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Impact of Shared Autonomous Vehicles on Automotive OEMs Business Models

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Abstract

This work aims to analyze the evolution of the business models of car manufacturers, with particular regard to the effect of completely automated vehicles on the former. This work aims to show that the advent of such technology might have a very significant impact on the way car manufacturers set their business models and on the concept of the car itself: in a couple of decades, the car might not be intended as a good anymore, but as a service. New technologies, platforms, and business models might lead to an increased efficiency and cost reduction of car sharing, meaning that a standard user will probably shift preferences toward the use of these platforms instead of owning a vehicle. Furthermore, it is interesting to consider how these technologies will facilitate the life of older people and people with disabilities. Finally, the work intends to articulate several scenarios of car manufacturers' strategies and actions, and analyze the evolution of their business models. Of course, this analysis concerns only the market segments that will be affected by the advent of the new technology, therefore, sports cars, luxury vehicles, and several other segments that will not use self-driving technologies are excluded from the analysis. It is interesting to figure out how the companies embracing autonomous driving technologies will change as well as analyzing the strategy, competencies, and business models of these corporations.

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Introduction

Mobility-as-a-service (MaaS) market is increasingly important. According to Orbis, it will exceed 200 USD billion in 2025 (*Figure I.1*). However, this is not the sole evolution taking place. Along with rapid changes in mobility, the technology around cars is evolving. Autonomous vehicles are becoming an increasingly relevant topic and might lead to a radical change in the mobility paradigm. Indeed, autonomous vehicle technology is expected to have a net annual impact on the US economy of 1.2 trillion USD across 13 industries (Clements, Kockelman, 2017).

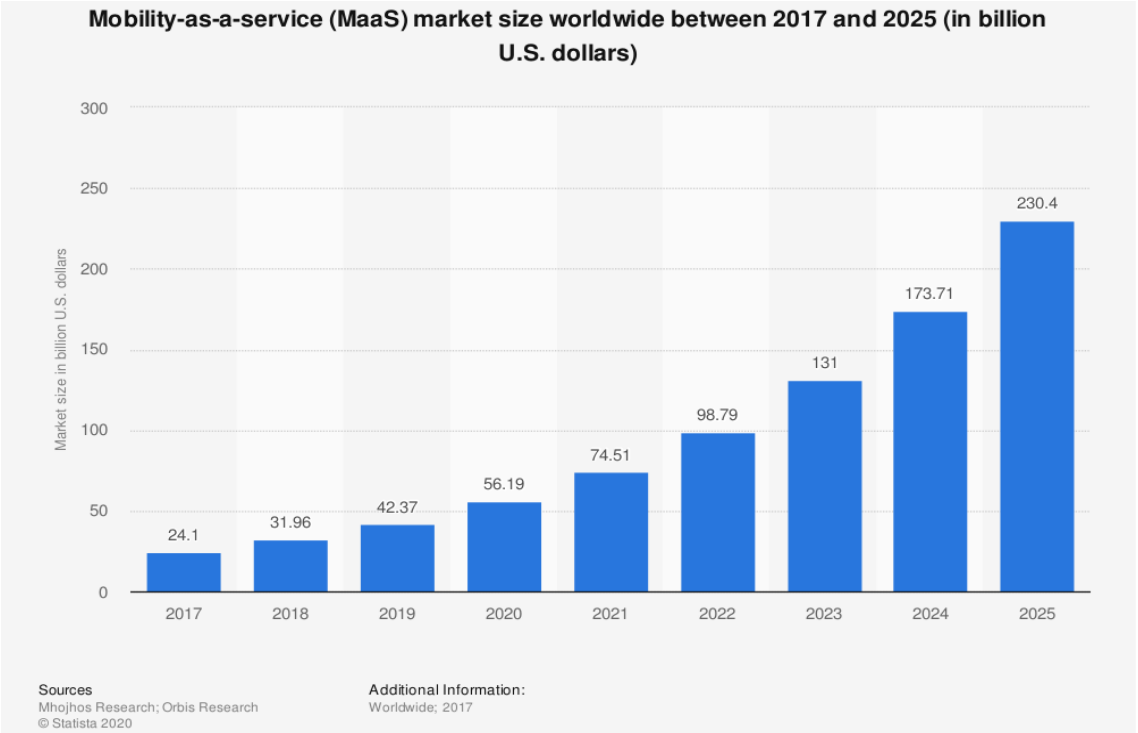

Figure I.1: Mobility-as-a-service (MaaS) market size worldwide between 2017 and 2025. Source: Statista, 2020

Of course, it is impossible to make accurate predictions. However, Deloitte depicted two scenarios of the market share of autonomous vehicles in 2035, as shown in *Figure I.2*. The high uncertainty due to technological, legal, and acceptance factors cause a very high difference between the base case and the best scenario. However, it is interesting to notice that previsions expect China to be the market with the highest share of autonomous vehicles in both scenarios. Additionally, the US market is second in both cases, with higher expected values as compared to Europe and Japan. As a consequence, many companies are investing in technologies related to autonomous vehicles. Of course, among these companies, there are several OEMs.

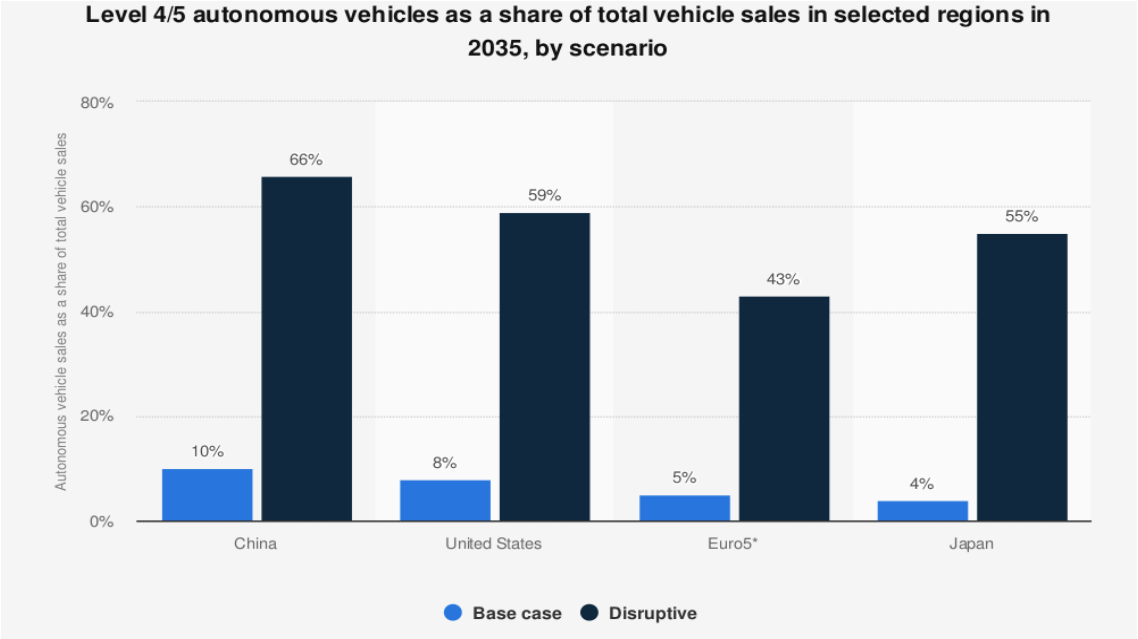

Figure I.2: Share of Level 4/5 autonomous vehicles for new vehicle sales by scenario 2035. Source: Statista, 2020

As shown in *Figure I.3*, however, OEMs are not the only ones investing in this technology. It is, therefore, reasonable to state that OEMs have to face higher and more heterogeneous competition. It is relevant to notice that the companies entering the autonomous vehicles market are mainly high-tech companies such as Google or Baidu, and first-tier OEM suppliers such as Bosch.

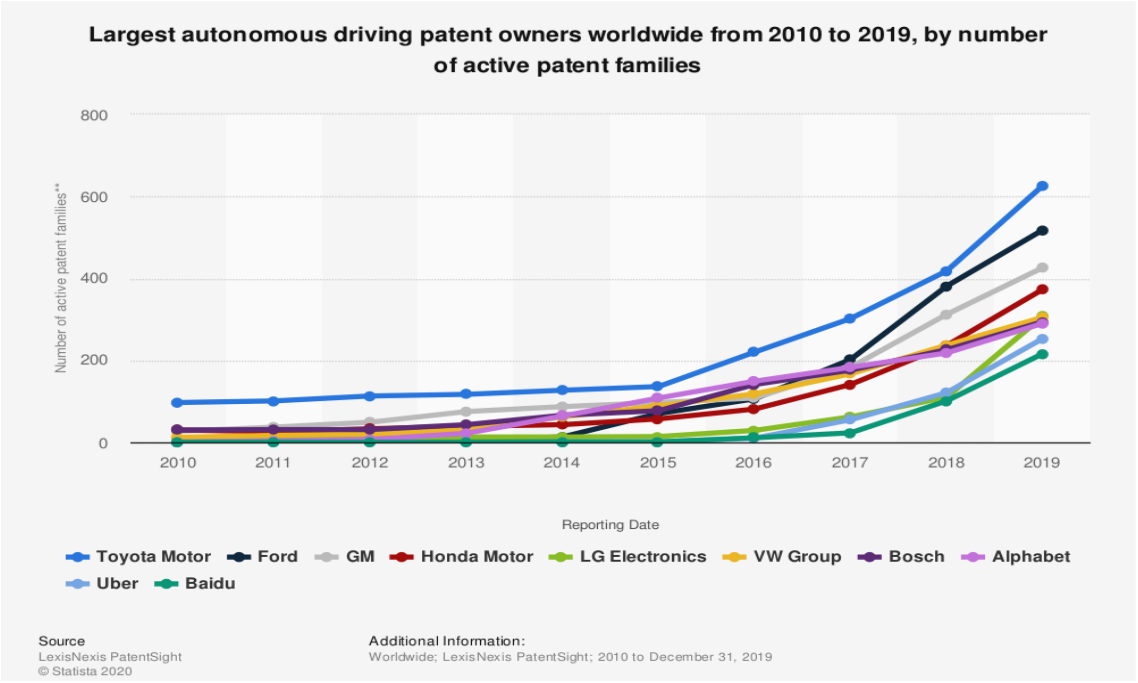

Figure I.3: Largest autonomous driving patent owners worldwide from 2010 to 2019, by number of active patent families. Source: Statista, 2020

Of course, beyond technological and legal challenges, autonomous driving vehicles will have to convince consumers. However, it is relevant to notice that, as shown in *Figure I.4*, more than 50% of respondents would be ready to ride an autonomous vehicle within five years.

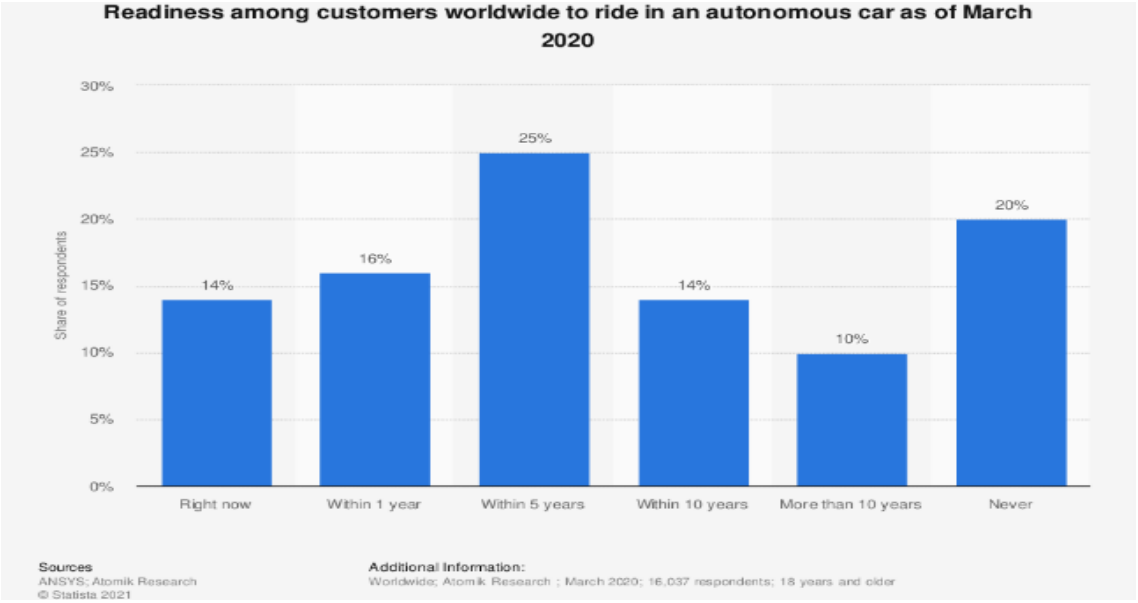

Figure I.4: Readiness among customers globally to ride in an autonomous car 2020. Source: Statista, 2020

Additionally, *Figure I.5* shows the primary concerns related to autonomous vehicles. The results suggest that, once the technological reliability will become a solved issue, the technology is likely to enter the mass market. So far, the trend suggests that the question is not if, but when the autonomous vehicles will enter the mass market.

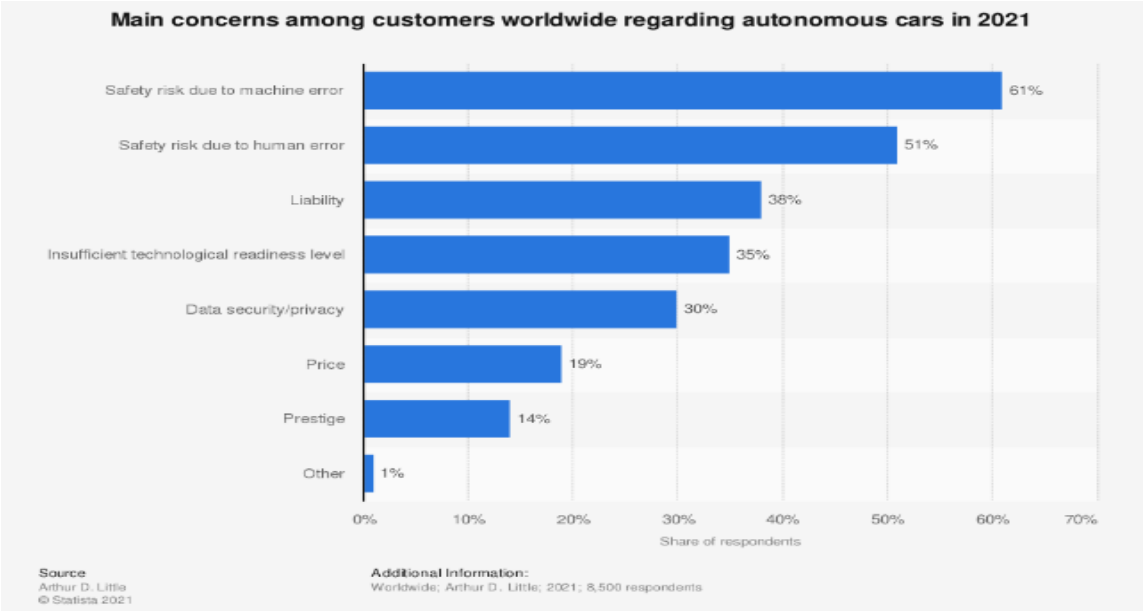

Figure I.6: Main concerns among customers worldwide regarding autonomous cars in 2021. Source: Statista, 2020

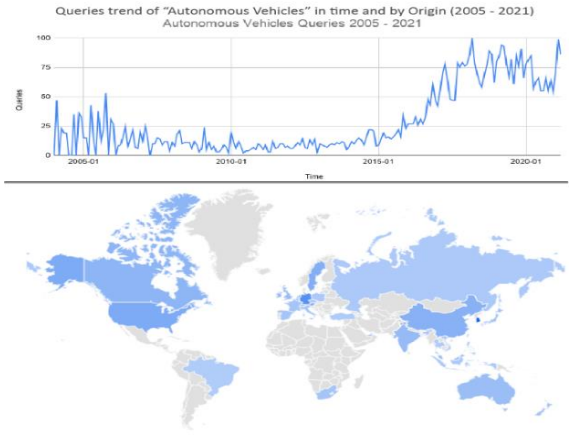

Figure I.6 - Source: Google Trends

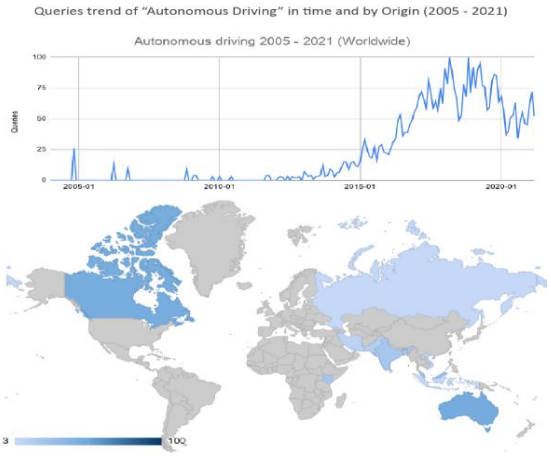

Figure I.7 - Source: Google Trends

As shown by trend analysis, topics as autonomous driving, mobility innovation, and fully autonomous vehicles are acquiring importance and popularity day by day. As shown in *Figure I.6* and *Figure I.7*, the terms "autonomous vehicles" and "autonomous driving" are increasingly popular, especially in the last five years. As shown, also the general public is interested in these topics, in particular in the so-called emerged countries. Therefore, it is more than reasonable to state that autonomous driving technology is already impacting the market. For this reason, it is interesting to investigate and discuss the impact this technology will have on OEMs and on their business models.

In this work, the main goal is to allocate the technology within a few frameworks and define the types of innovation discussed. In order to do so, it is necessary to start with a literature review. The main topics covered by the literature review are disruptive innovation, systematic innovation, and ecosystem innovation and structuring. The following step is to discuss the business model, focusing on the present changes in OEMs' business models. The subsequent step for this work is to analyze the organizational competencies that companies will need to acquire in order to be able to manage the innovation. Of course, topics such as the impact on organizational structures and ecosystems, and changes in corporate strategies, also have to be discussed. The final chapter will cover issues such as changes in mobility, the possible paths to comply with these changes and the transformation of the OEMs' business models. Finally, the last part of this work is focused on forecasting different possible scenarios and a discussion about which of the outlined situations is the most likely to come true.

Chapter One: Literature Review

In order to perform an analysis of the impact of autonomous driving technology, first of all, a literature review has to be presented. The first step is to define disruptive innovation, systemic innovation, ecosystem innovation, business model innovation, and to discuss each of them.

1.1 Disruptive Innovation

The definition of disruptive innovation was coined and deeply analyzed by Christensen in his book "The innovator's dilemma" (Christensen, 1997). According to Christensen, disruptive technologies are innovations that might underperform with respect to the existing products, at least in the short term. These innovations usually have a value proposition different from existing products and services (Christensen, 1997). Moreover, disruptive innovations often have diversified, and usually, new, features that initially are not valuable for the existing customer base: these features are not what the majority of existing customers are looking for initially (Christensen, 1997). Finally, disruptive innovation-based products are usually more user-friendly, smaller, more convenient to use, and have lower prices (Christensen, 1997). Several times these properties had a significant impact on the industry structure, being the industry in IT industry, leisure, or others. Moreover, often disruptive innovations were the initiator for social changes (Christensen, Baumann, Ruggles, Sadtler, 2006).

In his book "*The Innovators Dilemma*" Christensen pointed out **five principles** of disruptive technology, stating also that these principles are so strong that they give no chance of success to managers that ignore or try to fight them. The **first** of these principles is that "companies depend on customers and investors for resources" giving evidence to Pfeffer's and Salancik's "The eternal control of organizations: A resource dependence perspective". The basic idea behind this principle is that, since companies depend on a large group of stakeholders that includes shareholders, investors, customers, suppliers, and others, firms have to provide to these stakeholders the products, services, and results they want, otherwise stakeholders might find other companies that fulfill their interests. The dependence of the company on stakeholders

results in a regular rejection of disruptive innovation[1]. The main reason is the lower margins of disruptive innovations that stakeholders regard negatively. The paradox consists in the fact that disruptive innovations have a great potential in the long term, but they also require apparently non-rational investments. As a result, companies choose not to invest until the innovation enters the mass market. Unfortunately, by that time is usually too late to invest, and the firms struggle to survive (Christensen, 1997).

The **second principle** described by Christensen states that "Small Markets don't solve the growth needs of large companies" (Christensen, 1997). This principle is straightforward: a successful company aims to maintain its growth rate in order to keep share price stable, generate profits and give new opportunities to its employees. The result is that, as the company grows, it is increasingly difficult and challenging to grow at the same rate. To sustain the growth rate, companies often focus their attention and their investments on large markets. It is enough to do elementary math to show these principles: a 10 million dollar company needs $1 million to achieve a 10% growth, as the company reaches $100 million, in order to maintain the 10% growth, it needs $10 million revenue. Therefore, as a company grows, it is increasingly harder to find emerging markets that allow the firm to get enough revenues to sustain the growth rate. As pointed out by Christensen, a common approach for big firms is to wait until an emerging market is large enough to become attractive, unfortunately, this approach is rarely successful (Christensen, 1997). Christensen studied the different ways in which managers of large and successful companies usually deal with disruptive changes. It is possible to categorize the results into three main strategies. The first one is to try to boost emerging markets, making these markets appealing for the company. The main difficulty related to this strategy is that, at the very beginning, both manufacturers and consumers do not know some important features about the product. Nor manufacturers or consumers know "how" and "why" the product will be used. Consequently, the firms also lack information about which characteristics of the product will be valuable and which will not. Getting this kind of information involves a bilateral learning process among consumers and producers, and this process, by definition, requires time. As mentioned previously, a second common strategy adopted by managers is to wait until

[1] Disruptive Innovations include not only disruptive technologies, but also services and business models (Dan, Chieh, 2008; Christensen and Raynor, 2003)

the market becomes large enough to become interesting for the big firm. The problem with this kind of approach is that often firms that are in the market from the beginning build barriers and capabilities that aim to build a symbiotic condition among them and the other players in the markets. By taking these actions, existing players make it difficult for a late entrant to succeed in the market (Christensen, 1997).

Proceeding with the discussion about Christensen's five principles, the **third principle** states that "Markets that don't exist, can't be analyzed". The very core of this principle is straightforward: it is impossible to accurately predict when a market will significantly grow and how large the latter will become. It is relevant to remind that the whole discussion is about large, profitable, growing, and well-managed companies, in which managers rationally make decisions. The lack of information is crucial, especially considering that disruptive technologies involve considerable first-mover advantages. The latter is what Christensen refers to as "The innovator's dilemma" (Christensen, 1997). The main problem related to this principle is that when a company starts to develop an innovation, there are many unknown, and unknowable unknowns due to the fact that even customers don't know what will be the features they will want and value. As shown in *Figure 1.1.1,* the expectations about sustaining innovations were usually fully met. On the contrary, this was definitely not the case of disruptive innovations: in

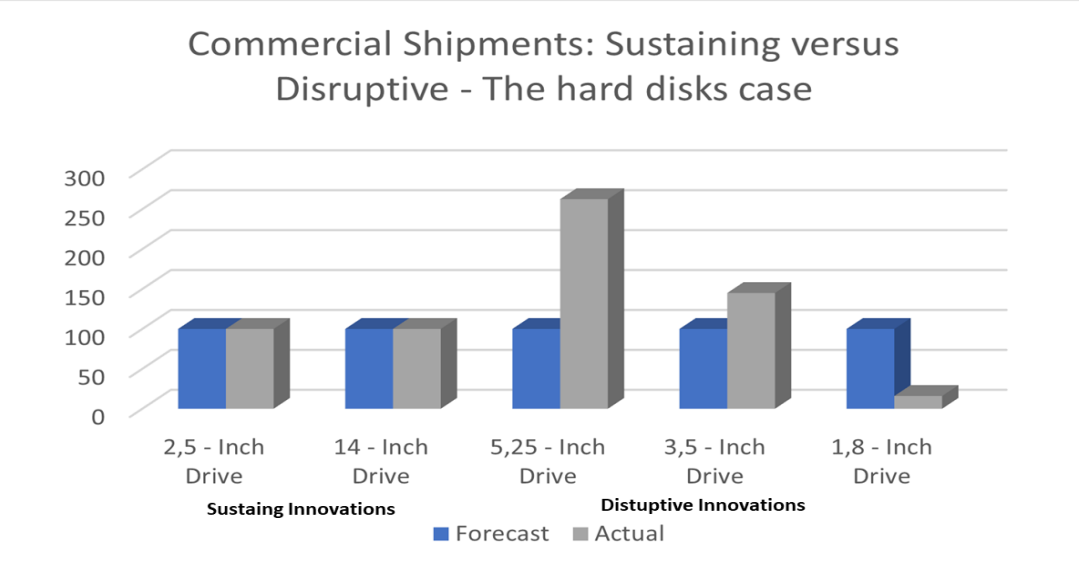

Figure 1.1.1 - Source: Christensen, 1997

the best case there was almost a 50% error, while in the worst, that is the 1.8-inch drives, the error was equal to 550%.

It is possible to identify several reasons for this inaccuracy and to point out some alternative strategies to deal with disruptive innovations. The first observation is that it is common for firms dealing with disruptive innovations to significantly change their original strategies once they learn which are their strengths and errors with respect to the market. (Bhide, 1992; Bhide, 1994; Hart, 1995; Christensen, 1997). Therefore, the key element of the strategy is not the originality, but the margin of error the company leaves for itself: initiatives have to be able to get more than one chances to get right, and thus companies cannot invest too many resources and make giant investments, draining their resources, without the information about the market.

Another significant element to be considered is the pressure experienced by the managers both from the market and from the company: it is common for managers to believe that they cannot afford to be wrong if they want to reach the top of the organization. This situation is clearly in conflict with the basic assumption of disruptive innovations, which is simply the need to make mistakes to be successful. The pressure exerted by companies and the market clearly acts as a dissuading factor for managers to enter emerging markets. Even though it is true that this logic diminishes the probability and the consequences of committing mistakes, it also prevents the companies from relevant gains. Decision-makers are reluctant to bet on projects that could fail because the market is not existing yet (Bower, 1970; Christensen, 1997). Since failure is a distinct possibility when establishing an emerging market, managers have to adopt a drastically different approach from the traditional *plans to execute.* When dealing with disruptive innovations, firms have to act before having the possibility to outline accurate plans. Therefore, companies have to fundamentally redesign their planning approach, and in particular, firms have to switch the scope of the planning activity from execution to learning processes. Companies should primarily plan the learning process to get the critical information for success and find the order of the information fragments. Organizations need to gather relevant information and solve important unsureness before heavily investing resources in projects. An approach that might help firms in the information gathering process is *discovery-driven planning*. Such an approach might provide valuable help, especially when addressing uncertainty deriving from disruptive innovations because it involves assumption identification and testing processes that allow managers to assess assumptions before taking obligations

that are hard to reverse (McGrath, MacMillan, 1995; Christensen, 1997). Moreover, since markets for disruptive innovations typically grow unpredictably, planning approaches such as *management by exception* and *management by objective* are almost pointless because their goal is to avoid unpredicted failures, not successes. A better approach to gathering the relevant information of disruptive innovation markets is to observe how consumers actually use the product. Such an approach, namely *agnostic marketing*, is based on the assumption that neither companies nor consumers possess beforehand the information about how and by how many people the product will be used. Given a situation of high uncertainty, companies often prefer to stand by and observe. Although, given the vast possible gains arising from the significant first-mover advantage, they should invest in gathering information (Christensen, 1997).

The third common approach to handle disruptive innovation is by creating or acquiring independent, small organizations. This strategy makes sense for at least three reasons: first of all, a small project is considered marginal in large organizations. Consequently, nobody really cares about it, and this kind of project is the first one to be eventually eliminated in hard times. In contrast, if the company working on the project is small enough to be thrilled by small achievements, the employees will work even harder on the project because they perceive the project as crucial for the success and growth of the firm. Moreover, since the emerging markets for disruptive technologies are typically small initially, a small company is more than appropriate. Additionally, by creating or acquiring small organizations to deal with disruptive technologies, a large corporation has complete control over them. Consequently, the large corporation is able to encompass the whole set of capabilities required when the market grows. As matter of fact, the corporation could even radically change thanks to the capabilities deriving from the small companies (Christensen, 1997).

Furthermore, large markets are expected to become saturated, meaning that both the margins and the volumes, sooner or later, are going to decrease. In addition to what was previously discussed, considering the fact that product life cycles are getting shorter (Schilling, 2013; Schilling MA and Vasco CE, 2000), companies cannot invest only in mature and large markets if they want to grow continuously. It is clear that large firms

have to face a dilemma since they cannot invest in emerging markets because the latter are too small and, although these are destinated to grow, they do not allow the company to maintain its growth rate, on the other side, investing in large markets that are becoming saturated, could lead for the firm to be outdone and therefore pushed out of the market.

The following topic is Christensen's **fourth principle** which states that "organization's capabilities define its disabilities". It is reasonable to commence the discussion by examining the framework describing organizational capabilities. Capabilities are composed of three main clusters that together define what an organization is able to do efficiently. These clusters are resources, processes, and values. Resources are the most visible factor since these incorporate assets that can be easily acquired or sold and include tangible, intangible, and human assets. The importance of resources is as considerable as relevant: the availability of resources raises the firm's odds to deal with new challenges. However, resources alone are not enough to explain organizational capabilities. Following the discussion, it is reasonable to define the ways and logic used to transform resources into more valuable products or services, namely organizational processes. In this case, the term process refers not only to the classical industrial set of proceedings but also to mechanisms used in planning, human resource management, product development, and resource allocation. It is meaningful to notice that processes can be formal or informal. Managers write the formal processes, which are visible and act as rules. On the other hand, informal processes originate from the influence of organizational culture, which affects the routines and forms the unspoken rules across the company. Both formal and informal processes are designed to handle specific tasks, and they are very effective in addressing those problems. Unfortunately, the very same process will not be a good solution in tackling a different issue. Therefore, it is reasonable to state that a process representing a capability, also constitutes an organizational disability in performing diverse tasks. The main reason is that companies set up proceedings to ensure that tasks will be completed in the desired way. Another relevant attribute of processes is consistency. Nevertheless, it also causes a strong resistance towards changes, increases the company's rigidity, and decreases the ability of the latter to manage innovations, especially disruptive ones (Christensen, 1997). The last element constituting the organizational capabilities are organizational values. These

are the principles used in deciding which are the priorities. As a consequence, these greatly influence the investment choices of the company. As the company grows, the number of decisions to be made increases exponentially. Consequently, values become increasingly critical as the company grows since the top managers cannot make all the decisions. Thereby it becomes critical to train employees and cultivate their values aligning the latter with the organizational ones. The main problem related to values is that these eventually define the minimum acceptable gross margin and size: since the margin of disruptive innovations is often low and initially have small markets, employees will discard these projects because they do not fit with the values (Christensen, 1997). As it emerges, while resources can be acquired or created relatively easily with respect to processes and values, these are very hard to modify. When a company lacks the capabilities to copy with a new task, managers have three possible ways to create them. The first possibility is to acquire a firm that possesses the required capabilities. The second option is to alter the current capabilities of the company. Finally, managers can create an independent company with the desired capabilities within the former. Within the first approach, an important consideration is that the acquired company should not be incorporated into the parent company if the company is acquired mainly for its processes and values. Integration could lead the processes and values of the acquired company to vanish. A better approach would be for the acquiring company to foster the values and processes of the acquired company while letting the latter operate independently. On the other hand, an acquisition is principally aiming to obtain ownership over significant resources of the target company, such as patents. The second approach, namely, changing or creating capabilities internally, is very challenging because of the resistance by managers, organizational boundaries, and culture: Processes and values are very rigid by definition. Trying to build new processes and values also means bringing these into contrast with the existing ones. Therefore, it is very challenging to succeed with this approach. Finally, the third approach, creating an independent organization, is more viable with respect to the second one. However, there are still two crucial considerations: (1) it is relevant to avoid putting in competition its projects with the ones of the mother company, (2) it is essential to separate the resource allocation process of the spin-out from the one of the parent company (Leonard-Barton, 1992; Christensen, 1997). It is also important to mention that, since

disruptive innovation is a cycle, companies could understand and learn how to innovate and do it continuously, even when it results in controlled cannibalization of the core business (Bower and Christensen, 1995).

Finally, the **fifth principle** states that "Technology supply might not equal market demand". The reasoning behind this principle is that, in the beginning, disruptive technologies are used in small markets and usually underperform compared to the mainstream ones. However, the former gradually fill the gap between their performances and the ones requested by the users. When the disruptive technology and the existing one become comparable, customers can choose among more than one technology and, since their needs in terms of functionality are satisfied by both technologies, they assess different features as valuable. Differences in properties are particularly relevant when the performance of mainstream technologies exceeds the one required by the market, which is not willing to absorb the increased functionality. Christensen defines this phenomenon as *performance oversupply,* and it is due to the more rapid development of functionalities of mass technology with respect to the performances required by the market. Therefore, companies should closely monitor the ways consumers utilize their products to predict when the basis of competition in the market will change. In such a situation, observing customers is necessary because, in this situation, disruptive innovation has the possibility to invade the mass market, and once the main functionality requirement is satisfied, other attributes, for which the demand in terms of functionality is not satisfied, become critical. Moreover, if there is a situation of performance oversupply, also differentiation strategies lose significance and efficacy. Furthermore, performance oversupply plays a pivotal role in the evolution of the product cycle. When it comes to product cycles, for the purposes of this work, it is meaningful to describe the *buying hierarchy* framework that depicts four main steps and motivation characterizing shifts of consumers' preferences. These steps are namely (1) functionality, (2) reliability, (3) convenience, (4) price. Usually, in the beginning, the market lacks a product that fully satisfies the functionalities required. However, at a certain point, few companies successfully fulfill the former requirement. At this point, consumers start to base their choice on how reliable the supplier is, and not all vendors satisfy the requirements. Then, the same mechanism is then applied when more companies meet the reliability requirements: consumer preferences begin to be based

on the convenience of using the product. Finally, when the third kind of requirement, namely convenience, is fulfilled, the choice starts to be based mainly on the price. However, many large corporations continue to push on functionality requirements, even when these cannot be absorbed by the market, to outcompete rival companies, but in doing so, they can easily miss the change of the attributes valued in the market. In these kinds of situations, disruptive innovations can really succeed for two reasons. The first reason is that features that make disruptive innovations in mass-market are their strengths in emerging markets. Secondly, disruptive products tend to outperform mainstream products with regard to simplicity, price, convenience, and reliability. Consequently, these products become strong and diversified competitors once they match the market requests. It is interesting to notice the different approaches in dealing with disruptive technologies between established firms and emerging ones: the formers usually had a technological strategy, pushing technology to meet the requests of existing markets. On the other hand, emerging companies focus on finding, or even building markets in which the competition is based on attributes that were favorable to them. This different approach often brought big companies to focus on increasing product functionality more than the market can absorb, being then outperformed by rivals investing in disruptive technology (Christensen, 1997). It is important to mention also that market willingness to pay for an attribute that is fully satisfied, is decreasing as the firm wants to cover a larger share of potential customers, while the willingness to pay for an attribute perceived as valuable and improvable, is increasing (Schmidt & Druehl, 2008). It is easy to apply this principle to the hard-drive sector: if we consider the willingness to pay for extra capacity, is decreasing as the number of potential costumers increases, adding to main-frame costumers, mid-range ones, desktop users, laptop user, and so on, the opposite happens if the considered attribute switch toward the size, as the latter diminishes, the willingness to pay of the same customer segment considered previously, increase (Schmidt & Druehl, 2008).

It is relevant to notice that there is not only one pattern to deliver disruptive innovation. As mentioned by Christensen, there are also companies that brought disruptive products to market starting with a premium product and then making it more affordable for the market (e.g., I-phone), other companies were just too fast to deliver their technology and to increase the technology trajectory that they made it impossible for

incumbents to catch up (Christensen, Raynor, McDonald, 2016). Consequently, it is possible to further differentiate disruptive innovation into two categories: (1) market-creating innovations that, in a certain sense, reinvent a complex and costly product into a much easier to use and cheaper, and (2) efficiency innovations, these are designed to increase efficiency but sometimes can eliminate the incumbents, even if this is not their primary purpose. Worth to be mentioned is also the fact that, in the current scenario, the speed of innovations is constantly increasing, and this causes big, successful, and slow to react at a disadvantage. Consequently, fast adaptation became a necessary capability. Adaptability, in this case, refers not only to products and services but also to business models: companies have to continuously defend their profits, and this embeds the ability to find new ways to make money. Another possible approach is continuous innovation: in this case, the company's central goal is to deliver to market innovations that create value. For these companies, the profit is not a goal but a result. Christensen observed that this approach, which sees innovation as a requirement, is the only long-standing solution to the innovator's dilemma (Denning, 2016). Therefore, it is reasonable to state that disruptive innovation became a dynamic capability of certain firms (Assink, 2006) and that it includes the ability to renew organizational capabilities in the present quickly evolving market (Teece, Pisano, Shuen, 1997). Some other studies suggest that the strategies proposed by Christensen are not the best way to react to innovation. The most common motivation is that, as mentioned in *The Innovator's Dilemma,* disruptive innovation involves a whole set of different organizational capabilities, which means that the shift toward innovation is usually competency destroying. It follows that to avoid destroying competencies, companies should estimate the value of winning and compare it with the value of trying to exploit existing capabilities. The second suggested step is to leverage existing capabilities if these can be deployed in new markets. Finally, incumbents can collaborate with entrants as complementors (King, Baatartogtokh, 2015). In the automotive industry, collaborations might be both among vertically interdependent companies and among firms that are horizontally interdependent. These collaborations should aim to exploit complementarities and create win-win scenarios (Pinkse, Bohnsack, Kolk, 2014). These suggestions are also due to the fact that there is a significant number of entrants in the market and the automotive industry is not an exception. Indeed, original equipment

manufacturers are no more the only players, and therefore they have to compete not only among them but also with entrants providing customer-centric mobility that alter the entire value network (Riasanow, Galic, and Böhm, 2017; Berman and Bell, 2011; Matt, Hess, and Benlian, 2015). Considering the evolution of the market, companies have to adapt, and this means also modifying their business models if they want to remain competitive (Riasanow, Galic, and Böhm, 2017; Chanias and Hess, 2016).

Conclusions

The literature about disruptive innovation is certainly vast and with different opinions about its exact definition. However, the great majority of scholars agree on the fact that disruption is a process, not a one-time event. Another point upon which scholars generally agree is that disruption does not mean success. Many innovations with high potential fail (Christensen, Raynor, and McDonald, 2015). Besides, it is reasonable to stress the fact that disruptive innovation is not referred just to a product or a technology, but it includes innovations applied to services and business models, and one of the disrupters' advantage is that their business models are diverse from the ones adopted by incumbents (Christensen and Raynor, 2003; Christensen, Raynor, and McDonald, 2015). Of course, incumbents can react by changing their business models. Scholars suggest four categories of business model transformation commonly used in the automotive industry: creation, termination, extension, and revision (Hanelt, Piccinini, Gregory, Hildebrandt, and Lutz, 2015). Considering the innovations such as the advent of autonomous driving, increased digitalization, expected in the automotive industry, it is likely to observe all the types of business model innovations: OEMs could terminate relationships with car dealers and replace the latter with virtual tours, the formers might also extend their business models toward new ways of attracting customers such as through social media, revision might take place because of the architecture of the autonomous vehicles that require OEMs to combine digital and physical components, the autonomous vehicles could also require manufacturers to initiate business models related to data services (Riasanow, Galic, and Böhm, 2017; Chanias and Hess, 2016). As emerged from the literature, digitalization is significantly impacting the automotive industry and OEMs. The latter have to face the entry of several kinds of players, including car sharing platforms, infrastructure providers. Thereby, carmakers have to

simultaneously try to keep the largest possible share of value and collaborate with the new players. The evolution of the business ecosystem means that OEMs have to innovate themselves and switch from a value chain towards a value network (Riasanow, Galic, and Böhm, 2017).

1.2 Systemic Innovation

The second theoretical framework to be addressed concerns systemic innovation. It is appropriate to specify that, even though the term *systematic innovation* is increasingly popular, its meaning is not unambiguous. According to Midgley and Lindhult, this terminology is used in at least four different contexts and with diverse meanings: (1) a technology produced in an innovation system, (2) related to regional policies to enhance innovation, (3) a turning point for sustainability affecting the infrastructure utilized by companies for forthcoming innovations, and (4) a process to enhance the reasoning of people from a broader point of view (Midgley and Lindhult, 2017). For the purposes of this work, systemic innovation denotes the process of innovation within an innovation system composed of multiple divisions or companies (Midgley and Lindhult, 2017; Teece, 1986). Autonomous vehicles are an excellent example of systemic innovation as intended in this work.

It is reasonable to commence the analysis by highlighting the distinction among autonomous innovations, namely, those that have no or little effect on the other components, and systematic innovations, which involve the rearrangement of several parts of the system. In some cases, a company might own all the divisions involved but, it is an exception rather than the rule since different firms usually are involved. The multiplicity of players involved brings new challenges, obstacles, and hazards, threatening the success of the innovation. When dealing with systemic innovation, a company has to face several internal, external, environmental, technological, and strategic challenges. Moreover, the company must protect the innovation and capture as much value as possible, keeping in mind complementarities and interdependencies with other players. It is, therefore, rational to examine in depth the main factors to have a greater understanding of the challenges faced by a firm when dealing with systemic innovation (Midgley and Lindhult, 2017; Teece, 1986).

Uncertainty

As also discussed in paragraph 1.1, innovation involves uncertainty. It is especially true in the case of systemic innovation because of the complexity and the coordination required. Uncertainty arises from internal, external, system, and market factors. Internal factors derive from investments and opportunity costs, technologies, capabilities, and culture. The main external and system critical variables are coordination, opportunism, communication, integration, organizational boundaries, appropriability, technological interrelatedness, and market assets. Therefore, stating that companies often spend time fishing in the dark is not too far from reality. By extension, factors such as serendipity and fortune become relevant. Teece mentions three types of uncertainty. The first kind is uncertainty intended as random and unforeseeable facts and variations of the status quo. The second sort of uncertainty results from miscommunication among different players and the fact that a company has no chance to know the plans of the others. It is worth noticing that the second type of uncertainty is strictly related to the organizational form and its boundaries. Companies can manage to a certain extent this type of uncertainty through vertical integration, coordination, and investment plan sharing. The third kind of uncertainty is due to opportunism, which could lead to some unpleasant situations (Midgley and Lindhult, 2017; Teece, 1986).

As it emerges from the discussion above, uncertainty has several sources and implications for a company, especially when dealing with complex systemic innovations.

Ambidexterity

In a complex environment characterized by increasingly rapid changes, companies have to adapt. Therefore, firms have to face challenges such as reconfiguring, integrating, adapting, and reorganizing internal and external resources. Teece defines the ability to meet these challenges as dynamic capabilities. The latter is particularly relevant considering the increasing importance of firms' ambidexterity and the rise in complexity of the business environment. Based on the assumption that a business seeks to generate profits above the industry average, it is reasonable to state that a company seeking sustainable superior returns in the long run, will try to build capabilities allowing them to exploit and explore simultaneously. Exploitation is the ability to make profits through mature products. On the other hand, exploration consists mainly of R&D activities

covering a longer time horizon that involves a higher risk but which the company needs to remain competitive and profitable.

These two different kinds of activities might seem conflicting because they demand different styles of handling. Exploitation focuses on efficiency; exploration needs to make some mistakes to create a profitable innovation. A common way of dealing with both types of activities is to set independent divisions with different cultures, which share common values and directors. The direction should also pay attention to a proper design of the incentive system. Moreover, managers must also scan the environment, validate their previsions, reassign resources, and build competencies according to their previsions. Additionally, cross-firm ambidexterity is required when dealing with systemic innovations. Companies need to integrate vertically and horizontally, align assets to minimize costs, and fuse the different components to maximize the efficiency of the systemic innovation. Each of the processes described is essential to deliver a valuable solution to customers. Finally, the various companies involved in the innovation process also need to co-create the market for their product: once again, ambidexterity, entrepreneurial competencies, and dynamic capabilities become crucial (Teece, 1986; Teece, Pisano, Shuen, 1997; Teece, 2010).

Stakeholders and Ownership

It is reasonable to state that systemic innovations produce value only when associated with complementary innovations that often originate beyond the organizational boundaries. This kind of innovation operates within an organized set of interdependent parts that form the system. When discussing such types of innovations, it is helpful to investigate who are the stakeholders and which is their point of view (Midgley and Lindhult, 2017). The definition of stakeholders is particularly relevant for several reasons: (1) innovation always involves a certain degree of uncertainty, (2) different players might have divergent interests, (3) when dealing with systemic innovations, boundaries of the organization blur, (4) the management of the value appropriability is crucial, (5) coordination among different organizational divisions and companies is difficult to achieve and could imply friction, (6) commercialization can be slowed down or made impossible for many reasons, (7) the different stakeholders might have different risk preferences, (8) partners could bypass initial agreements on distributing

costs and value, beyond that, opportunistic players could take advantage of unpredictable circumstances that are likely to arise, (9) some players might not be willing to disclose all the necessary information (Teece, 1986).

As it emerges, the mere presence and involvement of multiple players and stakeholders lead to several difficulties in coordinating and designing the whole development process of the innovation. The hazards become even more relevant considering that the success of the systemic innovation heavily depends on coordination in terms of goals, information flows, competencies, and technologies (Midgley and Lindhult, 2017).

One possible strategy of improving coordination, discouraging opportunistic behaviors, and aligning goals, is through cross-ownership. According to Teece, if there is no common ownership of the system, the stakeholders tend to be reluctant to adopt the systemic innovation. Indeed, this is very much in line with the second principle of organizational design that suggests that common ownership is likely to foster efficiency and integration among the different stakeholders (Teece, 1986). Considering the increasingly complex business environment, the transition from a value chain toward a value network, and the importance of coordination, integration, and cooperation when dealing with systemic innovation, it is clear that cross-ownership might have a positive effect in aligning the goals of each player involved and avoid opportunistic behaviors. On the other hand, such a strategy is not always viable since it requires a high level of liquidity. Moreover, acquisitions or significant participations require the acquiring company to have almost full information about the target company and its technology, and once the purchaser has the technological specifics, the relative value of the target company diminishes. Following the logic, it is understandable that stakeholder management, the choices of cross-ownership, and integration represent the first stumbling block of a company entering a systemic innovation system. (Teece, 1986; Teece, Pisano, Shuen, 1997; Midgley and Lindhult, 2017; Teece 2010).

Moreover, in addition to the delicate question about the cross-ownership, companies should pay attention to possible changes of the system, aiming to optimize the synergy among its players, and analyze the impacts on the technology, the way it creates value, and the probable impacts on the system (Midgley and Lindhult, 2017). The possible changes of the system are particularly relevant if different companies own significant

subparts of the innovation. Since every stakeholder has diverse costs and revenues, there are transaction costs and the possibility of spillovers to firms external to the system, and of course, there is the risk of opportunistic behavior by each player since every company aims to maximize its own profit. Consequently, the possibility of partners to capture the larger share of value depends on factors such as the degree of legal protection, the regime of appropriability, and the dependence of the innovation on the complementary assets (Teece, 1986).

Firms' trajectory

As it emerges, coordination, integration, uncertainty handling, and managing stakeholders are crucial elements when dealing with systemic innovation. However, these are not the only relevant aspects. Teece et al. stated that the champions in the modern marketplace are the companies that are flexible, responsive, and versatile in product innovation. Therefore, organizational and managerial capabilities are increasingly important. The extreme competition drives companies to strive to maximize the returns of their assets. As a result, the companies have no choice but to develop the abilities to build competencies and capabilities to sustain profitability. The emerging notion is that organizational capabilities are a crucial strategic tool since these are part of the difficult to imitate assets and an integral part of the ability to generate profits. However, capabilities are also the result of previous choices made by the company. Firms tend to be coherent with past decisions, and this anchors companies to a trajectory of competence development. The span of possible routes of an enterprise is significantly affected by its history. There are several factors influencing path dependency, the most common are previous: (1) investments, (2) increased returns to adoption, (3) network externalities, (4) complementary assets, (5) scale economy, (6) lock-in effect, (7) switching costs, and (8) binding contracts. Investments are particularly relevant from a strategic standpoint because they broaden or reduce the spectrum of possibilities, depending on the field of investment. Consequently, companies must carefully manage their capabilities, but they also have to monitor their path and organizational flexibility (Teece, 1996; Teece, Pisano, Shuen, 1997).

As a matter of fact, the innovation process typically demands specific investments, influencing the technology trajectory of the company. Additionally, innovations require

coordination and cooperation among the numerous sub-units. Moreover, the presence of complementarities and the control of innovation-specific assets are almost mandatory to succeed. With these considerations emerge that, when dealing with systemic innovations, the complications are much more problematic since different companies need to make specific investments while facing several risks. When investing in systemic innovations, companies take both the risk of financial losses and the hazard of not taking over a fair share of value. Appropriability hazards might arise from factors internal to the system and external ones. The internal determinants are mainly due to partners' opportunistic behavior. On the other hand, the external factors are due to competitors taking advantage of the innovation, especially when the legal protection of the innovation is weak (Teece, 1996; Teece, Pisano, Shuen, 1997).

Culture

Companies are increasingly conscious about the importance of the culture intended as the kernel of the firm's informal structure. Even though the rules that emerge from the organizational culture are not formal, they strongly influence the behavior of the employees by letting everybody know how to behave in a particular situation. Teece states that culture is critical, especially within an innovative company, for several reasons. The first reason is that culture allows people to know which are the norms in the development of a new product or process. Secondly, cultural norms empower to fail and to dare the state of play. Moreover, culture allows employees to communicate more openly within the company and beyond its boundaries (e.g., with customers). Finally, culture promotes and cultivates the desired values such as trust, flexibility, dedication, and teamwork. Culture, therefore, represents a key asset for an organization and might be even more critical when a company has to face technological development. It is meaningful to mention that culture has deep roots, and it is difficult to change it overnight. Unlike in the case of an investment, a statement of the managers will not affect the culture (Teece, 1986).

It is possible to describe culture as the personality of an individual. However, in the modern business environment, companies need to build networks, collaborate, compete, integrate, and become part of intricate networks similar to societies. Given the increased complexity, culture became even more relevant considering that it has to

be in line with the guiding principles of the whole system and that the network lacks authority relationships within it. Therefore, when operating within a system of organizations, managers have to act as bridges among different parties. Finally, culture is an integral part of the mentality within the company. Without an innovation-embracing culture, a company could slip into myopia. Organizational myopia happens when a company has free cash flows and becomes blind to new opportunities and to arising challenges. Short sightedness is mainly due to the "is has always been done this way" mentality (Teece, 1986).

As it emerges, culture is a core element of any company, but it becomes even more relevant in the modern environment dominated by strategic alliances, fast pace, global competition, and mutually dependent technological innovations.

Coordination and Complementarities

Coordination is one of the key activities within a company, especially in the present day's fastly evolving market. Companies need to align processes, meet deadlines, optimize production processes, and deliver new products to market as quickly as possible. Therefore, companies are increasingly careful in designing coordination mechanisms, especially since it could significantly impact the sustainability of a firm's competitive advantage and affect profitability. Scholars noticed that coordination routines are long-lasting and differ from a company to another. Consequently, it is possible to intend coordination as an organizational capability. The ability to coordinate in uncopied ways can lead to apparently unimportant technological changes, but the latter could significantly impact the competitiveness of incumbents, pushing them out of business. It is also significant to point out that companies have to coordinate not only processes but also incentives: if the earnings are not related to the performance of their business unit, there is the chance of reluctance in enhancing innovation. Such a process, known as low-powered incentives, is frequent both within a single company having to reward its employees and within a system of organizations jointly developing a new product. Of course, different companies have distinct requirements of coordination depending on various factors and the type of innovation the company is developing. As a matter of fact, one of the main differences between autonomous and systemic innovation is the design coordination required: the former needs very little design coordination to be

commercialized, on the other hand, a company cannot commercialize systemic innovations without articulate design coordination because it involves crucial interdependencies with other components, that could be either produced internally or by external firms. As it emerges, coordination is the primary hurdle when dealing with systemic innovation because the latter requires harmony among the actions of each member of the system. It follows that any mismatch in effort, competencies, or technology among companies has adverse impacts. As stated by scholars, when a contractor is in charge of developing the complementarity, it is likely to have delays. As mentioned above, multiple factors might cause delays, the most common are lack of capabilities, discordance among companies, differences in risk preferences. Commissioning a complementary part for innovation to an external firm also implies the risk of information leakage to competitors: the latter could befall either vertically and horizontally. Therefore, when appropriability hazards are severe, the company must take control over the innovation trajectory. Possible ways to seize the command over the innovation is by investing in R&D, through vertical integration, or by investing in the supply base in order to create a competitive market for complementarities. Therefore, it is reasonable to state that outsourcing decisions depend not only on costs but are a strategic choice. As a matter of fact, decisions on cooperation, outsourcing, and co-development depend on factors other than the mere cost. There are many additional considerations about reliability, culture, structure, and processes to be made in order to avoid opportunism. True enough, it is complex and costly for a company to monitor opportunism only by means of metrics and monitoring activities. Choosing the right partners and designing the appropriate incentive schemes is therefore critical. Innovators, however, have to draw up and execute strategies allowing them to capture the value besides creating opportunities. These strategic choices can contribute to building new organizational capabilities that are essential to cope with emerging opportunities. As it comes out of the discussion, the ability to create, rearrange, and exploit organizational knowledge and capabilities to create and retain value, is the core of innovation (Teece, 1996; Teece, Pisano, Shuen, 1997; Teece, 2010).

It is also meaningful to stretch the importance of complementarities in modern-era markets since innovations enhance the availability of complementary goods. The result is that there is a wide variety of interdependent products that reinforce each other.

Complementarities might benefit the firm by allowing to decrease cost, enhancing economies of scope, or creating externalities. From a theoretical perspective, it is reasonable to state that the value of combining complementary constituents is greater than the sum of the elements. Moreover, collaborating with the producers of complementarities might lead to co-specialization and further increase the value of the assets, especially if the parties are able to create a unique combination of co-specialized assets. However, in order to achieve long-term sustainability, a company must be able to adapt, react to changes in competition and preferences, manage its assets, leverage complementarities, and exploit its capabilities to continue fulfilling customers' needs (Teece, 1996; Teece, 2010).

As discussed, coordination and complementarities are crucial for an innovating company since these can bring significant advantages. Of course, there are also some downturns in terms of flexibility and hazards. Managers have to constantly monitor the activities of all parties within the systems in order to prevent opportunism. However, companies need not only complementarities but also components. It follows that managers must also design the supply chain in a way that allows cost-efficiency. However, if suppliers acquire significant bargaining power, they could jeopardize the innovator's profitability. Therefore, coordination activities are critical in supply-chain management. Once again, organizational capabilities are perhaps the most valuable asset for an innovating company (Teece, 2010).

Integration

As discussed above, coordination is one of the pivotal activities in systemic innovation. However, it is also desirable to discuss an alternative path for the companies, namely integration. When innovating, companies might choose to integrate in order to ensure value appropriability. Especially when managing systemic innovation, integration can be a powerful tool that accelerates information flow, enhances coordination, and guarantees appropriability. Furthermore, in novel industries, the companies might have no choice but to integrate because of the lack of complementors. In the absence of an adequate partner, firms must build themselves the value chain and the capabilities they need. As previously mentioned, building competencies is often challenging. It is easier for companies to acquire the competencies by vertically or horizontally integrating. The

most common integration methods are acquisitions, joint ventures, strategic alliances, or other forms of participation. Unfortunately, integration comes with several downturns: first of all, it is expensive; secondly, it might lead to aversion by the employees due to the "not invented here" effect. Moreover, usually, integration reduces flexibility, blurs the organizational boundaries, and demands significant rearrangement of the parts of the system. (Teece, 1996; Teece, Pisano, Shuen, 1997; Teece, 2010; Teece, 2017).

It is also reasonable to discuss the case in which a company has to decide whether to accept or not an offer to integrate. According to Teece, the decision depends mainly on four factors. The first one is the transfer cost to a partner compared to the transfer cost to an external company. The second is the extent of the legal protection of the innovation. The third factor is the efficiency and effectiveness of selling the technology through contracts compared to the effectiveness and efficiency of internal transfer. Finally, the fourth factor is whether the profits resulting from licensing are higher than the net income the company could gain by directly entering the market (Teece, 1996).

Other factors

In addition to the factors already discussed, it is reasonable to mention a few additional elements of systemic innovation. One of the main challenges the companies have to face is the pace of technological change. Since markets evolve rapidly, firms have to be able to innovate quickly to remain competitive. Therefore, companies have to be quick to build organizational capabilities, acquire resources and learn. For a company, the ability to learn is particularly relevant. Individuals and teams can perform tasks quicker and more efficiently through repeating the former and experimenting. Learning is referred both to individuals and to entire organizations. It can occur by means of emulation, routines, and collaborations that allow understanding complex problems. Moreover, innovations require the orchestration of multiple factors. Consequently, learning is a must-have organizational capability when innovating. Of course, different types of innovations demand different learning approaches. Single-loop learning is the process of incrementally improving a product or a service. On the other hand, double-loop learning is more far-reaching because it involves a radical change of the system's core assumptions. A company needs both single-loop and double-loop learning when

dealing with systemic innovation. Single-loop learning is necessary for improving a single component, while double-loop learning is a must-have in systemic innovation. Of course, an organization should have a proactive culture to develop the ability to learn. Another significant element is system thinking: it enhances open-mindedness, helps in building more efficient communication flows and collaboration methods among organizations. Another relevant concept is the cross-learning among firms. As a matter of fact, companies are increasingly embracing R&D alliances. The reason for forming these alliances is to leverage knowledge, competencies, and capabilities and to put products on the market at a faster pace. However, R&D alliances have some significant drawbacks: the first is the possibility of opportunistic behavior of the partners, the second is the higher probability of information leakage. It is, therefore, reasonable to state that learning is a crucial aspect of the company's strategy. Other relevant factors from a strategic perspective are processes, routines, culture, assets, and capabilities. In particular dynamic capabilities are vital in fast-evolving markets since these allow the company to adapt, integrate, acquire resources and competencies, and reconfigure assets and skills. Therefore, since dynamic capabilities enable firms to adapt to changes, these can build a long-lasting competitive advantage (Teece, 1996; Teece, Pisano, Shuen, 1997; Midgley and Lindhult, 2017; Teece, 2010).

Conclusions

As emerged within the discussion, systemic innovation is both powerful and dangerous for a company. There are numerous factors to consider and that demand attention. However, systemic innovation enables companies to increase efficiency, be more flexible, and deliver innovative products to the market faster. As a matter of fact, it became a common practice for OEMs to collaborate with tier 1 suppliers during the design of new products. This trend of tight collaboration will become even more critical with the advent of autonomous driving because of the growing complexity of complementary assets for OEMs. Consequently, the OEMs are strengthening their position within their ecosystems and trying to secure it.

1.3 Ecosystem Innovation

The third theoretical framework discussed within this work is ecosystem innovation. The analysis will mainly focus on Adner's work. The scholar defines "ecosystem" as the *alignment structure of the multilateral set of partners interacting for a focal value proposition to materialize* (Adner, 2017).

This definition highlights four core elements worthy of discussion. The first one is the alignment, which is the level of affiliates' agreement of their role within the system. Alignment should not be taken for granted as different companies might be unsatisfied with their positions or have divergent goals. Alignment requires a fine-tuned incentive system and a coherent structure of activities. The second key factor of the definition is multilateral. Adner states that the multitude of relationships within the ecosystem cannot be disassembled in a set of two-sided ties. Hence, the scholar emphasizes the complexity of interactions within the system. The third emerging factor is membership. That is, the list of member companies is defined. Even so, the list might not be complete or undisputed. The members might change or be added in order to complete the system. Finally, the fourth element is the focus on the value proposition to materialize. The discussion emerging from this factor shall focus on materialization and the possible dissimilarities in terms of goals. Materialization of the value proposition implies that actors have high motivation to achieve optimal coordination. On the other hand, divergence to be managed encompasses both dissimilarities in terms of goals and different expectations. Of course, both kinds of disagreements must be analyzed and realigned (Adner, 2017).

Additionally, the author makes a distinction between ecosystem as structure and as affiliation. In the first case, the focus is on interdependent activities within the ecosystem, orchestrated by a unique value proposition. In the second definition, the ecosystem is intended as the set of members that create an affiliation network. As it emerges by its definition, ecosystem-as-affiliation focuses on the blurring confines of the companies, increasing interdependence, and possible mutually beneficial relations among different players of the system. These multilateral alliances aim to encompass a higher number of companies connected to the core firm in order to improve the odds to create value within the system. In this case, the first step is to increase the number

of collaborations: in this way, the core company acquires importance and power and raises the probability of creating value. It is noteworthy that in this approach, value creation is the result of the collaboration. On the contrary, the ecosystem-as-structure follows the opposite path. Indeed, the first step with this approach is to identify a value proposition goal and then select the players to include in the system to reach the goal. The ecosystem-as-structure embeds four influencing the structure of activity flows and the materialization of the value proposition. The initial element is composed of the activities: these point out what companies have to do to reach the materialization of the value proposition. The next step is to assign the activities to members. It is relevant to highlight that usually, the assignment of tasks is disproportional. As a matter of fact, one company could be responsible for multiple activities. Similarly, several companies might perform only one task. The third factor to be discussed concerns the positions of actors and clarify the role within the flows. Each member must know to whom to deliver the results of the work to move forward. Finally, the links among members represent the fourth factor. Within an ecosystem, it is relevant to point out the transfer paths. It is pertinent to specify that links might move goods, information, money. Even though the elements in the two approaches, namely ecosystem-as-affiliation and ecosystem-as-structure, are the same, there are some fundamental differences. In ecosystem-as-affiliation, roles are a consequence of the position within the network. On the contrary, in ecosystem-as-structure, roles or positions are the results of the alignment structure. Furthermore, the first approach focuses on the links of the core organization, while the second approach also embeds relations that are not connected to the core company (Adner, 2017).

After discussing general definitions and differences, it is reasonable to focus the analysis on ecosystem strategy. The first relevant aspect is the alignment: when evaluating an ecosystem strategy, a company should try to inquire on which will be the core company, which players will agree on their role, and which will not, and which are the main possible disagreements. Building on these questions, Adner defined the ecosystem strategy as *the way in which a focal firm approaches the alignment of partners and secures its role in a competitive ecosystem.* The definition offers several points for discussion. (1) The first point is the focal firm. It is interesting to notice that, even though an ecosystem includes numerous companies, each has its own strategy. Therefore,

every company has its own vision on positions, risks, and goals. Of course, these strategies might be consistent or divergent. It follows that the actions of different actors will converge if their strategies are in line, but these might diverge if the strategies are different. Diverging strategies might lead to significant issues, particularly when a firm invests, erroneously assuming that strategies are coherent. (2) The second element of the definition to emphasize is the alignment of partners. The latter is evaluated with respect to the core firm's ability to position and assign roles to the partners. The approach requires identifying gaps and creating the circumstances that allow filling these gaps. Additionally, there are two main risks related to partner alignment. The first is co-innovation risk and concerns the partner's ability to deliver their contribution according to plans. The second type of hazard, namely adoption chain risk, relates to the priority partners assign to the required activities and their willingness to perform the latter. Therefore, the optimal strategy is to manage these hazards directly and proactively. However, risks are not the only aspect to be monitored and managed: in an ecosystem, position and role expectations also need to be monitored. (3) The third relevant point emerging by the ecosystem strategy definition is the necessity of securing the role. Since every company has its strategy and view, some actors might disagree on which company should be the focal one. Moreover, the core company usually has to manage the processes, set deadlines and rules, and demand the actors to respect the latter. Therefore, leadership is not inalterable, especially given that the core company usually gets the largest share of value produced. It is worth mentioning that leadership might be simultaneously in the hands of more than one company. (4) Finally, the fourth major component of the ecosystem definition is the competitive ecosystem. As a matter of fact, the competitiveness of the ecosystem and of its actors guides the strategy. Within an ecosystem, competitiveness refers both to the internal competition among actors and among different ecosystems. As for traditional organizational strategy, the goal of an ecosystem strategy is to create value and sustainable competitive advantages. The main distinction is that in an ecosystem strategy, the competitive advantage derives from the uniqueness of relationships and their strengths. As a consequence, within an ecosystem, a company must be extremely careful in managing the relationships with other actors and facing interdependence risk (Adner, 2017).

At this point, it is reasonable to focus on more practical implications of the ecosystem. Above all, it is worth considering that ecosystems are born out of the need for complementarities and integrating parts for innovations. However, it is reasonable to mention also that these systems are very complex and imply several new challenges and risks the company has to face. It follows that a discussion of the main risks is mandatory. The list includes (1) risk of delays, (2) initiative risk, (3) feasibility risk, (4) risks deriving from interdependence, and (5) risks related to integration. On the other hand, the main challenges are (1) timing, (2) decisions on where and how to compete, (3) learning, and (4) complementors challenges (Adner 2006, Adner, Kapoor, 2010).

The risk of *delays* derives from the interdependencies among actors: the delay of one actor is likely to cause a postponement of the innovation's introduction in the market. It is also notable that as the number of actors increases, the probability of delays and their cost also grows. *Initiative* risk concerns the feasibility of the innovation. When innovating within an ecosystem, companies have to determine which risks to assess and which ones to share or externalize. Moreover, companies have to estimate the *feasibility* of the product and its value for consumers. Finally, firms have to examine the presence of competitors and the adequacy of the supply chain. *Interdependence* risk involves the ability of partners to fulfill their tasks. Higher interdependence means lower control over innovation. Therefore, companies have to take into account the possibility of partners not respecting deadlines. Additionally, it should be considered that partners might behave opportunistically. For these reasons, the focal company has to incentivize its partners, but it must also build backup plans with alternative partners. Finally, if the dependency is too high, the focal firm might consider the possibility of moving along the supply chain or changing the product to reduce dependence. To better explain the *integration* risk, it is reasonable to start by stating that there are many intermediaries between the innovator and the final consumer. To deliver the innovation to the final customer, each of these intermediaries must adopt the innovation. Of course, if the adoption is not beneficial for the intermediary, the latter will not be interested. Therefore, as the number of intermediaries increases, the market result becomes more uncertain. Additionally, when setting expectations, a firm has to consider the length of adoption cycles. Of course, there are strategies to deliver the product to the customers faster. These include pre-launch marketing, incentives, and distribution optimization.

Finally, it is to notice that the company has to estimate a cost-benefit analysis of every intermediary since the latter will not be willing to adopt an innovation unless he benefits from doing so. In assessing costs, the company should estimate direct and indirect costs such as switching or opportunity costs. The resulting information might facilitate the design of the incentive scheme. Additionally, innovators have to consider all the features of the target market. Some of the characteristics, such as the availability of complementarities, are crucial (Adner 2006, Adner, Kapoor, 2010).

Besides risks, innovative companies operating within an ecosystem have to face several challenges already listed above. The first to assess is timing. As mentioned previously, ecosystem innovation often relies on complementarities. It follows that being ready could not lead to any benefit if complementarities are not available. Therefore, a company has to analyze the progress of complementarities before deciding when to market the product. Sometimes it might be better to wait until complementarities are ready. A common approach to forecast delays is by mapping the ecosystem and estimating possible delays at any stage. Once the company has the information, it can elaborate a cost-benefit analysis of potential delays, make more rational decisions, and plan with more accuracy its innovation process. Hence, the firm can adjust its expectations, the list of partners, and strategy. Additionally, the market for some innovations might not arise when predicted, and companies have to act consequently, and sometimes this involves waiting. Therefore, timing is a crucial strategic decision when innovating. However, the decision about when to enter the market is only one of the crucial choices a firm has to make. The companies also have to decide where to compete. Innovations usually have several potential market applications, and companies have to evaluate each of these. The optimal market could be internal to the ecosystem or external, depending on the degree of ecosystem risk and market opportunities. Another vital decision is about how to compete. Within an ecosystem, this challenge is remarkably complex since firms have to manage. Besides organizing capabilities, the firm needs to manage its role within the ecosystem. Role management and securitization are especially critical for a company seeking to lead the ecosystem because taking the leadership might be very costly and time-consuming. Therefore, the company has to evaluate the ecosystem risk when deciding its strategy. Subsequently, the company can adjust the original strategy in a tactical way. Moreover, the company

needs to set expectations ex-ante in order to evaluate the results objectively ex-post. Of course, expectation setting is complex, especially when there are vital interdependencies and complementarities. Furthermore, in an ecosystem, firms need to face learning challenges. The latter could involve the integration of new components or processes and impact technologies and organizational routines. Therefore, learning could be exceptionally challenging, especially when uncertainty and complexity are high. However, in this kind of situation, the learning opportunity is significant, meaning that learning could turn into a potential competitive advantage. Moreover, learning ability can provide the ground to improve the performance of several components and therefore create more value for the customer. One strategically significant attribute of components to take into account is its modularity. If the producer of a modular component is a supplier of the focal firm, rivals could behave opportunistically by avoiding investments and just acquiring the component once it is available. Therefore, in these situations, the focal company must protect the innovation in order to preserve the competitive advantage. Finally, the focal firm has to face several challenges related to complementarities. As mentioned above, innovation is valuable for the customer if the complementarities are available. As a matter of fact, if the supplier of a complementary component fails to deliver the complementarity or has delays, it might compromise the value of the final product or cause the launch of the latter to be postponed. Additionally, if the final product heavily depends on the complementary component, the supplier of the complementarity might exploit its bargaining power to renegotiate the agreements and behave in an opportunistic way to gain a larger share of profits. Such a risk is known as behavioral, and it concerns opportunistic conduct of partners, opportunity cost, switching costs, and incentives. A common strategy to assess behavioral uncertainty is through vertical integration. Therefore, as in other cases, the company needs to find the trade-off between several possible choices concerning integration, agreements, contracts, patents, and collaborations (Adner, 2006; Adner, Kapoor, 2010).

Conclusions

As it emerges in the discussion, ecosystem innovation is extremely challenging and involves several significant risks. The major strength of this approach is the presence of multiple companies and a shared vision. However, there are also many downturns and challenges since each actor has its own strategy and goal. Additionally, coordinating numerous parties is challenging, especially if deadlines have to be planned.

Conclusion

As it emerges in this chapter, disruptive, systemic, and ecosystem innovation assess complex innovations. The frameworks, of course, describe similar situations with slight but relevant differences in the approach of managing these situations. Within the frameworks, there are some interesting similarities. The first topic highlighted in all the frameworks is uncertainty since, as described by the scholars, innovation always implies a certain degree of uncertainty. Since all the frameworks deal with complex innovations involving more than one division or several companies, the second topic assessed in all the frameworks is complementarity. Innovations alone rarely deliver value to the customer since they need complementary goods or services. If complementarities are produced by other firms, managing bargaining power becomes critical. Consequently, companies also need to decide whether to integrate or not. Integration decisions depend on several factors and are usually a trade-off between control and flexibility. Finally, the last two topics that all the discussed frameworks have in common are culture and dynamic capabilities. The ability and the proactivity towards innovating of a firm depend on these factors. As a matter of fact, without the right culture and the capacity to renew capabilities and learn, a company is very likely to innovate successfully (Bower, 1970; McGrath, MacMillan, 1995; Christensen, 1997; Teece, 1986; Adner, 2006; Teece, Pisano, Shuen, 1997; Adner, Kapoor, 2010).

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Chapter Two: Business Model and Innovation

As mentioned in the first chapter, appropriability is one of the crucial issues when managing innovation. According to scholars, innovation often requires the company to adapt or redesign its business model (Christensen, 1997; Teece, Pisano, Shuen, 1997; Adner, Kapoor, 2010). This chapter aims to discuss the business model and business model innovation. Subsequently, the discussion will focus on current and future business model innovation trends in the automotive industry. Moreover, when innovating, companies are required to adapt their competencies and capabilities. Consequently, it is reasonable to discuss these changes, their effects on organizational capabilities, and possible ways of facing these challenges.

2.1 Defining the Business Model and Business model Innovation

While the business model is a recurrent topic in literature, there is little agreement on its definition. Therefore, it is meaningful to define the business model and investigate its origins before proceeding with the discussion. A reasonable approach is to start with the semantic analysis of the terms. The broad definition of "business" is the provision of goods and services. A commonly accepted meaning of "model" is a simplified representation of a complex entity or process. Therefore, by combining these two definitions, it is possible to define the business model as the simplified representation of the provision of goods or services. According to Ostenwalder et Al the business model is defined as *the tool containing the set of objects, concepts*, *and their relationships with the objective to express the business logic of a specific firm* (Ostenwalder, Pigneur, Tucci, 2005, pp 3). The mere semantic definition reveals that the business model embeds both the conceptual tools and the relationships among them to describe how the company delivers value to its consumers. The business model had its diffusion in the last decade of the 20th century in concomitance with the growth of information technology. The development of information technologies led to a decrease in transaction costs for the firms that resulted in business model experimentation. An increasing number of companies started to explore new ways to deliver and capture value. Therefore, the kernel of a business model is the value proposition. It is also meaningful to stress that the business model represents the company's status quo at a specific moment. Furthermore, even though business models are related to strategy, there are substantial

differences between these terms. As a matter of fact, the business model does not include competition. Moreover, it has a short-term perspective. However, the business model, organizational capabilities, and strategy mutually affect each other (Ostenwalder, Pigneur, Tucci, 2005; DaSilva, Trkman, 2014).

From a more practical perspective, commonly, the business model encompasses nine interrelated building blocks within four categories. The product pillar includes the value proposition that describes which is the benefit offered to customers. It is related to the customer's problems the company is seeking to solve. Finding the right value proposition is vital for a company, and it is the first step of a business model design. The second pillar is the customer interface, which includes customer segmentation, distribution channels, and relationships. Since a company has to satisfy customer's needs, it has to identify the customers, decide how to relate to these customers, and which channels to use to reach them. The third pillar is infrastructure management, and it includes key activities, core competencies, and partner network. Once the company knows who its customer is and which value proposition to deliver, it has to coordinate the activities and resources, outline the required competencies, and depict the main partners. The third pillar is the essential source of competitive advantage since it embeds unique combinations of competencies, processes, resources, and partners. Finally, the fourth pillar includes the cost structure and the revenue model. Therefore, within this pillar emerges the profit model of the innovation (Ostenwalder, Pigneur, Tucci, 2005; DaSilva, Trkman, 2014).

As mentioned above, the business model represents the logic used by a firm to deliver value. The representation clarifies which are the customer segment, the relations with them, the distribution channels used to reach the customers, the value proposition, the key resources, processes, activities, and partners, the cost structure, and the revenue model. Altogether these nine blocks articulate the value proposition, how and to whom to deliver this value, and how the company profits. The business model is helpful for several purposes. In the first instance, articulating the business model might enhance its comprehension both among managers and scholars since it highlights the links among its elements. As a result, it is easier to visualize relationships, problems, and potential competitive advantages that can be enhanced and exploited. Additionally, the business model might be helpful in the analysis of the business logic and, therefore, in targeting

the measuring activities on which to focus. In this case, the business model might serve as a guide to assign priorities to the problems. Moreover, since the business model is a structured representation at a certain point in time, it can be a tool for comparisons. Therefore, the business model allows highlighting changes in the company. Furthermore, it can be helpful in comparisons among different companies and competitors. Finally, business modes can be a powerful tool for management. It assists managers in optimizing decisions on how to react to external pressures. Additionally, since it allows a greater understanding of the business logic, it supports managers in improving the speed and the quality of decisions. Finally, the business model can be a source and a tool for innovation. As a matter of fact, it can help to identify how to innovate and serve as a guide in planning and implementing the change. The change in question might involve products, processes, or the business model itself (Ostenwalder, Pigneur, Tucci, 2005; DaSilva, Trkman, 2014).

Business model innovation is increasingly relevant for companies. A survey showed that the majority of managers prefer business model innovation over product innovation. There are a number of reasons to focus on business model innovation. Firstly, it might bring significant value in the future. Additionally, business models are harder to mirror because they include several interrelated activities. Finally, business model innovation allows the firm to exploit its competencies, resources, and capabilities in different markets. Noteworthy, a company should consider the possibility of competition from companies that traditionally operate in diverse industries. As a result, business model innovation might allow finding the equilibria between expenses and earning by optimizing the firm's way of doing business (Amit, Zott, 2012).

But how can managers know if they have to change the business model? Scholars suggest a three-step approach. The first step is to delineate the success factors of the existing business model. The second step is to search for warning lights, such as changes in competition, in the market. The third step is to perform a cost-benefit analysis of the business model change and see if the business model innovation can alter the market. If the answer to the last question is positive, the business model innovation has a good chance to pay off innovation expenses (Johnson, Christensen, Kagermann, 2008). Consequently, once executives decide that a business model innovation would benefit

the firm, they must determine how to innovate. The core idea of a change of the business model is that it will allow to enter a new market or to exploit novel possibilities in the existing market. However, managers can innovate business mainly in three ways. The first method is integration: the firm might start to perform additional activities by integrating or differentiating its offer. Scholars refer to this type of innovation as content innovation. Of course, to initiate new activities, the firm needs to obtain and organize all the resources required. The second innovation method is through altering the connections among activities. This type of innovation, also known as structure innovation, impacts the structure of the activity system. Usually, the innovation occurs by changing the order of the activities or the ways these are linked. The third approach involves the change of the actor that performs a task. Often, this type of innovation is also known as governance innovation. As it emerges, a company has several possibilities when innovating its business model. However, in order to decide how to innovate, they have to answer six questions. The first is, of course, addressing the new value proposition delivered to the customer. Then the company should analyze which are new activities required to bring value to the customer. The following step is to explore the possible ways of relating the novel activities. At this point, the company needs to examine who will perform the activities and the reasonable governance arrangements. With these three steps, the company is essentially exploring the possible business model innovations with regard to content, structure, and governance. Finally, the firm must articulate how it will create value for its stakeholders and decide which revenue model to adopt. Another noteworthy fact is that there are four main value drivers in business model innovation. The first of these factors is novelty, and it is the level of business model innovation assimilated by the activity system. The second driver is lock-in, intended as the set of activities that create switching costs or incentivize the participants to remain in the system. The last two value drivers are complementarities and efficiency. These elements are related to interdependencies among activities and cost-saving through structure innovation, respectively. Sure enough, a pragmatic approach might be helpful for a company, but it is not a panacea. Firms still have to be mindful of coherence and interdependencies among different elements of the business model. Additionally, business model innovation might lead to significant advantages. As a matter of fact, it might help the company to improve its position within a system, gain

bargaining power, and manage interdependencies in a better way (Teece, 2010; Amit, Zott, 2012).

As mentioned above, when innovating the business model, managers must, above all, focus on a precise value proposition. It is common for managers to spread their efforts in trying to fulfill several needs of the customers. The problem usually is that they entirely satisfy none of the customers' needs. Therefore, business model innovation requires precision and coherence. Of course, technological innovations might enable companies to fulfill their customers' needs. However, the business model innovation is likely to face some resistance due to inertia, conflict with the existing business model, and risk aversion. Interestingly, the concept of disruptive innovation discussed in chapter one also describes the resistance toward a disruptive innovation of the company's business model. Once again, the existing business model creates commitment, lock-in effects with complementarities, and is perceived as superior by the managers. On the contrary, the company perceives the innovative business model as a threat to the firm's value since the margins of the innovative business model are initially lower. Additionally, often business model innovation requires the company to target different markets, different segments of customers, and diverse distribution channels. Furthermore, even when the firm undertakes the innovation process, the innovative business model and the existing one will have to be managed simultaneously for a certain period of time. Consequently, managers will have to assign the resources wisely and shift resources from the existing business model to the innovative one at the right time. Nonetheless, scholars state that a company should attempt to innovate its business model before being forced to change by external factors (Jonhson, Christensen, Kagermann, 2008; Chesbrough, 2010; Teece, 2010). Therefore, companies with a greater understanding of the customers' needs and the ability to satisfy them usually are the market pioneers. Pioneering could lead to significant advantages, especially considering that business model innovations might create new industries (Teece, 2010).

Hence, companies need to explore new possible business models, adjust them, and learn. Several scholars agree in stating that companies need to experiment. Additionally, Chesbrough suggests that companies should consider the fidelity and the cost when performing an experiment. Additionally, time and learning opportunities are other

relevant factors. Moreover, the author explicitly distinguishes between failures and mistakes. Failing is one of the possible results of a test and can be a valuable source of learning. On the other hand, errors derive from poorly engineered experiments and bring no value. Therefore, companies should put more effort into designing experiments. One of the possible approaches is discovery-driven planning. It is useful when assessing assumptions and using the results as data for the next decision. Furthermore, it is an appropriate approach when a company wants to challenge the dominant logic of its business model since companies usually lack data to assess emerging opportunities. Consequently, this trial-and-error approach is helpful both to acquire data and to learn more about consumers and the market. Therefore, when initiating a business model innovation, companies should be aware that failures are part of the recipe: business model innovation requires patience. Learning and fine-tuning are essential to innovate a business model successfully. Therefore, metrics and formal rules usually emerge after some time because of the need to adapt and optimize the business model. However, profitability at the early stages is a significant feasibility indicator (Jonhson, Christensen, Kagermann, 2008; Chesbrough, 2010; Teece, 2010).

Just as technological innovations, companies want to protect their business model innovation, and to do so, companies have three main methods. The first possible way to shield business model innovations is by patenting the business model or its peculiar elements. However, it might be challenging for a firm both to obtain and to enforce the patents. Indeed, competitors can often elude these kinds of patents. A second possible approach to protect business model innovation is by using hard to imitate processes and assets. Of course, within this approach, capabilities are essential. Finally, the third possible approach to protect business model innovation is by creating causal ambiguity. In this case, the competitors are uncertain about the way in which the company executes its business model. Therefore, competitors are not able to identify the value creation process nor the critical success factors. It is, therefore, reasonable to state that protecting business model innovation is vital but also challenging. As a matter of fact, entrants and competitors usually imitate innovative and successful business models in a short period of time (Teece, 2010).

2.2 Business Model and Business Model innovation in Automotive Industry

In the automotive industry, the business model had very few alterations for decades. However, in the last 20 years, the industry became more competitive. Moreover, technological innovations are pushing the OEMs towards innovating both in terms of products and business models. For example, in the 2000s, one of the relevant trends of the industry was modularization. The trend was related to product architecture, production system, and supply chain modularization (Takeishi, Fujimoto, 2001). As a result, today carmakers employ a few modular automotive platforms for a wide range of products. It is therefore interesting to discuss the traditional business model of OEMs and investigate how it is evolving. Unfortunately, the available literature is superficial. In order to have a more comprehensive understanding of the topic, it is reasonable to briefly discuss each of the nine blocks of the OEMs' business model before proceeding with the innovation trends (Brandtner, Freudenthaler-Mayrhofer, 2020).

Customer Segments

Traditionally, carmakers simultaneously target several segments of the mass market. These segments include both private consumers and businesses. Interestingly, despite the fact that OEMs have consumers as a target, traditionally, these companies never directly deal with privates.

Value Proposition

Typically, OEMs offer high-quality products. However, often the value for the consumer is not only the product *per se* but is also the status, the emotions, and the feeling related to a brand.

Channels

Traditional channels are exhibition rooms, dealers, websites, media, printed ads, distribution partners, and events. Nevertheless, companies are increasingly focusing on online channels.

Customer Relationships

Typically, carmakers diversify by brand, and each brand has some values related to its attributes and status. Topics such as brand image and the characteristics connected to the brand are vital. Additionally, reliability is critical in relationships with dealers.

Revenues Streams

The first revenue stream is the one deriving from the sale of new vehicles. However, companies also sell spare parts and have revenues from after-sales and maintenance services. Additionally, carmakers often have financial departments responsible for incomes from leasing, rental and financial loans.

Key Resources

For a carmaker, the key resources are staff, intellectual properties, contracts with partners, facilities, inventory, brand, know-how, distribution network, and processes.

Key Activities

Key activities include design, engineering, manufacturing, supply chain management, logistics, R&D, distribution, and brand management.

Key Partners

The key partners include Tier1 suppliers, other suppliers, dealers, distributors, governments, universities, financial institutes, joint venture members.

Cost Structure

The majority of costs are related to manufacturing, components, payments to suppliers, distribution costs, maintenance, and R&D.

Of course, there are many differences among carmakers. However, for the purposes of this work, it is enough to outline the general aspects of the business models. The brief description serves for a better understanding of the ongoing transformations in the automotive industry. As mentioned by scholars, at the beginning of the 2000s, the automotive industry was a mature and stable market. However, the situation changed drastically since then due to several factors such as technological innovations, regulations, and market alterations. The first phenomenon to be considered is globalization. As a matter of fact, globalization is impacting the industry in several ways. Indeed, as a consequence of globalization, new markets such as Russian, Chinese, Brazilian, and Indian became available. Additionally, globalization paved the way to enter the industry for several players from emerging countries such as China and India. Secondly, the governments are increasingly stringent on emissions, safety, consumption, and other indicators. These regulations are increasingly pressuring the

OEMs and endangering the profits of carmakers. This trend is very actual, as evidenced by the recent UE law, applicable by May 2022, that requires OEMs to equip with 30 ADAS technologies for all new road vehicles sold on the EU market (Regulation (EU) 2019/2144). A third significant transformation of the automotive industry is due to technological advances. In the last two decades, technological innovation led to incremental and radical innovations in the industry, and some are still to be adopted. Two very actual examples of technological innovations are electric vehicles and carsharing respectively. Both of these innovations resulted in changes in the business model of the carmaker. In the case of the EVs, the OEMs had, and still have, to develop new competencies, acquire resources and machinery they are less familiar with, and find the right partners. As a matter of fact, companies such as Panasonic and LG Chem are becoming increasingly relevant players and crucial partners for OEMs because of the ability of the former to manufacture batteries for EVs (Cabigiosu, 2017). However, OEMs have not just to alter their partners, equipment, product architecture, and resources. Indeed, OEMs also need to facilitate the development of the recharging infrastructure and, therefore, change investments. Hence, it is plausible to state that the diffusion of electric and hybrid vehicles are technological innovations that led to change the business model of the carmakers. On the other hand, the carsharing platform business is an example of a company adapting the business model to exploit available technologies and emerging trends. Indeed, Daimler is not only selling vehicles, but it also operates in the carsharing industry through a subsidiary. Similarly, Toyota entered the platform business model with Kinto. However, entering diverse markets and industries of OEMs is not only a matter of differentiation. As mentioned by scholars, it is also a strategic move aimed to enhance learning, acquire new competencies in fleet management, exploit the cross-fertilization of knowledge, and explore the links among innovation, acquiring knowledge, and business models. This type of strategic move is coherent with the ongoing mobility paradigm change. Sure enough, the automotive industry is becoming more customer-centric and is focusing on allowing consumers to move from their place of departure to their destination instead of focusing on selling vehicles (Schulz, MacDuffie, Taube, 2015). The trends discussed above are also confirmed by McKinsey's report, as shown in *Figure 2.1*. The trends discussed above are also confirmed by McKinsey's report, as shown in Figure 2.1. The report highlights that

the areas of investments are related to technological innovations and, in particular, to autonomous vehicles and EVs (McKinsey&Company, 2019). Additionally, it is interesting to notice that more than 25% of the investments are in E-hailing, but it results in very few patents, as emerge in *Figure 2.2*. Moreover, the number of patents of electric vehicles is comparable to the one of autonomous vehicles and advanced driver assistance systems.

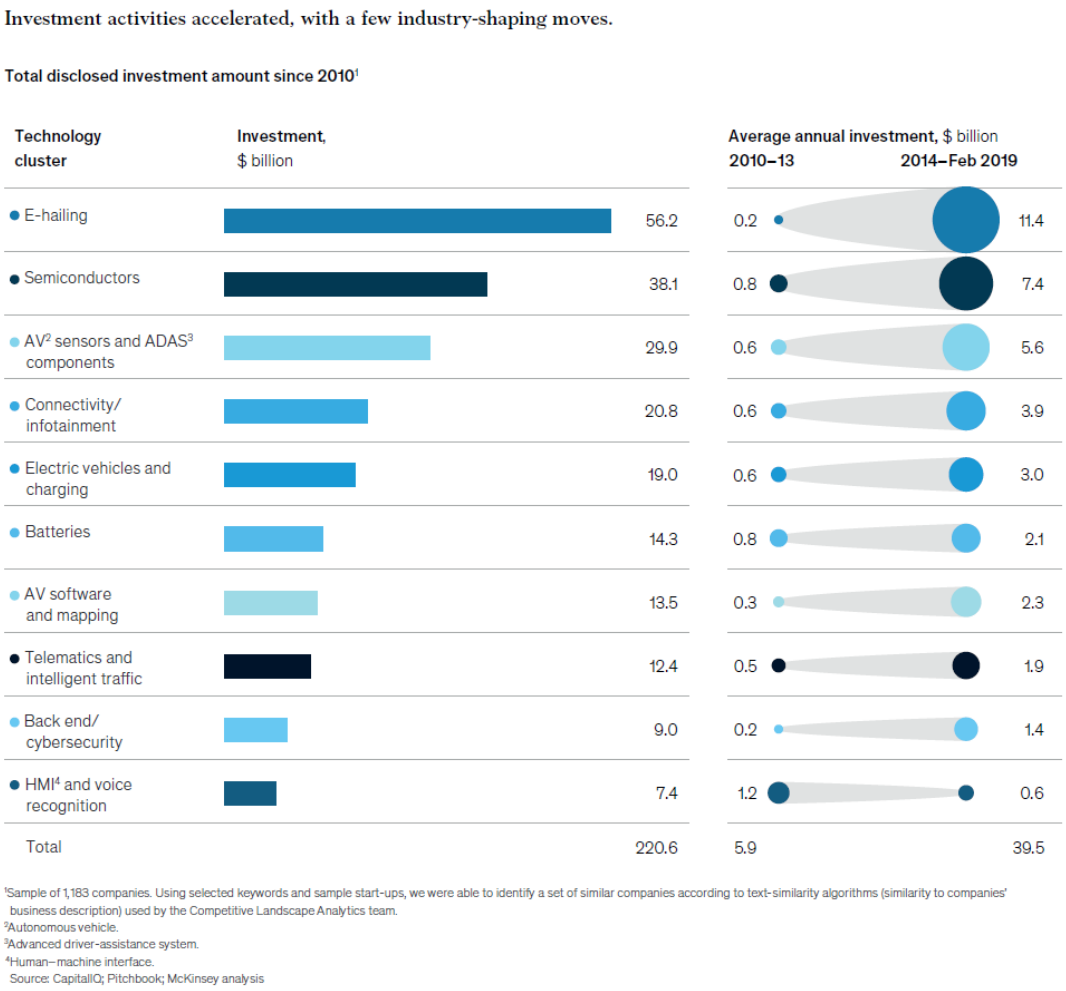
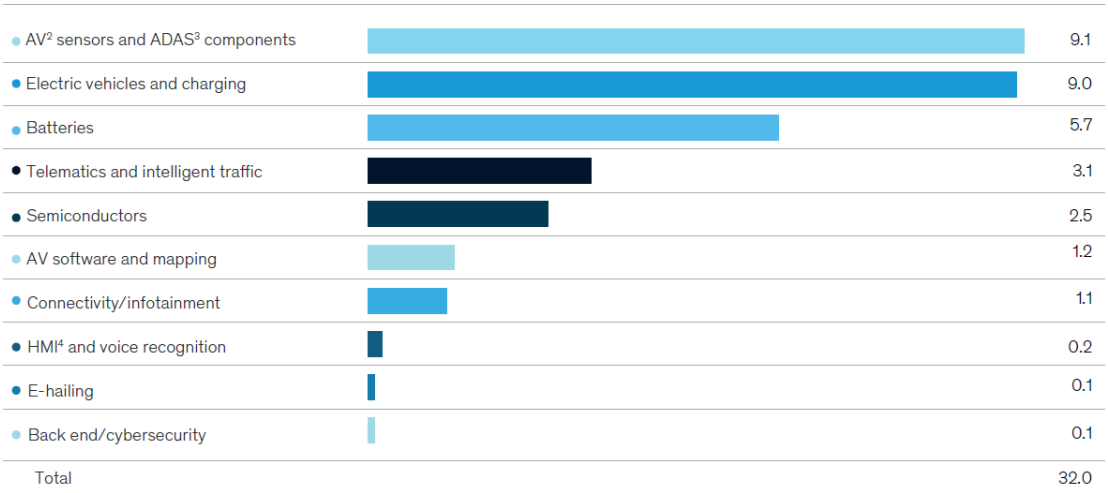


Figure ***Errore. Nel documento non esiste testo dello stile specificato.****1: Total disclosed investment amount since 2010. Source: McKinsey&Company, 2019*

Moreover, it is relevant to notice that companies are innovating by means of partnerships. As shown in *Figure 2.3*, companies share the pain with competitors and suppliers when innovating internal combustion and electric vehicles. On the other hand, partnerships aimed toward autonomous and connected vehicles are composed primarily of tech companies. These partnerships are made to acquire the necessary capabilities and technologies (McKinsey&Company, 2019).

Analyzing patents offers another lens on market dynamics.

Total number of patents since 2010,[1] thousand



[1]Sample of 1,183 companies. Using selected keywords and sample start-ups, we were able to identify a set of similar companies according to text-similarity algorithms (similarity to companies' business description) used by the Competitive Landscape Analytics team.
[2]Autonomous vehicle.
[3]Advanced driver-assistance system.
[4]Human–machine interface.
Source: CapitalIQ; Pitchbook; McKinsey analysis

*Figure **Errore. Nel documento non esiste testo dello stile specificato.**2: Total number of patents since 2010. Source: McKinsey&Company, 2019*

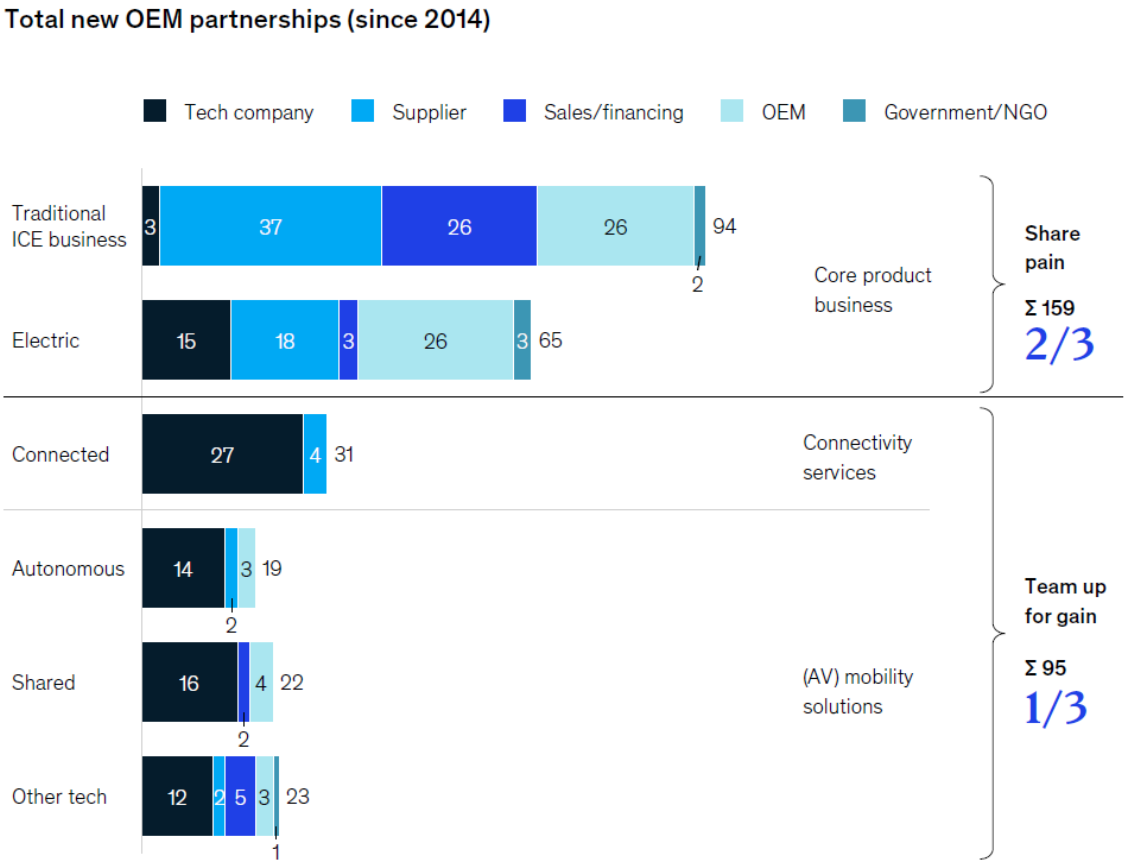


*Figure **Errore. Nel documento non esiste testo dello stile specificato.**3: Total new OEM partnerships since 2014. Source: McKinsey&Company, 2019*

As is clear from the analysis of the main trends of the automotive industry, technological innovations are shaping the industry, the companies, and the business models. The major innovation areas are electrification, globalization, change in the mobility paradigm, connectivity, and autonomous driving. Each of these innovations impacts OEMs and their business models in several ways. It is enough to consider that carmakers usually are not in touch with the final customers. However, the OEMs running a carsharing must deeply understand customer needs and be constantly in touch. Moreover, establishing a carsharing platform forces the OEMs to redesign, at least partially, their business models. Indeed, to establish a carsharing platform, carmakers need to develop IT competencies and infrastructure, acquire fleet management skills, develop the app, and cooperate with local authorities. Within the traditional business model, none of the listed elements were part of the business model. Therefore, companies need to adapt and balance the coexistence of the different business models. The same logic holds for the innovation deriving from electric vehicles. It is, therefore, reasonable to state that OEMs have to manage exceptionally complex environments. Additionally, carmakers have to strive to acquire the competencies required in the market. Concerning competencies, depending on the innovation, companies might decide to innovate by themselves or form partnerships like the ones described in chapter one. Remarkably, OEMs have to face innovation challenges that are even more complex with respect to the ones described in chapter one. Indeed, electric vehicles fit the definition of disruptive innovation for OEMs. However, EVs are also a systemic and ecosystem innovation. Therefore, the companies have to adopt hybrid strategies in acquiring competencies. Indeed, OEMs are adapting their competencies and innovating not only internally, but also through ventures, partnerships, acquisitions (Bucherer, Eisert, Gassmann, 2012; Schulz, MacDuffie, Taube, 2015; Cabigiosu, 2017; McKinsey&Company, 2019).

Furthermore, technological innovation is increasingly relevant for OEMs, and the industry paradigm is shifting towards mobility-as-a-service. Consequently, carmakers are investing not only in automotive innovation but also in mobility innovation. As a matter of fact, in 2017, Toyota founded Toyota AI Ventures, a standalone venture capital fund focused on mobility. This incubator focuses on five principal areas: (1) enhancing mobility and accessibility for everybody, (2) reducing congestion and pollution, (3)

improving house efficiency, (4) employing AI and robotics to assist people, (5) data sourcing to drive planning decisions. As a matter of fact, Toyota AI Ventures has projects related to computer vision, connected vehicles data analysis, robotics, electric passenger aircraft, charging infrastructure, hydrogen transportation, and other innovative areas (Bourgoise, 2021).

Conclusion

As it emerges in this chapter, the automotive industry was a mature market at the beginning of the 21st century. Consequently, the business models of the carmakers, as discussed, were predictable. However, the industry became extremely turbulent in the last two decades. New technologies, political factors, and increased competitiveness are increasingly exerting pressure on OEMs. Consequently, carmakers have to adapt their structures, adjust their business models, and continuously innovate to remain competitive. Within the modern automotive industry, ambidexterity is a must-have. Companies need to manage simultaneously radically diverse structures and business models. Additionally, there are some major incoming innovations such as autonomous vehicles. Therefore, currently, many OEMs are experimenting and innovating products as well as business models, industry areas, and mobility-related solutions. Companies within the industry are continuously adjusting their business models because of technological innovations or market pressures. Furthermore, OEMs are starting to operate in industries that are not related to their core businesses, as exemplified by Daimler's ShareNow and Toyota AI venture. Additionally, external players are entering the automotive industry, emphasizing increased competitiveness and turbulence. As a matter of fact, high-tech companies such as Google, LG Chem, Baidu, and Panasonic, became significant players in the automotive industry. In response to these challenges, OEMs started to innovate outside the automotive industry's borders. Moreover, as discussed, OEMs increasingly implement systemic and ecosystem innovation, partnerships, and joint ventures (Fujimoto, 2007; Schulz, MacDuffie, Taube, 2015; Jacobides, MacDuffie, Tae, 2016; Cabigiosu, 2017).

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Chapter Three: Impacts of Shared Autonomous Driving Technology

This chapter aims to discuss the impact of shared autonomous vehicles on the OEMs' business model. Before initiating the discussion, however, it is appropriate to specify that this work has a long-term perspective and has some assumptions on technology, legislation, and adoption. Indeed, within this work is assumed that technologies are available, that law allows the circulation of autonomous vehicles, that the necessary infrastructure is in place, and that there are no other radical changes apart from the ones discussed.

Additionally, within this work, the terms autonomous driving and autonomous vehicles refer to levels 4 and 5 of the SAE classification. The entire classification is reported in *Figure 3.1*. Finally, the aim of this chapter is to outline and discuss the more likely scenarios of future shared autonomous mobility.

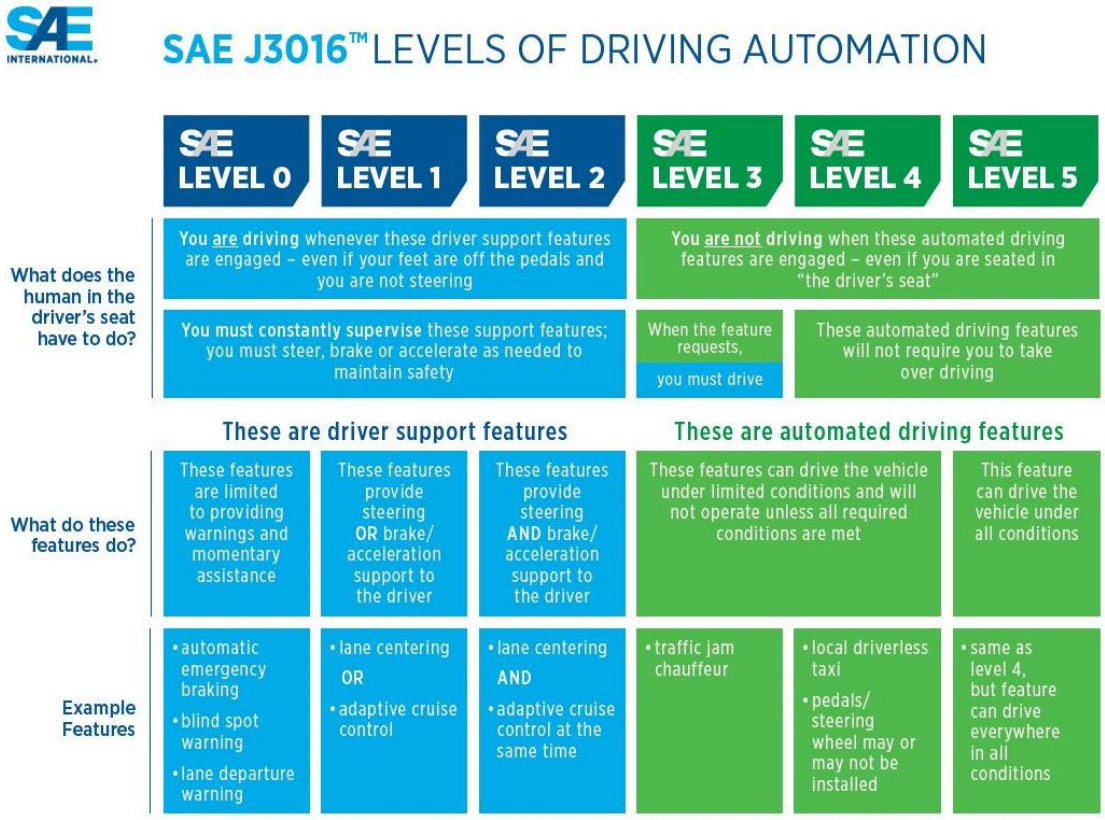

Figure 3.1: SAE Levels of driving automation. Source: SAE International website, 2021.

3.1 Introduction

In order to explain in a more comprehensive manner the topic, it is reasonable to start by briefly discussing the main components of autonomous vehicles, industry specifics, and some market forecasts.

Autonomous vehicle sensors set can be either computer vision-based, as for Tesla, or Lidar-based. As shown in *Figure 3.2*, the computer vision-based system includes eight cameras, one radar, and an ultrasound system. On the other hand, as emerges in *Figure 3.3*, lidar-based systems are much more complex, efficient, and expensive. Interestingly, Elon Musk is totally against employing lidar technology on autonomous cars. According to Musk, computer vision is good enough, and therefore, it makes no sense to install lidars on AVs because these are more expensive than the computer vision system (Templeton, 2019). However, there are two possible objections to Musk's statements. The first the fact that computer vision is still not adequate to run AVs. Secondly, the price of lidars is decreasing: the initial cost in 2007 was around $80.000, nowadays Velodyne aims to price lidars below $500 (Nellis, 2020).

Figure 3.2: Computer Vision system's sensor. Source: Tesla.com, 2021

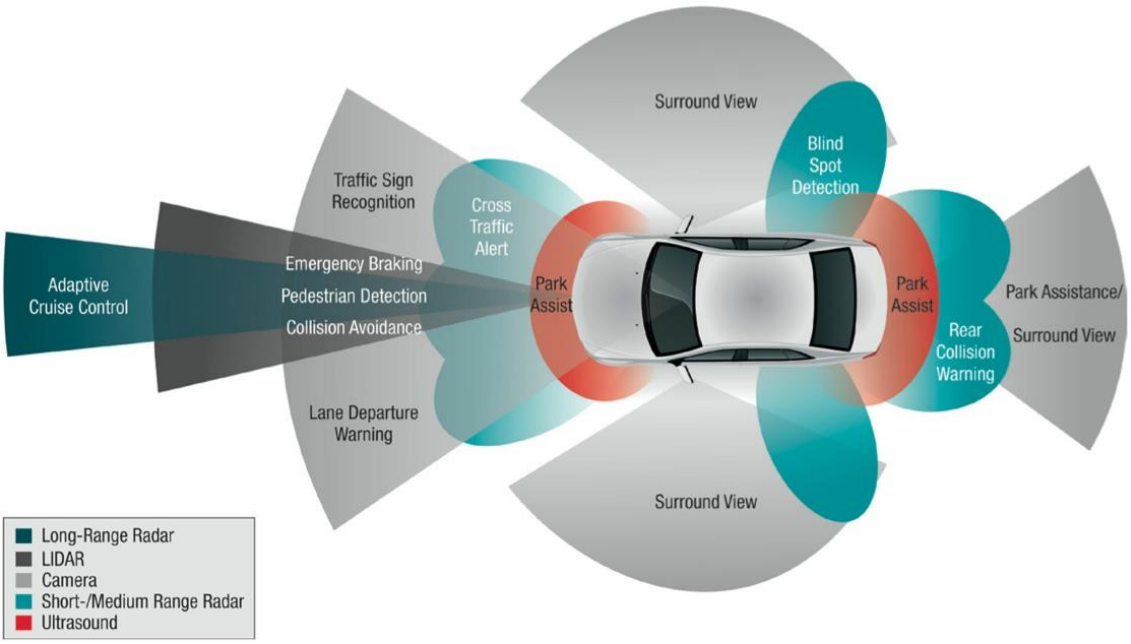

Figure 3.3: Lidar-based system. Source: Michigan Tech Research Institute, 2021

Additionally, according to McKinsey, by 2030, around 10% of the vehicles will be Level 5 AVs, and more than 20% will have a level of automation greater than Level 4. The forecast of the cumulative density function is shown in *Figure 3.4 (McKinsey&Co, 2019).*

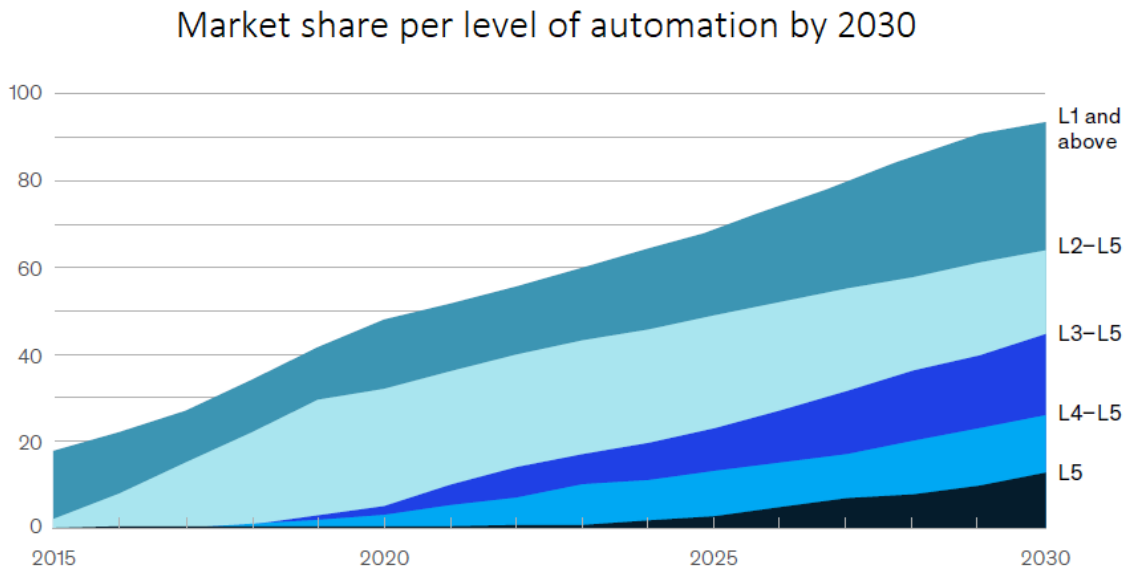

Figure 3.4: Market Share per level of automation by 2030. Source: McKinsey&Company, 2019

Another relevant piece of data is the forecast of sales of vehicles with a level of automation equal to or greater than L3 displayed in *Figure 3.5*. The graph highlights an exponential growth in the number of units sold. Therefore, it is reasonable to state that the estimated adoption rate is high enough to justify the investments required (Statista, 2021).

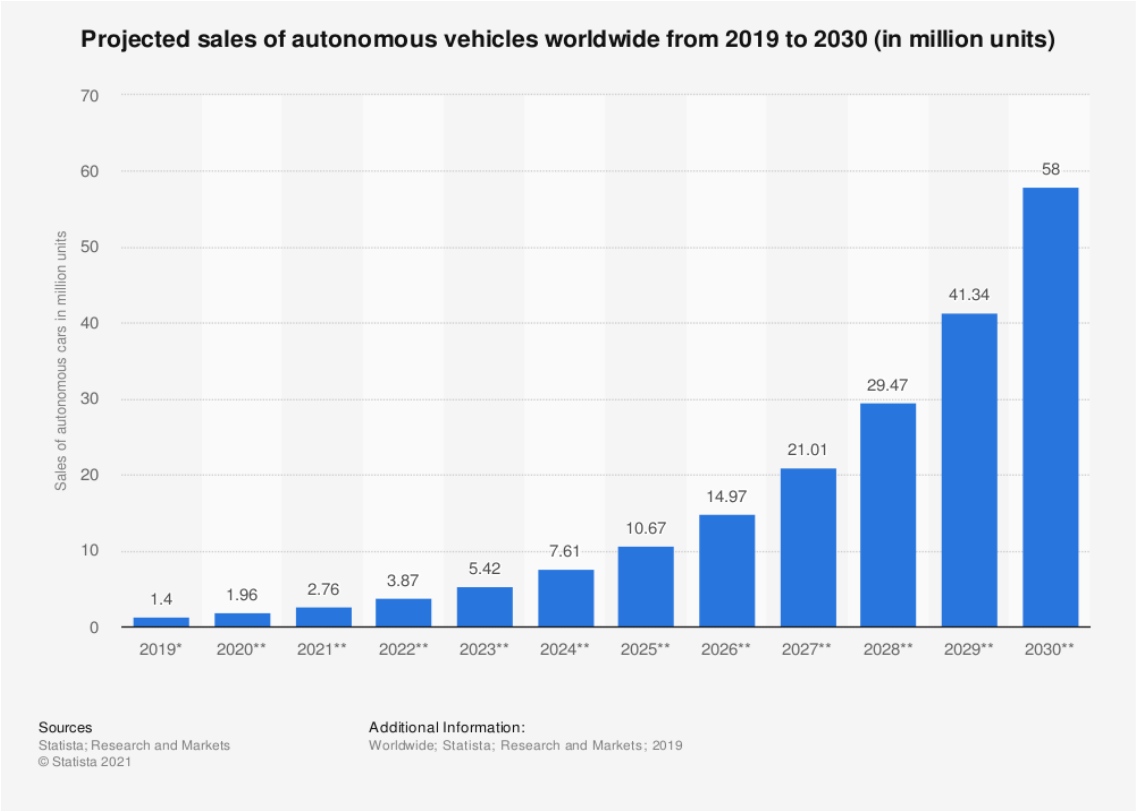

Figure 3.5: Projected global sales of autonomous vehicles Level 3 or superior 2019-2030. Source: Statista, 2021

It emerges that connectivity and autonomous driving technologies will significantly impact the industry and, therefore, OEMs. As shown in *Figure 3.6*, connected vehicles enable several potential revenue streams for the OEMs. The forecast of potential earnings for OEMs in 2035 is estimated to be approximately $32.5 billion (Schiller et. Al, 2020).

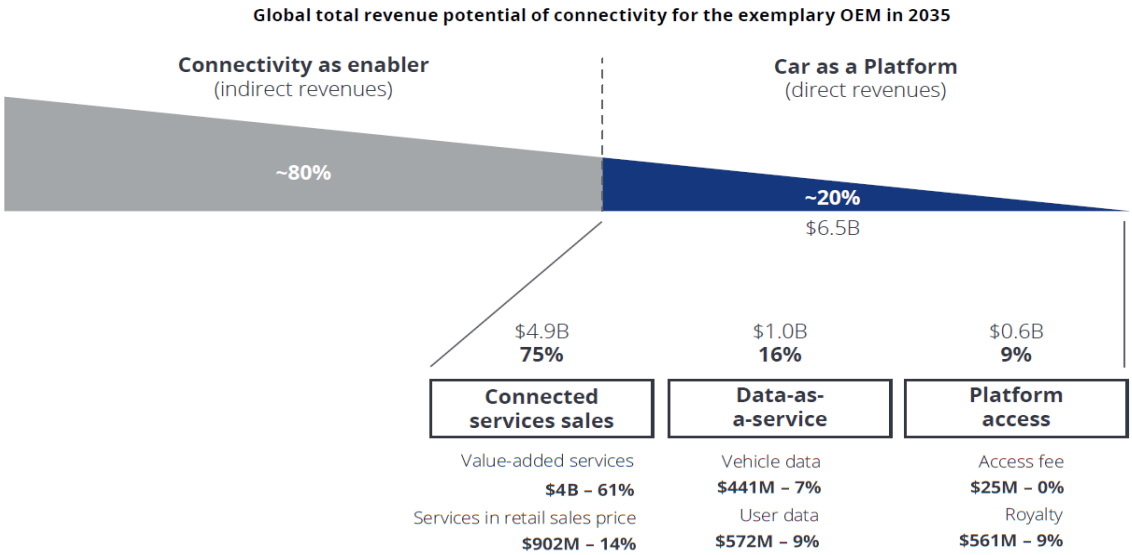

Figure 3.6: Global Potential revenue of connectivity for OEMs in 2035. Source: Schiller et. AL, 2020

The estimated direct streams depicted in *Figure 3.6* are further discussed in *Figure 3.7*, which shows the expected revenues and compound annual growth rates of three business segments, namely, financial services, mobility-as-a-service, and car-as-a-platform. According to Deloitte, OEMs' will double their financial services-related incomes. Additionally, the increase in revenues from data, platform access, and connected services sales is expected to result in incomes equal to approximately $6.5 B for the car-as-a-platform segment (Schiller et. Al, 2020).

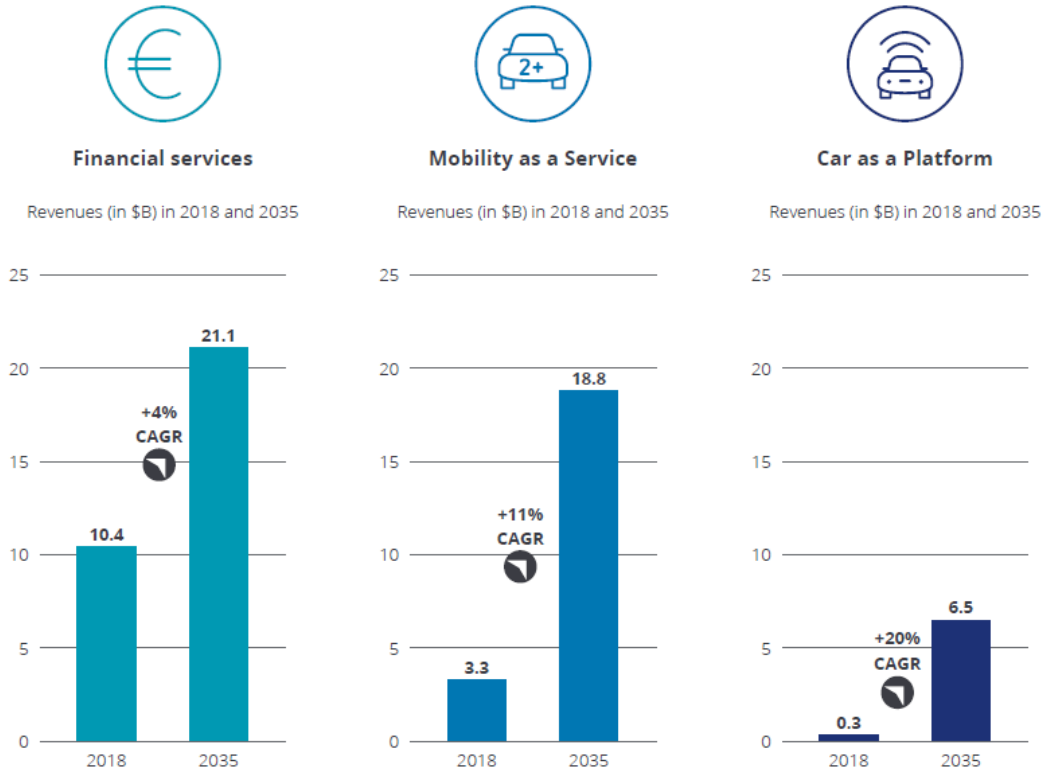

Figure 3.7: Expected revenues for OEMs and relative CAGRs of three business segments. Source: Schiller et. Al, 2020

As it emerges, the autonomous driving market has vast growth potential. Consequently, markets of complementarities and components for AVs are expected to grow as well. *Figure 3.8* depicts the forecast of the automotive sales and values of electronic and software markets with the CAGRs of the market segments. According to Mckinsey, electronic control units and domain control units will represent one-third of the electronic and software market. Additionally, it is possible to observe that EVs are likely to be increasingly relevant within the automotive industry. Indeed, the power electronics segment has a predicted CAGR of 15%, which is the higher growth rate among all the depicted subsegments (McKinsey&Company, 2019).

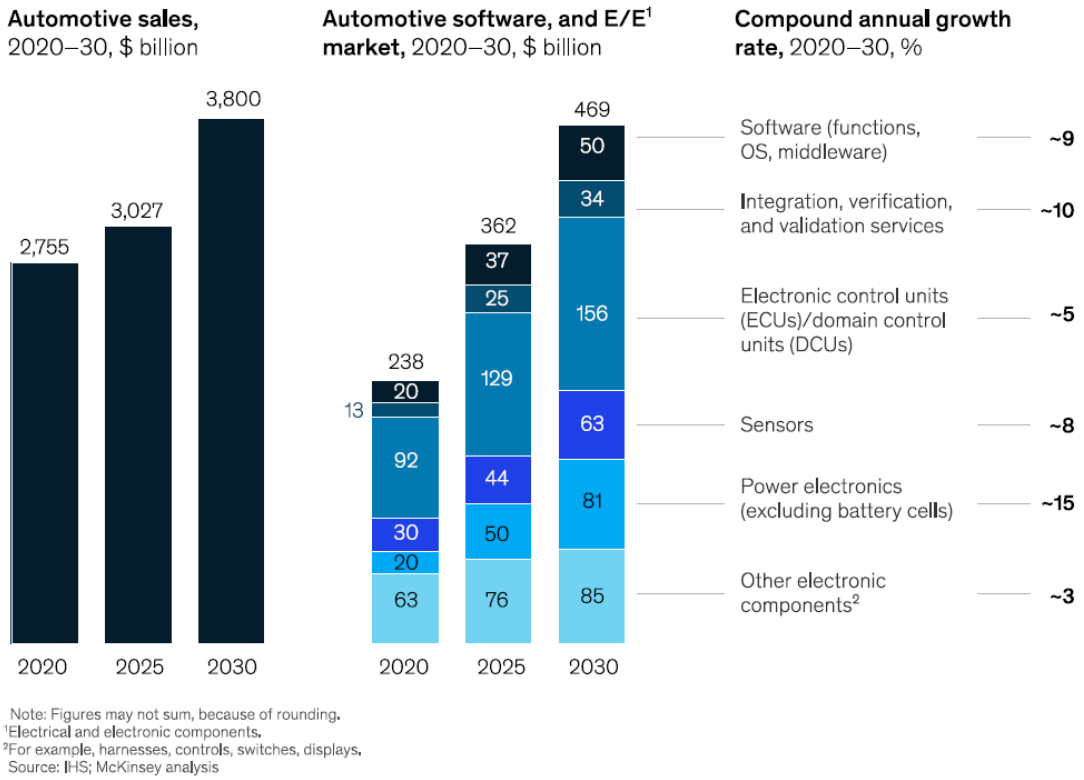

Figure 3.8: Automotive sales and values of electronic and software markets 2020-2030. Source: McKinsey&Company, 2019

Finally, it is appropriate to mention that technological innovations are likely to lower the cost of mobility. However, there is not a single reason for the decrease in prices. Indeed, mobility is anticipated to be cheaper because of several factors such as the lower cost of technology, the increased competition, the possibility to exploit economies of scale, the high adoption rate, and the optimization of resources (McKinsey&Company, 2019).

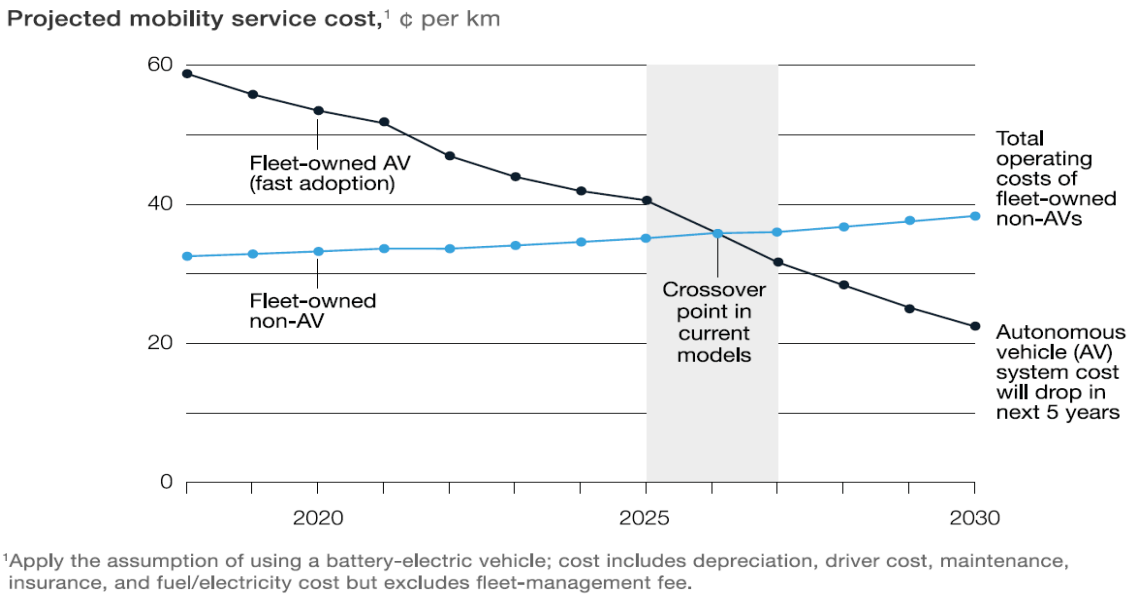

Figure 3.9: Projected mobility service cost per Km. Source: McKinsey&Company, 2019

Consequently, as depicted in Figure 3.9, Autonomous vehicle mobility is likely to be cheaper than non-autonomous fleets. The convenience of AV fleets results from the factors mentioned above combined with the lower insurance costs, increased efficiency, and the fact that autonomous vehicle fleets do not have any driver costs (McKinsey&Company, 2019).

Remarkably, the automotive industry is experiencing a series of technological innovations which are changing the mobility paradigm. As mentioned above, mobility is increasingly becoming consumer-centric. As mentioned by scholars, the result is that the whole OEMs' value network is undergoing profound transformations. *Figure 3.10* depicts the new value network of OEMs while the traditional one is encompassed in the red rectangle. As a result, OEMs have to manage an increasing number of technological innovations and relationships with different actors, while seeking to capture and maintain value. (Riasanow, Galic, Böhm, 2017).

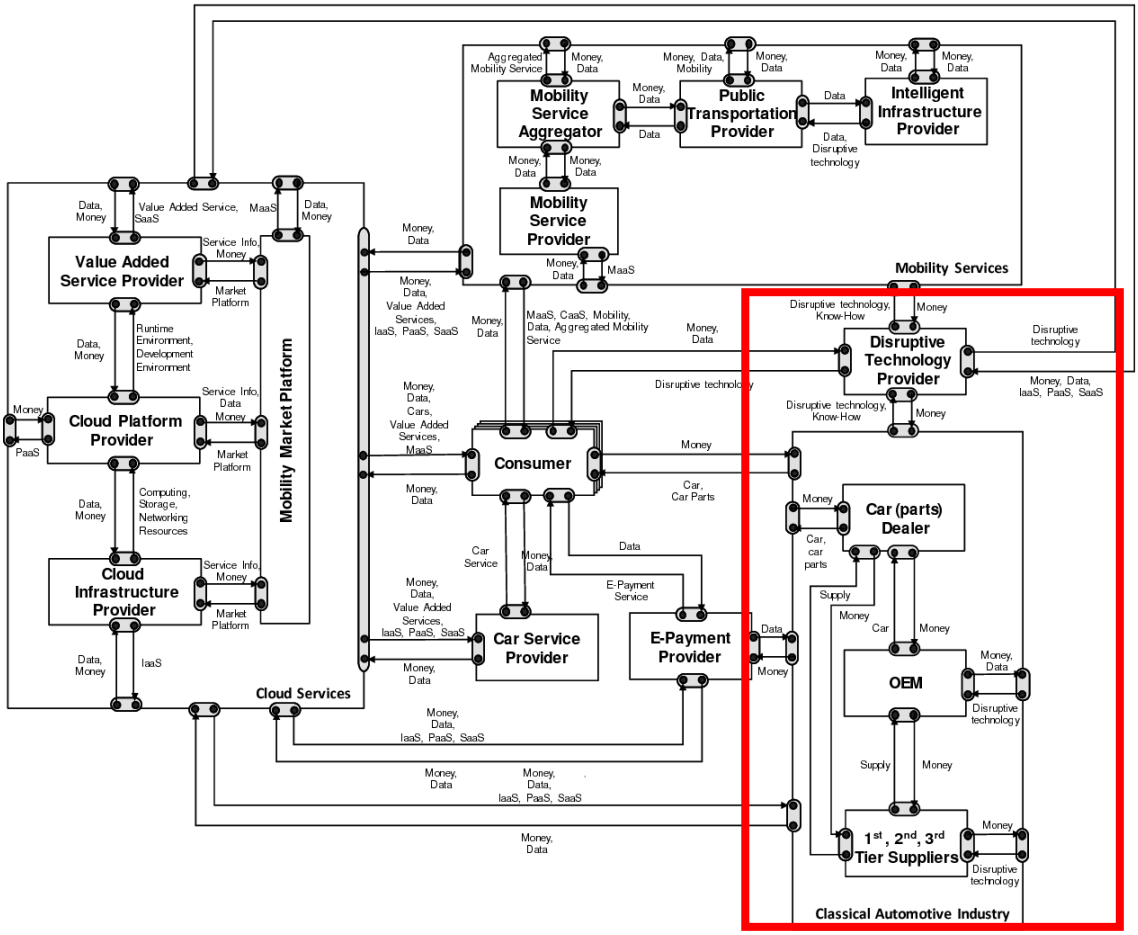

Figure 3.10: Proposed Generic Value Network for the Automotive Industry. Source: Riasanow, Galic, Böhm, 2017

The technological innovations, together with the change in the mobility paradigm and the increasingly complex value network, have significant impacts on OEMs' strategy. *Figure 3.11* exemplifies the increasing number of Toyota's partnerships with players whose core business is not related to automotive. As a matter of fact, there are companies such as NVIDIA, Baidu, Uber, and Microsoft, which are all high-tech corporations. Moreover, it emerges that Toyota is forming Joint Ventures with other carmakers aiming to co-develop autonomous vehicle technology (Firstmile, 2019).

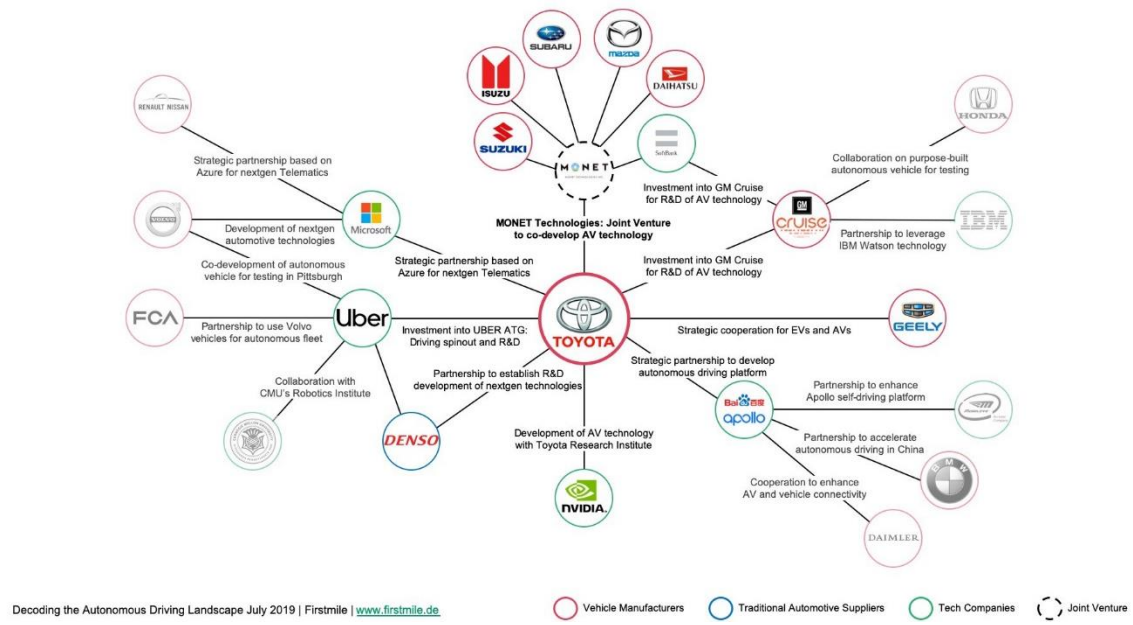

Figure 3.11: Toyota Ecosystem model. Source: Firstmile, 2019

Conclusion

OEMs are experiencing significant pressures because of the technological innovations and the change in the mobility paradigm. As a matter of fact, carmakers have to continue producing high-quality products, but they also have to innovate and explore areas that are not familiar to them. Many of the OEMs are investing significantly in innovation since the market for AVs is expected to be extremely large. Consequently, OEMs are aware that it is vital for them to keep pace with technological innovations and market requests. The reaction of the OEMs is self-evident: carmakers are radically changing their way of doing business, entering into innovative ecosystems and partnerships, forming joint ventures, investing heavily in innovation, and fostering cross-learning.

3.2 Impacts of Shared AVs on OEMs' Business Model

In order to illustrate and efficiently explain the impact of shared autonomous vehicles on OEMs' business models, it is beneficial to recall some of the topics discussed within this work. Above all, it is reasonable to mention that the shared autonomous vehicle innovation perfectly fits into the definitions of disruptive, systemic, and ecosystem innovations. Of course, each of these definitions embeds both opportunities and challenges. Additionally, it is helpful to remind the concept of business model and business model innovation discussed in chapter two. Finally, the emerging trends within the automotive industry are forcing OEMs to innovate in order to remain profitable. Autonomous vehicles represent an unprecedented challenge for carmakers. As a matter of fact, this technology is emphasizing the shift in the mobility paradigm and changing the dimensions on which OEMs compete. To successfully manage the autonomous driving innovation challenge, as mentioned above, OEMs are joining alliances and undertaking internal innovation processes. It is, therefore, interesting to discuss the possible future scenarios in a situation in which the technology is available. According to McKinsey&Company, there are three major plausible partnership models. In the first model, OEMs dictate the product design and features of the product and co-develop the AVs with partners. Within this model, the focal companies are the OEMs. The second model foresees that the companies setting the design standards and products' characteristics are the AV hardware and software suppliers. Within this model, OEMs have little decisional power over the design, and the focal firms are the AV high-tech companies. The last model envisages that the focal companies will be the mobility service providers. Consequently, the AV hardware and software suppliers and OEMs will assume the position of contract manufacturers (McKinsey&Company, 2019). It emerges that the appropriability of the value deriving from the AV technology might be the most critical aspect to be managed. To seize value, OEMs should become the focal firms within the innovation network and secure this position at any cost.

Additionally, according to a report by Deloitte, the future state of the industry depends on two main factors: the first is the degree of trend emergence, the second is the degree of OEM dominance. The emerging scenarios are discussed below. In a situation characterized by low trend emergence and low OEM dominance, carmakers will sell

mainly online and have little or no control over the innovation, resulting in an estimated revenue equal to $100B. The scenario changes if the degree of trend emergence increases: in this case, OEMs will be suppliers for third-party mobility fleets. As a result, the bargaining power of OEMs, in this case, will be extremely low, resulting in an estimated income figure equal to $ 100B. The situation is radically different in the case of a high dominance of carmakers. Indeed, even in the case of a low impact of AVs, carmakers could benefit and manage to reach omnichannel sales and reach higher revenues. As a matter of fact, the estimated earnings for this scenario are equal to $ 167B. If, on the contrary, the degree of trend emergence will be high, OEMs could maximize profits and shape the new mobility environment. Within this scenario, the estimated revenues amount to $ 237B (Schiller et. Al, 2020). Therefore, it is reasonable to state that OEMs' profitability strongly depends on the scenario. In turn, it is interesting to reason on how will change the OEMs' business models within different scenarios.

Scenario 1

OEMs do not manage to become the focal company of the innovation ecosystem. Mobility providers dictate the standards and the requirements for autonomous vehicles. In this scenario, the role of OEMs and AV hardware and software providers is limited to that of contract manufacturers. The resulted business model would probably significantly change as follows:

Customer Segments

Within this scenario, OEMs would end to have as customers mobility businesses. The result would be a significant shift and cause a greater distance among OEMs and final users.

Value Proposition

The focus of the OEMs offerings will remain the product quality. However, in this scenario, carmakers will not be able to leverage emotions and feelings. Instead, the focus would be on efficiency, flexibility, scale, and price factors.

Channels

If OEMs become contractual manufacturers, the distribution network built for decades would have no value. Being a B2B, the main channels would be the professional, with increased usage of sales personnel.

Customer Relationships

The OEMs' position in this scenario would be exactly the opposite of the one carmakers have now. Indeed, they would lose their bargaining power, meaning that they would have to adapt to their customers' requests. In this case, the brand image would be valuable only for manufacturing capabilities.

Revenues Streams

In this scenario, the major revenue stream would be the one resulting from the sales figure. Additionally, OEMs could continue to sell spare parts and manage the maintenance of their product. Unfortunately, within this scenario OEMs would lose financial revenues.

Key Resources

The main resources would remain the intellectual properties, contracts with partners, facilities, know-how, and processes.

Key Activities

The key activity will shift toward manufacturing. Activities such as R&D, engineering, and supply chain management would continue to be an asset, but they would partially lose value.

Key Partners

The key partners would include suppliers, distributors, governments, and joint venture members.

Cost Structure

The majority of costs would remain related to manufacturing, components, payments to suppliers, distribution costs, maintenance, and R&D.

Scenario 2

Within this scenario, OEMs would be partners in joint ventures and other forms of agreements. The focal firms within this scenario are the providers of hardware and software for AVs. Moreover, mobility service providers are also non-focal partners.

Customer Segments

Within this scenario, the main customers would be the AV hardware and software providers, the mobility service businesses, and the final users. Consequently, customer management would be critical, also because of the decrease of bargaining power.

Value Proposition

The focus of the OEMs offerings will remain the product quality. However, in this scenario, carmakers' ability to leverage emotions and feelings would be limited. The focus would be on efficiency, flexibility, scale, and availability, as well as on the status.

Channels

Within this scenario, the traditional dealers and exhibition rooms would be less valuable. On the contrary, a strong online presence could be crucial for OEMs.

Customer Relationships

The OEMs' position in this scenario would be radically different. As a matter of fact, carmakers today do not directly interact with their end customers. Indeed, in the depicted scenario OEMs, would have to manage direct relationships with several customer types.

Revenues Streams

In this scenario, the OEMs would have a more uncertain revenue stream due to their reduced bargained power. However, the number of potential sources would be higher. Indeed, their revenue streams might derive from AV software and hardware providers, mobility services, final users, and financial services altogether.

Key Resources

For OEMs, the key resources would be represented by its staff, intellectual properties, contracts with partners, facilities, brand, know-how, distribution network, processes, and the number of proprietary cars in the market.

Key Activities

Key activities would include design, engineering, manufacturing, supply chain management, logistics, R&D, distribution, brand management, innovation, and customer management.

Key Partners

The key partners would remain Tier1 suppliers, other suppliers, dealers, distributors, governments, universities, financial institutes, joint venture members, along with mobility service providers, and AV software and hardware companies.

Cost Structure

The majority of costs would continue to be related to manufacturing, components, payments to suppliers, distribution costs, maintenance, and R&D.

Scenario 3:

Within this scenario, OEMs would be the focal company within the innovation ecosystem. Indeed, these would set the standards and drive the technology definition process. Moreover, they would be running sharing platforms with subsidiaries or partners.

Customer Segments

In this landscape, OEMs' customers would be the mass mobility users. Therefore, OEMs would have to learn how to directly deal with final users and how to satisfy their needs.

Value Proposition

The focus of the OEMs offerings will shift toward providing mobility services, freedom, flexibility, comfort, at acceptable prices.

Channels

Within this scenario, the traditional dealers and exhibition rooms would be less valuable. On the contrary, a strong online presence could be crucial for OEMs.

Customer Relationships

Since carmakers today do not directly interact with their end customers, OEMs would have to learn how to relate to finale users. Indeed, OEMs would have to manage direct relationships and be very fast in providing the service.

Revenues Streams

In this scenario, the OEMs would maximize their revenues by capturing the lion's share of the market's revenues. However, the streams would be different since these would derive from subscriptions or pay-per-use programs. Therefore, the number of transactions would be significantly higher, and the amounts would be much more modest. Additionally, OEMs might continue offering services as maintenance and financial loans, and could, therefore, preserve these revenue streams.

Key Resources

For OEMs, the key resources would be its platforms, partners, staff, intellectual properties, contracts with partners, facilities, brand, know-how, distribution network, processes, and its customer base.

Key Activities

Key activities would include fleet management, costumers management, exception management, dynamic pricing, design, engineering, manufacturing, supply chain management, logistics, R&D, distribution, brand management, innovation, and customer management.

Key Partners

The key partners would be Tier1 suppliers, other suppliers, dealers, distributors, governments, universities, financial institutes, joint venture members, mobility service providers, AV software and hardware companies, insurers, and complementary services companies.

Cost Structure

The majority of costs would be related to fleet management, manufacturing, components, payments to suppliers, distribution costs, maintenance, and R&D.

Conclusion

As it emerges by analyzing the impacts of shared AVs on OEMs' business model, carmakers will probably strive to assume the role of the focal firm within the innovation ecosystems. Leading the ecosystem would lead to profit maximization, reduced risk, and increased bargaining power. However, if the third scenario would become reality, OEMs would be forced to drastically change their business models, their structures, and acquire countless competencies. Of course, just as OEMs, also other companies are trying to take the lead of the AV technology ecosystem. Therefore, the wisest possible conclusion is that more research and observations are required.

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