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Data Monetization Strategies in the Automotive Industry

Jannis Kallinikos
RELATORE

234661 Confalone Miro
CANDIDATO

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Introduction

This dissertation is a literature review aimed to study the transformation that the automotive industry has undertaken powered by the digitalization of systems, practices, and infrastructures. The world as we know it today wouldn't be the same without the invention of the car that has been and is still today a symbol of transformation and opportunity. Before the introduction of digital technologies and up to the beginning of this millennium the car's importance was derived both from its symbolic value and from its mechanical components like wheels, engine, horsepower, etc. When digital technologies have been introduced the car has crossed its traditional boundaries and has become a place in which many functions can be executed.

This dissertation starts with the description of what is meant with digital data, their ontological characteristics, their functions, and this section introduce the concept of big data with a cursory description of which elements firms must adopt to use them and seize value.

Then, I focused on the theoretical framework regarding the strategy for the administration of digital data, firms have three main strategies regarding data: *selling, bartering, and wrapping*. These three methods differ based on the kind of firm that is taken in the exam as for its capabilities, size, business models, and industry. Tech companies such as Facebook, Twitter, Google have become giant corporations thanks to their data management and monetization practices.

After all this theoretical introduction regarding the meaning of data and the strategy to optimize collected information, I moved to the microeconomic aspect of my thesis making a description of the new trends and enablers involving the automotive industry, the 4 ACES, *Autonomous vehicles, Connectivity, Electrification, Shared.* I've reported the main features and how companies can integrate these trends into their actual business models, reporting economic figures about the different trends and how they are important today, and what are the forecasts for the future.

Then, starting from a McKinsey&Company report (1) picturing the ecosystem divided into different layers, I've made my own examples based on corporate statements from other companies, previous knowledge, and papers. Each layer is accompanied by a description of which digital monetization strategy is applied and how it is applied based on the players belonging to each layer. I've produced a summary table for the three layers and the end of the section.

Specifically, this thesis will try to answer which data monetization strategy is associated with each part of the ecosystem

Keywords: Data Monetization, generativity, ecosystem, data-driven strategy, Big Data, data wrapping

Research design and methodology

The dissertation starts illustrating the main features of digital data accompanied by a general overview of the concept of big data thanks to sources from various papers and book texts. Moving toward a microeconomic setting with the automotive industry I've first treated firm strategy regarding the use of digital data to extract value, describing the three for of data monetization: *selling, bartering, and wrapping* (2). Continuing to restrict the focus of the thesis I've then described what are the four megatrends (*Automation, Connectivity, Electrification, Shared*) and main components of the digital transformation relating to cars and vehicles. The car transformed from just being a piece of design and mechanics to become a new environment that can serve multiple purposes and can be an essential component of everyday life. I've accompanied these four trends with statistical figures that embolden the hypothesis that these trends are effectively growing in the automotive industry and they are not just buzzwords or noise. I then zeroed in on the new ecosystem based on a McKinsey&Company report, I've analyzed each layer described in the report one by one and made several examples of how the players involved in the ecosystem monetized collected data and how they create new business relationships with unreported stakeholders and extract value.

I've then schematized the various ecosystem layer with the associated data monetization strategy.

1. The theory of data

Big Data and more in general digital data are pervasive in our everyday lives, businesses and scholars are investing a lot of resources to understand how to maximize their usability and how to maximize value. Data represent information, but in the last 20 years, they have become a tradeable good, a medium, or a resource. But what distinguishes data from traditional commodities is that they transcend the physical environment, their value is not rooted in the material object but rather in their relatability with other data, their malleability, scalability, and their multiple uses (3). This degree of independence from the fixed state of the matter offers a high degree of freedom when working with them, so data can be regarded as a new kind of resource that is unbounded from the classical scheme of resources utilization because differently from the traditional raw materials digital data can be adapted for purposes that sometimes go even beyond the boundaries of the firm. As resources they have several uses: they can be analyzed thanks to machine learning techniques for prediction, customer segmentation, sentiment analysis on texts, they can be fed into an AI algorithm that can learn from them and improve its performances, they can be recombined with data obtained from different sources also from other companies in a synergic effort to get powerful insights or to complete a certain task (4). Like the traditional value chain, different machines can be used in the same production process, but differently from the traditional setting, the digital value creation process allows for an easier synergy between departments, business partners, and people and opens up the boundaries of the organization. Digital data exist on a machine, they are intangible assets and in a product company they, of

course, don't produce anything directly, but they are valuable in supporting decisions and enhance the performances of those same types of machinery or companies through optimization of production processes, AI algorithms, or better utilization of human resources. Things change drastically when talking about service companies or the so-called tech companies, they center their operations around the exploitation of data from their customers and they differentiate their offers regarding the products sold. Some of these companies monetize from selling data to advertising companies such as *Google* or *Facebook*, or some other companies collect data from their apps or websites to offer an offline service such as *Uber* or *Open Table*. These data come in specific formats that are compatible with different operating systems. This interoperability disrupts the traditional value creation process and creates scenarios that are usually unpredictable (5). A key characteristic of data is their scalability, while their production can require heavy investments, duplicating them has near-zero marginal cost, they are non-rival, the consumption of one data doesn't exclude another (6), this is what revolutionized, for example, the music industry which shifted from the sale of hard copies such as CDs and pieces of vinyl to the sale of subscription plans. Data are not only scalable but are also sharable, and this characteristic was the catalyst of today's digital economy with business services such as the platform model which has seen the emergence of players such as Facebook, Twitter, Uber, Tripadvisors, and others. What is important to underline is that a single piece of data by itself is not able to generate so much value for a company if it's not related to other data from other sources, the same is for data from just a single customer. For example, a store that collects data only from a single or few customers will never be able to implement a data-driven strategy. Data are substantially a piece of information that can be edited, recombined, and analyzed for various purposes, but they need a context to be valuable, to understand which products could be sold to certain customers we need a sufficient amount of time, different data about different products, different data from different stores, past transactions, reviews, just to name few. These data usually come also with a lot of noise and they need to be cleaned and processed before even using any statistical techniques and obtaining useful results for the firm. Companies that can collect a vast amount of information and then utilize them at full have gained a great competitive advantage in the last 20 years and became giant corporations. This vast amount of data has taken the denomination of Big Data.

The term Big Data in popular culture usually means a large amount of data but it defining Big Data only for their size is incorrect and limited. The first that introduced the characteristics of Big Data was Laney, he observed that the big expansions of e-commerce produced a vast amount of Data and the challenges of this revolution were about managing three characteristics of data: *Variety, Velocity,* and *Volume* (7). These were also commonly called the "Three Vs".

Volume: refers to the vast amount of data collected, Google, for example, processes 20 million petabytes of data per day (8)

Variety: has to do with the type of data: structured, unstructured, etc. but also with the various sources of

data, smartphones, computers, smart homes, cars, sensors which many of which fall under the umbrella term of IoT.

Velocity: instead is about how faster are these data collected, processed, and shared; one of the key elements for the functioning and the success of the digital economy is about the speed and the delivery of information to the end-user.

After the seminal work of Laney other two Vs have been added: **Veracity** and **Value.** The former is about the quality of data, how reliable it is, how clean it is. Of course, this V is maybe less inherent in the original data since a person with enough technical skills can then manipulate the set of information by applying techniques that eliminate the noise. In dealing with data what matters is having reliable and truthful data more than having tons of unusable information**. Value** is on top of the four Vs and characterizes the most important function of Big Data, create value. It can be considered as the final product of using Big Data. So, if a company is for example able to collect a variety of data in a great amount but then doesn't know how to fastly process what has been collected that firm won't probably experience all the benefits of a data-driven strategy. Implementing such a strategy requires a heavy investment in infrastructures, such as broadband, data centers, hardware, and talent acquisition. These changes for a traditional company could be quite expensive, it would require transforming its business units, personnel, and production processes. In fact, as McAfee and Brynjolfsson (9) state a company has to face five major challenges if it wants to reach the full potentialities of big data:

Leadership: Big Data doesn't substitute human vision, as said before data support decision making, managers must drive the change with their ability to create and innovate. Managers must set specific goals and use their leadership to realize them. Even if AI could be thought of as a threat for managerial job positions, would be hard to think that those systems will be able to replace the human ability to communicate with the various stakeholders and shareholders or to spot opportunities.

Talent management: with new technologies available there is the need for new professional figures such as data scientist and computer engineers, the IT department must also be able to communicate with the other business units, so people who can deal with both languages, computer science language and business, will be required

Technology: Firms must invest in new machines such as data centers, servers, computers, new software. Processing a vast amount of data could require hours or even days if the computing power isn't sufficient, this would tremendously slow down the production process. So it is vital to invest in new technologies for analytics and data processing.

Decision-making: Decision-making is strictly related to leadership, a manager must know when to act, how to distribute the right resources to the right project, and sometimes must decide to keep a project

discarding another one. So it is important to have people with the right problem-solving skills because the innovation process is full of unexpected events.

Company culture: Companies still struggle to adopt a full data-driven strategy, based on a 2021 survey conducted by NewVantage Partners, among 85 Fortune 1000 companies such as McDonald's, Pfizer, VISA, etc. only 30% of the respondents report to have a well-defined strategy about data (10). This shows that companies are still struggling to reap the benefits of Big Data. So managers and top executives must reshape their way of doing business in some sense. Data are bound to historical facts, not to instinct, so managers that base their business decisions on instinct could end up being confused. Sometimes top executives struggle to understand the difference between causation and correlation or may think that specific patterns, which maybe are driven just by noise or bias, are reliable. However, a data-driven strategy seems to yield important results regarding company performances, in 2011 an analysis of 179 large public firms conducted by Brynjolfsson et al. in collaboration with McKinsey&Company, showed that firms that adopted Data-driven decision-making strategies reached a 5-6% productivity increase confronting with traditional strategies and also other measures of profitability such as ROE benefitted from a strategy based on data (11).

2. Data and strategy

The immediateness of data and their peculiar features have challenged the traditional business models and basic concepts of management (12). Firms able to get a competitive advantage when dealing with big data have three factors in common. First, they shifted their efforts from using data to understand the past to use data to improve their product or services in real-time or to predict what will happen based on specific patterns. Second, on the human resources side, they moved from data analysts to data scientists that are capable to manipulate and structure data and can make predictions with advanced statistical techniques, moreover, these professional figures can communicate to the top management and advice about actions to undertake. Finally, the third factor is about transforming the organization’s business units and processes, meaning that analytics is not just exclusive of the IT department, which has the function of automatizing business processes, but instead, analytics is now key for product development and implementation (13). The traditional concept of strategy has been disrupted, Porter (14) already stated that positioning was too static for the rapid changes that were happening at the time. When the Internet was introduced the pace of innovation rose at unimaginable levels and long-standing companies had to adapt their business plans to the new world. A strategy is designed to last for a considerable amount of time and to be based on solid foundations, but a large and variegated volume of data transformed the canonical methods of strategic planning. Since the gigantic amount of data collected every second rapidly affect the various prediction created by computer models the present is even more ephemeral and the past intended as log files, server databases are constantly changing and added with information and so the past is no more such a solid

reference point, the past has now a limited scope and the real-timeliness of data accelerated this phenomenon. Surely a strategy based on big data and analytics is forward-looking, but even a long-term strategy has a precarious existence since the pace of technology is unpredictable and new techniques or technology could completely change what has been produced not so much time ago (15). User-generated content such as comments, tweets, images, videos, etc. is the antithesis of top-down, deductive decision-making, and direction (15), it is the same concept of structured organization and command line that is affected by the digital revolution. Models such as Open Innovation or Crowdsourcing still necessitate top-down direction but they are solidly focused on bottom-up ideas generation and interaction (16). Data can be now monetized in various ways and this phenomenon has taken the name of data monetization. Wixom (2) defines data monetization as " *the act of exchanging information-based products and services for legal tender or something of perceived equivalent value"*. So the term refers to all the practices and processes related to the stream of revenues and the exchange of products and services deriving from data. For a transaction to happen there must be an agreement between two parties about the element that is exchanged, namely a product or a service. As discussed in Chapter 1 data have become a new kind of resource that can be used to create value or it can be regarded as an asset that can be shared or sold to other companies. A huge amount of data presents numerous challenges regarding data's differences, usability, and analytics capabilities. Based on Gartner (17) companies can directly or indirectly extract value from customer data, the direct way is selling or trading data to other entities while the indirect one is creating other products or services leveraging the gathered data. Based on Woerner and Wixom (18) companies have three ways to monetize their data: *selling, bartering, or wrapping*

Selling data has a long tradition among firms, data collected are often sold to advertising companies or research firms. POS data are a traditional asset that is exchanged for money, other kinds of data are sometimes difficult to be sold since the company that owns them may be worried about potential competitors or could have privacy concerns (2). This model of monetization is used by marketing companies like Nielsen or data brokerage companies like *Acxiom* (now LiveRamp Holdings), these companies are the ones that buy data and then resell them for profit, usually, data come in form of lists and datasets, there are over 4,000 of these companies around the world. LiveRamp Holdings, one of the largest, alone, has over 20,000 servers that collect and analyze data about over 500 million consumers, and up to 3,000 data points per person (19). The data brokerage industry is thought to value 200 Billion USD (20). LiveRamp Holdings alone has a market capitalization of 3.17 Billion USD (21). Other companies include Oracle, Equifax, and Experian.

Bartering is another form of data monetization that involves the exchange of data between different business partners in exchange, not always implies an exchange of money. Examples of this practice are financial companies that send data to receive credit ratings from agencies or companies that need pieces of advice from consultant companies (22), (23)), another form of bartering between the user and the digital

platform, in exchange for a free service such as Facebook, Whatsapp, Twitter, etc. the user must share some of his personal information such as its phone number, name, date of birth, email, etc. and in this sense the Big tech companies have brought back form of bartering from the long past (24). Data bartering enables collaboration between firms for value co-creation and models such as the Open Innovation model introduced by Chesbrough (4), companies can exchange data through M&A operations and joint ventures (25). Bartering adds the challenge of operations control since in this case the company still is linked to its data since has not given up its total liability in exchange for money. ((2), (23)). Companies that offer free services to their user have brought back bartering from antiquity, users can get free services as long as they agree on certain rules and they accept license agreements, but how these companies make money? *"We don't sell people's data, even though it's often reported that we do"* (26). This is what the Facebook founder and CEO wrote in an article for the Wall Street Journal, many in these years have discussed the business models of free-services applications, their controversies about user segmentation, recommendation algorithm (27), and how these companies harness data to extract value and sustain themselves. The quasi-totality of these firms' revenue is through selling advertising spaces to third-party companies, so rather than sending data in the form of files via encryption to the advertisers they sell a spot on their platform website or application, but most of all they offer a profile which has been individuated through cross-reference based on the user's activity, such as likes, comments, contents posted. So, in a sense, Facebook like Google or Twitter, "sell" their users' data without effectively selling them because it doesn't give up ownership. Companies that want to have their ads on the platform pay based on the number of impressions delivered or the number of actions undertaken by users.

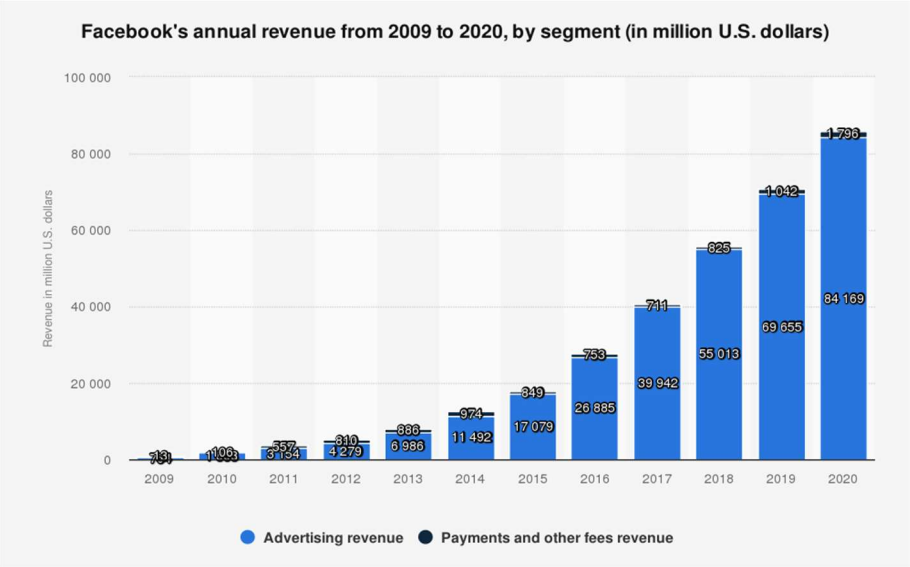

Figure 1. Advertising makes almost 100% of FB revenue (28)

Google (Alphabet Inc.) is similar to Facebook regarding data handling and advertisement but Google can rely on an incredible number of services and products, it differentiated more during the years through M&A and is also older than Facebook. Google services and products include Google Pixel phone, Google Home,

Google Pay, Youtube, Android, and its marketplace. Twitter, for instance, has a peculiar approach to data, its main source of revenue is still advertising, 86 percent, the rest is under the voice of Data Licensing and others (29). Twitter offers the possibility to license data to other companies for analysis purposes, Twitter allows users to create applications to analyze tweets, comments, and retweets such as sentiment analysis and representation of social networks with programming languages and software. This feature is very important for academic purposes but also for marketers.

The last method used to monetize from data is through *wrapping*, this method leverages data and "wrap" them around traditional products to improve their usability, processes, and to accelerate service. Based on Wixom and Woerner (18) the main purposes of wrapping are:

- Differentiation
- Make the product or service more attractive
- Enhanced value creation

Based on Schüritz and Wixom (30) data wrapping is unique because:

- **Data wrapping converts data indirectly into financial capital:** firms leverage data to offer a better and more personalized product, shifting from mass production to differentiation
- **Product owners control the wrap:** this is again core in a big data strategy of bringing data scientist out of IT departments and closer to product management (13)
- **Data wrapping is highly coupled with a core offering:** Data wrapping is made for personalization and must be well measured and designed

Data wrapping can improve traditional services like a bank account and add to it some functionalities such as budget management and savings planning (Walsh 2019). Data wrapping to be considered effective should *Anticipate, Advise, Adapt* and *Act*, these are called the Four "As" (31)

So, data wrapping should understand before what the customer may desire thanks to analytics technique that can predict the next move, then based on the result a firm can give advice or promote a certain item to the public and adapt during the time to possible changes in tastes or preferences, a predictive method can also help on behalf of the customer or the same firm preventing errors, lowering churn rate, and triggering behaviors that are beneficial to the customer. Based on an MIT survey managers told that data wrapping is beneficial to their customers regarding how s product is now easier more engaging or have more usages. A product that is easy to be utilized will encourage the use, improve the affinity toward the product or the same firm, and will encourage future purchases increasing revenue and lowering churn rate. Data wrapping differently from selling and bartering require additional attention on data analytics processes, a successful strategy must be communicated clearly and has to be based on usable data which have been correctly processed and are free from noise. Data wrapping also require high service standards and since data can be

collected in real-time companies must adapt rapidly to change, the process can please customers and increase their loyalty but firms must be ingenious in enacting data wrapping strategies ((2), (31))

	Selling	Bartering	Wrapping
Example:	▪ A retailer exchanges POS data to a data aggregator for money ▪ A data aggregator exchanges market basket reporting and analytics to a retailer for money	▪ A retailer provides POS data to a supplier in exchange for a software tool that helps the retailer analyze and improve selling the vendor's products	▪ A supplier provides product reporting to a retailer at no charge, and over time receives increased sales by that vendor
What do you get in exchange for your data?	Money	Products or services	Increased revenues from core products and services
Who should govern?	Dedicated organizational structure or business unit	Shared services group	Product management
What are key challenges?	▪ Complying with legal, regulatory, and contractual constraints ▪ Setting the right price ▪ Leveraging advanced technology and data science ▪ Sustaining competitive advantage	▪ Identifying and coordinating bartering across the enterprise ▪ Complying with legal, regulatory, and contractual constraints ▪ Preserving value during the bartering exchange process	▪ Avoiding merely "raising the bar" of core offerings ▪ Meeting promised or expected service levels to avoid damage to important stakeholder relationships

FIGURE 1: THREE DATA MONETIZATION CHOICES

Figure 2. The three strategies (2)

3. The new trends in the automotive industry

The automotive industry makes no exception regarding the revolution brought by digitization and the use of data and multiple models of monetization can be observed easily at the various levels of the value chain. The advancements in technology did not just digitize the world of private transportation, they revolutionized the entire concept of vehicle. By 2025 every new vehicle model will be connected (32) and it has been estimated that an average of four terabytes of data will be processed each day by 2025 and ten terabytes each month (33). The value associated with a vehicle is no more due just to its mechanical characteristics such as maximum speed, gears, or engine but also to the vehicle's connectivity and electronic functionalities.

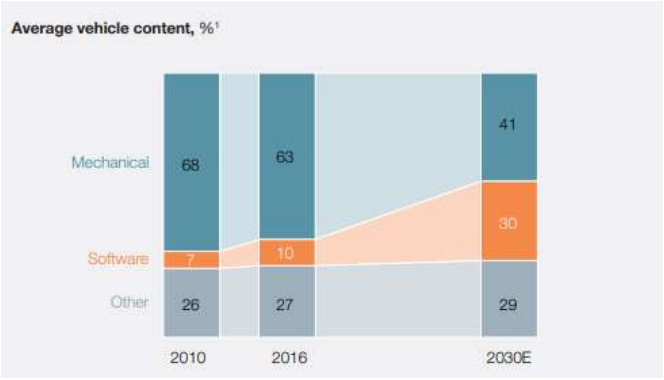

Figure 3. Repartition of vehicle contents (34)

Digital capabilities have brought the vehicle to transcend its traditional boundaries and it has become a source from which to extract value for several stakeholders such as automakers, financial institutions, insurance companies, etc. There are four main, disruptive trends in automotive:

- *Autonomous driving*
- *Connectivity*
- *Electrification*
- *Shared mobility*

These are also called the ACES. These four megatrends stem from changing customers' habits, from actions undertaken by governments such as in the case of stricter emission regulations, or new business models that push companies to change their behaviors. The generativity offered by the digital artifacts (5) opens the door to a whole new array of possibilities regarding value creation and business expansion.

To reap the full benefits of the digital transformation and connectivity features, there must be three key enablers (35):

- *In-car technologies*
- *Infrastructure*
- *Back-end processes*

The fundamental in-car technology is represented by sensors, these must be present if when a car manufacturer wants even think to implement a strategy to extract value from data. The technology evolved notably in the last two decades and allowed for the introduction of the ADAS (Advanced Driver-assistance systems) and created the basis for the transition to fully automated vehicles. The estimated number of sensors is between 60 and 100 and is expected to reach 200 in the next future. The traditional sensors are about car activity, its engine, brakes, wheels, fuel, these exist well before the digital transformation of the automotive industry. Nowadays, car manufactures have introduced other kinds of sensors such as cameras, radars, ultrasonic, positioning, these sensors help to drive through fog, heavy rain, low light environments, they are also used for assisted parking or other vehicle detection to prevent accidents. Sensors are also important to monitor driver activity, its driving style, or for prevention and security function thanks to alcohol odor sensors, facial monitoring system, or detection through behavior analysis, when the sensors detect certain behaviors the car triggers sound alarms and seatbelts are tightened immediately (36). These vital elements are key to security, for example, incident prevention the fatalities due to car accidents decreased by 53% in the period 2001-2016 (37). Other in-car technologies include HMI, Human-to-Machine Interface, these include car touchscreen, radio, GPS navigator, biometrics such as fingerprint reader, facial recognition. These technologies can create a high incentive for customers and revolutionize their experience inside the car thanks to the possibility to connect their smartphone through Bluetooth, WiFI, premium models offer also on-board TV and other advanced infotainment features. For example,

Tesla car models are provided with a large central touchscreen that gives all the information about the car position, speed, energy available, car condition and the driver can interact with it during all the travel.

Besides the technologies belonging directly to the vehicle, to extract value from the data collected there must exist an infrastructure that supports all the functionalities and creates overall benefits to all of the car ecosystem stakeholders. The city itself must transform its technologies and become "smart", with traffic sensors, intelligent light systems, data towers, cameras equipped with AI technologies such as object recognition, satellites for GPS signal. About GPS, government agencies must ensure a constant update of its road maps, such as new speed limits, traffic signals, street closures; these maps have to be precise with a low error margin and in high definition. Thanks to the car V2X (Vehicle-to-Everything) technology cars and urban areas blend together and become interdependent, V2X technology includes among others V2I (vehicle-to-infrastructure), V2N (vehicle-to-network), V2V (vehicle-to-vehicle), V2P (vehicle-to-pedestrians). Without these technologies, automotive companies could never implement a full data monetization strategy since they would be limited in scope and could not offer all the services that digitization offers, for instance, if V2N technologies wouldn't be available the car wouldn't be able to connect to the radio network, to make a call through the car phone system, or to offer the entertainment services that are desired by customers.

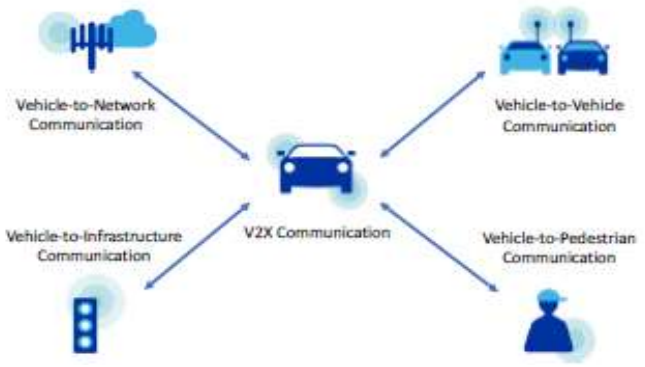

Figure 4 The V2X representation (38)

This synergy of car and external environment helps to create a sustainable environment with beneficial effects on drivers such as reduction on commuting time, better mobility, better lighting but also for the overall quality of life in the city. McKinsey&Company (39) estimated that thanks to smart-city technologies the commuting time has been slashed by 15-20 minutes on average on the daily commute in big cities like New York while it can be reduced by another 10 minutes in less dense urban areas. Transportation represents 29% of 2019 Greenhouse emissions in the US growing from 10% of 2010 (40), and implementation of traffic management technologies with sensors and AI added to the expansion of ride-sharing realities and vehicle electrification is expected to reduce greenhouse emissions by 10-15% (39). Infrastructure is not just related to municipal or state administration but also to companies that must possess

the underlying technology to collect data and elaborate them, firms will need servers both physical and in-cloud, databases, and machines that have the right computing power.

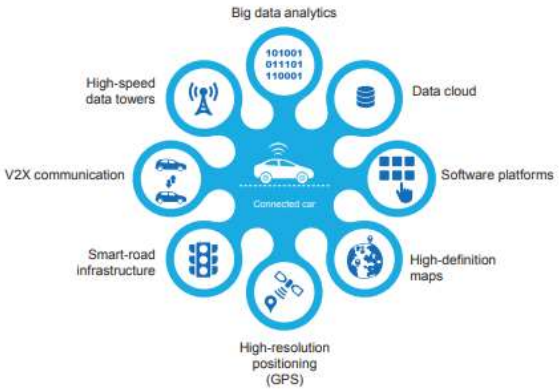

Figure 5: Infrastructure for connected cars (35)

The last enabler is represented by all the actions that players in the ecosystem undertake to make valuable insights from data, this enabler includes all the actions to collect, analyze, and enrich data and has its foundations o in-car technologies and infrastructure. The various stakeholders that belong to the ecosystem or want to maximize value from data need to have the right organizational design to allow for a correct analysis and elaboration of those data and a structure that allows information to flow and to be exchanged inside the firm or outside to business partners. These operations require a high level of coordination among the parts, for example, if a car has a malfunction the data can be received by more than just one entity; with sensors or cameras inside the cars, we can understand if the driver is still conscious or not, in that case, different levels of alert could be sent to different organizations, body shops for accident assistance, insurance company, ambulance in case of assistance (eCall), law enforcement bodies, or other pre-setted numbers. When collaboration among different firms includes the exchange of data, the actors involved in the process must ensure a high level of privacy and security, most of the data needs to be anonymized and firms must concentrate their efforts to invest in the cybersecurity area. Firms can develop an in-house solution or can outsource. Car Manufacturers cannot usually develop in-house solutions and they often recur to outside solutions, such as small firms or startups (41). Often OEMs recur to outsourcing also for infotainment, data analysis process, and HMI (1). So this enabler is tight to the capabilities that each player has and their strategy to implement a data-driven strategy.

Electric cars and autonomous vehicle trends represent the future standard of mobility, by 2030 it is estimated that the number of electric vehicles will correspond to 30% of the overall market. In 2019, the level of investments in electric vehicles has risen 19 fold in just one year from 3.2 billion euros to 60 billion euros (42). The rising interest in electric cars is pushed mostly by consumers' environmental concern since Electric vehicles such as Plug-in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEV) produce during its lifetime 50% less CO2 emissions than a conventional car in the EU (43). States are

continuing to set stricter emission limits for the years to come and they are granting incentives for electric cars to be adopted since the average price of an electric car is still higher than the median price even if it is decreasing in the last years. There are still issues to be solved such as the charger infrastructure, the battery range, which on Tesla Model S arrives at 387 miles (44), and various battery problems at a chemical level. Electric cars are a further evolution from connected cars, electrification on vehicles is dependent on connectivity, and this creates the possibility to offer innovative solutions to customers in terms of services, maintenance, and vehicle control. For instance, the customer can check directly the state of the battery, its temperature along with other features, full-electric cars come natively with the possibility of an at-distance door opening, car software, and other remote controls. Firms offer the possibility to install the charging dock at the customer's house. It is estimated that during the entire lifetime of an electric car the customer can save about 5000 USD (45). While the first electric car model was developed in 1882, the real turning point happened in 1996 with the launch of the Toyota Prius, the first mass-produced hybrid model, after that year many other models were launched, and companies started to explore other technologies related to mobility, one of these is surely represented by autonomous driving cars.

Self-driving cars represent the future of mobility and it is projected that in 2030 there will be 58 million units on the roads, 32 times more than the units on the market in 2019 (46). Autonomous cars are fully dependent on sensors and connectedness functionalities, moreover, an important technology is added, Artificial Intelligence with computer vision. Deep learning in cars is used for four main functions: perception, localization, planning, control (47). So thanks to cameras, radars, ultrasounds the car can recognize obstacles, offer a precise and comfortable driving experience, know when to turn, surpass other cars, and keep the right speed and distance from other vehicles. To obtain this result also infrastructure and back-end processes are fundamental, the car needs updated maps in high definition, satellites for accurate GPS signal, V2X technologies that can connect the cars to intelligent lighting systems, smart parking, etc. Thanks to its low latency 5G technology represents an important step forward in this direction. The car manufacturers and the various stakeholders need to equip themselves with efficient data analysis capabilities to exploit the full potential of this revolution.

The last element of the ACES framework is represented by shared mobility, which comprises both car-sharing (Blabla Car), micro sharing, or ride-hailing with companies like Uber or Lyft that emerged in the last decade and changed people's habits with regards to modes of transportation and ways to use commuting time. The rising in shared mobility has brought to a market of $60 billion in value across the US, Europe, and China, and shared mobility solutions are projected to grow by 20% by (1). The COVID-19 pandemic has affected negatively shared mobility travels since people started working from home or preferred using their private vehicle to commute, Uber users declined from 6.9 billion to 4.98 million in the entire 2020 (48). But shared mobility is going to remain and expand after the end of the COVID-19 pandemic and this is due to enlarging population in urban areas, by 2050 it is projected that 68% of the

world population will live in urban areas (49). Other factors are people that don't possess a driving license, cost reduction, and clarity about ride price. Self-driving cars are expected to change the shared mobility sector increasing the planning of travel using different types of vehicles and transitioning to modal transportation. Shared mobility has still issues such as short trips, like going to the supermarket and having to spend every time a fee, so it could result unfeasible in this case or special needs such as for babies or people with disabilities in case vehicles are not equipped with these special provisions. So car ownership is to remain but how people will move in the future will be different from how they have always been.

4. The new automotive ecosystem and data monetization strategy

What has changed in this digital transformation is the pure concept of the car, before the advent of digital technologies the car was a mere ensemble of mechanical parts with some electronic components.
Today the car is fully integrated with the external environment and its potentialities are yet to be discovered in the future when other technologies will be introduced. Multiple players besides the OEMs gravitate around this new ecosystem such as insurers, suppliers, workshops, financial institutions, advertising companies, etc. These players had to tailor themselves to this new setting changing completely their relationships with customers and their business models.

Digital is associated with the software, to connect multiple applications from different systems there is the need for special interfaces called APIs, the acronym stands for "Application Programming Interface", it is a piece of software, written in specific programming languages, that acts as an interface to connect two or applications from different sources and helps the creation of important services or functionalities. For example, a mobility app such as Moovit or s food-delivery app like Glovo can integrate the Google Maps API to supply map functionalities (location, directions) on their mobile apps. Other examples extend to digital payments, calendars, weather forecasts, stock markets, etc. So OEMs can create their own APIs and make them available for free or under the payment of a fee agreed by contracts signed by the parties. For instance, BMW CarData, a platform that allows companies to connect with data produced by BMW vehicles, this platform offers an array of APIs to which firms can access. The customer has always the final decision if to share its data or not, data are sent to BMW servers through the SIM installed onto the vehicles (50). BMW sets rules and limitations concerning the use of data by third parties and makes companies pay a maximum monthly fee of 5 euro per vehicle, a third party can have access to hundreds of thousands of cars and vehicles. (51)

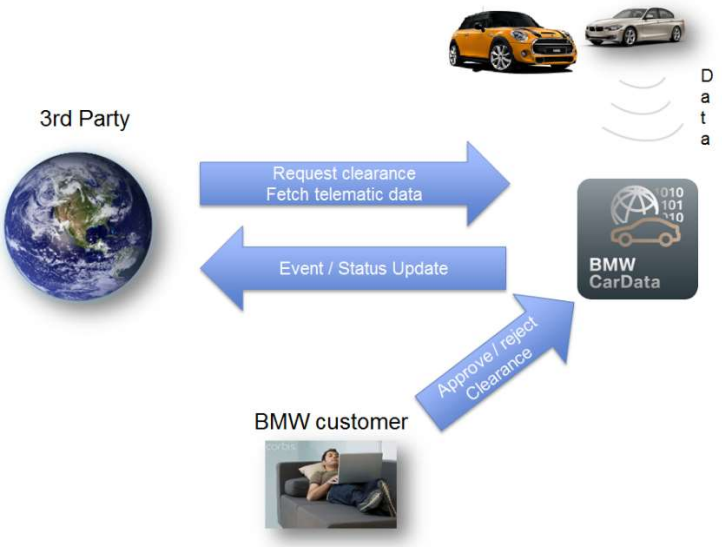

Figure 6 BMW CarData infrastructure (52)

Other companies like Daimler (Mercedes-Benz) or Volkswagen utilize the same approach for developing a strategy based on the commercialization of digital data. Volkswagen has become a conglomerate in these years acquiring brands such as Audi, Seat, SKODA and it offers a unique platform in which third parties just changing a small part of the API code can access different vehicles of different brands. So, the technologies that gravitate around the cars such as sensors, external infrastructures are needed to be numerous and well-functioning, but the APIs open up new possibilities with regards to how customers are treated during the life of the vehicle. Before the introduction of digital data and nowcasting (15), car manufacturers and dealer were adopting a business model that limited the interactions with the customers to the selling process and, if the customer didn't decide to repair its car to an independent garage, they could interact with the driver for scheduled maintenance or urgent repairs. Nowadays, the OEMs and car dealers can exploit the potentialities of data assisting the customer throughout the entire vehicle life, recommending repairs, using different pricing models, offering Pay-as-you-drive insurance packages, making recommendations about new models based on customer behaviors, and financial situation. Implementing new infotainment functionalities or applications through car software updates. So they can create value for themselves and not just for third parties. The global market size for Automotive software is expected to reach 18 billion USD by 2025 (53)

4.1 The new automotive ecosystem

So, the development of new APIs by OEMs is key to create the necessary infrastructure to make the new ecosystem thriving.

We could divide this new setting into three layers:

Layer 1 – OEMs, Components suppliers, and car dealers

Layer 2 – Rental companies, maintenance workshops, telematics players, and fleet management companies

Layer 3 – Tech companies, insurances, financial institutions, regulators, telecom infrastructure, advertisers, retailers, entertainment companies, and many others

A well-functioning ecosystem will generate new and unpredicted relationships, so the possible interactions and business partnerships are neither stable nor static. (5)

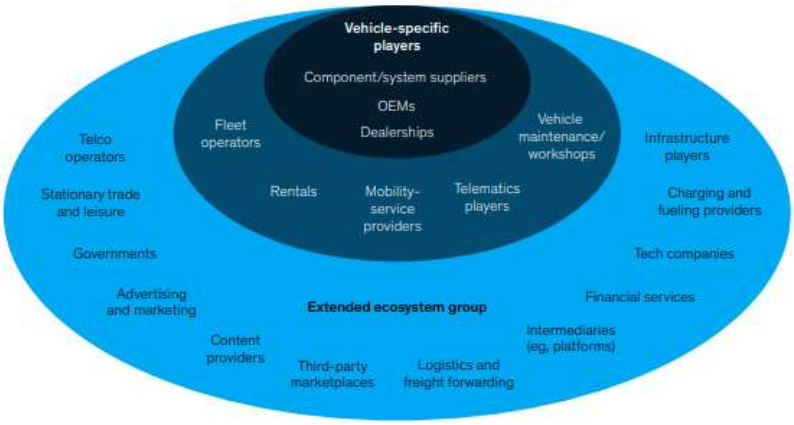

Figure 7. The new car ecosystem (1)

First Layer

The first layer is the one closest to the vehicle itself, it represents the basis for the mere existence of the ecosystem. The traditional selling channel in the automotive industry belongs to this first layer, the channel is composed of components suppliers, car manufacturers, and car dealers that sell to individual customers. Car APIs belong to this first layer and they can be created not only for third parties but of course also for in-house utilization. So car manufacturers may use car data to obtain useful information about the car status, improving customer experience, and prepare for various service deliveries. OEMs have changed their business models and their customer services business units in the last years differentiating their in-house services. Car manufacturers can now offer regular check-ups, urgent intervention on the car but they can also prevent shortages of components for repairs and optimize their inventory by communicating with car parts suppliers that can also access data through APIs. An important part of the selling channel is characterized by car dealers that can be both associated or with a unique OEM or they can be an independent company that sells multiple brands. Car data are an important source from where to extract value for these businesses, the dealership associated with specific OEMs are handled directly by car manufacturers so they rely on an extensive network across the country but they can also offer global assistance if the driver is using its cars in another nation. While acquiring a car from a dealership that is not associated with a specific brand can present a limitation for the customer. But especially this last kind of dealership can implement a Dealer Management system that can access the Car APIs and help them in scheduling car repairs, organizing the administrative aspect, check for the vehicle warranty status, and improving their customers' experience.

This first layer is less inclined to data services off-sourcing even if companies sometimes are not able to develop in house technologies such as APIs or car software (GPS, infotainment system, Human Machine Interface) so they rely on external partners which belong to other layers of the ecosystem, this layer anyway is figured to represent the core of the automotive industry such as OEMs and dealerships. In this layer all the strategies can be observed, companies when dealing with their partners have different options, they can *"sell"* their data under subscription contracts like the main companies like Volkswagen, BMW, and Daimler already do, for selling data, in this case, it means that they offer paid access to car data to third parties as Facebook or Google do. In these years M&A acquisition and joint ventures grew in numbers and firms are expanding on the market and accumulating market power, we have experienced the birth of new automotive groups thanks to mergers between historical brands, FCA (Fiat auto and Chrisler), Stellantis (FCA and PSA group), Volkswagen group (Audi, Volkswagen, Ducati, plus 9 other brands). M&A deals help to increase the resources and reorganize personnel and spaces, in a data-driven strategy two companies can work together in a joint venture or merging and increase their software and business analytics development capabilities and they can avoid off-sourcing. So bartering is more expressed by these expansion strategies but also through OEM-branded dealerships or maintenance workshops. Regarding data wrapping dealerships and OEMs can use data to improve their services and they surely do that, for instance, they equip software with algorithms that can improve the driving experience based on driver habits, data wrapping is also used for customer fidelization offering better services and personalized customer experience for new car purchase within the same car manufacturer or dealership. It is also true that data wrapping can be useful when combined with other sources and players, aggregating multiple data sources and offering a seamless experience. So, this first layer is the core of the ecosystem where car manufacturers have full control over data and they can rely on wrapping, bartering, and selling even if in this case being the car manufacturers the controller of data collection processes they can set their own rules and update them, so selling is facilitated in this layer. Bartering is achieved through M&A or Joint ventures and this phenomenon is increasing during these years.

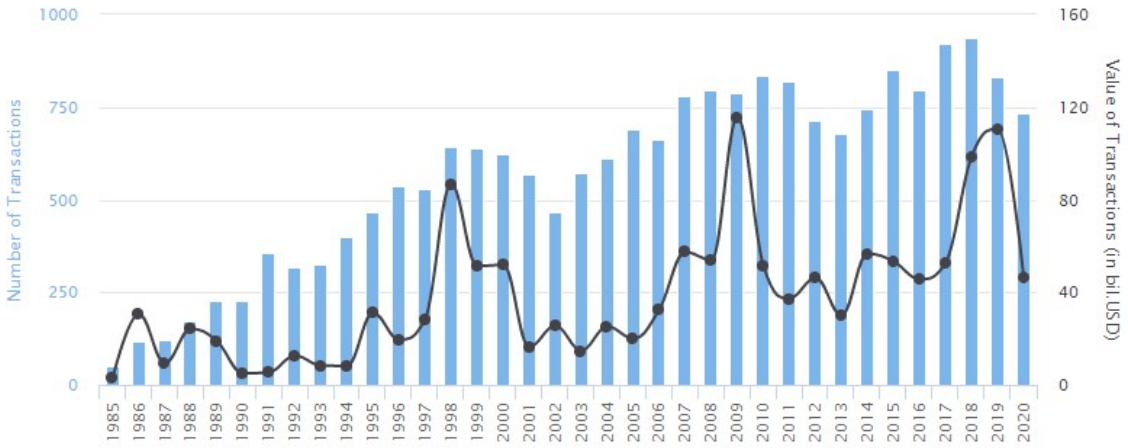

Figure 8. M&A operations in the automotive industry (54)

Second Layer

The second layer is composed of all those businesses that are complementary to the first layer, these companies include rental companies, maintenance workshops, telematics players, mobility service providers, and fleet management companies. This layer expands the reach and services offered by a car to its customers and business partners, sometimes OEMs are not able to develop in-house solutions so they rely on outsourcing the development and deployment to other companies. So services such as vehicle status, GPS tracking system, fuel management, handling logs for truck drivers can be integrated into the sensors installed in the car. Sometimes telematics service providers can supply old models that are not provided with advanced connectivity functions with portable devices that can be connected to auto parts and track performances transmitting that information to dealerships or car manufacturers. Another important sector in this ecosystem is represented by rental car services and fleet management companies, these two businesses have common characteristics since they both handle vehicle requests on behalf of their customers. While rental car companies handle both common users and businesses, fleet management firms work exclusively with other companies that need to manage their company's fleet such as transportation firms, business cars. So fleet management companies handle the need of their clients offering all the services based on car data and telematics, of course, a fleet management company could stipulate contracts with telematics service providers on its own.

Car data have become vital for these two kinds of companies, car data help them to track the activities of their customer, predicting when the vehicles will have to undergo maintenance, know how many kilometers have been driven. For instance, knowing the status of the car can prevent a customer to rent an automobile that has malfunctioning making the driver safe and avoiding any complaint due to car damage. Also from the regulation viewpoint, a rental service could prohibit a driver that wants to drive under influence of alcohol thanks to sensors installed in the cockpit. Thanks to GPS tracking companies can save on labor cost, knowing exactly which trips have been made, and can optimize route and assignment of personnel, their driving style, and why an accident has happened saving on legal expenses. In a survey of 2021 more than 45% percent of the responders told that they experienced a positive ROI within 11 months from the adoption of fleet GPS tracking solution (55) Part of this layer is composed of independent workshops that can extract important information about car status and increasing affinity from their customer offering special prices and increasing satisfaction, these businesses can partner with OEMs and dealership and offer their services to customers that are in a town or areas not covered by official maintenance services or dealerships ones. The last players belonging to this second layer is represented by Mobility service providers, companies of this kind offer services such as ridesharing, trip planning, payment services for transportation and can help customer to combine multiple modes of transportation. The use of mobility service providers has accelerated with the advent of mobile apps that allow users to plan their trips wherever they are. A driver could have different ways to access these applications, it may use an app installed on an

external device like its own smartphone or it could use the Human to Machine Interface already present in its vehicle, companies like BMW, Mercedes, Volkswagen introduced Artificial Intelligence voice assistants; these assistants can help the driver knowing where there is the closest charging station, they can supply information about traffic, parking available, drivers can check different itineraries and book a train or a plane all from their driving sit. Sharing car companies, airlines, and train companies rely on these mobility service providers since they are dependent on applications that allow users to book a ride and plan every aspect of a trip.

As stated before in this layer we find complementary activities that can support car manufacturers, in this sense we find a predominance of data bartering since most of these players need to communicate together and exchange information, for instance, a company that supplies telematics services like Geotab or Verizon that offer GPS location to track vehicles for fleet management companies or rental firms must maintain direct communication through cloud, databases, and servers and the infrastructure needs to be well-functioning. Other elements of this layer are represented by workshops that need to have access to the onboard computer to get real-time car status. Wrapping is also used here to obtain a seamless driving, renting, and working experience to optimize costs and maximize revenues. Selling of data is present but it's not so relevant as in the first layer where data were originating, companies could sell data to third parties but they should acquire it first from the car and is not an easy task since usually, companies give the grant to access to car data rather than selling them and losing ownership. Players in this second layer can create their data bartering activities, as a telematics player that collaborates with a Fleet operator or a rental company. So a predominance of bartering can be observed in this layer, the services offered are still limited, and similar to the first layer, there is increased specialization and to be sustained there is the need for higher synergy between the parties. These players don't have o much control over data produced directly by the car but of course, they could produce their own data through computer elaboration and sell them to third parties

Third Layer

The third layer completes the car ecosystem, even if unpredicted stakeholders can always add to the current scenario. In this layer, several companies help the ecosystem to work properly and stabilize it; one of these is represented by government agencies that are an important element that can be both an obstacle or a catalyst for new technologies and start-ups. Governments are the ones that set climate policy, build and repair streets and bridges, fund R&D expenses, and put incentives for the purchase of new cars as in the case of electric vehicles especially municipal agencies are responsible for the implementations of smart cities strategies and technologies such as intelligent parking, smart lights, they have the power to authorize or deny the installation of data tower, a vital element for connected cars. So having a city that invests in its digital infrastructure is vital to reap all the benefits offered by connectivity such as interconnections

between vehicles, public transportation, pedestrians, and infrastructures, namely V2X technologies. Fuel and charging stations can offer their applications and can connect with the car connectivity system to offer special offers for example through a point system, electric charging station, based on the battery status and model which voltage is suited for that car and display on the car GPS navigator the nearest charging point. Companies offering recharge or fuel service can optimize their investments based on the models on the roads and the routes more common, the time spent by drivers at charging stations, and the overall demand for fuel or electricity. Regarding data towers and wireless networks, governments usually stipulate contracts with major telecom companies that own the infrastructure, a connected car is connected to these towers through sim cards or chipsets that are equipped with 4G or 5G capabilities, the user can integrate its mobile phone contract and configure an eSIM allowing the driver to make calls without having to take its smartphone, thanks to contracts between OEMs and telcos the customer can utilize services like car hotspot that offers the possibility to full connectivity for all the passengers who can use their own devices and access all their favorite apps connecting directly to the car Internet connection. Thanks to the wi-fi connection enabled in the car, OEMs have integrated services such as Apple CarPlay or Android Auto, the driver can also utilize specific applications such as Spotify, Microsoft Outlook e-mail service, weather apps, news. Tesla allows passengers to watch Netflix and Youtube while the car is parked. For instance, BMW offers the integration with Amazon Echo, a driver even before starting its trip can know how much fuel there is, what is the engine oil level, the tires pressure thanks to the voice assistant. Tech companies are key also for the mere existence of the apps on the various stores like Apple Store and Google Play, so OEMs must interact with these companies, offer updates to their applications and cure their UI/UX features. So, OEMs and dealerships are not just selling a machine but they are offering a multitude of services, they have become suppliers of financial services founding proprietary banks such as FCA Bank, Opel Bank, Volkswagen Financial Services, among many others. This phenomenon falls under the sector of captive finance. This transition has eliminated disintermediation allowing the driver to ask for loans, insurance coverage directly from the car manufacturer, or car lending; this phenomenon helped to consolidate the relationship with the customer, for instance, OEMs and dealerships can offer tailored insurance plans to clients thanks to car APIs based on kilometers driven, incidents, but also this system can detect insurance frauds and thanks to GPS location a stolen car can be immediately located. Car manufactures need other financial entities such as banks, insurance, states to know what is the credit score of their customers and if they are authorized to open an insurance position or receiving a loan. Of course, not only OEMs may need access to car data to offer financial services, many times customers have their own insurance companies and they could be a client for many years. In this case, external financial services suppliers or insurers can access car data to offer tailored services as OEMs do, car manufacturers, in this case, can monetize data through selling. What is changing is that now major brands can subtract market power from traditional insurance companies or financial institutions offering an all-inclusive service. Car manufacturers can be also partner with payment service providers such as VISA, Mastercard, Apple Pay to process transactions

demanded by drivers while driving, for instance, a driver can pay for in-app services such as in case of streaming platforms or can book a train or plane directly from the car computer connecting to the payment service network, customers can also order from retailers and have the items delivered to their home. Drivers can also pay tolls automatically thanks to a direct connection with their bank account. So to summarize, the car is now a medium by which thousands of firm can extract value for themselves and their stakeholders, the layers presented here are not divided neatly but they blend into a heterogeneous ensemble, interactions between the first and the second layer may seem sufficient at first glance but they are not. For instance, the interaction between maintenance workshops and OEMs may seem enough to repair a car, but if the right infrastructures such as data towers belonging to Layer 3 firms cannot achieve those nowcasting capabilities that are one of the main advantages of connected cars and car data. Only these intertwined relationships can create the opportunity for the ecosystem to grow and create competition and spur innovation. Of course, these companies need to adapt their structures to host data and analyze them, as stated in the previous chapters they must have the right talents and the right computational power to process data and extract powerful insights to be traded or exchanged with other businesses partners.

This layer completes the ecosystem, even if new relationships are hard to predict sometimes since the setting is so variegated. Here bartering and wrapping blend together and they create powerful sources of value. Regarding data wrapping, multiple companies use data to offer better products such as insurance companies that can offer Pay as you Drive services, logistic firms rely on data and they offer better predictive solutions for shipping and vehicle transportation by rail or trucks. Content providers use data wrapping to enhance user experience in infotainment services; retailers and external marketplaces, can predict and suggest new items to customers for their cars or themselves. The pattern observed regarding the second layer repeats here with a predominance of data bartering, for instance, if a user wants to have access to a loan to purchase a vehicle, the seller has to contact a financial institution to get information about the buyer credit status, etc. Same for governments or municipal agencies. Also, big tech companies such as Apple with Apple CarPlay or Google with Android Auto must have a direct exchange of data with the car manufacturer to offer their services, but also customers give up their information to obtain free services. These tech companies can then employ their own business models and grant data access to other third parties through *"selling"*. In this layer, we can observe a predominance of bartering and wrapping, with numerous exchanges between various players. Selling is present but being these services at the extremum of the ecosystem, even if they are vital for its survival, the chances that these companies have full control over data produced by the car and so the right to license them are a lot diminished concerning the other layers.

Ecosystem Layer	Relevant players	Selling	Bartering	Wrapping	Predominant
First	Suppliers, OEMs, Dealerships	✓	✓	✓	Bartering, Selling
Second	Rental companies, Fleet management, Telematics Players, Workshops	✓	✓	✓	Bartering
Third	Big tech, telco, government, infrastructure, infotainment services, retailers, platforms, charging and fuel providers, Marketing and Ads companies, Logistics, Financial & Insurance Services	✓	✓	✓	Wrapping, Bartering

Final remarks

We have seen through the various sections how the industry is thriving with new ideas and new ways to extract value, different players collaborate with one another in a complex environment, but also how the car evolved through history, from a mere aggregation of mechanical parts to a multi-functional entity that can be a source of opportunity. Of course, this is only a limited study on the digital transformation of the automotive sector and others have already examined the phenomenon from the technical perspective regarding connectivity technologies, regarding privacy and cybersecurity issue that represents one of the most important fields where conducting studies and research. Consumer confidence is one of the key factors for the adoption of these technologies; there is a lot of interest in these new functionalities, 77% of the consumer in five European countries, but people not always know which data are collected and if this process respects their rights or not (56). So, communication clarity is vital for a correct marketing strategy regarding connected cars. A deeper analysis can be conducted on the same topic with a quantitative approach or a qualitative one through surveys, in this way it would be possible to analyze the effects of the adoption of these technologies regarding revenues, costs, and other financial indicators. A survey could aid to obtain even more granular data regarding consumer confidence and demand about specific services and components. There is a lot of room for further research in this field, also from the perspective of ethics and justice about autonomous vehicles, AI, and data collection techniques. It is important to say that based on different countries there are different outcomes, for instance, in Europe we can find stringent policies regarding data protection and consumer right, these are factors that are worth taking into consideration when approaching a strategy for data monetization or conducting a study on the subject, it could represent an important variable for a quantitative study. Since data encompass all the industries in this modern world,

the same analysis from this dissertation can be executed on other economic sectors, both public and private. At a public level, a study on smart city integration with connected cars can be conducted, especially regarding the administration of integration processes and urban transformation. The literature landscape is full of vertical studies from consulting companies and other corporations, what seems missing or scarce is the academic publication on this subject that can include different topics on the same subject horizontally across different concepts and fields. In this dissertation, even if it treats a specific industry, I've tried to link data theory and strategy theory to the automotive sector's digital transformation trying to contribute to academic research.

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