automakers.

2. Increasing RD costs for Evs, autonomous, connected platforms and manufacturing are eating into automaker's profits.

3. Increasing complexity with the automotive industry is impacting decision makers trying to keep pace with consumer desires.

4. Increased vehicle electronics and component value are negatively impacting manufacturers servicing costs.

5. Increasing competition from industry disruptors means manufacturers must develop higher quality vehicles and services.

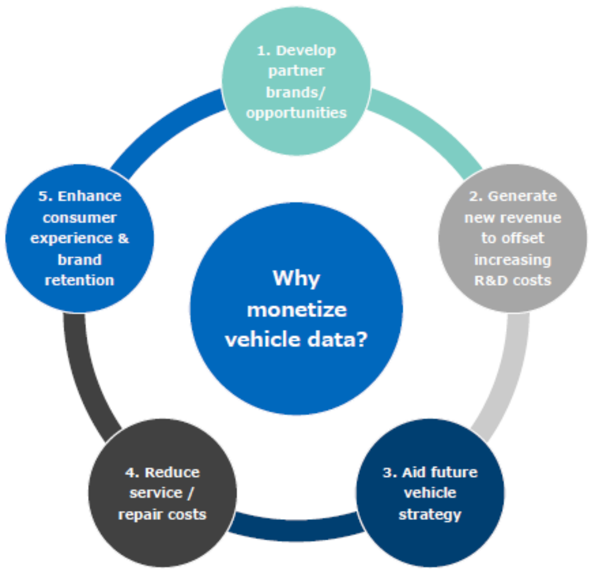

Figure 2.6: Why automakers are trying to monetize vehicle data

Typically the Big Data monetization environment is divided in two main streams: the **Internal Data** and the **External Data**.
The Internal Data monetization refers to the use of data for internal benefits, notably process efficiencies made possible through timely trigger and/or the reduction of assumption through rel-time visibility to the connected fleet. This requires clear business requirements, careful handling of personally identifiable data and a means to access the data.

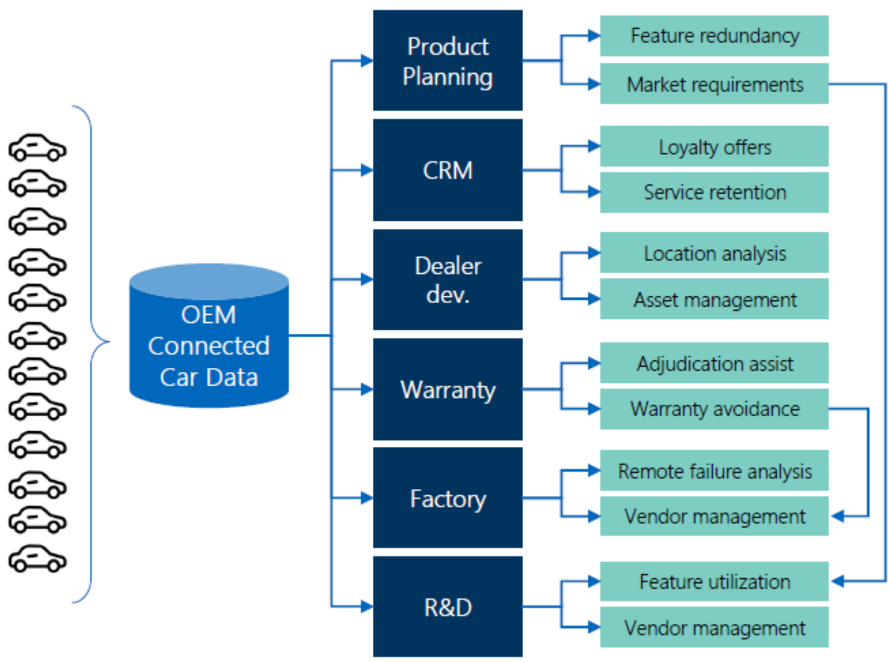

Figure 2.7: Internal Data monetization

Whereas, the External Data monetization refers to selling or trading connected car data to third parties outside of the originating organization's boundaries. The most typical use cases today are established by providing third parties with a reduction in costs, as they can trade dongles and asset management for a contract or subscription to TCU data.

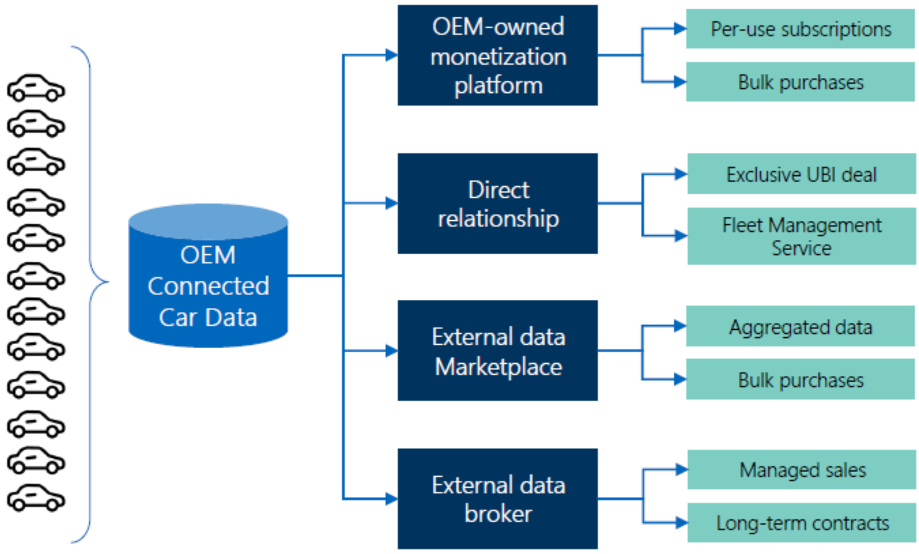

Figure 2.8: External Data monetization

However, the real question is: "Why is there a need for a vehicle data monetization ecosystem?". Traditionally, OEMs focused on vehicle design, manufacturing and retailing; in the last ten years, OEMs have struggles to provide customers with the consumer electronics-type of technology in vehicles, an area outside the traditional core competencies; instead now that vehicles generate potentially valuable data (the raw resource), there are opportunity to manipulate, consume and selle this data. OEMs have neither the resources or experience to turn this into a refined product for consumption and and for most of OEMs, this should be delegated. Essentially, data monetization is an activity in a different "vertical", or industry, than automotive. Just as an IT company would struggle to manage the vast parts supplier network and supply chain management of an OEM at a global level, OEMs struggle with the data ecosystem. Every OEM has developed its connected car solution and associated data environment independently. At the global level, this has dozens of incompatible data sets that third parties want to access, each changing and evolving over time. The end consumers of this data do not want the burden of integrating independently with each OEM. Therefore, a demand has arisen for platforms that can act as the broker between OEMs and developers, providing easy monetization opportunities for OEMs and scaled data access for developers. In fact, nowadays the vehicle data monetization ecosystem has this shape, as we can see in the figure 2.9.

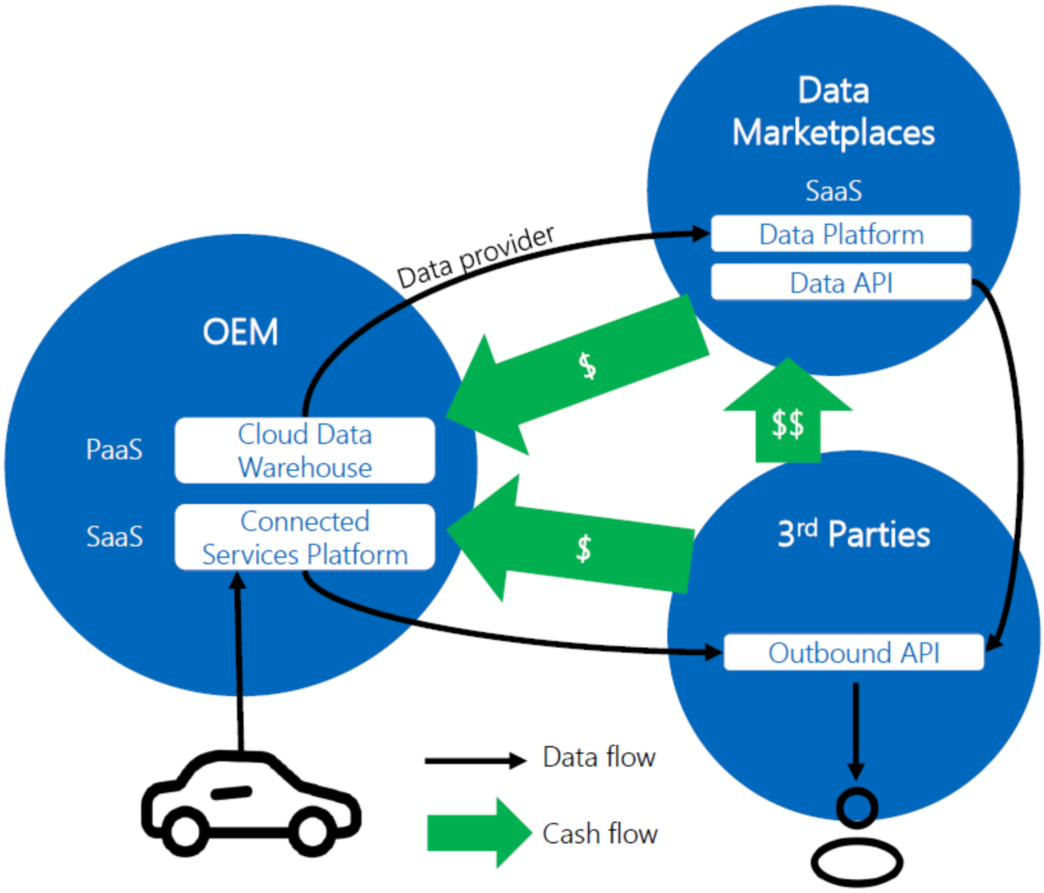

Figure 2.9: How the current vehicle data monetization ecosystem looks like

The OEM can choose to expose data externally in the manner that bets fits their goals and desired business model. There are two general ways OEMs expose data:

1. As a data provider to data marketplace service providers who then manage the integration with various 3rd parties;

2. As a data provider to individual 3rd parties using an in-house API or integration model.

While marketplaces may offer better scale, 1:1 relationships with developers can create unique, value-add services curated based on strengths of both the OEM and the 3rd party. Data Marketplace generally treat their platform user as either data providers or data consumers. Data providers to marketplaces provide vehicle data and are generally automotive OEMs, or in some cases telematics service providers and fleet providers. Data consumers are the parties that use the vehicle data which is generally accessed through a common API.
In basic terms, data provides the opportunity for triggers (when to do something) and insights (visibility to a situation or condition). Therefore, data helps to fuel business processes and these processes must be well defined and implemented for the data to provide its value. This means that there are a number of steps required, calling for varying areas of expertise and resources. As a result, different experts are required to perform specific steps, creating a value chain. Some parties are

well-suited to handle parts of this value chain. However, others are foreign and complicated, requiring partnerships, thus creating an ecosystem. In recent times, a new area of the connected car ecosystem has opened up, comprising startups or new departments of entrenched industry players who provide “data services”. These companies provide a wide array of services such as integration into data marketplaces, such as Otonomo, wejo or Continental’s blockchain-enabled platform; white-label data server products such as IBM or Ericsson and API development tools such as HIGH MOBILITY or Smartcar. OEMs who are pursuing a data monetization strategy have taken to partnering with multiple companies as it is still unclear who or through which model future success will come.

2.7 What does the future hold for automotive data?

The future of the automotive data industry will be shaped by several external factors over the next few years. The most notable is the regulatory landscape which will create many hurdles for automakers, yet these changes should be seen as a necessary step to ensure a level playing field globally and to provide fair treatment to consumers. In the more distant future, it’s likely that technology plays a greater role in shaping the service model, with advanced 5G (and 6G) networks and edge processing enabling new use cases that had once not been feasible.
More precisely, we can summarize the future of automotive data in the following main pillars, making a bit of a prediction on what the future scenarios may be:

- **Regulations:**The European Data Act will be coming into effect in 2025 creating a paradigm shift in the ownership of data. In addition, the EU’s Data Spaces will begin to spur commercial growth in the data analytics industry. The USA will also likely enact federal legislation that provides a similar form of data protection and portability. Automotive data analytics and services now involve governments, researchers, and service providers working in many other sectors including public health safety, power generation distribution, road infrastructure planning, and predictive mobility services.

- **Consumer Needs:** Consumers will begin to demand portable digital profiles that follow them from their smartphone to any car, laptop, or other interactive device. Certain services such as traffic information and map updates will be mandatory. Usage-based-insurance may begin to gain in popularity if it is provided seamlessly. Consumers will have become familiar with the concept of managing their data rights and they will ensure their rights are not infringed. They will expect seamless profile portability between products and platforms. Micro transactions for connected services are now more common than subscriptions.

- **Technology:** New platforms will feature more centralized electrical architectures enabling greater interaction between the vehicle’s systems and the back-end connected car platform. OTA updates are ubiquitous for major components. Higher power computing is beginning to shift processing from the cloud to the edge. High power computing is ubiquitous, enabling onboard processing of complex data including video and LiDAR. Insights from the data can be processed onboard and transmitted to the OEM's backend platform for AD/ADAS model improvement. Commonplace 5G enables backend systems to react to live data in real time.

- **Automaker Business:** Most major automakers have some form of connected vehicle platform in place, yet only a few have developed sustainable internal and 3rd party use cases. Those that are still developing their connected vehicle business will likely emulate services already in place by competitors. Some OEMs will choose to set up not-for-profit data programs, rejecting monetization completely. 3rd party services such as aftersales service, usage-based-insurance, pay-as-you-drive, and mobility subscriptions will be fiercely competitive with the OEMs' own services, forcing the OEM to leverage brand loyalty, perceptions of quality, and convenience, to win the business.

- **Data Platform Business:** Data collection, aggregation, and brokering are becoming more difficult as regulations such as the EU's Data Act drive down the value of vehicle data, and analysis paralysis plagues clients. The business is now focusing on enabling 3rd party services, deriving unique insights, and consulting services. Smart city and mobility services are finally becoming a reality with Data Platform Providers serving as a critical link between automakers, various mobility services, and government bodies. Data collection and aggregation is fully commoditized, yet deep insights leveraging edge processing and ML, are prized.

In conclusion, in order to give a more precise and numerical outcome regarding the future perspective of the automotive data, see 2.10, we can finish saying that between 2020 and 2025 automotive data volumes are expected to increase 1000-fold. Even when considering the effect of falling mobile data costs, this could lead to automakers facing data bills as high as $300/month.

	2020 →	Factor	→ 2025
Data Volume[1]	10,000,000 Bytes per Car per Month (For mid- to high-segment vehicles)	x 1000	10,000,000,000 Bytes per Car per Month
Mobile Data Cost / MB	\$0.01 - \$0.05 / MB	÷ 2 (Following current trends)	\$0.005 - \$0.03 / MB
Data Cost	\$0.10 - \$0.50 per Car per Month	x 500	\$50 - \$300 per Car per Month

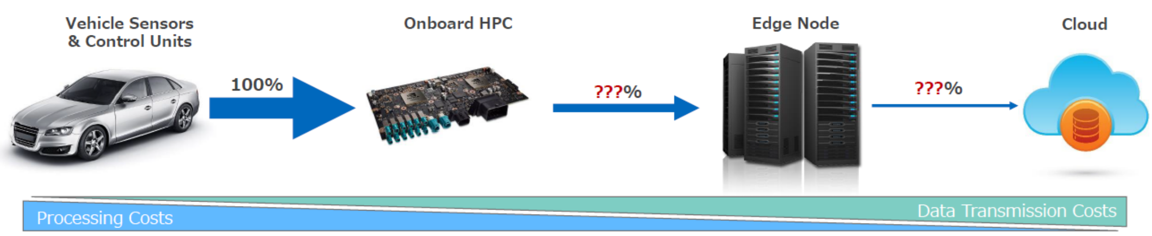

Figure 2.10: Data volumes and costs could skyrocket by 2025

Clearly this is not a sustainable business model, meaning that to take advantage of the large quantities of data generated by these vehicles, automakers will need to consider new strategies such as the generation of data insights on the vehicle instead of in the cloud. This could take the form of new high-power edge processing architectures delaying transmission of certain data until the vehicle is able to connect to a WiFi access point. The latter strategy would work well for transmitting sensor and vehicle data to train machine learning algorithms, or perhaps uploading road condition data to local road authorities.

Chapter 3

Lamborghini Projects on Big Data

All the mega-trends and mutations that are affecting the automotive world has also led Lamborghini to be forced to follow these new changes in order to always keep up with the new needs of the market without, however, descending from its roots and its DNA which has always been distinctive among all the OEMs in the world.
Therefore, Lamborghini has also begun to carry out several Proof of Concepts (PoCs) related to the analysis of Big Data of connected cars that it has already placed on the world market, which have the main goal to understand how derive value from these data and, in particular, what kind of data, among all those available, can be more useful both from a revenue and strategic point of view for the company.
The study of data, as already seen in the previous chapter, leads to a new business model approach, profit pools shift even more towards new technologies and services; in fact, for this reason Lamborghini has undertaken the study of the connected data in order to understand what are the main driving habits of its customers to offer them services more suited to their type of driving.
This type of approach finds two main benefits, first of all improves by far the customer experience and, secondly, the study on the Big Data can bring a great advantage also to the company, because it has the power to focus more on what customers really want rather than on less flashy things. Therefore, the different projects on which Lamborghini has been focused in the last year will be discussed and on each project there will be a focus on the quality of the KPIs that have been reached.
All the PoCs made are not based on the same inputs,in particular all the PoCs are based on the same data stored on SDP which is the central point of the Lamborghini Huracan connected vehicles and it manages all the data sent by the cars, IT systems and customer touch-points, but we must make a distinction among the four PoCs considered; in particular three PoCs are focused on a static data-set in which all the data that had been stored from January 1st to November 29th, 2021 by 1457 connected Huracan; instead only one PoC is based on the same SDP data but on an extraction, in particular all analyses are based on the last five months' data stored from 457 different vehicles. Furthermore, both considering 1457 vehicles and the extraction of only 457 vehicles, a static data-set was always used, this choice was made for simplicity and in particular, for the purposes of the PoCs, it was not important what type of data-set is used, whether static or dynamic, but the main goal is to understand how to extract value from these data and define new KPIs from Data for Connectivity.

3.1 First PoC launched by Lamborghini

The first work carried out by Lamborghini lasted about four months, from October 2021 to January 2022 and as previously mentioned the entire work focused on the analysis of static data saved on a historical database from connected fleet from January 1st to November 29th, 2021 by 1457 connected Huracan. In this first study, the main goal was, first of all, identify user types using the data collected by connected cars; second, develop an algorithmic solution that allows the car to be associated with a user type. Obviously not all the information was taken into account for the creation of the clusters but only a few, in particular the information used for the creation of the clusters are six:

1. Maximum speed;
2. Minimum speed;
3. Frequency of use;
4. Duration of car use;
5. Total distance traveled;
6. Number of cars taken into account.

Additionally, the days of use were calculated as a fraction of the days of use at speeds greater than zero on the days elapsed between the first observation of the dataset and the last, November 29th. The maximum speeds have been calculated as the average of the maximum daily speeds of each car. The kilometres now represent the average number of kilometres travelled per day. The driving hours per day refer exclusively to the series that the algorithm has considered useful for the analysis, thus excluding small movements not very relevant.
So on the basis of these six parameters, it was made a cluster analysis. Cluster analysis involves the autonomous discovery of clusters in the data based on patterns. This type of statistical technique allows to assign vehicles to a group of similar cars on the basis of common characteristics without the need of preset categories. At the end of the analysis, five clusters have been mathematically found that describe the different types of behavior that can occur when a person is driving. So, the five clusters, as shown in the table 3.1, identify the possible ways in which a driver can use his car in everyday life, namely:

– *semi-daily use to go to work every day*;
– *use in the city and on weekends*;
– *periodic use on the track*;
– *extra-urban use on weekends*;
– *extra-urban use on weekend.*

By studying the data coming from a given car it is possible to immediately understand in what kind of cluster it falls into.

	Top Speed	Average Speed	Frequency Use	Duration of Car Use	Total Distance Traveled	N. vehicles	Qualifications (hypotheses)
Cluster 1	Medium	Medium	High	Medium-low	Medium-breve	221	Semi-daily usage, to go to the company
Cluster 2	Low	Low	Medium-low	Low	Short	285	Quite driving in the city, week-end car
Cluster 3	High	High	High	High	Long	74	Professional driver, frequent use on track
Cluster 4	Medium	Medium	Medium-low	Medium-low	Short	391	Extra-urban usage, on weekend
Cluster 5	High	High	Medium-low	High	Mediium-short	208	Car used on track, test car/track rental

Figure 3.1: Lamborghini cluster customization

In addition, a further analysis was also made to verify the cluster customization made previously. In the figure below 3.2, it is possible to see a certain number of machines near the Misano circuit and on the basis of the parameters recorded by each vehicle it is possible to group that particular car directly to one of the five clusters seen above.

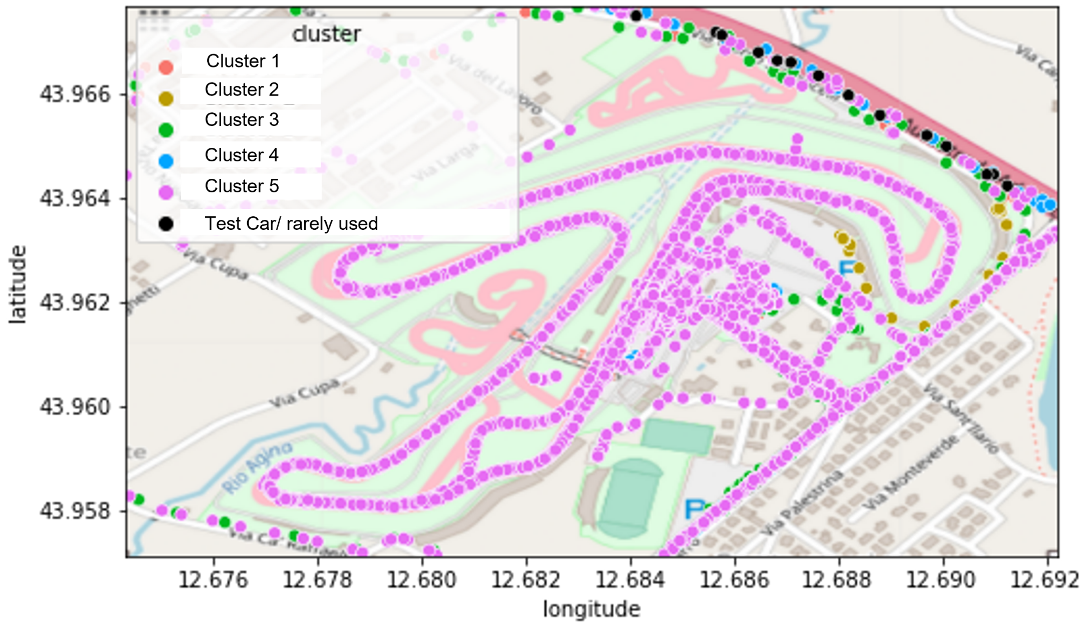

Figure 3.2: Visualization of the clusters

In this case, the realization of the different clusters, done previously, by means of special algorithms based on scientific clustering techniques, brought a very good result, because intuitively the colors that appear on the circuit are reliable, given the fact that all the dots that are in the circuit belong to the same cluster and those

that are in the surroundings of the circuit belong to diversified clusters which makes absolute sense.
Finally, the study ended with a further analysis, that is, using the data referring to the total distance traveled and duration of car usage, a forecast was made on the average distance traveled by each vehicle between two journeys. What emerged was that on average the distance traveled between two journeys is the same for all five types of clusters and approximated to a value of 4 hours (3.3).

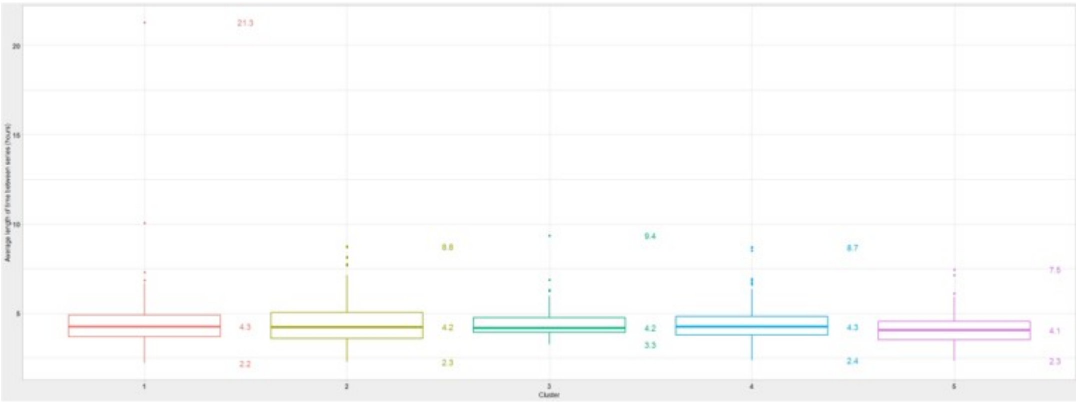

Figure 3.3: Big Data as enabler for the electrification

Following the line of the previous analysis, it was also estimated how many kilometers on average are traveled each trip, and it emerged that on average never exceed 78.2 kilometers. These last two analyzes, in view of a future in which the electrification of cars will be increasingly present, among which Lamborghini will also be the protagonist, these data could be taken as a starting point in deciding what kind of batteries a Lamborghini of the future will wear. These last considerations could be of great value for Lamborghini, especially in view of the great changes that the automotive world will see in the coming years in which it is planned, as already stated by the European Commission, to stop cars with internal combustion engines by 2035, switching exclusively to the electric mode.

3.2 Second PoC launched by Lamborghini

The second project on which Lamborghini has focused, lasted about five months, from October 2021 until the first week of April 2022, and the whole work was always focused on the same data-set as the 1457 connected Huracan, like the PoC seen before, but in this case the results that have emerged are very different from those seen previously.
Regarding this PoC, I have been an active part in the decision-making process so in this chapter we will only see the main data that have been examined and the general outputs that have been obtained; I will talk about this PoC in more detail in the next chapter where each analysis and parameter obtained will be examined in great detail.
In comparison with the previous study, in this case the input data were not taken individually, but were grouped as follows:

1. Vehicle Dynamics;
2. Driving Settings;
3. Powertrain;
4. Geo-localization;
5. Weather Data.

After careful filtering and cleaning of the input data, several outputs were obtained, which opened the door to interesting use cases and important KPIs that Lamborghini can use in the decision-making phase in the strategies of the future. The outputs that have been obtained are as follows:

- Geo Spatial distribution of vehicles (World region, country, cities);
- Usage analysis on the entire fleet, single vehicle and single journey;
- Driving mode clustering and characterization;
- Correlation between driving habits and weather conditions;
- Race track visits;
- Service Shop visits;
- Interactive Dashboard for data reporting.

As already mentioned above, in this chapter, regarding the following PoC, I limit myself only to saying what were the parameters taken into account and what kind of outputs were obtained from these, all the further details and insights will be given in the next chapter, in particular, given that all the use cases addressed have been put on an interactive Dashboard and, for that reason, the visualization of the uses cases will make the idea of the work done even better.

3.3 Third PoC launched by Lamborghini

The third study carried out by Lamborghini lasted just under three months, from November 2021 to January 2022, and here the data-set taken as reference is different to the usual one seen so far, but instead is based on 457 connected Huracans and focusing on only five months of the data that has been recorded, and indeed the final outcome showed that the results emerged were very different from both analyzes seen previously. In this case, an interactive dashboard that updates itself real-time has been implemented.
Three different Use Cases were addressed in this PoC:

- **Statistical Data Analysis:** analyze the MQTT data sampled from the vehicles in order to discover useful statistical data.
- **Digital Marketing:** analyze the MQTT data in order to propose new functionalities or to invite the Customer to events.

- **Connected Services Usage:** analyze the usage of the connected services in order to invest in the development of innovative connected services.

Starting from the first use case, the main goal was to identify the most used driving mode for each vehicle model and model year; in fact the parameters that have been studied are data such as the kilometers traveled in each geographical area, the driving mode used for each area and the kilometers traveled for each model and model year in each area (3.4).

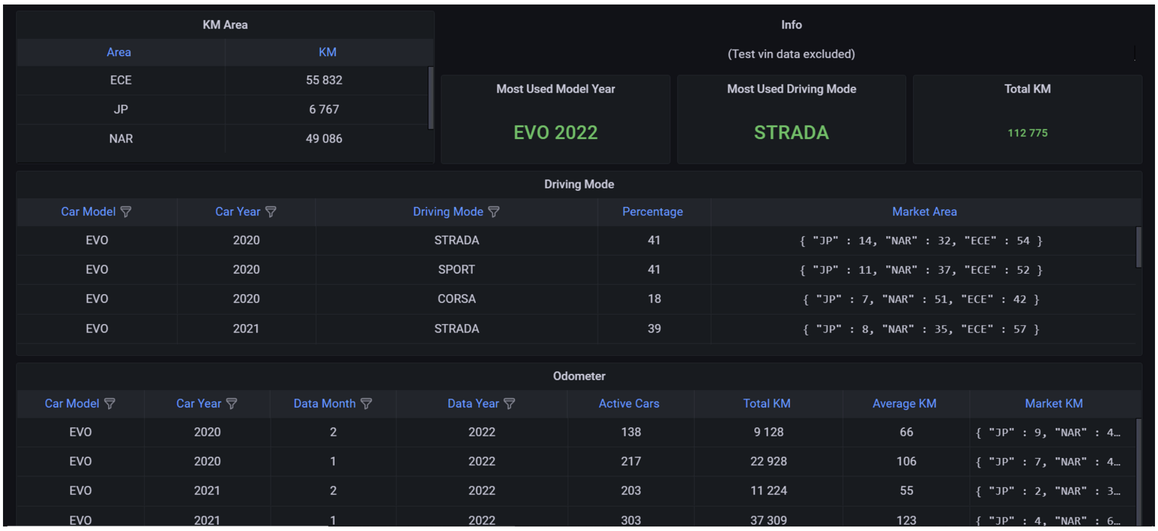

Figure 3.4: Statistical data analysis on Dashboard

After that, the second use case was related to the digital marketing goal, here the focus was to analyze the driving mode combining with the vehicle configurations in order to propose the telemetry functionality. As shown in the figure 3.5; for this specific use case, the Dashboard shows the Lamborghini events where are geographically located and below are returned the whole list of cars that could be interested in participating in these types of events. The list is created based on some criteria, as the distance, so the single car will be put in the list only if it is in the vicinity of the event otherwise it would be useless; the second criteria is based on the driver's driving style, maybe those who drive more cautiously will be interested in different types of events than the type of customer who likes to drive the car more aggressively.

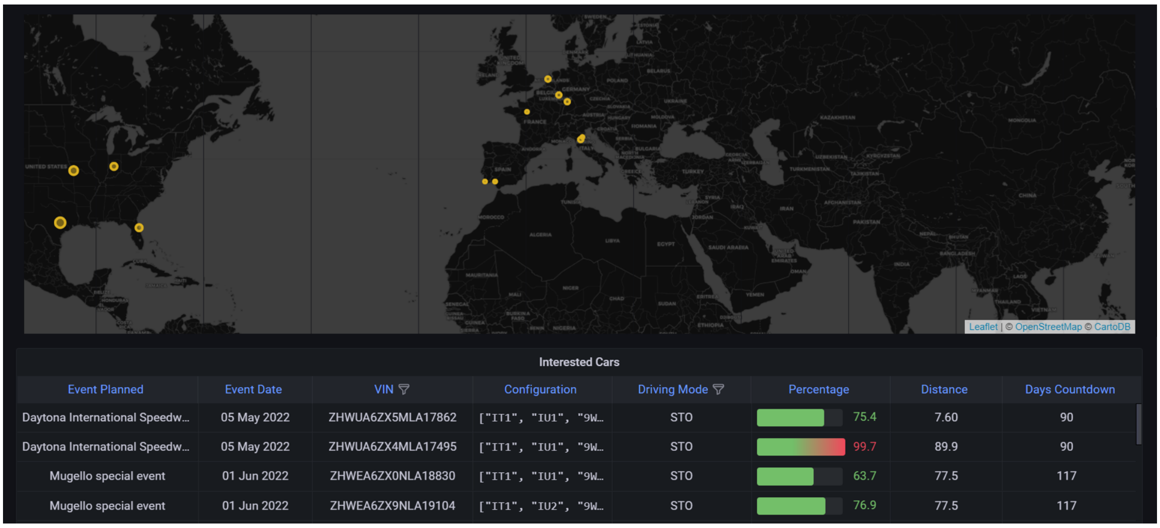

Figure 3.5: Dashboard for digital marketing

Finally, the last use cases was also extracted value from the connected services usage (3.6). In this case, the dashboard shows different insights about remote services, pairing status, and on/off privacy status. This last use cases were the ones of greatest interest and usefulness for Lamborghini because, in real-time and in an absolutely precise way, it is possible to see the status of pairing and privacy, making everything super automatic and easy to manage.

Figure 3.6: Connected services usage Dashboard

In conclusion, the request for this PoC was born because the current tracking modes are not yet collected on an ad-hoc platform/dahsboard by Lamborghini, but the outputs obtained showed excellent results in this direction having everything automated on a single dashboard; therefore, at the same time it has offered new ideas, such as the use case focused on digital marketing for events organized by Lamborghini around the world. In general, this PoC has brought many interesting ideas to focus on that will be evaluated very soon by Lamborghini.

3.4 Fourth PoC launched by Lamborghini

Finally, the latest study carried out by Lamborghini is a work that began in July 2021 and is still ongoing. This last PoC is structured in a completely different way from those previously seen, as it is based on a broader and at the same time more complex vision, all focused on the Predictive Maintenance use case. As can be seen from the architecture, figure 3.7, the information are extrapolated not only from the connected Huracans but also from other types of sources such as the data recorded by the workshops and dealers, but why? Because the main object of this PoC is to process the data from the connected cars and predict possible faults/failures or need for servicing; but as can be guessed, to implement such a use case, it is impossible to rely only on the data stored by the car, but there is the need also of external data that can help the cause, such as the reports from the dealers.

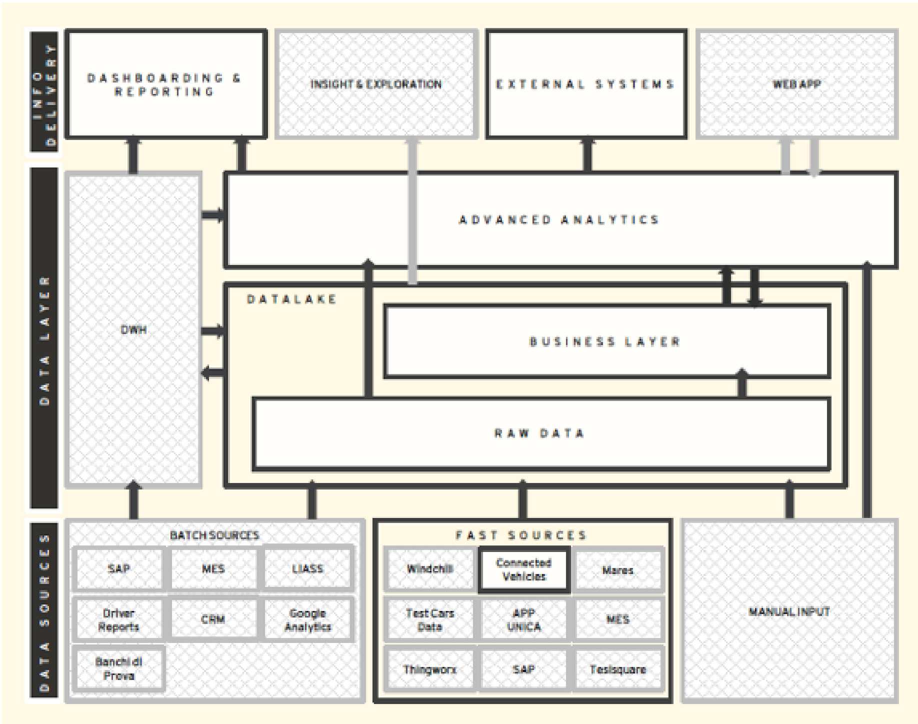

Figure 3.7: Data Lake architecture

The benefits that could brought this PoC is the increasing of vehicle reliability and reduction of the warranty costs; it would also allow dealers to be proactive in contacting customers in case of a service/breakdown need. Currently there are several problems in the implementation of the PoC, in particular the pain point is the difficulty to assess vehicle reliability and identify ways to reduce warranty costs.
Finally, in this type of analysis, through predictive analysis and advanced modeling algorithm the need is to extract value from a huge amount of data, not only those data coming from the connected Huracans, so the work behind it is much more articulated and more complex than the PoCs seen previously, in fact it is also partly for this reason that this project is still ongoing.

Chapter 4

Data Analysis and Dashboard Implementation

As already mentioned in the previous chapter, in the last year Lamborghini has been focused on different projects regarding Big Data, to understand how to really get the most value from the data of the connected cars put on the market, in order to improve the customer experience as much as possible and reach at the same time the greatest economic gain.
As already anticipated, in this chapter I will directly investigate more in details a PoC already mentioned in the previous chapter, in which I was an active part in some decisions that have been taken.
Obviously, the PoC in question was always based on the static data-set referring to all data taken into account from 1st January until 29th November 2021 of the 1457 connected Huracans; but now I will go, step by step, into the main phases in which the data were analyzed and how they were correlated between them in order to obtain valuable data.

4.1 Data Preparation

The starting ecosystem from which it all began is the one shown in the figure 4.1.

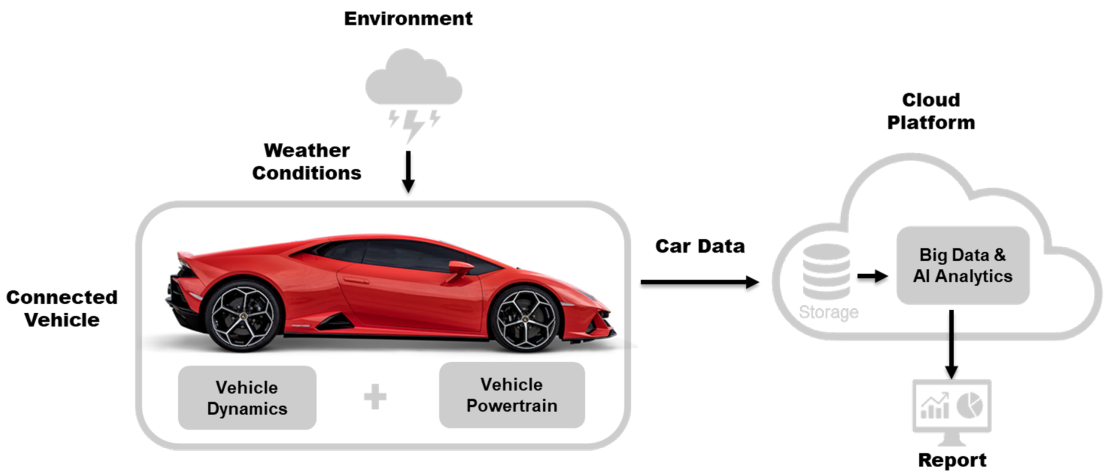

Figure 4.1: Ecosystem of the Architecture

As can be seen, the data that have been taken into consideration for the analysis of possible use cases are various. The data relating to vehicle dynamics and powertrain dynamics, such as acceleration, maximum speed, average speed, etc., were taken directly from the static Lamborghini data-set; whereas, the data referring to the meteorological conditions are not part of the reference data-set, but it was decided to insert it later because it could be useful to extract other relevant use cases.
So, the first thing that was done is to work on data that make sense and that are as correct as possible, so the first phase, as well as for all the other PoCs seen in the previous chapter, was the preparation of the data and this had several steps, which are those of the figure 4.2.

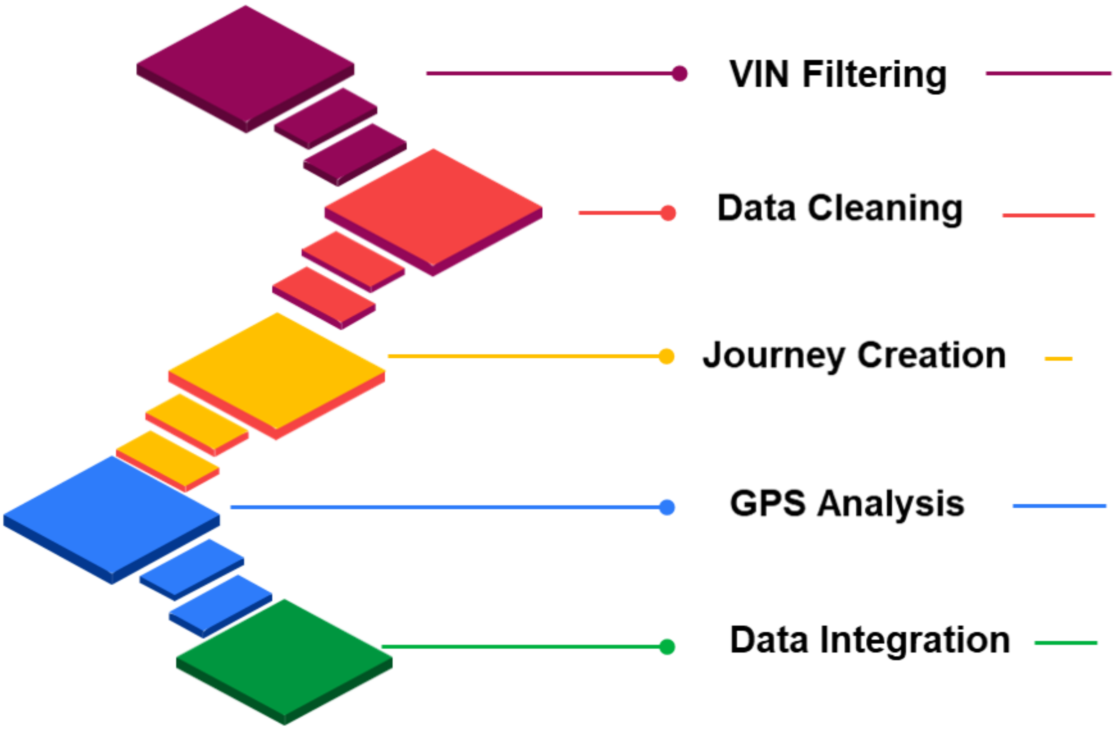

Figure 4.2: Data Preparation

The first step was to take all the raw data that were part of the starting data-set and do a first VIN filtering. As previously mentioned, the total connected vehicles taken into consideration are 1457 of which 46 were test machines, therefore in order for the analysis to be as accurate as possible, the test machines have not been taken into consideration because they are machines that are used for different purposes and therefore fail to represent a typical use.
So once we only had the data from connected machines to actually work on, the second step was to do a cleanup of this data. This cleaning was fundamental at the end of the study, since in the starting data-set there were some measurement errors, for example sometimes maximum speeds of 500 km/h were reported, or sometimes there were gaps in measurement leaving the box empty; therefore this second phase was very important because it made the data-set more coherent and more precise in the measurements that were contained within it.
After that, the third phase was a little more articulated but at the same time very

useful. On the basis of the data obtained from the second phase just seen, macro clusters have been created so that a division of the journeys can be created for a better understanding of them. The clusters were created taking into account the data that refer to the dynamics of the vehicle and the powetrian, such as speed and acceleration, in order to differentiate the typologies of journeys.
In addition, as a fourth step, was made a GPS analysis in such a way as to further clean up the data-set by considering only those countries that are really connected; this type of preparation, as will be seen later, was very useful for different use cases.
Finally, the last step was relating to a weather analysis, in particular data were taken regarding the weather conditions not of all cities around the world but only of three cities: Milan, Miami and Los Angeles. These data were very useful for correlating the use of the car on the basis of the weather conditions, in order to create new and interesting use cases to be taken into consideration.
After this first phase of data preparation, the first results were brought out through a data analysis.

4.2 Data Analysis

The data analysis starts from the pre-elaborated data set obtained from the previous data preparation phase and in particular eight types of analysis were made:

1. Route Analysis;
2. Driving Mode Analysis;
3. Circuit Analysis;
4. Temporal Frequency Analysis;
5. Nearby Service Shop Analysis;
6. Fleet Analysis;
7. Weather Analysis;
8. Country Comparison Analysis.

4.2.1 Route Analysis

The first analysis focuses on understanding what kind of places and streets are typically frequented by a Lamborghini customer. This analysis has been studied by correlating the GPS position and the powertrain data of the vehicle, such as speed and acceleration.

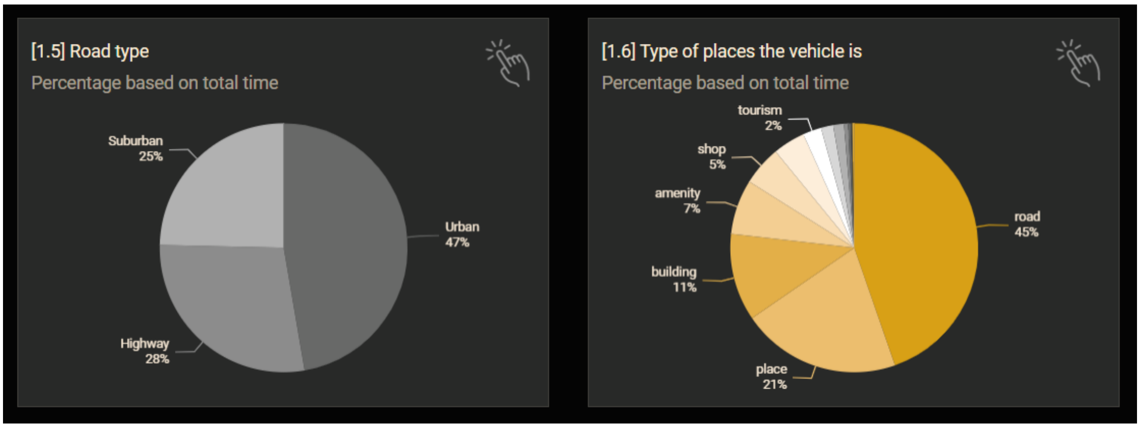

Figure 4.3: Road and places most frequented

In fact, as can be seen in the picture 4.3, the percentages of the graphs refer to the total time, therefore the correlations depend on the time in which a determinate condition is observed, for example if 130 Km/h have been recorded for half an hour, probably the car has been driven on the highway. So by correlating vehicle data, GPS and duration time, on the Dashboard it is possible to see the most places and streets frequented by Lamborghini customers.

4.2.2 Driving Mode Analysis

In this second analysis the result was the characterization and clustering of the most used driving modes. In this specific case, since we are working with data on Huracans, the following three clusters have been considered for simplicity: Strada, Sport, Corsa. This would not be quite correct as for example the Huracan STO model has different driving modes which are: STO, TROFEO and PIOGGIA. The same would also apply if the analysis were extended to completely different models such as the Urus and Aventador, which would have different driving modes to take into account; but the choice of dividing the driving modes into Strada, Sport and Corsa was made to simplify things because the number of STOs considered within the data-set was negligible compared to the number of Spyder EVOs and Coupe EVOs, but also because for the purposes of the PoC this was not strictly necessary but the most important thing was to extract value from all these analyses.

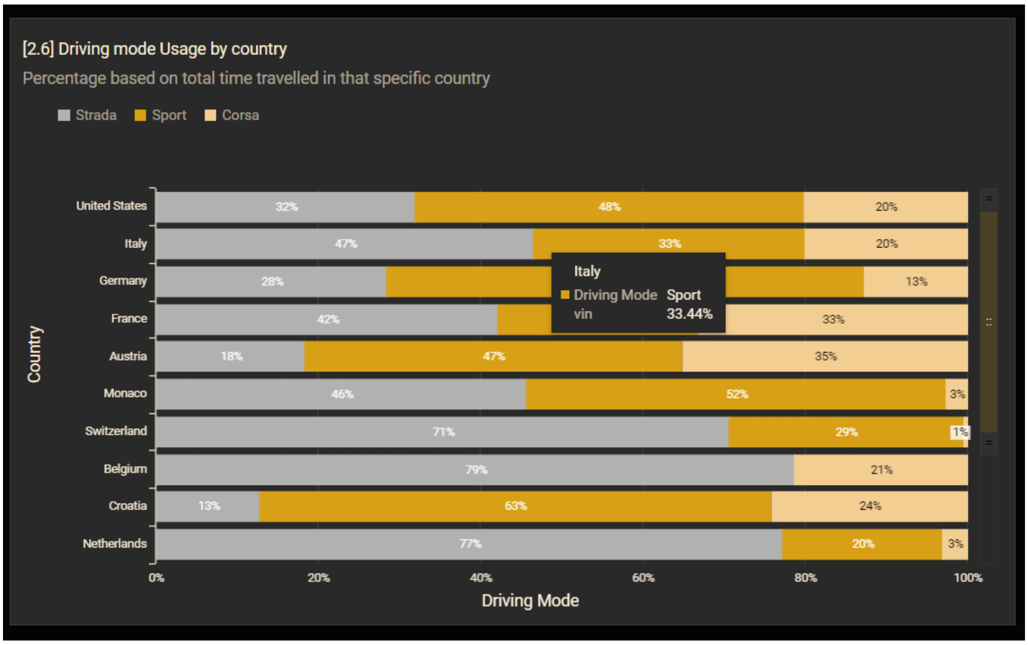

Figure 4.4: Driving mode usage by country

For example, in the graph 4.4, you can understand how the three driving modes are used between different countries, it can be intuitively noted that the Corsa setting is the least used in percentage compared to the other two.
Similar analysis was also made between the different Huracan models: Spyder EVO, STO Coupe and Coupe EVO. What emerges in this case, 4.5, is that depending on the model chosen, the use of the single driving mode varies a lot. For example, who buys a Spyder EVO uses much more than the others the Sport mode.

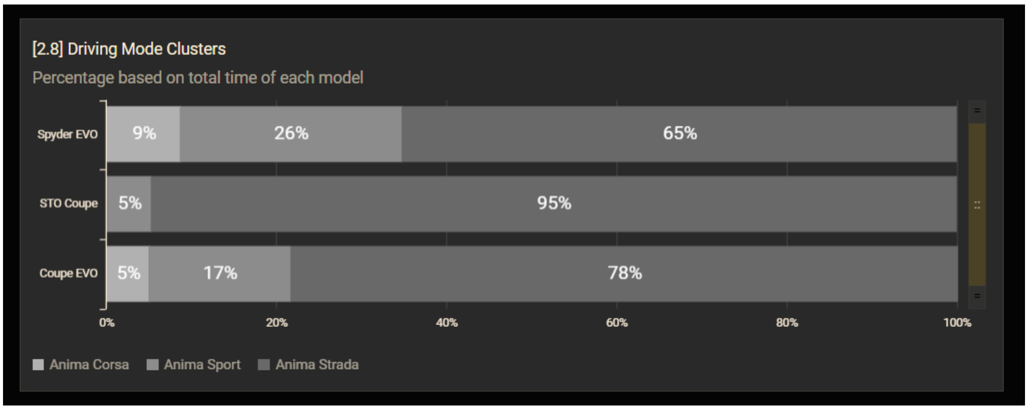

Figure 4.5: Driving mode clusters per model

Finally, it was also studied on the entire fleet of vehicles analyzed what is the use of these three drivign modes. As can be seen from the graph 4.6, the driving mode most used by Lamborghini customers is the Sport mode and the least used is the Corsa mode.

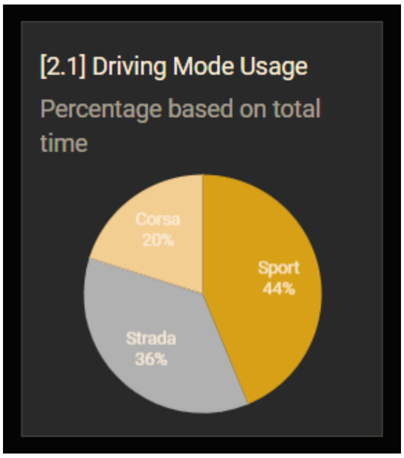

Figure 4.6: Driving mode usage

Obviously, these analyses are a great cue to start thinking about why some driving modes are more used than others, leaving ample space to new alternatives that the company could introduce on the base of these studies.

4.2.3 Circuit Analysis

The third analysis was all focused on the study of driving habits when customers go with their car on the track. In this case, it should be specified that only Italian circuits have been considered; in fact, the GPS data of the circuits were not part of the static data-set, but these have been added externally for the purpose of detecting interesting use cases.
First of all, in this case it was analyzed which were the circuits most frequented by customers and, as can be seen from the graph below 4.7, for each circuit we went to see how many were the total visits and how many were the visits of each VIN, so that we could have a more precise estimate of how many different people attended that particular circuit. The study has shown that the two circuits most frequented by Lamborghini customers are the Franciacorta and Misano circuit.

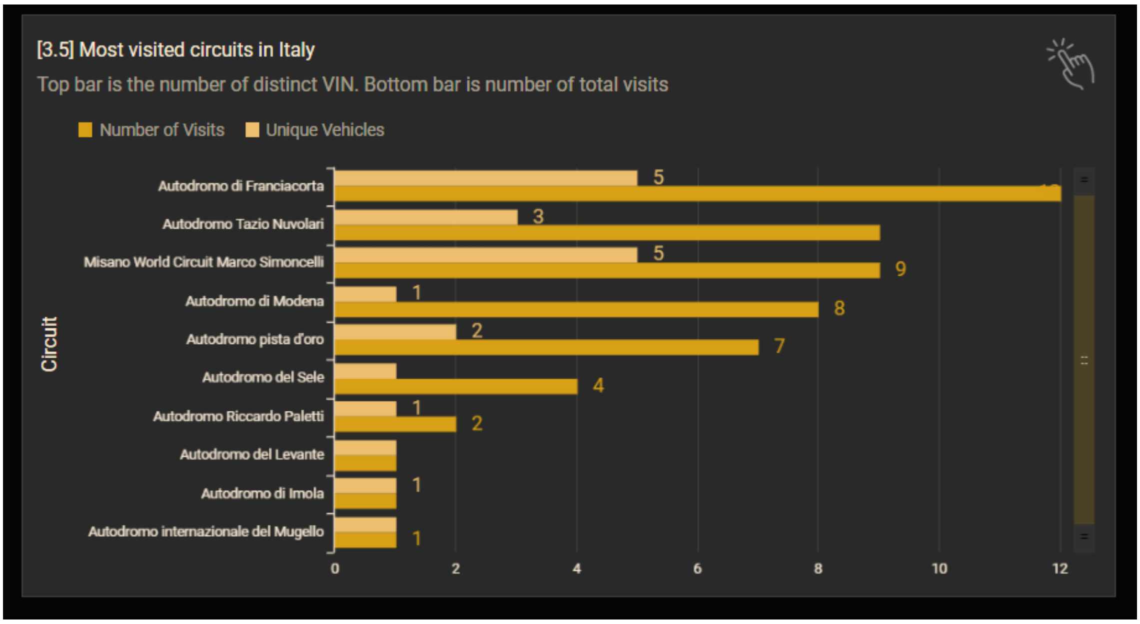

Figure 4.7: Most visited circuits in Italy

After this, the monthly visits to the circuit of Italy were analyzed, and what was discovered, as was easy to imagine, that during the winter months virtually no one brings his Lamborghini on track, but prefers the summer/autumn period (figure 4.8).

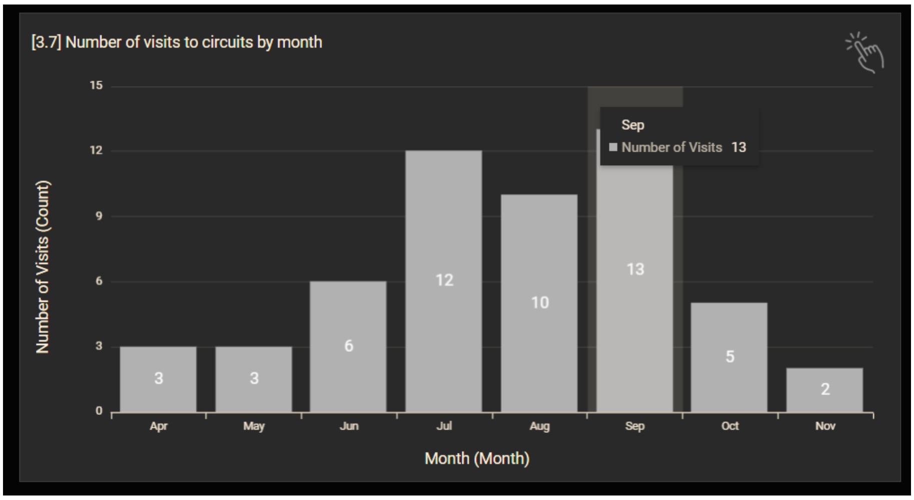

Figure 4.8: Number of visits to circuits by month

Another very interesting estimate that has been made is how much time passes before a customer brings their Lamborghini on a circuit (figure 4.9). What has emerged is that on average a customer, after fifty days of purchase, makes his first visit to a circuit, and brings the car back to the circuit after an average of thirty-three days. This is a very interesting fact becaus, after having done the first experience on the track, the time that passes with the second visit is much less than it took the first time.

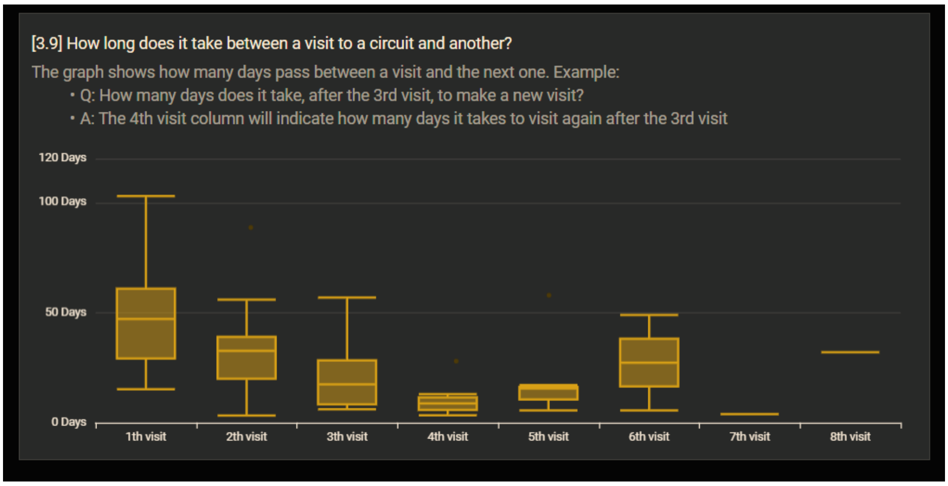

Figure 4.9: How long does it take between a visit to a circuit and another?

Finally, we also analyzed the number of unique VIN to the circuits for each visit number; and the thing that stands out most from this study is the fact that only one VIN out of 21 totals came to bring his car seven times on track, so here the question that comes naturally to ask is: why customers do not have all this desire to go on track frequently? These are excellent points for reflection on which Lamborghini will have to reflect in the future.

Figure 4.10: Number of unique VIN to the circuit for each visit number

Of course, it is only fair to point out that all the analyses in the current chapter are based on data that were recorded from January to November 2021, i.e. just under a year, so these are qualitative analyses; it is difficult to say that the driving habits of a Lamborghini customer are always these, but it would be incorrect because we have analysed far too small a time span to draw conclusions.

4.2.4 Temporal and Frequency Analysis

In this type of analysis we went to understand how cars are frequently used over time during the year and here several ideas emerged. For example, as shown by the figure 4.11, the months when on average the cars are used more by their customers is in the hottest months and the trend is that a Lamborghini Huracan is used more at the weekend than during the week. So, already from this first analysis, the Lamborghini in the eyes of its customers, it does not turn out to be a car to be used every day to go to work but more a car to be used in the free moments.

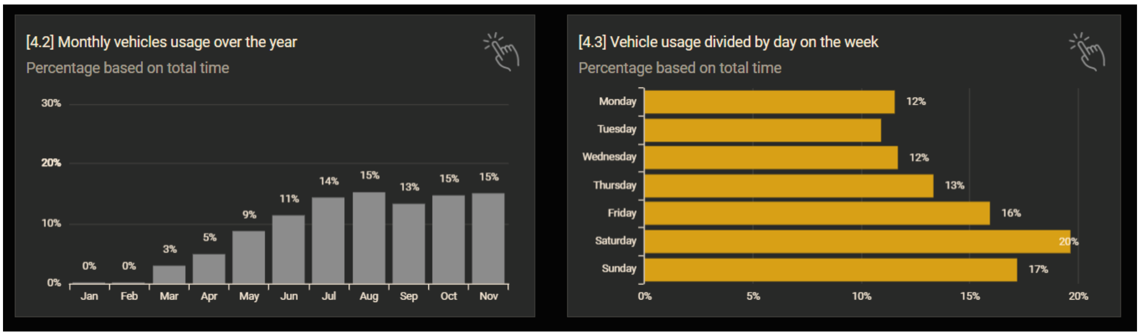

Figure 4.11: Monthly and weekly usage of cars

In addition, it was also seen when typically a journey begins and what has emerged is that those who have a Lamborghini Huracan tend to begin its journey mainly in the late afternoon, from 4:00 PM onwards. This result verifies even more the analyses made previously, that this type of Lamborghini model is more used in the free moments of the week rather than like a daily car.

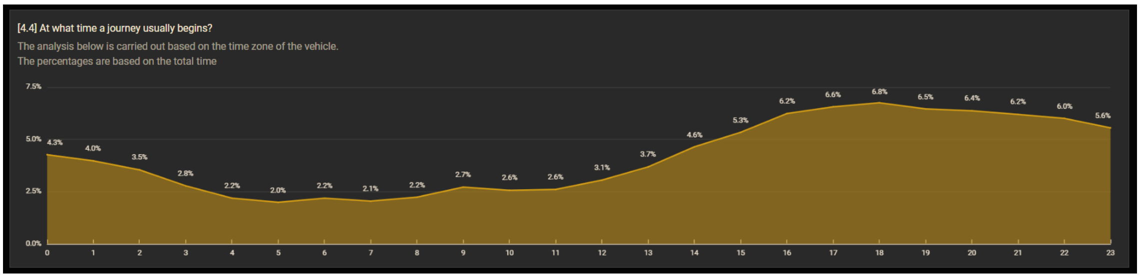

Figure 4.12: At what time a journey usually begins?

4.2.5 Nearby Service Shop Analysis

In this study it was analyzed how many times a customer Lamborghini is near the service shop but we must make a clarification because otherwise this would lead to wrong conclusions. When a customer is near a service shop it is not necessarily said that he/she has had a problem with the car and therefore needs for assistance, but simply because the whole analysis is GPS based and thus recognize the fact that a VIN is in the vicinity of a service shop. Moreover, also in this case, as for the circuit, only Italian service shops were considered.

First of all, we saw immediately the number of visits per service shop (figure 4.13), both total and the number of visits of the unique VIN. What is easy to notice is that the most frequented service shop is that of Milan, especially the 112 total visits were generated by only 20 vehicles, which means that the same vehicle had to deal with the service shop several times so here it would be interesting to understand the reasons for all the other visits made, if they passed there by accident or had problems with the car several times.

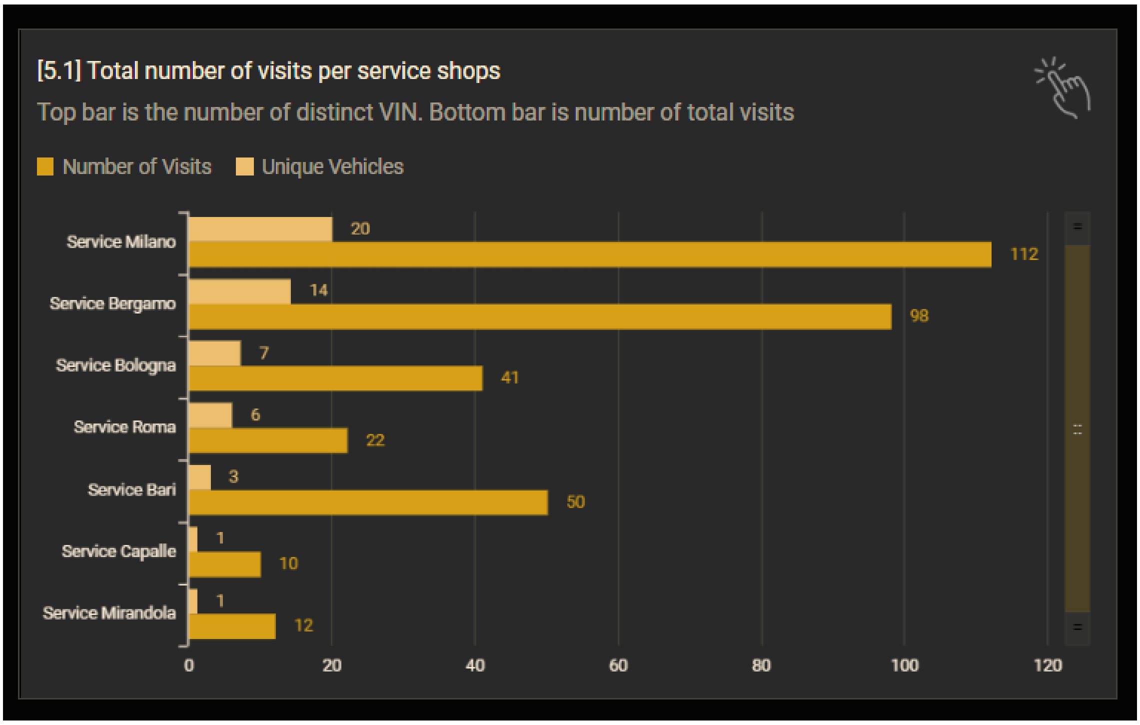

Figure 4.13: Total number of visits per service shops

In addition, we also calculated the number of visits to the service shop distributed over time (figure 4.14); the good thing is that the result is very consistent with the analysis made previously because before it was pointed out that the period in which a Lamborghini Huracan is mostly used is summer/ autumn, and this also coincides with the greater number of visits to the service shops, this shows consistency with the previous one analyses.

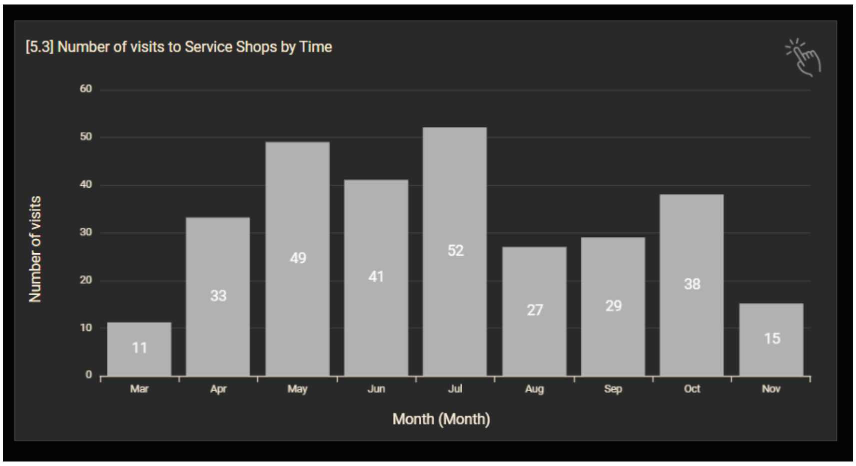

Figure 4.14: Number of visits to service shops by time

Another very interesting analysis that has been done is how much time passes between a visit and the following at the service shop (figure 4.15). In this case, the most noticeable thing is that little time elapses between two visits and also here it would be interesting to understand the reason, if the customers constantly encounter problems with the car or they are visits untied from all this.

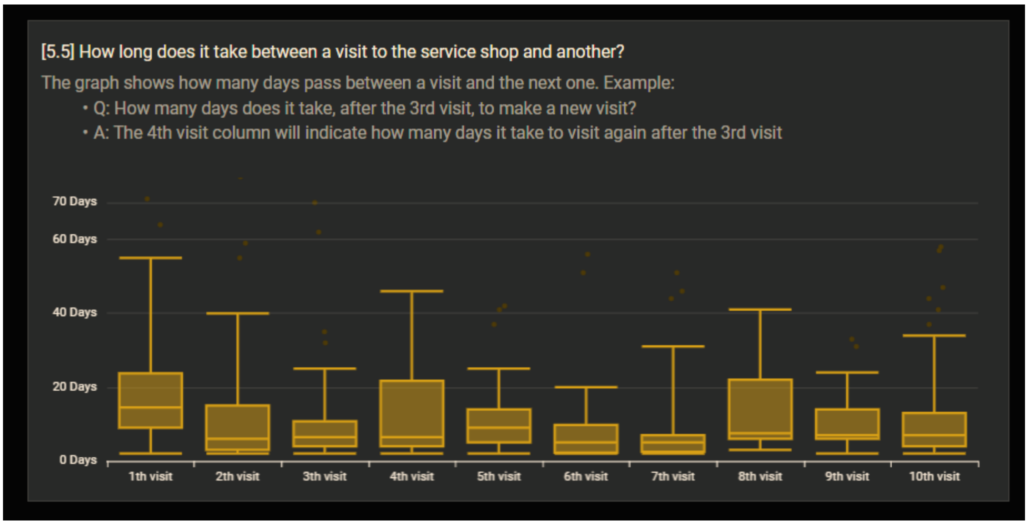

Figure 4.15: How long does it take between a visit to the service shop and another?

This analysis regarding the service shops has great potential if carried out in more detailed way, such as correlating this GPS-based analysis with the recorded data of the service shop, so that it can be seen very precisely whether the customer actually went there because of problems with the car, or whether he/she just happened to be there. Obviously understanding the real reason why a customer is near a service shop would bring more value to this use case and this would mean increase the value of the company, allowing to position itself in a position of advantage compare to its competitors.

4.2.6 Fleet Analysis

This type of analysis is a more generic study than those made previously, includes all the connected fleet, so what has been examined are more "static" information in the sense that are more correlated to the vehicles itself than to the driver. For example, in the graph below, we calculated the kilometers travelled by the entire fleet, the total hours that were in motion, the total countries in which they travelled and how many vehicles in the fleet were connected during the period considered from January to November 2021.

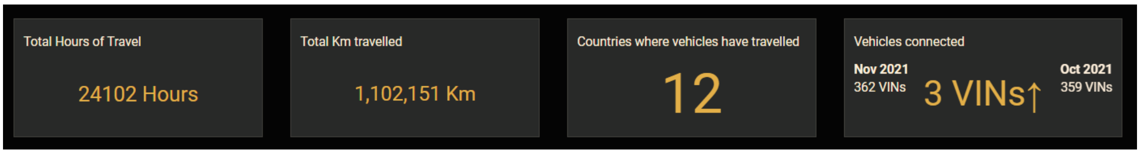

Figure 4.16: The general values attributed to the fleet

In addition, we saw how in the time-frame considered (figure 4.17), i.e. January to November, what was the distribution of connected vehicles over time. This may be a rather trivial indication, but it could come in handy if we come across connectivity problems; for example, if a certain vehicle is connected, it must be present in the dashboard; otherwise, this is a problem that needs to be resolved as soon as possible. As seen from the graph, selling connected vehicles is now a MUST, and taking care and especially monitoring the connectivity of the customers in the right way shows how Lamborghini is becoming more and more connected and how much it is investing in this direction.

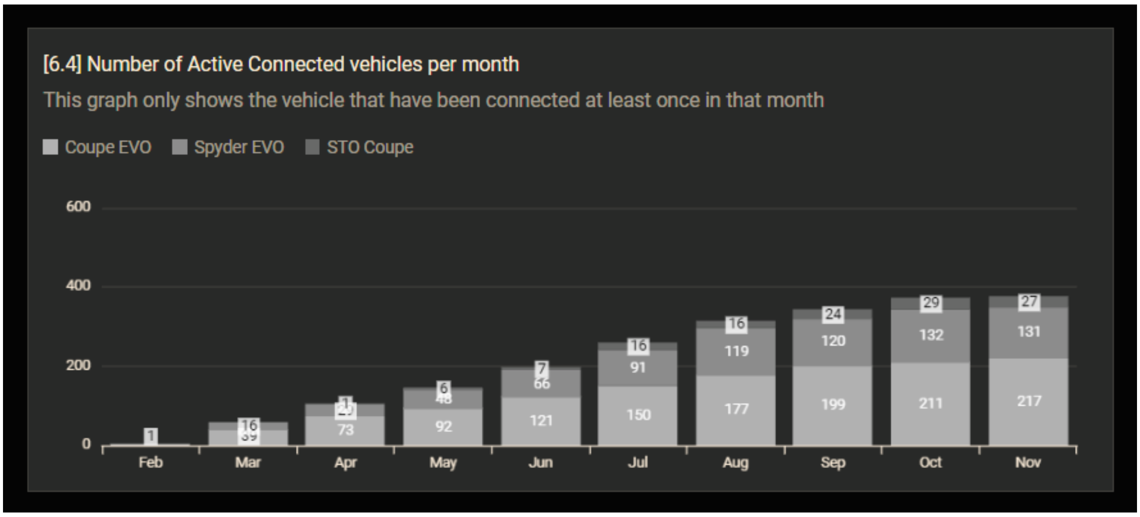

Figure 4.17: Number of active connected cars per moth

Finally, a study was also made on the tons of CO_2 produced by the fleet of Lamborghini connected (figure 4.18). In this specific case the estimate of CO_2 produced was calculated using some external parameters, such as the consumption of each Huracan model, so by making a correlation between kilometers traveled, type of model considered and consumption for each model, we are able to visualize the graph of

CO2 produced. This graph will have to be made more accurate in the future, i.e. the estimate of the CO2 produced will have to be based directly on reading the tank level indicator in order to have a direct correlation on how much CO2 the machine is emitting. This graph will have to be made more accurate in the future, i.e. the estimate of the CO2 produced will have to be based directly on reading the tank level indicator in order to have a direct correlation on how much CO2 the machine is emitting. This will be a cue for the next steps to be taken in order to make the data we read on the dashboard more and more valuable.

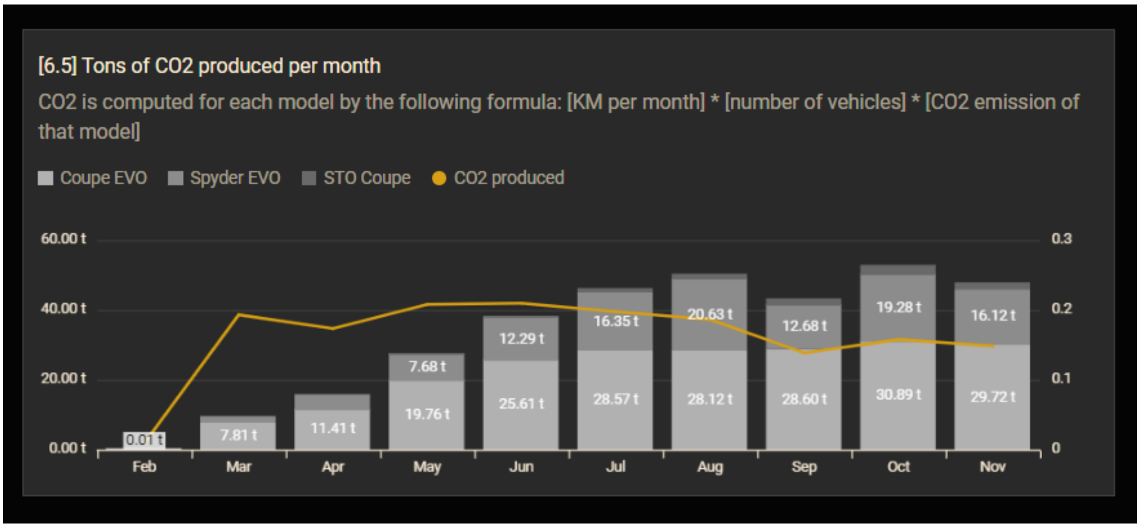

Figure 4.18: Tons of CO2 produced per month

4.2.7 Weather Analysis

This analysis has been done in such a way as to get out of the interesting use cases, in order to consider also the driving habits on the base of the meteorological conditions. As mentioned above, for simplicity, only three cities have been considered, since most of the connected cars taken into account are located in these three areas: Milan, Miami and Los Angeles. In fact, as you can see in the figure 4.19, it has been related to the weather conditions that there were in those three cities during the year with the use of the car, so as to verify whether the car was used more or less under certain conditions. What was highlighted is that, for example, in Miami last year it rained heavily about 20% of the time but the car, in those conditions of heavy rain, was used 23%, which means that, despite little rain in Miami, the vehicle is used regardless of light or heavy rain conditions.

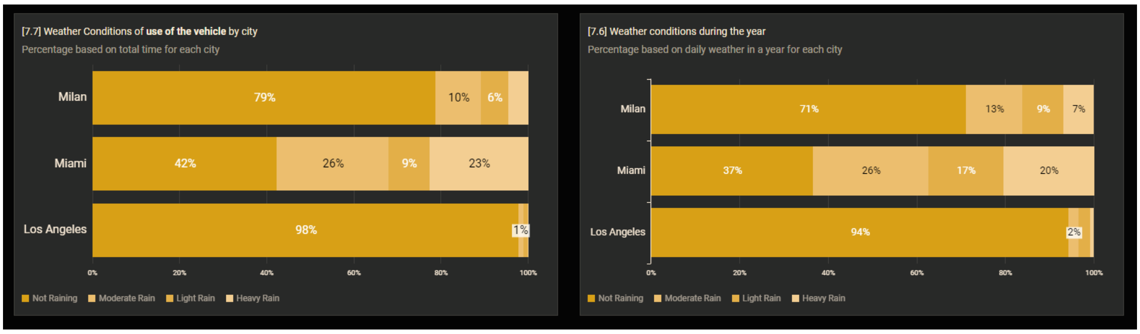

Figure 4.19: Weather conditions of use of the vehicle by city

Another interesting analysis was to relate driving modes to weather conditions. This pointed out that as the intensity of the rain increases, the use of the more aggressive trim, Corsa, decreases; conversely, the more intermediate mode, the Sport mode, increases with the intensity of the rain.

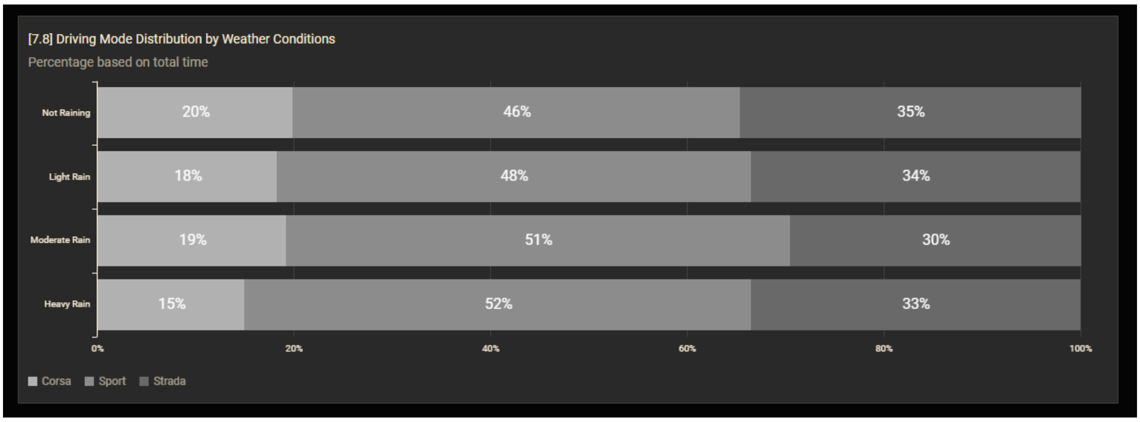

Figure 4.20: Driving mode distribution by weather conditions

The thing that emerges is that, even in heavy rain conditions, the preferred mode is that of Sport and it would be interesting to go and understand why.
Knowing and investigating why customers make certain choices could bring a considerable advantage to the company, allowing it to realise and implement increasingly customer-driven strategies so that the driving experience can be more and more unique.

4.2.8 Country Comparison Analysis

Finally, the last analysis made is to put in comparison the driving habits between different countries. The comparison in this case was made between Italy and America but other countries could also be compared. Again, since most of the data were for Italian and American vehicles, for convenience the comparison was made directly between Italy and America, but later when the data-set gets bigger and bigger will be possible to compare any country we want.
The first thing that has been highlighted from the graph figure 4.21 is that the car is used more by Italian customers during the year than the Americans, and at the same time, the use of a Lamborghini Huracan also in America, as in Italy, is prevalent over the weekend, this also emphasizes the previous analysis already made, when it was said that a Huracan is used expressly only in leisure time.

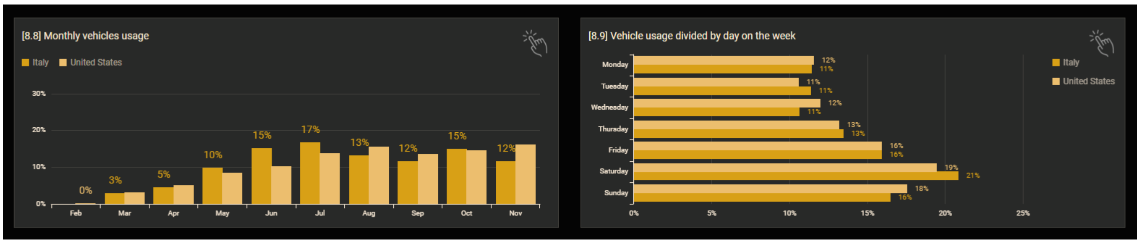

Figure 4.21: Vehicle usage divided by country

Another thing that turned out to be slightly different is the use of driving modes. In particular, in America there is a propensity to use the vehicle in a somewhat more aggressive mode than in Italy, in fact the Strada setting is little used by Americans.

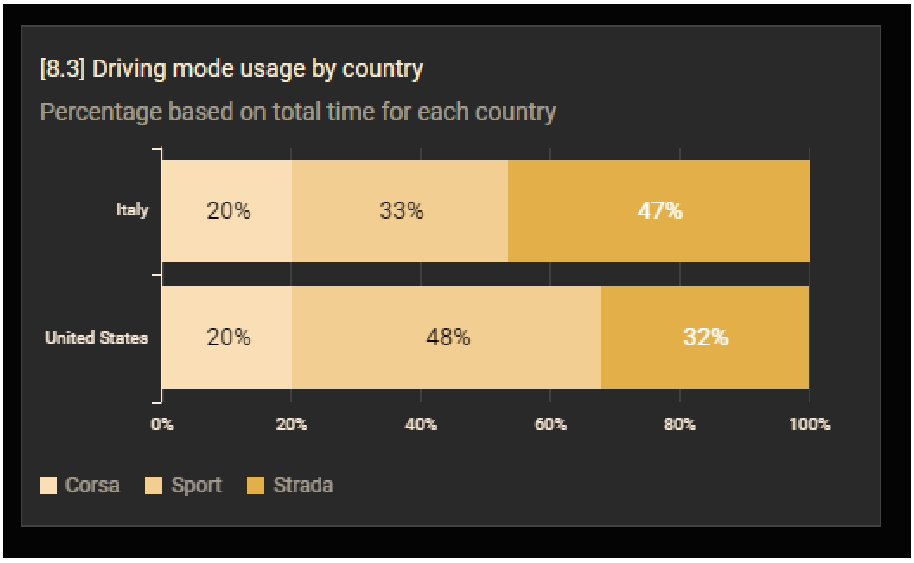

Figure 4.22: Driving mode usage by country

Finally, another interesting analysis is about the time when a journey begins. Here the difference is clear, in America a Huracan is typically used to go out in the evening until late at night, in fact as is seen in the figure 4.23, an American journey ends around 4:00 AM; in Italy instead the trend is the opposite, it is preferred to use the car at more convenient times, without making a worldly life.

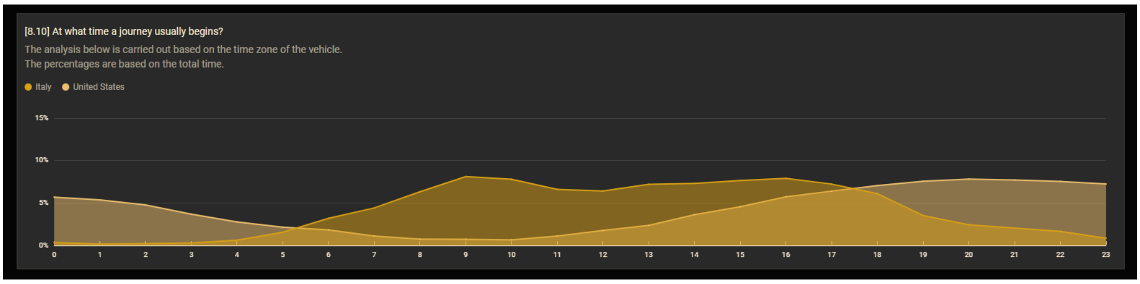

Figure 4.23: At what time a journey usually begins?

All the analyses just seen allow the first insights on how Lamborghini customers like to use their Huracan and this brings great value to the company itself which can already understand, based on these registered driving habits, on which driving services it must more push in the next strategies.

4.3 Privacy and data protection in connected vehicles

Not only drivers and passengers, but also vehicles are becoming more and more connected, which is why, also in the automotive sector, there is more and more talk about privacy and data protection on board.
Many models launched on the market in recent years from all the most important OEMs, integrate sensors and connected multimedia equipment that can collect and record various parameters such as engine performance, driving habits, places visited and potentially even biometric data for authentication or identification and/or safety (i.e. the physical safety of people) purposes. This data processing takes place in a complex ecosystem, which is not limited to the traditional players in the automotive industry, but is also influenced by the emergence of new players from the digital economy.
These new service providers may offer infotainment services such as online music, road conditions and traffic information or provide driver assistance systems and services, vehicle condition updates, usage-based insurance or dynamic mapping.
Furthermore, as vehicles are connected via communication networks, road infrastructure managers and telecommunication operators involved in this process also play an important role with respect to the processing of personal data of drivers and passengers (think of future 5G networks that will increase connectivity from the vehicle to the outside, i.e. so-called V2X). Increasingly connected vehicles generate increasing amounts of data, most of which can be considered personal data as it relates to drivers or passengers. Even if the data collected by a connected car is not directly related to a name, but to technical aspects and characteristics of the vehicle, it will always affect the driver or passengers of the car. For example, driving style data such as:

- distance travelled;

- wear and tear on vehicle parts;
- cameras that study the driver's behaviour, as well as information on other people who may be inside or outside the vehicle.

4.3.1 Privacy and data protection in connected vehicles: the principles

In the field of cyber security, the three main objectives are well known and are often referred to according to the CIA triad (Confidentiality, Integrity, Availability), which we take up here as a definition:

- **confidentiality:** information is not made available or disclosed to unauthorised individuals, entities or processes;
- **integrity:** data cannot be altered or deleted in an unauthorised or undetected manner;
- **availability:** the computer systems used to store and process information must function properly and be available as resources at all times.

Similarly, the following three objectives can be defined at the level of privacy:

- **predictability:** The ability to know what data from the various devices around us is being collected and how the information will be processed and handled thereafter;
- **manageability:** Correlation between data can lead to sensitive information, we need to know the granularity of how our data is processed and how to change or delete it;
- **non-associability:** i.e. treating data in such a way that it cannot be associated with individuals, avoiding tracking and profiling.

This ecosystem is not very different in the end from the IoT (Internet of Things) world where the challenges in terms of privacy appear very similar. Today, in fact, a connected vehicle is already a network element capable of 'talking' with other vehicles, with roadside systems, with servers in the cloud and, of course, with the passengers themselves, who increasingly interact with on-board functionalities via Bluetooth or Wi-Fi or USB/SD ports (such as memory or connectivity devices).

4.3.2 Privacy and data protection in connected vehicles: Regulations

When it comes to privacy and data protection in connected vehicles, it is also possible to comply with a number of regulations and best practices. On 28 January 2020, the EDPB (European Data Protection Board) issued the European guidelines: 'Guidelines 1/2020 on processing personal data in the context of connected vehicles and mobility-related applications'.

This document focuses in particular on the processing of personal data in connection with the non-professional use of connected vehicles: e.g. drivers, passengers, vehicle owners, hirers and so on. More specifically, it deals with personal data:

- processed inside the vehicle
- exchanged between the vehicle and personal devices connected to it (e.g. the user's smartphone);
- collected inside the vehicle and exported to external entities (e.g. vehicle manufacturers, infrastructure managers, insurance companies).

The EDPB document summarises the guiding principles for the protection of personal data:

- importance and minimisation of data;
- data protection by design and by default (privacy by design and by default);
- processing of personal data;
- anonymisation and pseudonymisation;
- data protection impact assessment (DPIA);
- data subject rights;
- security and confidentiality;
- transfer of personal data to third parties;
- transfer of personal data outside the EU/EEA;
- use of in-vehicle Wi-Fi technologies.

The main conclusion to be reached through reading the document is regarding vehicle drivers and passengers who may not always be adequately informed about the data processing that takes place in or through a connected vehicle.

4.3.3 How Privacy was addressed for PoC purposes

In all of the PoCs seen in the previous chapters, being PoCs for internal and not external purposes, Lamborghini decided not to immediately address in a structured way the privacy issue, but since the sole purpose of the work was to make the company understand how much potential there was behind the data of the connected Huracans, we only focused on how to get the most value out of the data-set.
The only thing that has been done is to consider all available data as anonymised aggregated data, so that there was always maximum confidentiality with regard to each VIN (Vehicle Identification Number) that was used for the analysis in question.
Since this PoC was only disseminated internally within the company for the purpose of explaining the PoC, a proper PIA (Privacy Impact Assessment) was not necessary,

which, however, will have to be done if the company decides to bring the Big Data project into production; in this case, the data collection must be done accordingly with Privacy and Security regulations.

Chapter 5

Lamborghini KPI

The acronym KPI stands for Key Performance Indicators and these are a set of quantifiable measures that a company uses to evaluate its performance over time. KPI are key to helping you make informed and informed business decisions based on the performance of the activities being analyzed.
In the previous chapter, many different types of analysis were done and what we need to focus on now is if Lamborghini can use some of these analyses as KPI that can help the company make strategic decisions. In my opinion, there are several very interesting metrics seen in the previous chapter, that can be taken in the future as KPI on which to start and base interesting business discussions and now we describe the main ones.

5.1 Driving Mode KPI

When we previously covered all the analysis about driving modes, very interesting results emerged. For example, based on the type of Huracan model bought, the use of driving modes was different. In fact, as can be seen from the driving mode clustering graph (figure 5.1), the CORSA mode is used very little compared to the other two available modes. This could be a first starting point from which to start thinking about whether to continue spending energy and money on the production of this driving mode or not. For example, for the Huracan STO model, which was created precisely for track use, it would make sense to maintain the use of the Corsa driving mode, which in reality, as already mentioned in previous chapters, within the STO the driving modes do not take these names but are: STO, TROFEO and PIOGGIA; but in any case, it makes sense for this one to maintain a driving mode based on the Corsa concept. On the other hand, for the Huracan Spyder EVO and Coupe EVO models, which are perhaps less suitable cars for the track, one could probably think here of replacing the Corsa driving mode with another one which might be appreciated by customers who own a Huracan EVO.

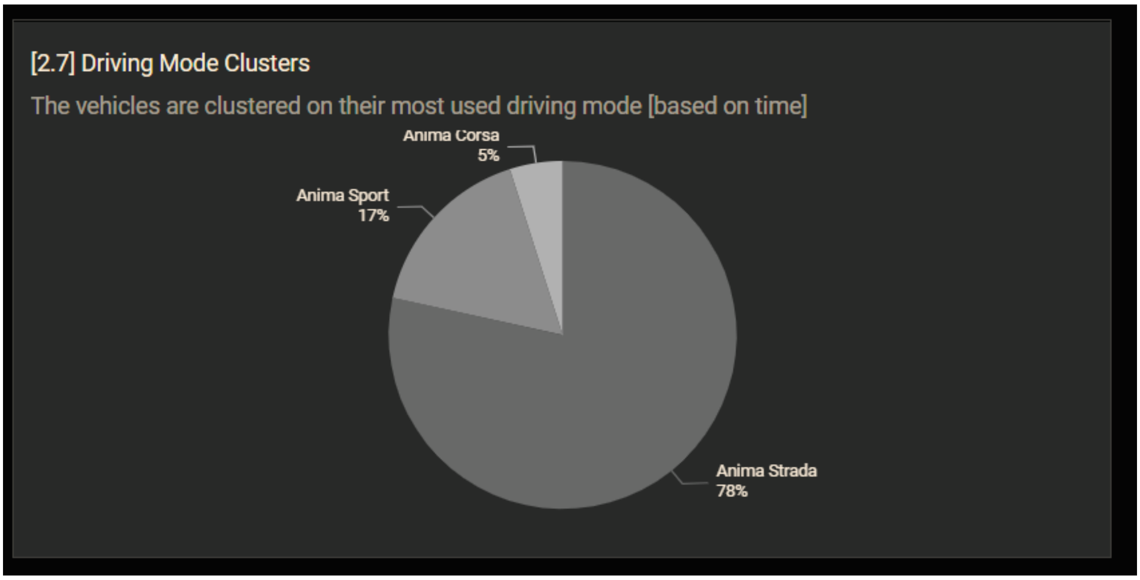

Figure 5.1: Driving mode clusters could be used as KPI

Also, going to clustering the vehicles under consideration, the easy thing to notice is that the Corsa driving mode is used very little, only a 5%. This data can also be taken as a strong enough indicator for the company to reason about why the customer uses that driving mode so little. Maybe customers feel unsafe driving and prefer a less aggressive setup? Well, in this case, Lamborghini could promote to these customers, through the use of the UNICA App, some ad-hoc driving lessons with professional drivers so that they can feel more confident to use the Corsa setup more frequently and bring their Lamborghini to the limit.
Instead, if the usage of Corsa setting always remains so low, Lamborghini could also consider replacing it with another driving mode that could be used more by the customer, or remove it completely without replacing it, thus saving a lot of money in the production phase.

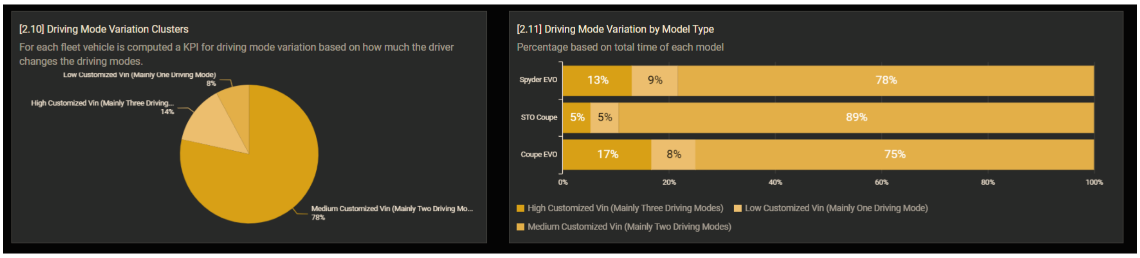

Figure 5.2: Driving mode variation clusters could be used as KPI

Another indicator worth thinking about is the variation in driving modes over time. Indeed, the graph shows us (figure 5.2), on average over time, how much a driver changes driving mode while driving the car, and this yielded interesting results. In fact, irrespective of the Huracan models, most drivers prefer to drive using two driving modes, while those who typically use all three or only one of the three available are a very small percentage.
Obviously, we must always remember that these results emerged from the study of a data-set that is based on a very small time interval of observation so we can not

directly draw conclusions, but what came out is that most of the customers who own a Huracan prefer to drive using two driving modes. From the outcome that emerged, so that we can go to stimulate the customer to use more frequently all three driving modes present, always through the use of the UNICA App, it could be possible to create rewards based on how many kilometers the customer drive with a certain driving mode. For example, once he/she have covered a certain mileage with the STRADA driving mode, a notification will arrive to the customer telling him to go to his dealer to pick up a customized gadget such as a bracelet or keychain; instead, if the customer had to do a certain mileage with the SPORT driving mode,there will be the possibility to unlock a certain number of months free within which the customer can take advantage of some On-Demand services that typically Lamborghini makes available for a fee. Instead, when the customer will exceed a certain mileage with the CORSA mode, then here a reward could be free access to a certain circuit that is located near a location where the customer prefers to go.
Obviously this "reward game" will have to renew as the customer begins to unlock rewards; then once the customer has reached the first reward with the use of a driving mode, will be unlocked the achievement of the second reward with the use of the same driving mode. This will bring great benefits to both the customer and the company itself, because in this way the customer will be encouraged to drive more frequently their Huracan and this will bring a great benefit also to the company because it would mean storing more data to analyze and nowadays to own more data means to have the chance to make more money.

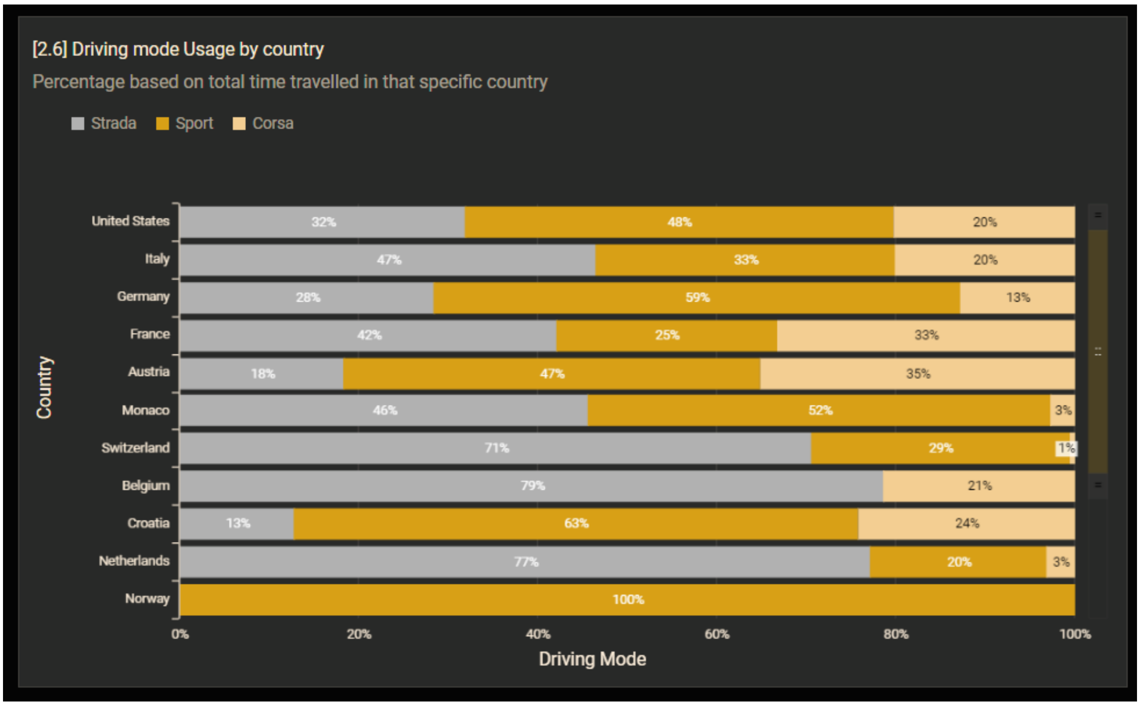

Figure 5.3: Driving mode variation by country could be used as KPI

The last thing we need to consider as an indicator for driving fashions are using these from country to country. In fact, as can be seen in the graph 5.3, in every country the use of driving modes changes a lot, for example passing from Italy

to Austria, despite being neighboring countries, the use of driving mode STRADA changes a lot; obviously the physiognomy and the regulations of a Country influence a lot also on the driving style. For this reason, Lamborghini will have to carry out an analysis of driving modes and customize them from country to country. For example, if in Netherlands it is almost always used the STRADA driving mode, it would be useless in this case to promote an event on the track, but maybe it would be better to promote some Peace-Of-Mind service so that the driving experience is as relaxing as possible; while in Austria, where the landscape allows the car to be driven a little more to the limit of its performance, in fact the CORSA driving mode is widely used, then here it would make more sense to promote a driving lesson with a professional driver.
In general, the indicators seen so far, manifest the need to create OTA (Over-The-Air) Ego driving modes, i.e. driving modes for the user's personal use and downloadable from the UNICA App, so that, regardless of the car model and the customer's driving ability, the user can at any time download and use the driving mode that suits him or her best, so that it is as customizable as possible.
So taking this data as indicators, it would lead to the emergence of new marketing strategies.

5.2 Circuit KPI

Also with regard to the analysis made on the most frequented Italian circuits, several very interesting factors had emerged to be taken into account. In particular, something that had been noticed that very few people just buy a Huracan tend to take it straight to the track maybe they go there a couple of times and then they stop altogether. Of course, to draw that conclusion as true, we would have to consider more data than we have analyzed for this POC and a much larger time frame, but for the moment we try to make consideration on this result that has emerged out of this first analysis. Viewing and monitoring this type of data could be crucial to understand on average if there is really great interest from the customer to attend the track more assiduously and, based on the result, this could be a great indicator for make Lamborghini understand how to move or how to improve certain strategic choices.

Figure 5.4: Number of unique VIN to the circuit used as KPI

This can lead to asking the company why customers tend to take their cars to the track less and less over time; maybe they don't feel comfortable taking the car to the extreme on a circuit. So these values could be kept in consideration, leading the company to make different decisions, such as introducing on-demand services more related to the circuit than to the road, or services aimed at rewards and one of these could be a free day at a circuit or a daily lesson with a professional driver; another option could be to make the vehicle a game console on which the customer can simulate, through a projection on the windshield, a real experience on the track, this will allow each customer to train before having a real experience on the track, but at the same time it will allow to create a certain link between the car and the driver because the simulation will take place inside the cockpit then using the pedals and the steering wheel of the car itself. Another way to encourage more and more customers to take to the track with their car is to implement a semi-autonomous guide system inside the vehicle that will take the control of the whole vehicle only when the driver makes mistakes while driving, such as cornering or braking before the turn, this will generate greater safety to the driver, so it will also give the

possibility to those who are not a professional driver to be able to bring the vehicle to the limits.
In general, before coming to any conclusions, the analysis has to be done in more detail because typically spring and summer are the periods when cars are most often taken to the track, so if a customer buys a car in winter it is not that he does not want to go to the track, but simply because he waits for the warmer periods to go. So the whole analysis must also be done taking into account the period of year in order to draw more precise conclusions. Therefore, there are many ways to increase the presence of Lamborghini customers on the track.

5.3 Nearby Service Shop KPI

Another very interesting analysis was that about the proximity of the service shops and it was noticed that typically, on average, every 20/25 days a Lamborghini car was in the vicinity of an italian service shop, the reason is not known, if the customer is there by accident or to actually request a maintenance of the car for problems related to the vehicle. But the interesting thing that could be studied is the possible relationship that could be among the most used driving modes with respect to all those cars that are registered near a service shop.
Now in this case the cars that are most often found near a service shop are the same ones that have the most use in the SPORT and CORSA driving modes (figure 5.5); this makes a lot of sense because the more the customer uses the track mode, more the car will need maintenance, as the brakes, tyres and suspension of the car are put under more strain. So it could be taken as an indicator the relationship that there is between how much the Corsa/Sport mode was actually used by that cars that have been seen near a service shop, because maybe a possible scenario for the future could be that those who use these two driving modes more frequently, through the predictive maintenance, a direct relationship can be established between customer and service shop, so that the customer can be notified a reminder for the next maintenance, or perhaps be alerted as soon as something strange is detected by the service shop, such as strange engine-related values, or when parts are available for replacement, as for example replacing the suspensions with other more performing in order to reduce vibration.

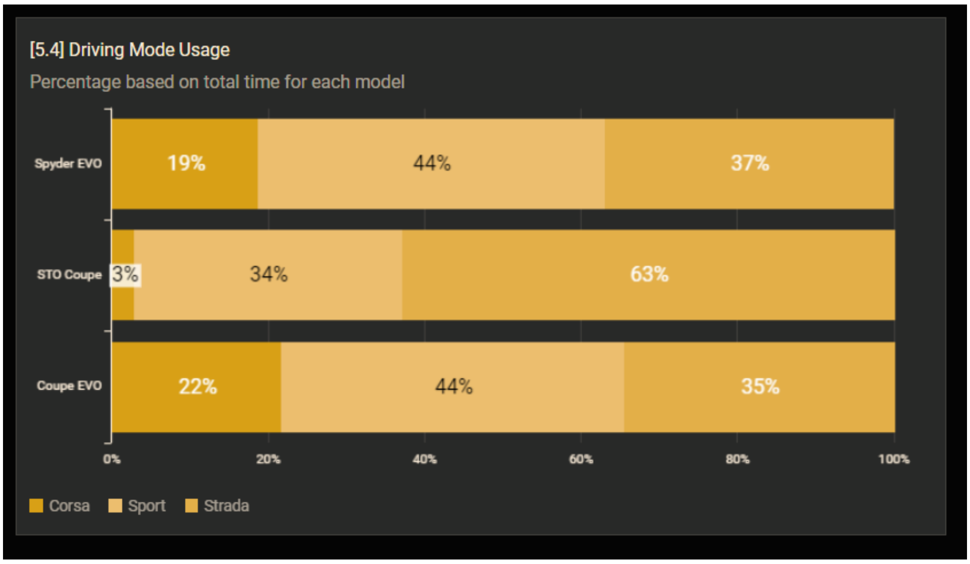

Figure 5.5: Relation between driving mode most used by the vehicles that have been seen near a service shop as KPI

Predictive maintenance allows optimisation of all maintenance operations with significant benefits in terms of cost reduction and increased productivity. A predictive maintenance system, which can be customised according to requirements, can automate most maintenance management processes, with considerable savings in time and resources. Intervening only if and when needed leads in fact to a reduction in machine downtimes, labour costs as well as machine replacement costs, with a consequent increase in production continuity and revenue, but at the same time also to greater customer loyalty due to excellent customer care.
Obviously Lamborghini is also focusing and working on the predicitive maintenance side in order to take advantage of this additional service as soon as possible.

5.4 Weather KPI

Another interesting analysis was that relating to the use of vehicles on the basis of weather conditions. In that case, the study had only been conducted for three cities but, despite this, was always found something interesting. For example, it was seen that in Milan, despite having rained heavily 20% of the time during the year, the use of the vehicle in these conditions was used 23% of the time. This means that, despite the weather conditions were not optimal, the Lamborghini customers like to go out with their Huracan in these circumstances.

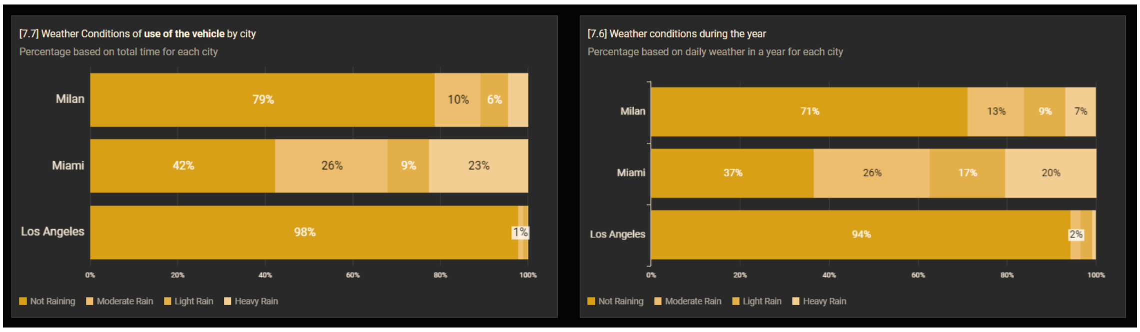

Figure 5.6: Relation between the usage of the vehicle and the weather condition as KPI

Therefore, taking this as an indicator, the company could start thinking about developing safety services in heavy rain, such as a semi-assisted driving in case the driver loses control on the wet road, so that even those customers who may not yet feel very confident with the machine can feel even more comfortable and secure.
Furthermore, since it has just been noted that the Huracan is also used a lot in the rain, the RAIN drive mode could also be brought into the Coupe EVO and Spyder EVO models, since the STO already has it inside, in order to make the driving experience even more complete and fascinating.
Again, as in the case of the driving modes seen above, it would be interesting as a solution to have OTA driving modes, so it would be possible via UNICA App to download and use driving modes that the car itself does not possess at the production stage, so that the user in whatever circumstances he finds himself, can use the driving mode most comfortable to him.

5.5 Country Comparison KPI

Finally, the last analysis made was about the country comparison, how the vehicles are used depending on the country. This study is in general a source of great value because it allows to understand what are the main driving habits depending on the country of origin, thus allowing to develop ad-hoc products and services based on their habits.
For example, we analyzed in the previous chapter the time at which, usually, begins a journey in Italy and America. The result was quite contrasting, as it found that in America the car is used purely at night, even until 4 in the morning; while in Italy the use is different, you prefer to go around at more convenient times.

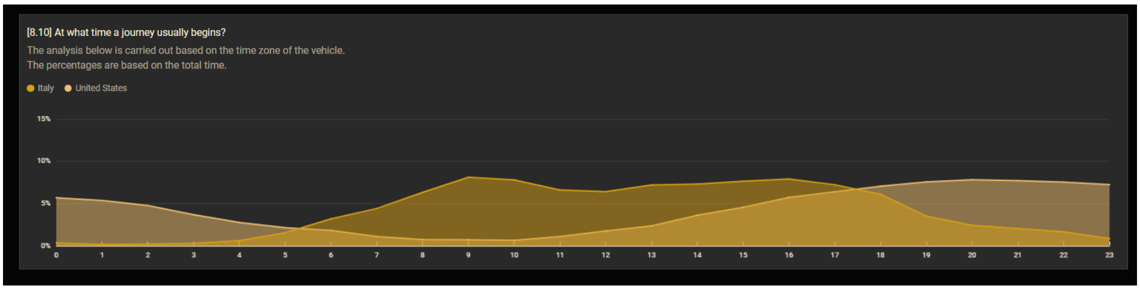

Figure 5.7: Country comparison among at what time a journey usually begins as KPI

Just going to study the greater differences of use that there are between a country and the other, it would allow the company to focus on different aspects on the basis of the market considered; in fact as for America maybe it could be more reasonable thinking more on services for nightlife than Italy in which the addition of these services could be avoided.
At the same time, once we understand the most widespread habits within a country, we may also use this information for digital marketing purposes, as for example the organisation of events can also be influenced by these analyses, e.g. in America it would make more sense to organise a Lamborghini event in the night, whereas in Italy in the afternoon.

5.6 Electrification KPI

Finally, through the merger of different sources, it would be possible to obtain some very useful results for the electrification that as never is a very topical theme, in fact as already said by the European Commission from 2035 will have to stop the sale of ICE vehicles; for that reason, it would be useful to have indicators that can help in view of the change that is coming.
In fact, as seen in the previous chapter, we have several information that could be useful to us, as for example we had seen how long a journey lasted on average of a customer who owns a Huracan, calculated from the moment the vehicle is set in motion until the moment of switching off (figure 5.8).

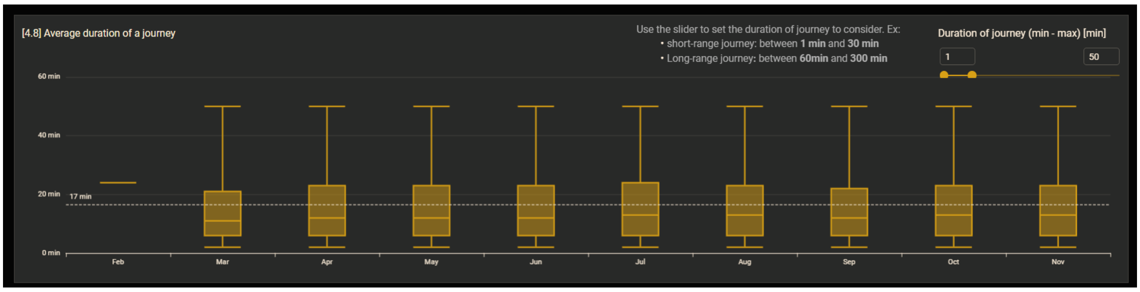

Figure 5.8: Average duration of a journey used as KPI

In addition, it would also be possible to read the signals of the fuel level sensor and relate this to the distance travelled by the individual vehicle, in order to arrive at an accurate estimate of consumption.
All this information, if related to each other, could prove to be excellent indicators and information that would be very useful in the design or choice of electric batteries that will have to be introduced in the Lamborghini of the future. This will open the door to new strategic decisions for the company that could also bring great economic savings, because for example if the distance estimated for each journey is around 25 Km, it would be useless to think to put inside the Lamborghini a battery with an autonomy of 1000 Km, but maybe it would make more sense to put smaller batteries that would bring great advantages both in the management of space and also from an economic point of view, but, at the same time, this would not affect the customer experience because in any case the customer will be able to drive without any kind of worry.

Chapter 6

Next Steps

In light of the above, the entire thesis work that has concerned me in first person has been the PoC discussed in detail in chapter four. The entire analysis has highlighted possible value KPIs that could lead Lamborghini to take new strategies in the future. All the analyses and considerations have shown great potential, leaving all the members of the strategy departments very satisfied. For this reason, there was a planning on what could be the next steps to be done, in order to add even more value to the work that has already been done. The result was that there would be many different things to be able to expand and add, but each of these has also highlighted different temporal needs, for this reason, the next future steps can be divided into three macro-areas:

1. Short Term
2. Middle Term
3. Long Term

6.1 Next Steps: Short Term

In this section will be shown all those next steps that could be implemented in the short time, which have a very low commitment and that could be brought to a short term. The short term next steps are as follows:

- For the PoC we have always considered a static database, now the next step will be create a real time dashboard directly linked to SDP database;
- Extend the circuit analysis to other countries in order to make a more accurate study and see if also in other parts of the world the relationship that the customer has with the track is the same or different from the one seen in small part by us;
- Specify the number of vehicles considered on total and on each country, because for the moment it is not specified on the total of the vehicles taken into account how many belong to a particular country and it would be useful to have this information to go more and more customizing the driving habits country by country;

- Further comprehension of the car in racetracks; for the moment we have too little data and a time frame of observation too small to deduce conclusion about the real behavior of the user on the track. Until today we have seen that typically in Italy the presence on the track is not too crowded, but in fact we should collect more data to deepen the study of the circuit;
- Improvement of the platform architecture considering the continuous data growth; so the future step will be to consider a Cloud architecture that will be more robust than the one used in the PoC, at the same time it will also have to be more secure because it will have to handle a huge amount of data whose privacy and security will be very important, and finally, it will have to be fast enough in the distribution and computation of data;
- The analysis of the driving modes will have to be done in more detail, i.e. for each Huracan model considered, it will be important to use the driving modes that really belong to it, in fact for the STO we have already said that the driving modes are: STO, TROFEO and PIOGGIA. Consequently, the clusters can no longer be STRADA-SPORT-CORSA, but the three new clusters referring to the corresponding driving modes must also be considered for STO.

6.2 Next Steps: Middle Term

In this section we will see what may be other next steps that will not be immediate but it will take some time before seeing them, for this reason they are considered in the middle term and are as follows:

- Get access to customer database in order to link the information and have a complete data-set client-car;
- Investigate possible application for the next gen SSC (Super Sport Car);
- It would be interesting also to see how many vehicles frequently pass through those urban areas called Zero Emission Zones, in which it is possible to drive only in electric mode, and analyze how many kilometres are travelled in full electric mode. In that way we could understand the mileage allowed to estimate what kind of batteries need to be put on board so that the customer can travel electrically inside these zones without the risk of having little autonomy;
- Privacy On/Off in order to see in real time the privacy mode, to have everything automated and easy to trace;
- U.S.A study based on zone/region, in order to differentiate and cluster better the driving habits as the zone changes;
- In the PoC, the calculation of CO2 emissions was based on the kilometres travelled multiplied by the number of vehicles considered and in turn multiplied by the value of CO2 emitted for each Huracan model (calculated as g/Km). The next step would be to go directly to read the signal, which travels on

CAN, based on tank emptying, so as to have the most accurate estimate of CO_2 emitted;

- Monitoring of the Remote APP services;
- For the moment, the weather analysis has only been implemented for three cities: Milan-Miami-Los Angeles; perhaps in the future, as next step, the product marketing will need to expand the same analysis for other cities that are relevant for Lamborghini commercial strategies.

6.3 Next Steps: Long Term

In this section, instead, we will go to consider all the next steps more complex that will have to wait a long time before seeing them realized. The next steps are as follows:

- Consider in the future also the test vehicles behavior that have been always excluded in the previous PoC;
- Try to read the passenger sensor signal in order to understand if the driver is alone in the car or together with another person. This might be interesting to understand whether Huracans are typically used only by the individual driver or whether they are used together with a passenger;
- Link between Service Shop and LIASS (Lamborghini Integrated After Sales System) in order to have a better knowledge if the driver really brought his car to the service shop for a maintenance or if instead he/she only passed there by accident;
- Development of the use case for predictive maintenance, in particular analyze the vehicle data, such as the brake pads, in order to identify the point of fault and inform the user through the App UNICA before the breakdown occurs;
- Integration of the analysis processes on Urus fleets in order to expand the Big Data study also on the other Lamborghini product lines;
- DTC (Diagnostic Trouble Codes) acquisition in order to improve the reliability of each components for better diagnostic analysis;
- Increase the frequency data acquisition, today each data item is acquired every ten seconds, in the future it would be good to improve this value. The reason is that because if we acquire each data every 10 seconds the analysis we could do would be poor from the point of accuracy because a Lamborghini goes from 0-100 km/h in about 3 seconds, if we acquire every 10 seconds we will see very little correlated data between one and the other. So for values relating to the powertrain or vehicle dynamics it would be better to have very high sampling rates, even under a second; while for readings of other things like the door or the passenger signal it would be useless to acquire them every second because they are not things that vary every second, so in this case it would make sense to keep the sampling rates lower.

Finally, these are all the next steps that have been set to improve the previously treated PoC. These new ideas will be used both to adjust the analysis already made but also to improve and expand the entire study, so that all the analysis can be as accurate as possible to bring us to the KPIs of great value.

Chapter 7

Conclusion

Automotive connectivity is changing faster than ever, significantly increasing the potential for data monetization for players across the ecosystem. Data suppliers, such as OEMs and vehicle fleets, are well positioned to benefit, as are insurance players, companies in the automotive aftermarket, cities, infrastructure providers, and other data customers. Importantly, all stakeholders must act fast. Given the industry's current underperformance on data monetization, new players with innovative approaches could rapidly gain an advantage over slower-moving incumbents. Those that fail to act now will miss the opportunity to differentiate themselves in one of the industry's key customer-facing spaces. While OEMs, suppliers, and other players along the value chain increasingly realize this imperative, they have not yet consistently created new offers and services that customers find compelling. They often fall short because customer expectations keep increasing and technology advances are occurring rapidly. If they continue to underperform, their brand appeal and profit pools could suffer, decreasing their market share. Conversely, those that harness the opportunity before them may unlock new profit pools for the industry and enable new, profitable growth.
Lamborghini has been one of the first OEMs, in the field of super sport-cars and luxury, to move towards this new trend, all the projects mentioned in previous chapters and the same thesis work are great witnesses.
In summary, in this thesis work the main objective was to analyze the data of connected cars, going to understand if these could really achieve important and valuable results. Lamborghini is now a year that is increasingly trying to meet the demands of the market and especially the trend regarding Big Data. Precisely, because of the new trend in the data of connected cars, Lamborghini has carried out four different initiatives in the last year with the development of four PoCs. The goal, in each case, was to be able to get the most value from the data analyzed in order to obtain some KPIs that can direct future business models and decisions. In particular, my contribution has not been linked to all four of the PoCs discussed but only to one of these, on which I had different decision roles, as:

- What types of use cases to focus on;
- How to try to correlate data to get interesting use cases;
- Dashboard layout and graphical view;

- Notify some possible problems related to the analysis made and solve them with possible next steps;

- Continuous contacts with the technicians working on the dashboard to guide them in the choices made by the Strategy-Connectivity team.

The results obtained for the purposes of the PoC were very convincing, making open the eyes to Lamborghini that great value is behind data of the connected cars and how much it is worth investing in this new trend of Big Data because it is really full of opportunities and in the future there will be more and more, given the continuous increase of connected cars.
In conclusion, the PoC had as only objective to make to understand the potentialities that have these data and the great benefits that can be drawn from it; considering the obtained results and the opinion of the team, the objective has been reached with great success. In fact, nowadays at Lamborghini is increasingly clear and aware that to differentiate from its competitors and remain competitive in the market, this is the right direction on which to continue to focus and on which we will have to work more and more soon.

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