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The Open Innovation in the automotive sector: the case study of Porsche NEXT OI Competition

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Academic year 2022/2023

Chapter 1: Introduction

The automotive industry has long been recognised as an hub of innovation, constantly pushing the boundaries of technology and redefining mobility. Within this context, open innovation has emerged as a prominent approach, fundamentally transforming how companies in the automotive sector foster creativity, collaboration, and breakthrough advancements. This thesis focuses on the captivating Porsche NEXT OI Competition case study, delving into open innovation.

The foundation of this exploration lies in comprehending the multifaceted nature of innovation. By examining the defining aspects of innovation and delving into the visionary perspective of Joseph Schumpeter, the groundwork is laid for understanding the transformative power that innovation holds within the automotive industry. The journey then takes us through the evolution from closed to open innovation, revealing how companies have embraced this paradigm shift. The thesis highlights the evolutionary concepts of open innovation and presents virtuous examples of its practical implementation by companies.

Moving forward, the thesis presents an overview of the application of open innovation in the automotive sector, providing insights into the industry's global and European innovation landscape. The dynamic relationship between innovation and emerging trends is explored, uncovering their transformative potential for the automotive industry. To illustrate the practical implementation of open innovation, three compelling case studies are examined. Case Study 1 focuses on BMW Group's innovation strategies, while Case Study 2 delves into Tesla's disruptive innovations. Finally, Case Study 3 explores the collaborative ecosystem of Startup Autobahn within the Mercedes-Benz Group.

In the last chapter, attention is shifted to luxury automotive innovation, specifically focusing on the pioneering advancements within the Porsche industry. The thesis explores the innovations shaping the luxury car market of tomorrow and examines their implications for the overall automotive landscape. At the heart of the discussion lies the Porsche NEXT OI Competition, a captivating case study showcasing the power of open innovation within the luxury automotive segment. Analysing the most innovative solutions from this competition provides valuable insights into the future of Porsche cars and their impact on the industry.

By delving into the concept of innovation, exploring open innovation through compelling case studies in the automotive sector, and examining luxury automotive innovation with a focus on Porsche, this thesis sheds light on the dynamic interplay between innovation and the automotive industry. Through this exploration, the transformative potential of open innovation is unravelled, emphasising its significance in driving the evolution of the automotive sector towards a prosperous and sustainable future.

Chapter 2: The concept of innovation: from Schumpeter to the open innovation

2.1 Innovation: Defining aspects and Schumpeter's definition

During the last ninety years, innovation has been treated on a large scale and changed a lot, starting from the Austrian economist Joseph Schumpeter in 1934 to the present with the idea of open innovation.

The main question, "What is innovation?" has been covered extensively, and over the years, more answers have evolved with different authors and examples. To cite an example, according to the Cambridge Dictionary, an innovation can be defined as "a new idea or method that is being tried for the first time, or the use of such ideas or methods."

The main key ingredients of innovation are the following:

- Idea: the development and application of an idea
- Need: If there is not, it has to be created
- Strong link between need and function: Eventually, a process is a profound need
- Breaking rules
- Luck and serendipity: Finding good things in bad luck
- Insight: How to process work and how to simplify it

Another central question that has been frequently asked, especially during the last years: "Is technology fundamental for innovation?" received several answers.

The conclusion is that technology is not necessarily fundamental for innovation but can play a critical role in the idea, application, and disruption of channels, that is, the organisation. An invention may consist of a technology in the product or an enabling technology. For example, the fax was impossible without a telephone, and the phone enables the technology to make fax

work. A good innovation alters the market structure; a company can create innovation by touching any of the nine boxes of the business model.

The business model describes the rationale of how an organisation creates, delivers, and captures value. (Mongkolkittaveepol, P. The development of a customised support framework to guide tailored support for business incubators). It can be expressed through nine basic building blocks that show the logic of how a company intends to make money. The nine blocks cover the four main areas of a business: customers, offer, infrastructure, and financial viability. (Laode M, K., Suryani, A., & Gunawan, 2012). It is like a blueprint for implementing a strategy through organisational structures, processes, and systems (Osterwalder, 2005). Indeed, an effective way to gain innovation is through a good business model.

Trying to get more specific, what is "Business Model Innovation"? Organisations often dedicate substantial endeavours to innovate their processes and products to attain revenue growth and sustain or enhance profit margins. However, innovations to improve processes and products tend to be costly and time-consuming. They necessitate significant upfront investments in research and development (R&D), specialised resources, new facilities and equipment, and even the establishment of entirely new business units. However, the future returns on these investments are still being determined. Faced with the reluctance to engage in such significant commitments, many companies are turning to business model innovation (BMI) as a more cost-effective and lower-risk alternative, either on its own or in conjunction with product or process innovation.

A global survey conducted by IBM as part of its 19th Global C-Suite study, encompassing over 2,000 CEOs, revealed that 50% of the CEOs surveyed perceived their existing business models as vulnerable to competition from technology-driven entities that offer more compelling value propositions. Only 18% of these CEOs regarded their business models as secure from such threats (IBM, June 2023). Additionally, a comprehensive study conducted by KPMG, which involved interviews with 530 executives, unveiled that most of the surveyed companies (58%) are actively developing new or reevaluating existing business models (KPMG, 2015).

As mentioned, a business model encompasses a boundary-spanning system of interdependent activities centred around a focal firm. It also incorporates activities performed by its partners, suppliers, and customers to pursue value creation and capture.

To better understand this, let us consider Netflix and the business model innovation it introduced in the movie rental industry. Towards the end of the 1990s, Netflix adopted a business model that significantly diverged from the prevailing models of established movie rental companies like Blockbuster. Netflix collaborated with movie studios to offer movie

rentals on DVDs through its website, moving away from the traditional VHS tape format and physical rental stores. To deliver DVDs to customers, Netflix partnered with the U.S. Postal Service (USPS), utilising pre-paid return envelopes for ease of return. Consequently, Netflix introduced novel elements to its business model, including new activities such as DVD burning and shipping, novel governance by engaging USPS for delivery, a new structure allowing online ordering, and a changed value logic through the adoption of a subscription pricing model that enabled customers to rent and choose three movies at any given time. These choices collectively rendered Netflix's business model new to the movie rental industry in the United States and pioneering globally.

Determining whether a business model change can be considered "new," "novel," or "innovative" is subjective and dependent on the perspective of the observer. Startups often perceive business model innovation as introducing a novel business model within the product-market space in which the firm operates. For instance, Netflix was likely the first to submit a subscription-based DVD rental model without physical stores, thus truly pioneering a "new state of the art" business model. On the other hand, established firms like Ford or IBM may not have as stringent criteria and often label a business model change as an innovation if it is new to their specific organisation, without necessarily being new to the industry or the world.

Peter Ferdinand Drucker, an Austrian naturalised American economist and essayist, was one of the best-known and most influential thinkers and writers on management theory and practice. He was very committed to the concept of innovation. According to his perspective, innovation is an entrepreneur's specific tool, exploiting change as an opportunity for a different business or service. It can be presented as a discipline capable of being learned and practiced. Entrepreneurs need to search purposefully for the sources of innovation, the changes, and the symptoms that indicate opportunities for successful innovation. They need to know and apply the principles of successful innovation (Drucker, 1985).[1]

He explained that innovation is the specific function of entrepreneurship, whether in an existing business, a public service institution, or a new venture started by a lone individual. (Djordjevic, B. (2013). Strategic Entrepreneurship: Issues and Challenges). It is how the entrepreneur either

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[1]Drucker, P. (1985). *Innovation and Entrepreneurship*

[2]Harvard Business Review, (2013). *HBR's 10 Must Reads on Innovation (with featured article "The discipline of Innovation", by Peter F. Drucker)*

[3]Schumpeter, J.A., *(1989). Essays on Entrepreneurs, Innovations, Business Cycles and the Evolution of Capitalism*

creates new wealth-producing resources or endows existing resources with enhanced potential for creating wealth (Harvard et al., HBR's 10 Must Reads on Innovation with featured article "The Discipline of Innovation", 2013).[2]
Drucker thought that innovation in any way would have generated wealth, and, for him, invention is based on “faith” in growth.

Joseph Schumpeter, an Austrian economist, is widely acknowledged as a pioneering figure in economic development theory and the generation of new value through technological change and innovation. His influential work[3] (Schumpeter J. A., Essays On Entrepreneurs, Innovations, Business Cycles and the Evolution of Capitalism, 1989) identified various sources of innovation available to entrepreneurs, encompassing the introduction of new goods or production methods, the creation of new markets, the discovery of new supply sources, and the reorganisation of industries. Schumpeter introduced the concept of "creative destruction" (Schumpeter et al., 1942), recognising that following technological advancements, entrepreneurs can access rents from risky ventures in uncertain and complex environments. Schumpeter is considered the father of innovation studies. Innovation is thus defined as "the new combination of production factors." This concept of a "new combination" refers to the following five cases:[4]:

- The introduction of a new good, with which the consumer is not familiar, or qualitative increases of a good
- The use of a new industrial process
- The opening of a new market, which has never been explored before or did not exist before
- The development of new sources of raw materials or other new inputs
- New forms of industrial organisation

However, innovation differs from invention, as the latter is considered a prerequisite for the former. It is regarded as an innovation only when a story is commercially exploited. After outlining the innovation concept, Schumpeter focused on the subjects who can implement these new combinations: entrepreneurs (Schumpeter et al., 1934). These individuals can carry out innovative actions, and it is precisely through this modality that the economic system evolves.

[4] Schumpeter, J.A., (1934). In the *Theory of Economic Development*

According to the author, entrepreneurs' main distinguishing characteristic is their courage to develop a new plan, even without knowing the factors involved. However, “the more accurately we learn about the natural and social world, the more perfect our control over things becomes, and the more things can be simply calculated quickly and reliably, the less significant this function becomes."[5].

Therefore, it is possible to observe how, in Schumpeter's vision, entrepreneurial action is fundamental, both about entering a particular market with an invention, thus transforming it into innovation, and managing the risks and issues that may arise.

According to Schumpeter, innovation is characterised by novel combinations of resources and their services, and it constitutes the primary source of value creation, serving as the foundation for new products and production methods (Schumpeter J., 1942). Schumpeter's concept of innovation extends beyond products and processes to encompass novelty in factor markets, distribution channels, marketing methods, and, impressively, novel ways of leveraging information long before the advent of mobile phones and the internet. In essence, Schumpeter's ideas paved the way for recognising the entire business model as a source of innovation and value creation, extending beyond the products or services offered to customers, typically how most people perceive innovation.

Building upon Schumpeter's perspective on value creation, the resource-based view (RBV)[6] considers the firm a collection of resources and capabilities. The RBV asserts that the effective combination of complementary and specialised help and abilities, which are heterogeneous within an industry, scarce, durable, not easily tradable, and difficult to imitate, can lead to value creation. Since its development in the 1980s and 1990s, the RBV has gained widespread application and has matured as a theory.

In his works "The Theory of Economic Development" (1934) and "Capitalism, Socialism and Democracy" (1942), Joseph Schumpeter presents two distinct patterns of industrial innovation. The first pattern, Schumpeter Mark I, is characterised by small firms operating in highly competitive industries as the primary source of innovative activity.

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[5] Schumpeter, J.A., (1934). Quote from *The Theory of Economic Development*

[6] Barney, J., (1991). *Firm Resources and Sustained Competitive Advantage*
The resource-based view (RBV) argues that a firm's sustained competitive advantage is based on its valuable, rare, inimitable, and nonsubstitutable resources. The capability of firms to create or acquire these resources affects their performance and competitiveness over their competitors.

In contrast, the second pattern, Schumpeter Mark II, involves large firms operating in oligopolistic industries taking on the role of driving innovation, often through extensive research and development laboratories. While the visionary entrepreneur plays a central role in the former pattern, the latter emphasises the significance of large-scale R&D efforts.

Schumpeter's analysis of innovation has been influential and has inspired various economists to study technological innovations. From these studies, three main strands of thought have emerged. The first strand focuses on market structure variables such as firm size, industry concentration, entry, and their relationship to innovation activity. The second strand examines patterns of innovative activity throughout the life cycles of industries, while the third strand emphasises industry-specific technological regime conditions and their impact on innovation activities.

These theories have sought to validate the Schumpeterian innovation patterns empirically. The first and third approaches utilise cross-sectional or short-term time series data to analyse the relationship. In contrast, the second approach relies on long-term time series data to study industry evolution. Although these approaches differ in their level of analysis, they all indicate that both Schumpeter Mark I and Mark II patterns of innovation can coexist in the economy across different industries during the same period. One of these patterns tends to dominate during different phases of the long wave.

Schumpeter places technical change at the core of his approach, considering capitalism as an evolutionary process that constantly revolutionises the economic structure through creative destruction. In "The Theory of Economic Development," (Schumpeter J., 1911) highlights the role of innovations and entrepreneurs in disrupting established routines and driving progress. Creative destruction leads to a qualitative transformation of economic systems, with some firms adapting and thriving while others fade away. This continuous process creates the foundation for further change and innovation.

Schumpeter's perspective on innovation evolved between "The Theory of Economic Development" (1911) and "Capitalism, Socialism and Democracy" (1942) as he observed different industrial structures. Empirical studies have shown that research intensity does not linearly increase with firm size, with smaller firms often being more efficient in utilising their knowledge base due to organisational advantages. Additionally, the relationship between industrial concentration and innovative activity is complex and nonlinear, influenced by technological opportunity class and other qualitative factors. Although earlier studies on the relationship between firm size, concentration, and innovation were inconclusive, more recent research has considered specific technological and knowledge conditions. This research has

indicated that smaller firms contribute significantly to creation, particularly in the early stages of an industry life cycle. However, the overall relationship between firm size, concentration, and innovation output varies depending on the industry's technological opportunity class and other factors.

In conclusion, Schumpeter's theories of innovation have led to different interpretations and empirical studies on innovation patterns. The relationship between firm size, concentration, and innovative activity is complex and context-dependent. Schumpeter Mark I and Mark II patterns of innovation can coexist in the economy, with their prevalence varying across different industries and phases of the long wave.

2.2: From the closed to the open innovation

For many years, companies have pursued innovative activities through generating, maintaining, and accumulating knowledge within their organisational boundaries. This was considered the right approach to bring new ideas to the market. Therefore, companies heavily invested in R&D, seeking to hire the best talent in the market, generating innovative output that allowed them to be the first to market.

Innovative companies created a virtuous cycle of innovation powered by investments in R&D. These organisations then aggressively sought to protect their intellectual property to prevent competitors from exploiting it, thereby further circumscribing knowledge within the company's boundaries.

This paradigm of closed innovation (Chesbrough, 2003) has been the reference model for most of the 20th century and is still used in some sectors.

David Mowery was one of the strongest supporters of internal Research and Development within the firm, as the only organisational structure capable of benefiting from research itself, namely all the results deriving from the commercialisation of industrial knowledge.

Henry Chesbrough[7] formalised this concept in a paradigm called closed innovation. Through fast innovation, "companies generate ideas on their own, develop, build, bring them to market, distribute and finance them themselves."[8]. Companies that use this innovation management model are considered strictly self-confident, convinced that only they can develop technology according to their own needs, not knowing the performance of other companies. In his book,

[7] Henry William Chesbrough is an American economist and writer. He is a professor and executive director renowned for coining the term and concept of open innovation.

[8] Chesbrough, H., (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*

Chesbrough proposes a series of implicit characteristics that identify the closed innovation model:

- Hiring the best and brightest people is necessary so that the most competent employees work for the company. This is partly due to the Not Invented Here (NIH) syndrome: a sort of xenophobia where an external solution that should be, for example, a product, a service, or a process, is rejected because it has not been developed internally. Therefore, no other factors lead to the assertion that a solution developed internally is superior to one from outside.
- To introduce new products and services into the market, it is necessary to discover and develop them independently. In this way, it is possible to be more efficient thanks to a greater understanding of the environment, which leads to the formation of natural monopolies or economies of scale.
- Intellectual property must be protected so competitors do not profit from the company's ideas. "Intellectual property was created internally, used internally, and occasionally brandished externally only to repel intruders or settle an ongoing lawsuit."[9].

In addition to the overall management of the development of a particular product or process, one of the reasons why companies adopt the closed innovation paradigm is the possibility of creating a virtuous circle. Starting from the fundamental technological discoveries made in the company's internal research laboratories, made possible by investments in this department, it is possible to arrive at the creation of goods and services capable of satisfying the needs, new or existing, of consumers. This leads to increased revenues, and the margins formed are reinvested in the internal R&D department to generate further new technological discoveries.

[9] Chesbrough H., & Di Minin, A., (2008). *Open: Modelli di business per l'innovazione*

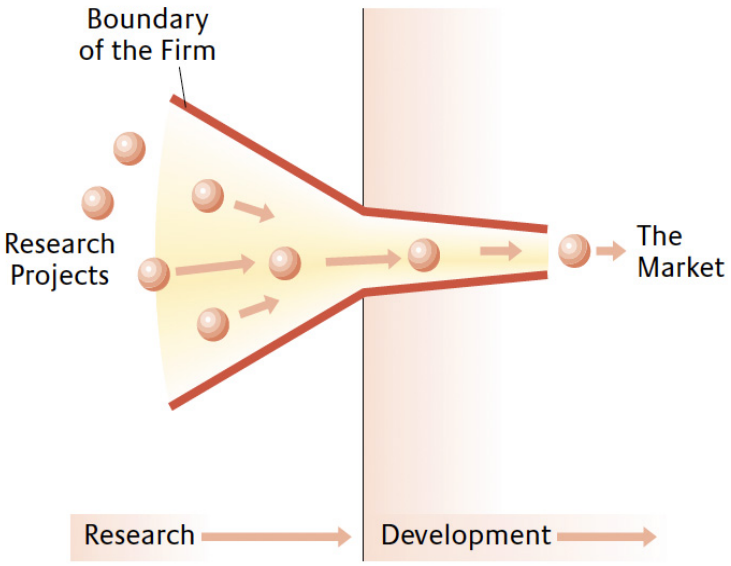

Figure 1: The closed innovation model

Source: Chesbrough H., The Era of Open Innovation, 2003

Within the company, the management of Research and Development takes place through this flow (*Figure 1*): research projects are developed from the internal scientific and technological base within the company's boundaries. Subsequently, these projects move to the development phase and then reach consumers in the market. However, these processes are designed to recognise and discard the so-called "false positives," projects whose initial outcomes appear extremely interesting but later are unsatisfactory.

The lines representing the company's boundaries are depicted entirely to emphasise the closed nature of the model: an internal research project can only move outside if brought to the market by the company, and no external project can enter within those boundaries.

As previously observed, the internal Research and Development structure has a decisive weight within the entire organisational structure of the company. For many years, this model was successful, becoming the growth matrix of modern industry and channelling most of the company's investments. The company relies solely on its abilities in a knowledge landscape detached from universities, small-medium enterprises, and public administrations.

In conclusion, the uncertainty of innovation processes, the high transaction and relationship management costs, and the risk of losing strategically relevant assets for the company's survival do not incentivise organisations to activate collaborative innovation processes.

Towards the end of the 1980s, a combination of factors decreased the effectiveness of closed innovation practices. Two of these factors were the reduction in product life cycle and the increase in research and development costs. The latter made R&D activities more economically burdensome, while the former decreased the possibility of return on investment due to premature product exit from the market. Another factor, perhaps the most important, was related to employee retention. Indeed, in those years, the number and mobility of knowledge workers dramatically increased, making it more challenging for companies to control their ideas and knowledge. It is also worth mentioning the growing availability of access to private capital sources, which allowed new companies to commercialise ideas more efficiently, reducing the barriers to entry. The last factor, but not the least important, is the advent of the internet, which facilitated access to knowledge and its exchange. As Chesbrough highlights, the virtuous cycle on which the closed innovation logic was based was interrupted thanks to these factors. The author then reports the example of two companies operating in the telecommunications instrumentation market (Chesbrough et al.. The New Imperative for Creating and Profiting from Technology, 2003): Lucent Technologies based on the closed innovation model and Cisco Systems, which used and still uses the open model. Although Lucent could count on one of the most important and performing internal R&D structures of those times, Cisco was constantly able to keep up with Lucent, even surpassing it on many occasions.

While Lucent used significant resources in an attempt to develop revolutionary innovations through internal R&D, Cisco acquired every technology from the outside, in most cases through partnerships and investments in startups. In this way, Cisco could keep up with one of the world's best companies in terms of R&D. In this new model of open innovation *(Figure 2)*, companies commercialise ideas that come from inside and outside the company. New technologies are not exclusively developed within the company but are often acquired from the outside, speeding up development times and simultaneously reducing costs. In addition, organisations no longer spend economic resources to protect intellectual property but sell the internally generated knowledge to the outside, mainly through licensing agreements and joint ventures. By selling internally developed technology to third parties, the company can thus rely on new sources of revenue.

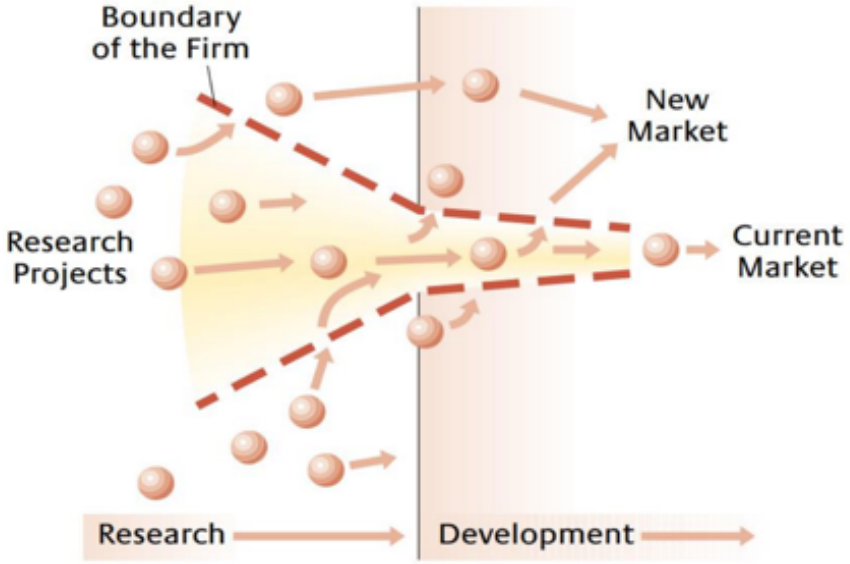

Figure 2: The open innovation model

Source: Chesbrough H., The Era of Open Innovation, 2003

Upon presenting the fundamental characteristics of the closed innovation paradigm and its effects on competencies and internal learning within the enterprise, we will now analyse the motivations that have driven enterprises, over the years, to rely on external sources of innovation increasingly. Many environmental changes have been faced by enterprises throughout the 20th century, with the most important being the growth of skilled workers, which allows for an increase in the level of knowledge of external suppliers, providing more significant opportunities for large, structured enterprises to rely on external research and development of innovative products or processes.

This paradigm is defined as open innovation: the "use of useful knowledge flows to accelerate internal innovation and to expand external use markets of innovation."[10]. Therefore, innovation can derive from different channels, not exclusively from the internal but also the external one. The implicit characteristics proposed by Chesbrough of this paradigm are:

- Only some of the best people work within the organisation: there is a need to work with the best people, whether inside or outside the organisation.
- External research and development can create value, while internal research and development must integrate such value captured from the outside. Organisations must

[10] Chesbrough H., & Vanhaverbeke W., & West J., (2006). *Open Innovation: Researching a New Paradigm*

act quickly for internal research and development times, as due to the speed of environmental change, there could be a risk of losing a competitive advantage.

- Building a suitable business model is of fundamental importance: the strength of organisations must reside in the ability to integrate knowledge and information from multiple sources. In this way, they become more efficient: more skills and capabilities are acquired at lower costs.
- The organisation benefits from licensing intellectual property but also needs to take advantage of others' intellectual property if it is adaptable to the organisation's business model. It is possible, therefore, to manage intellectual property to contribute to value creation: by granting some of it externally, it is possible to create a standard or a joint knowledge base, which is very fertile ground for research and development activities, capable of strengthening one's business.

Therefore, it is a collaboration between the enterprise and the economic environment surrounding it, making the boundaries of the enterprise porous: technological knowledge is no longer considered an asset available only within the enterprise. However, it becomes a real economic good that can be purchased on the market. The use of this approach, furthermore, allows for technological exploration and exploitation. On the other hand, it provides for sharing core competencies with other companies.

Businesses can benefit from the proactivity of the external market, helpful in conducting new experiments, improving products and services already present on the market, or creating products designed by consumers themselves. External networks are the main field where technology exploration activities can be analysed, and these networks allow the company to address specific knowledge needs without spending much time and money required for the internal production of such detailed knowledge. The exploitation of technology, instead, involves three main activities through which it is possible to benefit from internal knowledge: activities related to venture capital, activities related to intellectual property management, and the involvement of employees not engaged in research and development activities in innovative activities.

It is time to consider some problems open innovation can encounter. Most scholars still publish descriptions of successful cases or report the results of extensive statistical surveys on the innovation benefits of the new approach. Some have proposed excellent crowdsourcing analyses, asking how best to formulate a request for proposals or whether to encourage

potential participants to cooperate or compete. However, with few notable exceptions, academics have ignored the failures of open innovation.

Open innovation involves generating, disseminating, and assimilating incoming and outgoing knowledge flows. These are the three sides of creation, which we must consider in the context of individual companies. More is needed to discover or identify helpful knowledge merely. It is also necessary to transmit it to the right people and in the appropriate places within the company. Furthermore, other employees must study, understand, and potentially modify or extend the knowledge if the company wants to utilise it. The best way to promote knowledge transfer from one person to another in this hyper-connected and perpetually connected world is to allow them to be close and interact enough to share and communicate what they know. Therefore, a fundamental condition for the success of open innovation is that the workforce has a high level of education and skills and that the mobility of workers from one company to another is reasonably high so that knowledge can spread widely in society. These are difficult conditions to meet in specific contexts.

For example, the labour market is divided into two levels in Japan.[11] The first, more numerous, consists of workers who, as soon as they graduate, enter a specific company and remain there for a very long part of their working life. The second level instead includes workers with temporary contracts who move from one company to another, usually occupying low-quality jobs. Worker mobility still needs to improve in the first level of the labour market. This rigidity is an obstacle to open innovation because, even if they bring external ideas into the company, the same people who worked for them a year before, the year before, and even earlier will try to assimilate them. Thoughts can enter the company, but only some of the people who cultivate them are capable, if necessary, of modifying and adapting them to work well in their business. Even the division into functional areas is often an obstacle to open innovation. Practical internal knowledge may be blocked by one or the other of these functions, or that a defensive manager keeps it to himself. One way to counteract this lack of communication is to allow employees of both the innovation and other business units to exchange positions so that the former can transmit what they know about the most promising innovation projects. These transfers are often followed by modifications or adaptations of the initial idea, without which the business unit could not develop and bring it to the market. The same is true for the inside-out component of open innovation. Here, too, it is often necessary for one or more company employees to follow the project for a certain period outside.

[11] Ishikawa T., (2002). *Income and wealth*, pp. 241-282

Another requirement for effective dissemination and assimilation of new knowledge is the existence of an internal research and development department. Open innovation is an excellent reason to procure the R&D necessary outside the company. However, those who need to understand the nature of this innovation strategy need to understand it. A company can only make external knowledge its own to the extent that it can use it if it has a certain amount of creative drive and can leave the people working on new knowledge enough time to apply it together. Open innovation works best if people are willing to work alongside those in the company, sharing their expertise with themselves. These people cannot be acquired from outside. They must be talented employees of their organisation. Equally important are the people who play a boundary-spanning role, that is, people who have access to knowledge from diverse sources and find ways to combine them. Their work can do a lot to overcome the divisions between functional areas and counter their tendency to specialise and close themselves off to outsiders.

An obstacle to open innovation can also be a well-known attitude of many R&D departments: the "Not Invented Here" (NIH) syndrome. Companies with a solid technological tradition tend to have R&D employees convinced that everything they did not invent must be unimportant or not good enough. It is a presumption typical of companies with a long history of good technological results. It should also be noted that non-technical people need help to evaluate the skills and abilities of the research and development staff.

2.3: Evolutionary concepts of open innovation and how companies apply it with virtuous examples

The concept of open innovation originated from a series of case studies on collaboration between two companies, initiated by one of them to open their innovation process. However, today, open innovation is used to encourage the involvement of a much more comprehensive range of stakeholders, called upon to cooperate in different roles. In simple terms, designing and managing innovation communities will become increasingly important in the future of open innovation. This is true for companies and the broader society in which they operate. Companies such as Uber, Airbnb, and Amazon have succeeded in developing high-value businesses by building and then expanding platforms whose function is to connect consumers of various types of goods and services with many different suppliers. These platforms are relatively pure because their owner does not need to own virtually any traded assets. However, open innovation goes far beyond these single-line examples. It is transforming several

companies, both business-to-consumer and business-to-business, by extending their scope and sphere of interest to the entire surrounding ecosystem. By paying more attention to the ecosystem they operate, these companies can identify new growth opportunities. Most empirical evidence on global open innovation comes from case studies, frequently of larger companies in technology-intensive industries.

In April 2014, Henry Chesbrough and Sabine Brunswicker conducted one of the most compelling surveys on open innovation[12]. They surveyed 125 large firms in Europe and the United States, with annual sales surpassing $250 million, to determine the extent to which large firms practice open innovation. The results showed that 78% of firms employ open innovation, and none have abandoned it. Moreover, 82% of companies practising open innovation declared that it is more widely used today than three years ago (Chesbrough, H., & Brunswicker, S., 2015). The survey consisted of a 23-item questionnaire, taking 15 to 20 minutes to complete, with an additional demographic section and five sections about the adoption of open innovation and strategic moves to pursue open innovation, the role of individual open innovation practices in the firm, the organisational implementation, the measurement of innovation activities, and performances. The sample of 125 companies included low-tech and high-tech firms. The median firm was 78.5 years old, with annual revenues of $2.9 billion and 7,980 employees. (Chesbrough, H., & Brunswicker, S., 2015). The adoption of open innovation is not limited to the information and communication technology sector, as data indicates that enterprises from low-tech and high-tech sectors also practice this paradigm. Moreover, according to further analysis, companies have been adopting open innovation for a median of about five years. Although open innovation is not pervasive among large companies, it is widely employed, suggesting that it is fast-growing and well-established. Henry Chesbrough and Sabine Brunswicker distinguished between inbound and outbound open innovation. They created a matrix to classify open innovation practices, including financial and non-financial compensation methods. Their research revealed that inbound open innovation procedures are more commonly used than outbound ones.

[12] https://www.researchgate.net/publication/272566700_Managing_Open_Innovation_in_Large_Firms

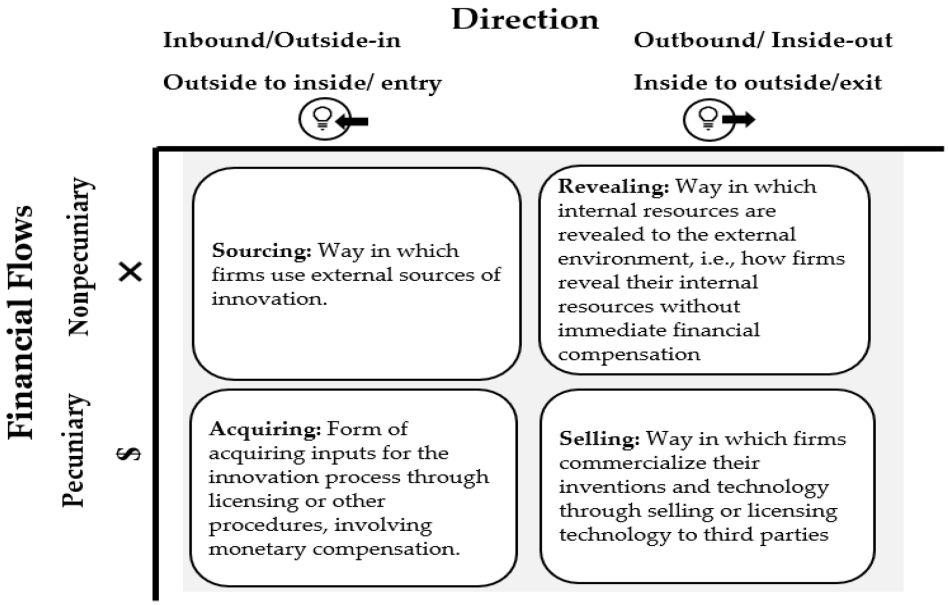

Figure 3: Modes of open innovation

Source: Chesbrough and Brunswicker, 2013

In addition to analysing the importance of inbound and outbound open innovation practices, examining preferences for particular types of partners involved in open innovation activities was crucial. The survey asked firms to rate their preferred partners, and interestingly, the most critical source of innovation ideas was internal employees. This finding counters the notion that open innovation is a way to reduce internal R&D staff. On the contrary, the data suggest that respondents consider employees a key element in their open innovation efforts (Chesbrough, Henry, and Sabine Brunswicker, 2014).

In their analysis of 124 companies,[13]Gassman and Enkel found that the open innovation approach is mainly used in high-product modularity or high-speed industries. According to the authors, there is an "era of open innovation", which can only be unlocked by firms that want to commercialise their ideas and other firms' innovations, using external processes to bring their in-house ideas to market. This is mainly because many products invented for specific businesses have given their best results in other markets.

For example, BMW used joystick technology from the video game industry to create the iDrive system, now incorporated in almost all the manufacturer's models.

[13] Gassmann O. & Ellen E., (2004). *Towards a Theory of Open Innovation: Three Core Process Archetypes*

To make a transition, a company has to allow innovation to flow between the external environment and internal processes of the firm. It is essential to fully integrate superficial knowledge fundamental to internal development and combine approaches that take market demands and the company's vision into account. According to Gassmann and Enkel, the most revolutionary way to change traditional innovation methods is by using open source, a phenomenon of cooperative software development by independent programmers who modify or develop lines of code to create new applications or increase program applicability. The researchers created a framework for open innovation involving three core processes: outside-in, inside-out, and coupled. Outside-in means enlarging a company's knowledge base through integrating suppliers, customers, and external knowledge sourcing. Inside-out is when the company sells or licenses IPs and brings its technology to market to gain profits from this activity. Finally, the coupled process concerns working on alliances with complementary partners, connecting outside-in and inside-out processes. These three processes represent an open innovation strategy (Palma, M. F. D., 2021), but only some processes are equally relevant for some companies. Gassman and Enkel concluded that the future of open innovation is about following a flexible innovation strategy, creating several innovations by combining various techniques and not outsourcing all internal innovation activities.

Innovation does not solely stem from creating or discovering impressive technology. We will briefly examine open innovation practices deployed by large and significant companies to observe the entire innovation system, from inception to dissemination to assimilation. The process commences with a heterogeneous series of mechanisms designed to generate or search for novel and promising concepts and technologies. This stage is followed by the meticulous dissemination of the identified technology within the company and its absorption, which can be achieved in various ways within one or more of its business units, leading to its eventual introduction into the market. By studying these cases, we can identify underlying principles that support and sustain open innovation within companies and some of the necessary boundary conditions for its success. If these conditions are not met, open innovation may not yield the desired results that the company expects.

Procter & Gamble's Connect and Develop Initiative is one of the earliest and most successful assortments of open innovation practices, developed in the early years of this century. In 2000, the company faced a financial crisis, with the failure to meet a series of objectives causing its share price to plummet from over 150 dollars to just 54 dollars in a few months. The CEO was replaced by an executive from the cosmetics division, A.G. Lafley, who witnessed the benefits of open innovation for developing new businesses in his sector. He was firmly convinced that

it would also prove fruitful for the rest of the company, leading to the creation of the Connect and Develop program. As reported by Larry Huston and Nabil Sakkab of Procter & Gamble in a 2006 article for the Harvard Business Review, open innovation has helped their company achieve significant savings in both time and money[14].

An excellent example is the Pringles Print initiative: Procter & Gamble wanted to offer Pringles chips decorated with pictures and words. Instead of investing his time and money researching edible dyes and food-friendly printing techniques, he found a bakery in Bologna that printed messages on cakes and biscuits using inkjet. P&G worked with the bakery to adapt the technology to potato chips and, in the process, developed their smaller basket product and brought it to market in half the time it would have taken with in-house development. Procter & Gamble worked also to create new brands by licensing technologies from other companies from various parts of the world. They were born with products like Crest SpinBrush, Olay Regenerist and Swiffer Dusters.

Today, the latter two are billion-dollar brands for P&G, and it does not matter where their essential technologies originated. However, Procter & Gamble also makes money today by licensing its technologies. An example is the joint venture with Clorox to exploit the Glad brand. P&G put the production technology, Clorox the brand and the product, and together they created a company that lasted more than ten years. More generally, P&G has adopted an intellectual property management policy whereby, given a new patent, internal businesses have nine months to find ways to exploit it with a new product once the patent is offered to others under licensing.

As soon as Lafley recognised the growth impact of open innovation, he determined that at least 20 percent of the contributions to his innovation process should come from outside the company within 1 to 5 years. At the time of this decision in 2002, only about 200 percent of innovative ideas came from others. It was, therefore, a very ambitious goal for the whole company, and yet in 2007 it was achieved.

To summarise, the best practices of Procter & Gamble were:

- Using good branding to turn external technologies into billion-dollar products.
- They are making unused internal technologies available to others interested in exploiting them, thus creating other brand billionaires. Use-it-or-lose-it politics can

[14] https://hbr.org/2006/03/connect-and-develop-inside-procter-gambles-new-model-for-innovation

drive internal divisions to pay more attention to technologies that would otherwise undervalued or ignored.

- It is allowing others to license the new patent. This will get internal units of the company to pay more attention to it, with substantial additional revenue, and identify suitable business models for developing the patented technology.

Another essential open innovation practice can be noticed in the General Electric industry. Despite facing significant challenges in recent times, General Electric has long been a pioneer of innovation best practices. One such practice is the Ecomagination Challenge initiative, which leverages open innovation to advance green and renewable energy. Although the company already had a considerable energy business, its customers primarily comprised utilities or power companies interested in purchasing large plants. However, many new technologies were emerging for generating green and renewable energy in modest quantities, such as small modules that often needed to be connected to the standard grid and could be installed on homes or commercial buildings. General Electric products required to offer in this market and needed more knowledge. To attract entrepreneurs with business projects in this sector, it launched the Ecomagination Challenge. If the company were interested in a project, it would offer its author an initial investment. The fund allocated for this purpose was $100 million. General Electric could have pursued this path alone. However, it realised that there was a network of venture capitalists with investment experience in this field and that it could learn a lot by working with them. Additionally, General Electric recognised that it needed to gain more knowledge of the daily realities of small startups. These require coaching, mentoring, and other services typically offered by venture capitalists. Therefore, it convinced four of them to invest another $100 million in the Ecomagination Challenge. The total funds allocated to the initiative were now $200 million.

Over 3,800 responses were received, ten times more than General Electric had anticipated. It took time and much effort to review them all. The company contributed its comments during this screening process, and the final vote also involved 70,000 people registered on the competition website. GE's People's Choice award recognised the most successful idea among external participants. The technical examination of the projects presented was instead conducted by GE's internal R&D team, which thus had the opportunity to get to know the new world of renewable energies in depth. Ultimately, General Electric agreed to fund a few more of the seventeen new companies and its venture capitalist partners for twenty-three startups. However, thanks to the Ecomagination competition, GE was also able to proceed with a

convenient acquisition that it would not have otherwise identified and understood that even the community of 70,000 participants was potentially a resource, so much so that, once the competition was concluded, it created the figure of the community engagement manager, whose job is to keep the interest of this community for renewable technologies and solicit its participation. Following this experience, General Electric launched similar initiatives for its other businesses, such as transportation, health care, and others in China. It is clear now that the outside world is the custodian of many acquaintances and that even a decidedly large and successful company can learn from outsiders.

To sum up, the best practices of the Ecomagination Initiative include soliciting ideas from others when seeking new business areas, allowing different parties to explore these ideas, and paying attention to the most valued ones. The R&D organisation should be enabled to learn by examining external ideas. Additionally, in some cases, it is advisable to collaborate with an expert in the field to invest in areas of activity far from the core business.

Finally, I would like to talk about the case of Enel. Enel, a prominent energy company based in Italy, exemplifies the efficacy of open innovation in sustainability, or what they call open innovation. Utilities are typically designed for stability rather than innovation. Nevertheless, in the first decade of this century, Italy and Europe introduced strong incentives to support investment in the renewable energy sector. Consequently, Enel established a new entity, Enel Green Power (EGP), and merged its various activities in this field, offering it on the stock market. Francesco Starace, a long-standing Enel executive, was appointed the new company's CEO. Enel Green Power swiftly recognised, akin to General Electric, that the renewable energy market differed significantly from Enel's conventional utility services. The technologies needed to be more mature, and novel approaches frequently followed established ones. The quantities of energy generated were smaller, necessitating swift decision-making, and financing startups necessitated flexibility and creativity. Enel Green Power adapted readily to these circumstances and achieved remarkable success. Indeed, its success was so exemplary that, in 2014, Starace was appointed CEO of all of Enel, and Enel Green Power was reincorporated. Upon joining Enel, Starace refused to become the head of a traditional utility company. Instead, he boldly proclaimed that the competition would centre on fossil fuels rather than utilities and that renewables would decide the company's future. The audacity of this new way of thinking is demonstrated by Starace's invitation to Greenpeace to discuss the company's renewable energy plan. This invitation is significant because Greenpeace had only occupied Enel's headquarters in Rome a couple of years earlier and unfurled a banner declaring the

company a danger to the environment. Enel has embarked on a transformation journey by decommissioning nuclear power plants, shutting down coal-fired plants, and expanding renewable energy facilities. In addition, the company has initiated microgrid experiments to provide energy to remote areas previously reliant on diesel generators.

Enel has also invested in the first thermodynamic solar energy in the United States, which employs photovoltaics to start the process and geothermal sources to sustain generation. Under the guidance of Ernesto Ciorra, a marketing consultant and poet, Enel has embraced a version of open innovation called open innovation, which incorporates sustainability as a mission. Consequently, the company has intensified its collaboration with startups and universities.

Enel currently collaborates with startups in its boot camps, located in four locations worldwide, and shares the results with its internal business units. Moreover, it has reorganised several university research projects by establishing more focused relationships with twelve leading universities. The new network of collaborations created in various technological hotspots, including Europe, Silicon Valley, Israel, and Boston, has placed Enel in a position to obtain knowledge from multiple sources.

Today, Enel is much more informed than before, and the promise to provide consumers with new and greener energy sources is likely to be realised. Enel has identified some best practices in open innovation, including recognising that certain new technologies require a new business model to succeed. Open innovation inside-out spin-offs, such as Enel Green Power, have been established on new business models that the parent company would have found challenging to organise internally. Furthermore, opening up structures in technological hotspots worldwide allows companies to collaborate with startups during the initial stages. Going where startups are located is essential rather than expecting them to come to the company. Environmental sustainability is critical in providing a better future for society, and open innovability is an effective business strategy to achieve this vision.

This chapter aimed to provide an overview of the concept of innovation, starting from a macroeconomic perspective through the analysis of the contributions of Joseph Schumpeter. A taxonomy of innovations was subsequently identified, focusing on the differentiation between closed and open innovation paradigms. The former is characterised by a complete lack of openness towards the external environment, leading to the belief that the only profitable investment is in the internal R&D department. This leads to both internal skills and internal learning consequences: Companies require the best workers and a culture of internal learning that stimulates and enhances such skills. On the other hand, the open innovation paradigm is based on complete openness to the external environment, using external collaborations to

integrate the internal R&D department, thereby increasing the company's innovation rate. Such a paradigm shift is due to a change in the environmental context, which requires organisational adaptation.
Finally, evolutionary concepts of open innovation are presented along with virtuous examples of how companies apply them.

Chapter 3: The open innovation in the automotive sector with related case studies

3.1: Innovation and new trends in the automotive sector with a global and European view

The automotive sector is the largest branch of the manufacturing industry, encompassing companies involved in the design, construction, and marketing of motor vehicles and their components.
The automotive industry is becoming increasingly competitive, demanding manufacturers to provide higher-quality vehicles at more affordable prices. It is a capital-intensive sector characterised by substantial investments in research and development. In the following paragraph, we will analyse some critical issues related to the global automotive and the European Union sectors. The motor industry is highly concentrated, with a few large companies wielding significant power on a worldwide scale. Eleven multinational corporations,[15] in Japan, Germany, and the USA, dominate the competition in major markets (Statista, 2021). This situation has been facilitated by a wave of mergers, acquisitions, and alliances in the 1990s, highlighting the crucial role of collaboration in achieving leadership in the automotive sector. The automotive industry is globally characterised by high capital intensity, vertical integration, and substantial economies of scale (Schulze et al., 2015). In recent years, increasing competition, globalisation, digitalisation, stricter regulations and the COVID-19 pandemic have posed challenges for all companies in the sector.
In terms of market value, it amounted to $1,604.5 billion in 2019, with a Compound Annual Growth Rate—of 16 1% from 2015 to 2019. Regarding market volume, it experienced a decline of 4.9% in 2019, going from 154 million units to 146.4 million units, with a CAGR of 0.5% from 2015 to 2019 (Marketline, 2020a). The year 2020 witnessed a further decline due to the

[15] Volkswagen Group, Toyota Motor, Daimler, Ford Motor, General Motors, Honda Motor, BMW Group, SAIC Motor, Stellantis, Hyundai Motor, and Nissan Motor.
(https://www.statista.com/statistics/232958/revenue-of-the-leading-car-manufacturers-worldwide/)

impact of the COVID-19 pandemic on the global automotive industry. However, the forecasts for 2019-2024 are optimistic, with an expected CAGR of 1.6%, bringing the industry to a value of $1,733 billion by 2024.

The automotive industry is undergoing a significant transformation. Global disruptions, technological advancements, and evolving consumer behaviours are simultaneously reshaping the industry on multiple fronts. While the traditional business model of designing, manufacturing, selling, servicing, and financing vehicles remains, the industry is rapidly moving towards a new era driven by sustainability and changing consumer preferences. This new world encompasses electric vehicles, connected cars, mobility fleet sharing, onboard sensors, innovative business models, and constant connectivity.

During the initial stages of the pandemic, the automotive industry faced substantial challenges as global supply chains ground to a halt, manufacturers and dealers temporarily closed, and people reduced their driving (The Future Of Automotive And Mobility). However, industry experts suggest that the pandemic accelerated the digitalisation process in the automotive sector.

The auto industry has experienced previous disruptions and has learned valuable lessons from past economic hardships, particularly during the downturn in 2008-2009. As a result, automotive suppliers have become better prepared, more resilient, and capable of bouncing back. Currently, automotive manufacturers are grappling with semiconductor chip shortages, which are impacting vehicle production. These ongoing disruptions to operations and supply chains have significantly expedited various underlying business and technological trends in the automotive industry. Advanced technology solutions play a pivotal role in driving these trends. Connected cars, sensors, electrification, and new business models like mobility-as-a-service all leverage advanced technology solutions. Industry experts emphasise that the automotive industry must focus on harnessing these technologies moving forward. From suppliers to automakers, the entire industry faces the challenge of maintaining profitable existing operations while embracing and adapting to these innovations. Striking the right balance between stability and profitability while also leading the way in disrupting their business models is crucial for companies in the automotive industry.

What will the future of mobility look like in the real world? The industry is already witnessing a wealth of collaboration and innovation in this space, with e-mobility advancements underway.

Here are a few examples:

- Cars that possess self-awareness and serve as connected platforms for new business models.
- Vehicles have numerous Internet-connected engine control units (ECUs) and sensors, providing valuable data and insights.
- Combining vehicle sales with subscription-based offerings for parking, electric vehicle (EV) charging, rideshare, and car-sharing services.
- Algorithm-based insurance tailored to data collected from connected cars.
- Fleet services, which are experiencing significant growth, will continue to expand and include charge point operations as more fleets transition to electrification.

Challenges confronting the European Union (EU) automotive sector are of paramount concern. Accounting for over six percent of total EU employment and more than seven percent of gross domestic product (GDP), this industry faces the formidable task of advancing the twin transition towards sustainability and digitalisation. This challenge arises when broader EU automotive interests are threatened due to heightened global competition from new market entrants and established companies from the Asia Pacific and North America.

While the COVID-19 pandemic has subjected the automotive Global Value Chain (GVC) to significant stress tests, such as semiconductor supply disruptions, it has also acted as an accelerant, positively impacting consumer demand for electric vehicles (EVs) and driving forces like electrification, digitalisation, and GVC resilience measures. Nonetheless, the increased disruption, particularly from non-EU entrants, poses risks to EU employment and the viability of many EU automotive enterprises. Considering that the automotive industry is poised to transform more in the next decade than in the previous century, significant winners and losers will inevitably emerge due to the ensuing challenges.

From a broader EU perspective, electrification, intelligent mobility, and shared transportation represent significant strides towards environmental sustainability and efficient mobility. These advancements are facilitated, to a considerable extent, by digitalisation. Regaining leadership in core technologies, particularly in the realm of connected and autonomous vehicles (CAVs), is the optimal pathway towards excelling in green initiatives and digitalisation while fully unlocking the potential of the EU automotive industry. The broader study findings have been substantiated and calibrated by conducting a comprehensive strengths, weaknesses,

opportunities, and threats (SWOT) analysis of electromobility and CAVs in Europe. The key findings are briefly summarised in *Figure 4*.

Figure 4: SWOT assessments for electromobility (left) and CAVs (right) in Europe

Source: IPOL | Policy Department for Economic, Scientific and Quality of Life Policies

The findings of the SWOT assessment have served as a foundation for the development of policy measures aimed at empowering the European Parliament to form an independent perspective on the necessary steps and initiatives that align the objectives of greening and digitalisation with enabling the automotive industry to regain and maintain its global technological leadership in electromobility and CAVs through innovation-driven competitiveness.

The EU has promoted the twin transition towards sustainability and digitalisation for several years through various guidelines, strategies, action plans, initiatives, directives, and incentives. This strategic and policy framework is unparalleled globally and provides a conducive environment for tackling the challenges of increasing international competition. Notably, by taking a comprehensive view, examining the entire automotive supply chain, emphasising skills development, and proactively addressing the industry's needs, most of the necessary policies are already in place to ensure technological leadership and competitiveness.

However, the study has identified specific gaps and opportunities for further action to advance the EU's agenda while supporting the European automotive industry in maintaining its role as

a driver of sustainable and inclusive economic growth and employment across all Member States. Recognising that the cumulative effect of the identified policy recommendations will have the most significant impact, prioritising specific requests over others is less than optimal. The automotive sector holds significant importance in the European Union economy. With over 6% of total EU employment linked to the automotive industry and its turnover accounting for around 7% of EU Gross Domestic Product (GDP), it plays a pivotal role[16]. Additionally, the industry is the largest private investor in research and development (R&D). However, the sector is crucial as various trends reshape the industry. Notably, these trends encompass the green transition, including electromobility and hydrogen fuel cells, and the digital transition, encompassing connectivity, autonomous driving, and software advancements. The twin transition alone poses significant challenges for the automotive industry. However, simultaneously, global competition is intensifying. It is projected that 80% of the global automotive industry's growth will occur outside the EU. Thus, it is imperative to lead and implement the twin transition effectively and ensure the resilience and development of the EU industry within the context of accessing global growth markets. Consequently, as a third trend, one must consider the industry's resilience and the broader economy in light of escalating international competition, evolving business models, and disruptions to global supply chains.

The transition from traditional internal combustion engine (ICE) vehicles to electric vehicles (EVs) has been a transformative game-changer in the automotive industry, even before the COVID-19 pandemic. While ICE-powered vehicles will still be needed in many markets for the foreseeable future, several prominent brands have already announced plans to launch an all-electric lineup within the next four years. This shift towards EVs profoundly impacts the automotive global value chain (GVC).

In addition to the shift towards EVs, other trends, such as connectivity and autonomous driving, have been accelerating the importance of software, data, and electronics in the industry. These trends will continue to drive changes in the automotive GVC. New technologies have significantly lowered market entry barriers, particularly in autonomous driving and connectivity. This has increased the importance of vehicle software and data, intensifying competition and highlighting the significance of Information Technology (IT) and electronic manufacturing services (EMS) companies. Large technology companies from the USA and China, with their financial capabilities, are at the forefront of investing in the development of

[16] https://www.europarl.europa.eu/RegData/etudes/STUD/2021/695457/IPOL_STU(2021)695457_EN.pdf

vehicle technologies. They could disrupt the market and challenge more traditional automotive companies.

These new technologies also drive the emergence of new business models. Advanced technological solutions are shaping the future of mobility in various areas. For instance, cars with self-awareness that serve as connected platforms for new business models like shared mobility concepts are gaining traction[17]. There is also the capacity to bundle vehicle sales with subscription-based offerings for charging and ridesharing. Algorithm-based insurance based on data from connected cars is another emerging trend. Customer loyalty is becoming less influenced by brand and more by the value of associated mobility options. The digitalisation of the entire supply chain is accelerating, and the automotive industry is in a race for talent, particularly in artificial intelligence (AI). Given the rapid pace of technological developments, collaboration has become necessary in the automotive industry. Top global tier-one suppliers are increasingly seeking joint venture partnerships to share the burden of research and development costs and achieve quick turn-around times in the design, testing, and production of new EV components, regenerative systems, and connectivity and autonomous functions. This desire for joint ventures to keep pace with technological advancements will continue to be a prevailing trend in the industry.

In conclusion, the automotive industry is undergoing significant transformations driven by the shift to EVs, advancements in connectivity and autonomous driving, and the increasing importance of software and data. These changes are reshaping the global value chain, intensifying competition, driving new business models, and necessitating collaboration to keep up with technological developments.

The global automotive industry is influenced by various topics that significantly impact its future. In 2017, Deloitte[18] Identified several critical issues based on their degree of impact and uncertainty:

- Connectedness of cars: Integrating vehicle connectivity technologies can transform the driving experience and enable new services and functionalities.

[17]For example, Daimler and BMW initially formed joint ventures to enter the shared mobility services market, launching platforms like Share Now, Free Now, Park Now, and Moovel. These ventures were aimed at competing with digital companies like Uber.

[18] Deloitte, (2017). *The Future of the Automotive Value Chain - 2025 and Beyond*.
Available at: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consumer-business/us-auto-the-future-of-the-automotive-value-chain.pdf

- Innovation: Continuous innovation is crucial for automotive companies to stay competitive and meet customers' evolving needs (What Companies Are In The Technology Field In 2023?). This includes advancements in technology, design, and business models.
- Light-weighting technologies: Developing lightweight materials and technologies is essential for improving fuel efficiency and reducing vehicle emissions.
- Autonomous driving: The emergence of autonomous driving technologies is reshaping the future of mobility, with implications for safety, efficiency, and user experience.
- E-mobility business models: The transition to electric mobility is driving the exploration of new business models, such as vehicle sharing, subscription-based services, and charging infrastructure.
- Talent competition: The automotive industry is facing a shift in required skill sets, with a growing demand for professionals with expertise in software, data analytics, and artificial intelligence.
- Trust in OEMs: Building and maintaining trust in original equipment manufacturers (OEMs) is crucial for consumer acceptance of new technologies and sustainable business growth.
- Role of suppliers: Suppliers play a vital role in the automotive value chain, and their capabilities and collaboration are crucial to driving innovation and competitiveness.
- Environmental regulations: Stringent environmental regulations, such as emissions standards and sustainability requirements, shape the industry's direction and drive the development of greener technologies.

In addition to the previous topics mentioned, these factors will be further explored in this study, as they significantly impact the competitiveness of the automotive sector. It is evident that as the industry moves forward, greener consumer preferences and digital technologies are driving disruptive changes throughout the entire automotive global value chain. However, the extent to which this transformation can maximise inclusive and sustainable economic benefits regarding job creation, innovation, value-added, entrepreneurship, trade, investment, eco-friendliness, and gender balance remains uncertain and requires careful consideration.

3.2: Case Study 1: Innovation at BMW Group

"At BMW Open Innovation, we create value for our customers by unlocking the innovation potential of startups, cross-industry technologies, intrapreneurs and innovation crowds. Thanks to our highly committed team and a comprehensive outside-in perspective, we significantly contribute to the innovation leadership of the BMW Group".[19]

From the historical perspective of the BMW Group, it becomes evident that the company's path to success can be attributed to its unwavering focus on meeting customer needs, coupled with a solid commitment to innovation and sustainability. The company takes great pride in its product responsibility policy. It invests significant efforts in various areas, such as efficient mobility, product safety, resource efficiency, recycling management, and future mobility, all to ensure customer satisfaction. These responsible practices are deeply ingrained in the company's target systems and organisational processes for product development. Given the impact of increasing regulations, fluctuating fuel prices, environmental concerns, and the growing awareness of climate change, customers' behaviours have been influenced, making alternative drivetrain systems and mobility services increasingly significant.

BMW addresses these changes through a tailored development strategy known as Efficient Dynamics. This strategy focuses on enhancing the efficiency of conventional petrol and diesel engines through engine optimisation, lightweight design, aerodynamics, and energy management. By doing so, the company aims to maximise the potential of electric vehicles and incorporate Efficient Dynamics as a standard component in their high-volume vehicles. This strategic approach contributes to meeting specific CO2 targets for environmental protection and positions BMW as a leader in pursuing sustainable mobility.

In fact, between 1995 and 2014, BMW successfully reduced CO2 emissions from newly sold vehicles in Europe by more than 38%. Simultaneously, the company has expanded its electrified drivetrain offerings, leveraging the BMW iDrive technology. The introduction of the battery-driven electric model BMW i3 and the plug-in hybrid BMW i8 received favourable responses from the audience, signalling a promising future for the widespread adoption of electric cars. Building upon this positive momentum, the German automaker launched the BMW X5 plug-in hybrid with eDrive technology in 2015.

However, the true potential of electric cars can only be realised when they are powered by carbon-neutral electricity. Recognising this, BMW allows customers to purchase a renewable

[19] Petrick K., *Head of BMW Open Innovation*

electricity package to charge their electric vehicles with eco-friendly power. Since introducing the "i" brand in 2013, the company has progressively incorporated electromobility into its core models. In parallel with the development of electric drivetrains, BMW is actively exploring alternative solutions, with hydrogen and fuel cell technology being particularly interesting.

BMW is renowned for its commitment to innovation and has implemented various formats to accelerate technological advancements. Some of the notable innovation formats employed by BMW include:

- BMW STARTUP GARAGE[20]: An initiative that provides support and resources to early-stage startups working on disruptive technologies. It offers selected startups access to BMW's expertise, facilities, and network, enabling them to test and develop their ideas in collaboration with BMW.

  The BMW Startup Garage is the global matchmaker between cutting-edge startup solutions and the innovation needs of BMW Business Units. As a venture client, they strengthen the BMW Group's innovation leadership by identifying a startup's product, technology or service before it reaches market maturity. In this way, the venture client model enables us to solve critical challenges across the entire organisation of the BMW Group fast and at scale. They support the startup in a 4-month pilot project to test and validate the impact of the technology for BMW and enable startups as suppliers and long-term partners. Participating in their program is the first step for a startup to succeed in the global automotive industry and network with top automotive engineers and managers. (BMW Startup Garage). They are looking for startups from all over the world to join them in sustainably shaping the future of mobility.

- BMW CROWD INNOVATION: The BMW Crowd Innovation Platform facilitates the engagement of innovators in harnessing the collective intelligence of internal and external crowds focused on innovation. This approach effectively identifies novel concepts and technical remedies to address existing and forthcoming challenges.

  BMW Crowd Innovation is dedicated to bolstering BMW's position as a preeminent pioneer within the automotive sector. Their perspective emphasises the indispensability of Open Innovation in streamlining and diversifying innovation processes. Through

[20] Video at: https://www.bmwstartupgarage.com/

Crowd Challenges, they empower innovators to refine their ideas or proficiently tackle issues by leveraging the expertise of diverse crowds.

In 2021, they took a noteworthy stride forward. BMW Crowd Innovation introduced the Crowd Platform, inviting involvement in the creativity and issue-resolution processes. It seeks participants characterised by their innovative and customer-centric mindset, individuals keen on showcasing their competencies and contributing knowledge to aid the BMW Group. One example of the current challenge is ALL ABOUT METAVERSE: BMW GROUP SUPPLIERTHON.[21]The participants must face three use cases from Vehicle Readiness, In-Car Experience and Virtual Ecosystem, merging the physical and digital worlds.

- BMW TECHNOLOGY SCOUNTING: The technology scouts within the BMW Group operate within an international framework, engaging both their internal technology hubs situated in the United States, Asia, and Europe, as well as external collaborators, including trend agencies, consulting firms, and institutions of higher education. Their principal objective is timely identifying emerging, inventive technologies and technology-driven trends, intending to translate these discoveries into practical applications for the BMW Group. Concurrently, they strive to comprehend the evolving demands of global markets about future mobility.

  They embark on discerning, dissecting, and assessing the potential opportunities and associated risks inherent in new technologies and trends, spanning a diverse spectrum of industries and academic disciplines. Subsequently, they facilitate the seamless transfer of these insights into the operational fabric of the BMW Group. In doing so, they play a pivotal role in significantly augmenting the innovation quotient of the BMW Group, spanning our overarching strategy, and extending to their products, services, and nascent business domains.

- BMW ACCELERATOR[22]: The BMW Accelerator is situated in Garching, Bavaria, providing a physical workspace and virtual support. Their mission is to assist ideas originating from BMW intrapreneurs across the globe, expediting their evolution into

[21]https://bmw.hype.de/servlet/hype/IMT?documentTableId=7025713847126678921&userAction=Browse&templateName=&documentId=00541d16421c518111a21ee5da809e31

[22] Video at: https://www.bmwgroup.com/en/innovation/open-innovation/accelerator.html

valuable mobility businesses with a customer-centric focus. Throughout our 12-week program, teams directly test their concepts and prototypes with customers, engendering meaningful and sustainable innovations. Their paramount objective is to provide a swift avenue for the outstanding ideas of their employees to transition into implementation. In this 12-week program, they aim to synergise the strengths of both the startup and corporate realms. To this end, they furnish their teams with innovative tools, entrepreneurial mentors, and a network encompassing alums and executives from diverse departments, facilitating the seamless realisation of projects.
Their commitment is to ensure exceptional ideas receive the requisite support, propelling the BMW Group towards new horizons.

- THINK.MAKE.START.: THINK.MAKE.START.[23] Represents a concise yet impactful one-week design sprint, orchestrated under the auspices of the BMW Group, with the express intention of nurturing innovation through collaborative efforts transcending organisational divisions. This endeavour provides employees with an exclusive opportunity to cultivate fresh solutions by adopting a focused approach to problem-solving, encompassing domains such as user experiences, untapped potential of emerging technologies, and ongoing challenges. Their primary objective is to foster innovation and expedite the inception of novel digital attributes within the realm of BMW. Each sprint constitutes a well-coordinated team comprising five adept employees with the optimal skill set. This undertaking receives robust support from UnternehmerTUM MakerSpace GmbH, among other stakeholders. The teams' labor to generate Proof-of-Concepts, thereby laying the groundwork for substantiating their ideas. Those projects demonstrating significant promise receive an allocation of budget, teamwork, and developmental guidance, thereby nurturing their progression.

These formats demonstrate BMW's commitment to staying at the forefront of technological advancements in the automotive industry. By fostering collaborations, investing in startups, and dedicating resources to research and development, BMW aims to drive innovation and shape the future of mobility.

[23] Video at: https://www.bmwgroup.com/en/innovation/open-innovation/think-make-start.html

3.3: Case study 2: Some aspects of Tesla's innovation

"Our mission is to accelerate the world's transition to sustainable energy. To accomplish this mission, we must design products far superior to their fossil fuel counterparts in every way, source and manufacture them sustainably, and sell as many of them as possible. We believe the best way to do this is by offering an ecosystem of products that comprehensively address our world's clean energy generation, storage and transportation needs. Impact Report 2022 Foreword: Every vehicle we sell, the battery we install and the solar panel we add move the needle toward a sustainable future".[24]

Tesla, Inc. is a distinguished American enterprise founded in 2003 by a group of engineers from the illustrious Silicon Valley. It specialises in producing electric automobiles, photovoltaic panels, and energy storage systems. The noble mission of this esteemed organisation is to expedite the transition to a world powered by sustainable energy sources.[25]

In the year 2015, Forbes magazine crowned Tesla as the most innovative company in existence. The renowned CEO and co-founder of this remarkable establishment is the visionary Elon Musk, who has been aptly hailed as a Future-Smart leader and a pioneer of the future.

Five monumental Gigafactories embody Tesla's prodigious manufacturing facilities:

- Tesla Factory: Initially an erstwhile Toyota factory located in California, this is where Tesla diligently crafted its diverse range of vehicles before expanding its operations to China and Germany.

- Gigafactory Nevada: A facility solely dedicated to producing batteries and electric motors.

- Gigafactory New York: Within its hallowed halls, Solar City, a subsidiary of Tesla, diligently manufactures photovoltaic modules.

- Gigafactory Shanghai: This sprawling establishment churns out batteries and the established Model 3 and Model Y.

[24] Tesla impact report, (2022). Available at: https://www.tesla.com/ns_videos/2022-tesla-impact-report.pdf

[25] Tesla website, (2021).

Figure 5: Gigafactory of Shanghai
Source: Tesla website

- Gigafactory Berlin: Tesla's inaugural European manufacturing hub, where batteries, electric motors, and the esteemed Model 3 and Model Y will come to life

In most factories, batteries are produced, the main cost component for electric cars and energy storage systems. Tesla is the epitome of a company that exploits the element of sustainability as a plus to gain consumer trust rather than a limitation. Its cars combine performance and sporty looks with high-quality design and technology. Tesla's strategy has evolved through three phases: the production and sale of niche luxury vehicles targeting technology and sustainability enthusiasts, followed by lowering the target to increase the customer base, and finally, reaching the mass market.

Technology and innovation have always played a central role in Tesla. The Californian company has always adopted Open Innovation practices to scale up the innovation process, preferring an approach based on networks of collaborations and strategic alliances rather than mergers and acquisitions. This concept is demonstrated by the numerous strategic partnerships the company has undertaken with companies such as Lotus, Panasonic, Toyota, Daimler AG, Freightliner, Electrify America, Liberty Mutual Insurance Company, and Airbnb. Collaborating with Panasonic has been crucial for developing next-generation batteries specifically designed for high-performance electric vehicles. This partnership has also led to the construction of Tesla's first Gigafactory, significantly reducing battery production costs.

The partnerships with Toyota and Daimler AG, two renowned automotive companies, have allowed all involved companies to benefit from each other's know-how. Through these partnerships, Tesla has gained the expertise and experience of the two automakers in terms of engineering systems, production methods, and vehicle quality. Traditionally, Tesla had a close approach to protecting intellectual property associated with the Closed Innovation paradigm. In the 2012 annual report, the company observed, "Our business will be adversely affected if we cannot protect our intellectual property rights from unauthorised use or infringement by third parties."[26]

Tesla's main fear was losing its competitive advantage if competitors brought a similar product. The strategy used to protect the company's core technologies was a combination of patent rights and other intellectual property rights. However, on June 12, 2014, Elon Musk announced in a blog post that "All our patents belong to you."

He then explained that the company would adopt an open-source approach regarding Tesla's intellectual property. According to the CEO, this would increase the development capabilities of the electric vehicle industry and facilitate the transition to a sustainable economy. This decision is consistent with Tesla's mission, which Musk defined as a company created to "accelerate the transition to a sustainable energy world."[27]

This open-source philosophy, adopted by Tesla in 2014, represents the most significant expression of open innovation the company has implemented since its inception.

Firstly, Tesla knew patents might not be sufficient to protect intellectual property rights and that protecting them would involve costly legal battles for the company. A second motivation is linked to industry growth. As Tesla is the leading player in the electric car sector, increased investments in this industry would accelerate the reduction of vehicle component costs and the construction of new charging infrastructure.

The OI practices adopted by Tesla, such as partnerships and alliances, are standard in the automotive industry. However, the open-source approach to intellectual property is different. This makes Tesla much more similar to Silicon Valley giants like Google and Apple than traditional automakers.

Figure 6 shows Tesla's revenues from the financial year 2008 to the financial year 2022*(in million US dollars).*

[26] Tesla website, (2012).
[27] Tesla website, (2021).

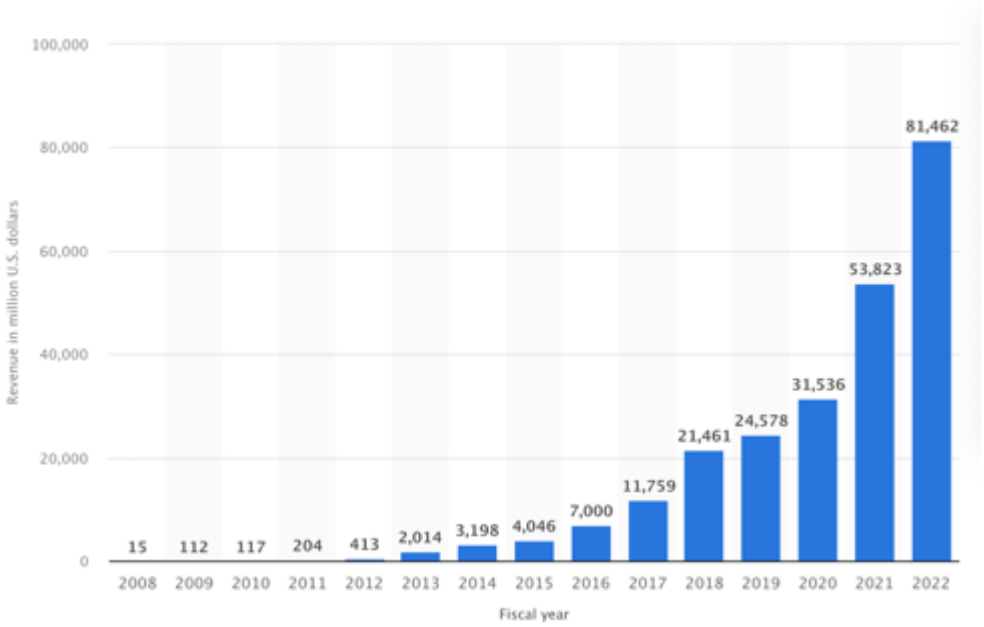

Figure 6: Tesla's revenues from the financial year 2008 to the financial year 2022

Source: Statista website, https://www.statista.com/statistics/272120/revenue-of-tesla/

Tesla's groundbreaking business model innovation in the automotive industry sets it apart from other original equipment manufacturers (OEMs). Unlike its counterparts, the Californian company has adopted a unique approach to its strategic structure. It entered the market in the high-end segment, introducing a premium sports car with a substantial price tag and targeting a niche audience. It then transitioned to the mass market by offering a compact sedan at a price point aligned with its competitors, expanding its potential customer base. Traditionally, other players in the industry targeted the low-income market first, with affordable city cars or compact vehicles, and gradually ventured into more luxurious segments, considering the initial high cost of owning electric vehicles. This strategic move is critical for Tesla in its pursuit of creating an affordable mass market for fully electric vehicles. To achieve this, Tesla boldly decided not to protect its trademarks and patents, allowing other interested players to utilise and enhance the technology without legal constraints. Following Tesla's example, Toyota also adopted a similar approach with hydrogen technology, aiming to popularise it in the mass market. At the core of Tesla's strategy lies its exceptional level of innovation embedded within its vehicle lineup, surpassing that of its direct competitors. The company embraces "learning by doing", continuously innovating and perfecting its products to increase productivity.

Regarding marketing and sales, Tesla deviates from the traditional OEM model.

While established manufacturers rely on a network of dealerships, receiving commissions for each vehicle sold, Tesla chose to market its vehicles directly through the Internet.

The company believes that the decision-making process occurs before visiting the dealership, emphasising the importance of capturing potential customers during their research phase. Tesla's stores, known as Tesla galleries, aim to introduce customers to a new driving experience, and the sales staff are not incentivised based on volume but receive fixed wages. By strategically locating these galleries in highly congested areas, such as inside shopping malls, Tesla integrates the consideration of purchasing their vehicles into the daily routine of potential customers. Furthermore, customers can reserve a car online with a down payment, eliminating the possibility of price negotiation as seen in traditional dealerships.

One significant divergence between Tesla and other electric vehicle (EV) players is Tesla's internal production of cells and battery packs. Unlike its competitors, Tesla collaborated with Panasonic to manufacture its cells and battery packs for internal use and sale to other manufacturers. Inspired by Tesla's success, several other carmakers have initiated their battery pack production facilities or formed partnerships. For instance, Nissan will produce batteries in England, while Ford is expanding its battery research and development in collaboration with the University of Michigan.

Another notable innovation introduced by Tesla is its infrastructure and battery-swapping service. Historically, electric vehicles faced limitations due to their limited range, restricting their use primarily to urban areas and short distances. Tesla has effectively eliminated the so-called range anxiety by establishing a vast network of superchargers and offering battery swapping in under two minutes. As a result, Tesla cars can be compared to conventional vehicles in areas with developed charging networks. This is the only OEM that has pursued this direction, with only a few electricity distributors and energy manufacturers entering the sector, yet their coverage does not match Tesla's. Moreover, the electricity generated at supercharger stations is entirely sustainable, sourced from solar panels. While the charging network is open to other EVs, they must pay for energy consumption, whereas Tesla owners enjoy free access.

In contrast to traditional carmakers, Tesla adopts an unconventional marketing strategy. Instead of heavily investing in expensive marketing campaigns and advertisements, Tesla relies on word-of-mouth marketing as its primary approach. The company has a minimal marketing department, with fewer than ten employees, and does not employ a Chief Marketing Officer. Tesla believes that satisfied customers are the best advocates for its brand, as they willingly share their positive experiences with others.

Additionally, Tesla leverages media and press coverage by inviting journalists and industry experts to events such as product presentations and press releases and engaging with clients through various gatherings.

Another differentiating factor for Tesla is its revenue generation model. While traditional OEMs rely solely on vehicle sales, Tesla diversifies its income streams in two ways that no other carmaker has explored. Firstly, Tesla sells electric powertrains and technologies to its competitors, leveraging its expertise and know-how. Secondly, Tesla generates revenue by selling zero-emission vehicle (ZEV) credits to other OEMs. As Tesla's entire lineup produces zero emissions, it can sell excess ZEV credits to manufacturers who still need to transition to electric vehicles fully.

3.4 Case study 3: Startup Autobahn, Mercedes-Benz Group

The Mercedes-Benz Group AG, formerly known as Daimler AG, stands proudly as one of the most accomplished automotive companies on a global scale. The company has established itself as a prominent provider of luxurious passenger cars and premium vans, earning a reputation for excellence in the industry. In addition to its impressive vehicle offerings, Mercedes-Benz Mobility AG delivers a comprehensive range of services, including financing, leasing, car subscription and rental, fleet management, digital charging and payment solutions, insurance brokerage, and innovative mobility services.

“Every innovation concept has the same goal: to create a better, more sustainable product. Our pioneers transform innovations into applications, develop them to the series production stage, and thus safeguard the pioneering role played by Mercedes-Benz products. Because they set standards and keep this goal in mind from the initial idea to its implementation." (Product Innovation | Mercedes-Benz Group > Innovation > Product innovation). [28]

The CASE initiative, which stands for Connected, Autonomous, Shared, and Electric, can potentially revolutionise the automotive industry. However, the actual transformation lies in the seamless integration of these elements into a comprehensive package:

- C - CONNECTIVITY: Connected, Autonomous, Shared, Electric: Each has the power to turn our entire industry upside down. However, the true revolution is in combining them in a comprehensive, seamless package.

[28] Mercedes Benz website, https://group.mercedes-benz.com/innovation/product-innovation/

On June 4, 2019, Mercedes-Benz, BMW, Ford, and Volvo, in collaboration with HERE Technologies, TomTom, and transport authorities from six European countries, embarked on a twelve-month test phase. This project explores how information about hazardous situations can be quickly shared with following or approaching traffic using Car-to-X technology. Leading original equipment manufacturers (OEMs) and navigation services work together on a joint, non-manufacturer-specific solution across the European Union. The transport ministries of Germany, Spain, Finland, Luxembourg, the Netherlands, and Sweden support this project, which aims to research car-to-X communication's technical, economic, and legal aspects. The project aligns with the EU's objective of promoting the development of networked and intelligent transport systems to enhance road safety. The long-term goal is to significantly reduce the number of fatalities and severe injuries in road traffic by 2050 (Daimler, Partners Test Car-to-X Communication - Smart Cities - Fleet Forward); communication and improved information flow can be pivotal in achieving this. The twelve-month project will focus on data compatibility, cloud-based data processing, and ensuring data security. The participating companies will initially use their existing communication technologies and file formats, making necessary developments and harmonisation in subsequent stages. The cooperation between project partners will begin in the Netherlands and gradually expand to other EU countries.

- A – AUTONOMOUS: Autonomous driving is revolutionising the role of automobiles, redefining their purpose beyond mere transportation. It enhances safety and comfort and grants us the precious gift of time previously consumed by the act of driving itself. As a frontrunner in automated driving and safety technologies, Mercedes-Benz has consistently set new standards in vehicle safety since the automobile's inception in 1886. Safety is deeply ingrained in the DNA of the Mercedes-Benz brand. The company has equipped its vehicles with advanced driver assistance systems (SAE Level 2) for years, making everyday life significantly easier. These systems provide support in various situations, including speed and distance control, steering, and lane changes. In a groundbreaking achievement, Mercedes-Benz became the first automotive manufacturer worldwide to obtain internationally recognised system approval for conditionally automated driving (SAE Level 3) in December 2021 (MENA Report 2022. "Germany : Mercedes-Benz Backs Redundancy for Safe Conditionally Automated Driving"). This milestone demonstrates the brand's commitment to pushing

the boundaries of technological innovation. Furthermore, Mercedes-Benz goes further regarding parking, introducing the Intelligent Parking Pilot, enabling highly automated parking. This remarkable feature exemplifies the brand's dedication to providing cutting-edge solutions that enhance convenience and efficiency.

- S – SHARED & SERVICES: The Mercedes-Benz Mobility product range embodies expansiveness and innovation. It encompasses financing, insurance, subscription models, and fleet management, all of which contribute to facilitating the mobility of private and business individuals in their daily lives. The scope of possibilities presented is virtually limitless.

  - Financing: Mercedes-Benz Mobility assists in realising the aspiration of owning a vehicle, offering loans under competitive terms where individuals can influence deposit amounts and contract durations.
  - Leasing: Mercedes-Benz Mobility AG provides adaptable and well-coordinated leasing arrangements. Through vehicle leasing, financial flexibility is maintained while consistently offering access to vehicles that align with current requirements.
  - Charging: In a forthcoming era dominated by electric vehicles, the focus on charging infrastructure takes precedence. This compels dedicated efforts to create a charging experience that is straightforward and exceedingly convenient for customers.
  - Rental Services: Driving pleasure is offered through Mercedes-Benz Rent, an in-house car rental company owned by the Group, ensuring continuous mobility for all customers.
  - Subscription: The comprehensive subscription initiative from Mercedes-Benz offers a remarkably flexible entry point into electric mobility.
  - Insurance: Mercedes-Benz Insurance extends coverage to vehicles globally and encompasses the entire Group, including Mercedes-Benz AG, Daimler Trucks, and their personnel.
  - Fleet Management: Mobility is transforming, with Athlon offering innovative fleet and mobility management solutions.
  - Payment Services: seamless payment occurs directly from the vehicle: Mercedes-Benz Mobility seamlessly integrates the Group's proprietary digital ePayment platform, Mercedes Pay, into numerous applications within the domain of Mercedes-Benz AG.

- E – ELECTRIC: The path towards achieving completely emissions-free driving through batteries or fuel cells is being pursued. In this context, Mercedes-Benz firmly believes the future revolves around electric propulsion. This conviction is the driving force behind the current efforts to lay the foundation for the future. This commitment is underscored through the EQ brand, which embodies intelligent electromobility.

Figure 7: VISION EQXX
Source: Mercedes-Benz website

The production lineup currently comprises six fully electric models. These vehicles are being manufactured at six different locations on three continents and have been seamlessly integrated into the ongoing series of production processes. Early investments in adaptable production processes and the implementation of the advanced MO360 digital production system have equipped Mercedes-Benz with the capability to scale up the production of battery-electric vehicles. The Mercedes-Benz electric vehicles' batteries are sourced from a global battery production network encompassing facilities across three continents. The localised production of batteries is a pivotal determinant for the success of the electric-focused strategy.
Starting this year, Mercedes-Benz has achieved carbon neutrality across all its proprietary manufacturing plants worldwide. Furthermore, the procurement of electricity within Germany is exclusively sourced from renewable origins, aligning with the commitment to carbon-neutral operations.

Another pioneering endeavour is the STARTUP AUTOBAHN.[29], an innovation platform extending its invitation to high-tech sector entrepreneurs. Operating as the team behind STARTUP AUTOBAHN at Mercedes-Benz, they serve as intermediaries between startups and Mercedes-Benz AG, combining specialised technological expertise with comprehensive automotive knowledge. The core objective is to ascertain, within a concise timeframe, the potential for collaborative ventures and partnerships between Mercedes-Benz and these startups. The alignment with Mercedes-Benz's strategic goals and the developmental stage of a startup's technology play pivotal roles in this determination. Their pursuit is directed towards innovative technologies and practical applications. Innovation has consistently been an integral facet of the Mercedes-Benz DNA, whether through swift implementations or disruptive breakthroughs. They firmly believe partnering with startups will contribute significantly to the metamorphosis towards future mobility. Their ambition is to craft a luxury experience that is fully electric, software-driven, and sustainable. Hence, as they scout for partners in innovation, their focus gravitates towards the subsequent themes. Nevertheless, their curiosity extends to all novel technologies and use cases, potentially enriching their customers' experiences.
The STARTUP AUTOBAHN operates biannual programs, each culminating in an EXPO event. This program is intentionally stage-agnostic and meticulously structured to provide startups with substantial backing. It achieves this by facilitating connections between startups and the appropriate business units of corporate partners. The ultimate goal is establishing a solid foundation for fruitful collaboration, potentially encompassing initiatives like pilot projects, full-scale implementation, or investment opportunities.

Chapter 4: Luxury automotive innovation, in particular with the Porsche industry

4.1: Innovations shaping tomorrow's luxury-car market

The hub of activity within the automotive realm currently resides in the luxury market. Beyond the conventional realms of comfort, convenience, entertainment, and safety features, luxury cars are adorned with sophisticated connectivity components, autonomous driving capabilities,

[29] https://startup-autobahn.com/

and the latest advancements in powertrain electrification. Moreover, they proudly bear some of the most formidable brands in the industry.

The latest report on the luxury automobile market updates McKinsey's extensive research[30] in the sector. It focuses on five pivotal trends within the global luxury automobile segment that are believed to shape the market over the coming decade. To develop this perspective, two scenarios for market growth and electrification have been created, one baseline and one accelerated, informing the thinking behind the report. The article primarily follows the accelerated scenario. Global political and economic trends can significantly influence the growth of luxury vehicles. The scope, pace, and characteristics of demand hinge on various factors, including wealth creation, regulatory promulgation, the state of the global economy, geopolitics, technological advancements, and the strategies pursued by OEMs and suppliers. The world is recovering from the COVID-19 pandemic, recent supply chain disruptions, and high inflation rates. The war in Ukraine has disrupted energy and food supply chains, and sanctions imposed on Russia have impacted economic stability. Consequently, economic development has become uneven across geographies, and the growth outlook still needs to be determined (The luxury car market: Five new industry trends | McKinsey).

There are various ways to segment the luxury car market, for example, by brand, powertrain, or price. Under the accelerated scenario outlined by McKinsey, the electrification of vehicles will serve as a distinguishing factor within the upper echelons of luxury tiers. By 2031, battery-electric vehicles (BEVs) are projected to dominate all luxury market segments, albeit with varying degrees of adoption depending on the price range. Our research indicates that affluent customers increasingly prioritise sustainability and are willing to embrace EVs. For instance, globally, over 70 percent of current owners of premium and luxury internal-combustion-engine (ICE) vehicles express their readiness to transition to EVs during their next vehicle purchase.

It is crucial to consider a vital caveat about a brand's embrace of battery-electric vehicles (BEVs), which revolves around the starting point of each brand. While EV specialists commence their journey from a foundation rooted in electric mobility, incumbent original equipment manufacturers (OEMs) with a history in internal combustion engines (ICE) must navigate many complexities stemming from legacy combustion-engine issues. These issues encompass challenges such as stranded assets, integration problems in research and development (R&D), and potential setbacks that may arise, all of which can impede their

[30] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-new-realities-of-premium-mobility

transition to BEVs. This predicament is particularly pronounced for the utmost luxury and performance brands, as they significantly need more economies of scale observed within the mainstream automobile sector. Consequently, these brands need help swiftly altering their technological trajectory or reallocating their assets, thus delaying their adoption of electrification.

China is set to play a pivotal role in driving the growth of the luxury automobile market (Mingyu Guan, 2022)[31]. Specifically, in the price tier exceeding $80,000, we anticipate China to emerge as the fastest-growing market for luxury cars by 2031, with a remarkable annual growth rate of 14 percent. This substantial growth trajectory is projected to elevate China's global share in the luxury segment from 24 percent in 2021 to approximately 35 percent by the decade's end.

Chinese consumers are revolutionising the concept of luxury. Regarding luxury cars, Chinese car buyers possess a broader perspective than their counterparts in major developed automotive markets worldwide. While traditional elements such as craftsmanship and quality remain influential factors in purchasing decisions, a survey conducted by McKinsey has revealed that Chinese car buyers display a strong interest in technology. They emphasise powertrain functionalities, digital interactions, connectivity, and advanced driver-assistance systems (ADAS) features *(Figure 8)*.

[31] Guan M., Köstring J., Middleton S., Möller T., (2022). *Five trends shaping tomorrow's luxury-car market*

Figure 8: The technological features that captivate Chinese luxury car buyers

Source: McKinsey & Company website

In contrast, German and American consumers prioritise styling, performance, and the overall driving experience. Furthermore, consumers in China seek fast-charging stations and battery services that effectively tackle concerns related to battery life. About 70 percent of Chinese consumers who hesitate to consider electric vehicles cite range and charging issues as significant barriers. Globally, original equipment manufacturers (OEMs), governments, and aligned organisations are striving to ensure the availability of an adequate number of charging stations along key routes to meet the growing demand for electric vehicles. However, this challenge remains a potent obstacle.

Consequently, local OEMs in China heavily engage in innovative endeavours within these domains. Notably, NIO has rapidly emerged as the leading brand in sales in the electric SUV segment in China. Among various factors contributing to its success, a seamless technology-driven customer experience within and beyond the vehicle has played a pivotal role in the company's growth.

Luxury car buyers have a strong inclination towards personalisation. According to a recent survey conducted among potential Chinese luxury vehicle buyers, an impressive 84 percent of respondents expressed that the ability to personalise their vehicles is essential or even very important to them. This desire for customisation surpasses other notable features such as

connectivity service, driving performance, high-end interior design, battery range capacity, and autonomous driving capabilities. Moreover, nearly 60 percent of these consumers preferred customised service throughout the buying process.

Global original equipment manufacturers (OEMs) are employing two distinct strategies to establish and strengthen their brands in China. Some OEMs are introducing renowned international brands that offer traditional local customisation options, such as premium exterior paint or exclusive interior features. On the other hand, other OEMs are developing bespoke models explicitly tailored to the local market. These models integrate unique features focused on connectivity, navigation, infotainment, and more. A prominent luxury car manufacturer recently introduced a range of exclusive bespoke models designed for the Chinese market. This strategic move aims to tap into the region's rising demand for luxury vehicles and demonstrates the brand's long-term commitment to the Chinese market.

In pursuing a 21st-century luxury car brand, automotive players must adapt to the rapidly evolving customer expectations, which luxury brands influence beyond the automotive industry. Customers now hold their best experiences across various sectors as benchmarks, compelling automotive players to keep up with the evolving landscape. Today's buyers seek seamless customer experiences encompassing simplicity, omnichannel reach, customisation, and experiential diversity.

To deliver an exceptional experience, automotive original equipment manufacturers (OEMs) must align themselves with the ever-changing needs of their customers. According to McKinsey's China Consumer Survey, nearly 80 percent of luxury car customers prioritise a seamless, omnichannel experience that ensures consistent interactions across various departments. They expect automakers to provide frictionless, on-demand service, with 83 percent expecting immediate engagement when contacting a company. Moreover, almost 70 percent of customers desire new channels and innovative ways to access existing products and services. An additional 62 percent emphasise the importance of speed and convenience, considering fast shipping as a fundamental component of a positive experience. Furthermore, 90 percent of customers seek transparency and predictability, which explains why many of these individuals rely on online reviews before making a purchase decision.

Established performance and luxury car brands often differentiate themselves by making distinct claims, typically focusing on individual luxury, performance, or a combination. These brands emphasise uniqueness, exclusivity, prestige, craftsmanship, artistry, and the extraordinary - conventional identifiers associated with sports and luxury brands. However, to stand out from these legacy brands, some of which have existed for over a century, emerging

luxury car marques emphasise the differentiating power of technology. They leverage technology to enhance the ownership experience and address societal concerns such as the transition to sustainable energy. The evolution of the go-to-market approach in the luxury automotive industry is shifting towards a direct-to-consumer model. Influenced by their encounters with luxury goods in other retail environments, affluent consumers seek continuous engagement and personalised experiences when purchasing luxury cars. These experiences have traditionally been crafted in highly controlled settings, where the luxury original equipment manufacturer (OEM) manages the customer journey. However, replicating this exclusive treatment within the traditional franchised dealership channel presents challenges, including conflicts in data ownership and the complexities of creating a seamless omnichannel experience. As a result, ensuring consistent and personalised customer engagement has proven difficult. Luxury car buyers, accustomed to personalised and exclusive experiences in other luxury retail settings, have higher expectations and are dissatisfied with the current retail experience provided by ubiquitous dealer networks.

While the luxury automotive sector has established itself as distinct from the mass market, there is an opportunity to capture even more profitable growth, particularly at the top end of the market. However, incumbent brands face significant challenges due to legacy retail and operational structures that rely heavily on dealer networks to deliver the desired customer experience. At the same time, market disruptors must address issues related to electrification, connectivity, and advanced technologies. In this competitive landscape, the player that successfully satisfies the diverse needs of luxury car buyers will emerge as the winner.

4.2: Porsche NEXT OI Competition

One of the world's most renowned luxury automotive companies, Porsche, conceived a cutting-edge competition in February 2018: the Porsche NEXT OI (Open Innovation) Competition[32]. Porsche NEXT OI represents an open innovation competition to identify pioneering concepts and seamlessly incorporate them into forthcoming Porsche sports cars. This competition offers participants the exclusive opportunity to create applications tailored for Porsche, utilising the latest simulated Porsche sports car Application Programming Interfaces (APIs), with the chance to secure rewards associated with the advancement of their applications. The

[32] Video at: https://newsroom.porsche.com/en/company/porsche-next-open-innovation-competition-pitch-berlin-porsche-lab-15506.html

competition has been meticulously designed to provide access to a comprehensive array of tools, systems, and platforms, establishing its position as one of the most inclusive developer competitions on a global scale. One shall have the opportunity to experiment with more than 300 distinct data sources and functions, employing both cloud and device software development kits (SDKs) and using all the other tools and resources provided on the platform. Notably, users and their respective teams shall engage in interactive testing of their applications and services within Porsche car emulators, accessible through web browsers, thereby simulating a realistic operational environment.

To facilitate the onboarding process, software development kits (SDKs) tailored for iOS, Android, and Node.js are readily accessible within the developer platform. The REST API is available for all other systems to meet one's requirements.

The Porsche NEXT OI Competition represents a distinctive hackathon experience, distinguished by its emphasis on aligning app prototype design with authentic user narratives. The competition encourages the development of applications that comprehensively address the three distinct phases of a user's journey: Home, Driving, and Arrival. Contestants have the flexibility to focus on a single element or any combination thereof, all the while bearing in mind the paramount importance of catering to the Porsche customer:

- Home: Participants are encouraged to conceive applications pertinent to the domicile. These may encompass aspects such as the connected home, IoT, predictive vehicle operations, and charging infrastructure – all aligned with the overarching objective of facilitating a seamless transition for the customer from their residence to the subsequent leg of their journey.
- Driving: Participants are tasked with envisaging how their app will influence the future of the Porsche driving experience. This could entail real-time personalisation, innovative gaming interfaces, on-the-go services, productivity enhancements, health, comfort, and convenience improvements. The scope of creativity in this category is boundless.
- Arrival: Contestants are invited to present their creative solutions for users' arrivals at various destinations. This encompasses concepts related to office or hotel arrivals, airport arrivals, and the smooth transition between different modes of transportation. Exciting innovations in this domain are highly anticipated.

Participation in the competition is open to various individuals and entities, including Web Developers, App Developers, Startups, Automotive Engineers, Students and Automotive Suppliers.

All these stakeholders are welcome to join and contribute their innovative ideas and expertise to the Porsche NEXT OI Competition.

Below, I shall list the seven finalists along with their respective winning ideas:

- ***Porsche Track Precision App 4.0/AI Edition by SoundReply*** (Germany)

  Regardless of the availability of a personal instructor and the associated planning and travel arrangements, every Porsche driver with a passion for racing should be able to enhance their racing skills anywhere and at any time. Presenting the next-generation "Porsche Track Precision 4.0/AI Edition," which includes an AI racetrack coach capable of delivering real-time performance analysis and offering personalised, track-specific instructions to the driver. Accessible with ease through touch and voice commands, this sophisticated conversational interface with coaches such as Mark Webber responds to the driver's queries during briefings, drives, and debriefings. It possesses knowledge of racetracks worldwide, including their pace notes. It provides information about the upcoming hairpin curve, guides the driver on maintaining the optimal racing line, and advises on the best braking points to set new lap time records. The developers are Farhoud Cheraghi and Andreas Kwiatkowski.

- ***Mobile Racing Visualizer by Randerline*** (Switzerland)

  The "Mobile Racing Visualizer" revolutionises converting authentic driving data into a digital 3D realm, eliminating the need for supplementary specialised equipment or data transfers. This innovative tool enables the capturing, examination, comparison, sharing, and virtual competition of actual and simulated races within a sophisticated mobile gaming environment.

  Distinguished by its swiftness and user-friendly interface, the "Mobile Racing Visualizer" represents an advancement in race tracking compared to existing solutions like the Porsche Track Precision App or the Gran Turismo 6 GPS Visualizer. It combines mixed reality and mobile gaming elements, ushering in a new era of immersive and accessible racing experiences. The developers are Dominik Stocker and Roger Rueegg.

- ***Dashride by Tom Bachant*** (USA)

  Dashride offers a comprehensive solution for the creation of a ridesharing service. Their white-labelled dispatching platform handles all aspects, from booking to invoicing, including customer reservation applications and an extensive back-end administrative portal. An automated dispatching algorithm intelligently selects the most suitable vehicle and directs it to the designated pick-up location.

  Through integration with High Mobility and Porsche vehicles, Dashride can facilitate a fully-fledged ridesharing service tailored for Porsche clientele. This empowers customers to reserve Porsche rides and access specialised Porsche services, including participation in Porsche Club events and on-demand test drives of new vehicle models. Furthermore, as Porsche embraces autonomous vehicle technology, the app and integration will enable vehicle dispatch to customers without the necessity of a human driver. The developers are Thomas Bacchant and Nadav Ullman.

- ***Porsche Smart Garage by Dräxlmaier Campus*** (Germany)

  The "Porsche Smart Garage" mobile application is tailored for Porsche owners, providing them with enhanced convenience in terms of vehicle maintenance. It affords users complete control over their vehicle's status, incorporating predictive maintenance capabilities that proactively inform users of impending service requirements via active push notifications.

  This application makes scheduling individual service packages, overseeing the service progression, and accessing service history straightforward. A Porsche representative collects the vehicle at the user's specified location and returns it upon service completion. The extensive digital service platform, known as the "Smart Garage Service Platform," autonomously manages all service requests in the background, facilitating seamless communication between the vehicle, the service garage, and the application user.

- ***Safe Drive - Choobs*** (Greece & Switzerland)

  In light of an ageing population, the challenges associated with fatigue, dizziness, and other factors impairing driving abilities, such as strokes or heart attacks, are expected to worsen. The "Safe Drive" application addresses two fundamental issues related to driver impairment:

1. Road Safety: It tackles the significant problem of accidents caused by impaired drivers, which result in severe road damage each year.
2. Emergency Response: It provides a solution for individuals experiencing impairment or medical emergencies while driving, such as strokes or heart attacks, by integrating accident detection, monitoring driver fatigue, tracking the driver's heart rate, and assessing their ability to respond.

   In an emergency, the application takes immediate action by stopping the vehicle and initiating automatic contact with emergency services. This swift response can make a critical difference in saving lives during emergencies on the road. The developers are Tobias Kuster and Nikolaos Doulgeridis.

- ***SETT by SETT*** (Bulgaria)

  The "SETT" app serves as an automation tool designed to empower Porsche drivers by facilitating the creation of customised combinations of car capabilities (referred to as actions) and third-party services, forming robust workflows. These workflows amalgamate a series of steps across various applications or the car interface into a single tap or predefined, automatically executed rules. This functionality streamlines and enhances the user experience, seamlessly integrating multiple functions and services. The developers are Teo Teodosiev and Martina Diyanova.

- ***AUTOmator by Team AUTOmator*** (Germany)

  Finally, the winning idea is the "AUTOmator": it offers a solution that empowers every Porsche owner to tailor their car experience by establishing connections between vehicle APIs and existing web APIs through an exceptionally user-friendly interface. The problem is that Porsche drivers have diverse preferences for their in-car digital interactions but are currently limited to predefined functionalities and applications. While APIs offer the potential to automate various tasks, they often require coding skills that the average Porsche customer needs to improve. The Solution is "AUTOmator," which enables every Porsche owner to shape their unique connected car experience using straightforward If-Then automation. Users can define triggers relevant to their needs by accessing all available vehicle APIs and specify actions linked to their favourite web and IoT applications (such as Gmail, Spotify, and Hue). Importantly, this customisation process demands no coding skills, thanks to an

intuitively designed user interface. The outcome is that Porsche owners will appreciate their car's digital experience even more, as "AUTOmator" offers the following benefits: infinite possibilities for personalisation, seamless integration with the apps and services they already use, continuous compatibility with the latest consumer applications, ensuring a cutting-edge experience. The Developers are Steffen Iwan and Valentin Rüchardt.

The primary objective underlying this competition was to integrate external technological advancements into the Porsche ecosystem. The overarching goal was to nurture groundbreaking concepts that could be seamlessly incorporated into Porsche vehicles, ultimately redefining the future driving experience for Porsche clientele. Merely establishing an email channel for idea submissions did not align with our vision. Instead, they aspired to create a comprehensive platform where ideas could promptly materialise.

In collaboration with High Mobility, they constructed an innovation platform. This platform empowers teams and individuals to conceptualise and test their applications using simulated Porsche sportscar APIs. By doing so, they offered startups, students, and innovators worldwide an extensive toolkit comprising various tools, systems, and platforms. Consequently, their competition is among the most inclusive developer contests globally, enabling diverse participants to engage and innovate.

In addition to the array of innovative concepts, entrepreneurial zeal, and interdepartmental cooperation, it is noteworthy that Porsche has successfully utilised the NEXT OI Competition as a platform for engaging with a diverse range of stakeholders. This includes suppliers, vendors, startups, students, and other entities with which the company is forging connections. While Porsche possesses an in-depth understanding of its operational intricacies and standards, the competition underscores the significance of fostering a dialogue for idea exchange and substantive discourse. Consequently, this competition served as a valuable avenue for facilitating such interactions.

4.3: Most innovative solutions with future Porsche cars

“Innovations are the future.” (Blume, 2022).

Oliver Blume, the recently appointed CEO of Porsche, has taken charge during a time of significant changes.

For him, innovation means generating fresh ideas and putting them into action. This resonates with Theodore Levitt's perspective, the Harvard professor who coined the term "globalisation". Implementing ideas is likely the more challenging aspect of innovation. It begins with a good idea, but true innovation only occurs when that idea is executed. This requires diligent effort, as innovations do not materialise spontaneously. No matter how novel or exceptional an idea may be, it only qualifies as an innovation if it propels a company forward, attracts customers, or yields other tangible benefits. An idea becomes an innovation when it garners market acclaim.

While understanding and meeting customer desires is crucial, innovation extends beyond that. The Wright brothers, for example, would have continued selling bicycles if they solely focused on customer preferences instead of inventing the aeroplane.

Under the Strategy 2025, Porsche is embarking on an innovation campaign. The rationale behind this initiative stems from the changing expectations of customers regarding cars and mobility in general. Furthermore, advancements in automotive engineering and production necessitate a fresh perspective. Electrification, digitisation, and connectivity are the key concepts driving this paradigm shift in the automotive industry, including Porsche. While it presents a significant challenge, it also offers a tremendous opportunity. Porsche aims to remain the most successful sports car manufacturer in the next few decades.

Establishing a culture of ideas and innovation cannot be achieved by simply flipping a switch. However, what can be done is creating an environment that nurtures creativity, freedom to innovate, and thinking beyond conventional boundaries. People play a pivotal role in this endeavour. To foster creativity, we must first understand the factors that facilitate or hinder idea generation. An innovation program invests not only in patents or inventions but primarily in people. Enthusiasm and emotion are integral to this process.

"Digitisation is precipitating an automotive renaissance, placing the car at the core of our digital lifestyle," asserts Thilo Koslowski.

Porsche, aiming to establish itself as a leading high-end digital mobility solutions provider, has founded Porsche Digital GmbH. Thilo Koslowski, an authority in the automotive and online technology industries, leads this new venture as the managing director. Koslowski recently joined Porsche from Gartner, a renowned American information technology research and advisory company.

Emphasising the significance of Porsche Digital GmbH, Dr. Wolfgang Porsche, Chairman of the Supervisory Board of Dr. Ing. h.c. F. Porsche AG ("Germany : Award-Winning.

Volkswagens Electric Platform Wins Renowned TU Wien Prize." 2021. MENA Report, October) states, "Our Digital GmbH will fortify the brand, cultivate innovative customer experiences, and forge new partnerships. We are blending the traditional Porsche ethos with the power of emerging technologies". Porsche Digital GmbH also envisions itself as a conduit between Porsche and global innovators, particularly in connectivity, smart mobility, and autonomous driving. This includes seeking suitable collaborators for Porsche's digital transformation, defining a digital ecosystem, and scouting worldwide trends. Porsche Digital GmbH will foster connections and synergies with pioneering companies and new technologies by participating in venture capital funds and collaborating with startups.
The establishment of this subsidiary represents only one facet of Porsche's extensive innovation campaign. Porsche Digital GmbH's headquarters will be in Ludwigsburg, near Stuttgart, with additional locations set to open soon in Berlin, Silicon Valley, and China.

Porsche Digital 33, born in 2016, aims to generate value and ignite enthusiasm through digital engineering. The advent of digitisation is disrupting entire industries, including the automotive sector. Porsche recognises these changes as opportunities that warrant exploration and exploitation.
The primary objective is identifying and expanding new digital business models while optimising existing products. To achieve this, Porsche Digital develops cutting-edge digital products and services, creating technologically advanced business solutions and acting as a catalyst within the digital ecosystem.
Their endeavours encompass the following:

- They develop digital products and services that extend beyond mobility, expanding the online offerings of Porsche. These endeavours are not exclusive to Porsche customers but encompass a more comprehensive range of domains.

- Utilising technologies such as Artificial Intelligence, Blockchain, the Internet of Things, and Quantum Computing, they enhance corporate processes through technologically advanced industry solutions. They aim to bolster the effectiveness and efficiency of these processes.

- Through their presence in nine prominent tech hubs worldwide, they actively engage as partners in innovation. They support promising digital companies in their business ideas' early and growth phases through scouting and strategic partnerships.

- With their company builder, "Forward 31," they collaborate with entrepreneurs and visionaries to establish new digital business models (Home – Porsche Digital). Their intention extends beyond the core business as they seek to explore and tap into new business fields.

The Porsche Digital team embodies the ethos of "Dream & Do" and "Do & Dream." While they do not produce sports cars or focus solely on mobility, they aim to transmit the captivating allure of Porsche into the digital realm.

MISSION E – Shaping the future is another step towards future innovation. It is called “the Porsche of the future”.
The electric Drive presents a twofold boon for Porsche. It enables the company to meet future, more stringent consumption and emission standards and substantially enhances the vehicles' performance.
Regarding electrification, Porsche emphasises the juxtaposition of "innovation and tradition" and "performance and suitability" for everyday use (Porsche MISSION E – Shaping the future - Porsche AG).
Each new generation of models showcases the manufacturer's remarkable engineering accomplishments. The guiding principle of "perform much, consume little" is continuously elevated to new heights.
Among the critical factors for the widespread adoption of electromobility, alongside costs, is the range and the availability of adequate infrastructure. Many available electric vehicles are designed for commuting or use in city centres. They often require frequent recharging, and their driving performance rarely meets users' typical requirements. Due to the relatively limited battery capacity, even during lengthy charging processes such as overnight or during working hours, the gained range remains limited. Porsche strongly advocates for adopting 800-volt technology, which holds significant potential in addressing this challenge.
At the 2015 International Motor Show (IAA), Porsche provided a glimpse into the future with the Mission E prototype. This vehicle represents a genuine Porsche and a fully-fledged alternative to combustion engine cars, excelling in driving performance and range. The efficient drivetrain and the high battery capacity allow for a range of over 500 km in the NEDC (New European Driving Cycle). This means that most journeys can be completed over multiple

days on a single battery charge, significantly reducing the need for frequent recharging. Instead of refuelling at petrol stations, the vehicle can conveniently be charged at home.

Porsche's turbo-charging concept has achieved remarkable results in terms of time efficiency. When covering long distances to minimise travel time, the duration of the charging process becomes a crucial factor, as extended waiting times are typically unacceptable to consumers. To ensure a swift charging experience, a high charging capacity is imperative. Traditional AC charging systems, due to their weight and dimensions, are no longer suitable for installation within vehicles. Consequently, high-power charging systems convert alternating to direct current at the charging station. The heavy, high-current charger is no longer necessary within the vehicle, with only the essential safety and monitoring unit remaining. A well-designed high-power charging infrastructure must cater to the typical user behaviour during long journeys and enable a convenient balance between travel and break time. Within the customary break duration of 15 to 20 minutes, power can be replenished for approximately 400 kilometres.

Significant reductions in charging time can be achieved by elevating the voltage level of the infrastructure to 800 volts. Even with the current cell chemistry, charging times that align seamlessly with the travel profiles of long-haul journeys become feasible. Assessing the required technology reveals that implementing this infrastructure is technically viable. Moreover, the economic viability is evident in its benefits to operators and users, ensuring a favourable customer experience.

Figure 9: ***MISSION E*** *– The Porsche of the future*

Source: Porsche website

Figure 10: The interior of ***MISSION E*** *– The Porsche of the future*

Source: Porsche website

Chapter 5: Conclusion

In conclusion, this academic thesis provides a comprehensive analysis of innovation, focusing on the concept of open innovation and its application in the automotive sector.
Chapter 2 explores the fundamental aspects of innovation, offering a precise definition based on Schumpeter's seminal work. It also clearly distinguishes between innovation and invention, highlighting their unique characteristics. Furthermore, the chapter examines the transition from closed innovation models to the collaborative and inclusive nature of open innovation. It elucidates various evolutionary concepts within the realm of open innovation and presents exemplary cases of companies that effectively implement this approach.

Chapter 3 delves into the automotive industry, specifically investigating the impact of open innovation through a series of compelling case studies. It begins by providing an overview of the current innovation landscape and emerging global and European automotive sector trends. Subsequently, it delves into three meticulously selected case studies, showcasing the successful integration of open innovation practices. These cases include an in-depth analysis of BMW Group's innovative strategies, the groundbreaking advancements of Tesla, and the collaborative efforts within the Startup Autobahn initiative, focusing on the Mercedes-Benz Group.

Chapter 4 narrows the focus to luxury automotive innovation, explicitly exploring the Porsche industry. It examines the transformative innovations shaping the future of the luxury car market, emphasising the significance of forward-thinking approaches and cutting-edge technologies. The chapter also introduces the Porsche NEXT OI Competition as a platform for fostering innovation and attracting novel ideas within the industry. Additionally, it highlights the most innovative solutions that hold promise for the future of Porsche cars.

In summary, this thesis contributes to our understanding of innovation by comprehensively examining open innovation and its practical implications in the automotive sector. By exploring case studies and presenting key findings, this research underscores the vital role of open innovation in driving progress and competitiveness. Furthermore, it sheds light on the specific context of luxury automotive manufacturing, particularly emphasising the Porsche industry. The insights gained from this thesis inform industry professionals, researchers, and policymakers about the potential of open innovation to shape the future of industries and drive technological advancements.

As the automotive industry continues to evolve in an era of rapid technological advancements, companies must embrace open innovation as a strategic imperative. By fostering a culture of openness, collaboration, and continuous learning, companies can stay at the forefront of innovation, adapt to changing market dynamics, and deliver exceptional value to customers.

In closing, this thesis may inspire future researchers, industry leaders, and automotive enthusiasts to explore the untapped potential of open innovation, driving the automotive industry towards a future defined by limitless possibilities and sustainable growth.

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