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Sustainability driving innovation in the automotive industry: risks, challenges and opportunities

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LIST OF ABBREVIATIONS

Abbreviation	Meaning	Page
ELV	End-of-life Vehicles Directive	8
WLTP	World harmonized Light-duty vehicles Test	8
ULEZ	Ultra Low Emission Zone	9
OEM	Original Equipment Manufacturer	9
IOT	Internet of Things	10
MPV	Multi-purpose Vehicle	11
SUV	Sport Utility Vehicle	11
ICE	Internal Combustion Engine	12
R&D	Research and Development	20
CEVT	China Euro Vehicle Technology	23
AV	Autonomous Vehicle	23
EV	Electric Vehicle	23
ESP	Electronic Stability Programme	26
AR	Augmented reality	26
AEB	Autonomous Emergency Braking	31
EVSE	Electric Vehicle Supply Equipment	34
AFID	Alternative Fuel Infrastructure Directive	34
HEV	Hybrid Electric Vehicles	36
AI	Artificial Intelligence	45
IP	Intellectual Property	54

1 SUMMARY

This project offers an insight into the critical challenges being faced by the automotive industry and identifies several important trends and factors that should be considered by automotive companies when making investments decisions. These include but are not limited to consumer preference, regulations and trends of shortening product lifecycles.

In this report are also discussed the threats posed by new market entrants, such as technology and software companies, and recommendations are made to manufacturers. Despite the threats present in today's global market there are also several opportunities, which are highlighted in this report, with particular emphasis on the role of sustainability in company's innovation strategies and the areas manufacturers should exploit to remain competitive.

The importance of collaboration between different functions has been reiterated, especially in a period of disruptive innovation and fast paced advancement in new technologies. Functions such as marketing must ensure businesses have a clear understanding of consumer trends and requirements as well as collaborate with R&D to ensure investment spending is optimized by allocating funds to projects that are likely to provide positive returns. The involvement of product development teams is also key during a period of disruptive innovation as the synergy between the different functions allows reducing time to market of new products and maximise profits in a global market.

Responding to disruptive innovation may be one of the greatest challenges established firms face. The findings of this research aim to provide managers in automotive companies, which often have the power of making strategic decision, with the business intelligence required to navigate the sustainability and innovation challenges present during the transition period of the automotive industry and make important decisions in very uncertain situations.

This report also provides a perspective of current consumer and technology trends revolutionising the automotive sectors. The insights provided by this research highlights areas of focus for both automotive manufacturers and suppliers, and governmental institutions regulating the current and future mobility market.

2 AIM AND OBJECTIVES

2.1 Aim

The aim of this report is to:

- Identify the critical challenges being faced by automotive companies.
- Identify market opportunities available for automotive companies in order to maximise investments returns.
- Provide recommendations for automotive companies and governmental institutions.

2.2 Objectives

The aim of this report will be achieved by:

- Analysing consumer and market trends in the automotive industry and changes in the product lifecycle of vehicles.
- Extracting and collecting relevant data and information from recent industry reports and surveys.
- Understanding new policies and regulations driving innovation in the automotive industry and the impact they have and will have on companies strategic planning.
- Identifying emerging technologies with potential for mass adoption that manufacturers can exploit to maximise profits.
- Critically and objectively analysing the research findings and formulate recommendations for automotive companies and governmental institutions acting as policy makers.

2.3 Justification

In a period of disruptive innovation, such as that being experienced currently in the automotive industry, it is paramount that companies base their decisions on timely and relevant information and data. Although the talking points in this report may have been discussed in previous research, there is a constant need for timely and relevant insights as they often support vehicle manufacturers in their investments decision making as well as the company strategic planning.

3 INTRODUCTION

In recent years the automotive industry has experienced significant changes due to rising global competition between manufacturers. This has resulted in new market propositions and increasing customer requirements and expectations. Company's values are also shifting from a constant need to increase profits and exceed customer expectation to greener solutions. Although this shift requires companies to invest significant resources in research and development, they must also analyse past trends and identify key areas of focus to remain competitive in a constantly changing market.

The changes in product life cycle in the last two decades are a clear indication of the changing trends in the automotive industry. Over the last decade the average product life cycle in the automotive industry has been shortened from approximately eight years to four, and the average time for product development, from concept design to start of mass production, has been reduced from an average of 48 months to 25 (Sabadka, et al., 2019).

With shortening product life cycles customer needs are met more effectively, companies can achieve higher average sales throughout the lifecycle and do not need to reduce prices as demand decreases, but instead innovate or launch new products. However, there are also several disadvantages, such as the requirement of higher development capacities, products are produced in smaller batch sizes and manufacturers have to absorb costs in a shorter time frame (Schramm-Klein & Wagner, 2011).

The decrease in average product life cycle has been a result of a significant reduction in time spent in the introduction and decline phase. These are respectively the market development stage in which a company launches a new product, increases product awareness and time to market capabilities, and the phase in which competition increase and the market is saturated.

The decline phase has shortened due to company's tendency to minimise the duration of the highest yielding stages of the product lifecycle. During this stage companies tend to discontinue the product or innovate to return in one of the previous stage of the product lifecycle (Volpato & Stocchetti, 2008).

Growth and maturity phases, which are the second and third stages in the product life cycle, have almost remained the same. During the growth phase both market share and profit increase, whilst during the maturity stage sales are at the highest but start to flatten. Shorter product life cycles have not only resulted in an increased frequency of new product introduction, but also faster product development and increased speed to market. This poses

numerous challenges for the development and introduction of new products, which must be completed in less time while also increasing quality.

One of the key factors for the successful introduction of new products is the ability of automotive brands to effectively overlap life cycles of old and new models to compensate for decreasing sales of old models, thus keeping overall sales constant.

German brands, such as Audi, Volkswagen and BMW tend to be more effective at this compared to Italian and French brands such as Fiat and Renault (Volpato & Stocchetti, 2008).

Exploring the development and introduction process for new products in the automotive sector can be a complicated process due to the high number of aspects influencing and triggering this process. These include: changing regulatory environments, increase in global competition and new/emerging technologies (Sabadka, et al., 2019).

According to Porter's Five Forces Analysis there are five competitive forces that affect the product life cycle in the automotive sector. These are: the threat of new entrants, the threat of substitution, bargaining power of suppliers, bargaining power of buyers and rivalry among competitors, which will be analysed in more detail (Schramm-Klein & Wagner, 2011).

3.1 Regulations driving innovation

The changing regulatory environment in the automotive industry is pushing manufacturers towards innovation and sustainability with regulations such as the international End-of-life Vehicles Directive (ELV), which sets recovery targets for recycling of vehicles and components, and encourages manufacturers to design vehicles with part reuse and recycling in mind whilst also restricting the use of certain heavy metals in the manufacturing processes (European Commission, n.d.).

Some of the most recent regulations that are impacting the automotive sector are in areas such as fuel efficiency and emission standards aiming towards net-zero emissions, and safety. Due to these new policies and regulations companies have been forced to adhere to tighter emission standards and perform standardised tests, some of which are local to regions, such as the current Euro 6 emission standards for Petrol and Diesel vehicles, while others are adopted globally such as the WLTP (World harmonized Light-duty vehicles Test Procedure), which determines the levels of pollutants, CO₂ emissions and fuel consumption, and is adopted by the US, Japan, China and the European union.

Tighter emissions standards and the introduction of the Ultra Low Emission Zone (ULEZ) in UK has affected the diesel market by drastically reducing sales. However, it has also forced companies to innovate and improve to meet new standards such as the above mentioned Euro 6 standard.

Regulations on safety are also becoming tighter such as those stated in the European General Safety Regulation, which become mandatory in 2022. According to these regulations new vehicles must have warnings for driver drowsiness and distraction, intelligent speed assistance, reversing safety with camera or sensors, and a data recorder ('black box') in case of an accident as well as lane-keeping assistance, advanced emergency braking, and improved safety belts for crash-test (European Commission, 2021).

3.2 Global competition

The introduction of new policies such as free trade agreements has also allowed new global competitors to enter more isolated markets by exporting products at lower costs. Although global competition increases the pressure on local manufacturers it is also a driver for innovation. Local manufacturers are pushed to enhance performance by innovating and adopting process and product improvements, which leads to improvements in productivity through enhancement in process efficiency, the introduction of higher value added models with higher quality, more features and the creation of new jobs.

Despite the top 17 global Original Equipment Manufacturers (OEMs) accounting for 80% of global sales, and the number of independent automotive companies having reduced in recent years, due to a rise in alliances and acquisitions, global competition is constantly increasing.

Lower tariffs have also acted as an incentive for manufacturers to export their products or migrate their businesses to foreign and emerging markets to increase sales and profits (McKinsey & Company, 2013).

3.3 Emerging technologies

Current trends in the automotive industry show increasing ability of automakers to collect, store and analyse large amount of data, which enables manufactures to quickly identify emerging trends and usage, and translate them into new products and service offerings. This has led to an increase in frequency of new product development and the need for companies to be able to develop and introduce new products quicker than ever (Brian Hoey, 2020).

The increasing speed of innovation based on the collection of data through Internet of Things (IOT) devices and software driven applications mean that in the coming years new product development and innovation in the automotive industry will be predominantly software driven.

Traditionally cars have been sold as finished products and buyers do not expect new cars to improve or change once purchased, apart from the occasional maintenance or repair to keep the vehicle functional. However, by adopting digital innovation practices, such as the release of frequent software updates to improve and change the functionality, cars can be modified continuously throughout their lifetime (Bertoncello, et al., 2021). However, it is inevitable that this will bring upon manufacturers not only the opportunity of after sales but also challenges for innovation and product life cycle management because managers and strategists will need to plan for the modifiability of the product throughout its life cycle.

New opportunities such as vehicle electrification, hydrogen fuel cells and autonomous vehicles are also being widely explored by many car manufactures. Although, the infrastructure required is not readily available and changes in the regulatory environment will be required prior to mass adoption, carmakers need to be prepared for challenges such as handling products at the end of the product life cycle, especially the recovery of electric vehicle battery packs.

4 RESEARCH

4.1 Consumer requirements and trends

Customer requirements are constantly evolving and as they change, companies product portfolios also expand to meet those needs.

4.1.1 Rise and decline of MPVs

In recent years the range of automotive products offered by manufacturers has increased with the addition of sports vehicles, multi-purpose vehicles (MPVs), sport utility vehicles (SUVs), Roadsters, hybrid and electric vehicles into the market. The use of MPVs, also known as people carriers, rose in the late 80s and 90s due to its significant amount of space for both passengers and luggage, which made it the preferred choice for families with children. In recent years there has been a decline in sales of MPVs as they have lost traction with both marketing departments and consumers. They have been replaced by SUVs, which are primarily off road vehicles that can be driven on roads. SUVs have been designed and manufactured with families in mind and therefore tend to be the choice for families, not only due to its size and versatility, but most importantly because of its styling. Although they are not necessarily safer than other vehicle types, most people tend to feel safer and more confident driving this type of vehicle due to the raised seated position, which offers better views of traffic and road area (Insurance Factory Ltd., 2019).

SUVs have experienced a substantial growth in recent years, from 25% of total new European car sales in 2016 to over 40% in 2020, which has not only been a result of buyers switching to SUVs from MPVs, but also from hatchbacks and estates (Aucock, 2020).

Although the demand for SUVs is no longer growing at the rates seen in recent years, and despite SUVs having higher prices and emission levels, its demand is not showing any signs of stagnation and it is likely to continue to be popular in the future, particularly, in USA, China and Europe (JATO Dynamics, 2021).

Both MPVs and SUVs have the potential to survive the change in powertrain from internal combustion engine to more sustainable fuels as they could suit electric architecture due to their very large wheelbases, which offers substantial room for locating batteries in their chassis. However, the adoption of electric vehicle could also be a threat to MPVs and SUVs, as they are less aerodynamic and currently electric vehicles are more efficient and offer a greater range when used with lighter vehicles (Aucock, 2020).

4.1.2 Consumer demand

Consumer preference does not only differ from a vehicle type point of view but also varies between European regions. Buyers in countries such as Belgium, Germany, United Kingdom and France tend to prefer internal combustion engines (ICE) as opposed to hybrid vehicles, while in countries such as Spain and Italy, hybrid vehicle are the most preferred by consumers (Statista, 2021).

When analysing changes in customer demand in the automotive market across different regions, the trends emerging in China cannot be ignored as it is the largest automobile market worldwide with almost 20 million new car registrations in 2020 alone (Statista, 2021).

The recent COVID-19 pandemic has not completely transformed the automotive market in China, but it has accelerated trends that were already underway. The use of personal cars has nearly doubled since the beginning of the outbreak, while the reliance on public transport has fallen by more than half, with taxis and ride hailing the most severely hit by this trend. The trend of increasing vehicle ownership is evident in China where more people are opting for mobility solution like ride hailing (Ipsos, 2020), but also in the UK where young adults that previously didn't own a car are considering purchasing one as an alternative to public transportation.

As well as new vehicle types, more features have been added to cars such as safety and reliability features, as well as entertainment features such as touch screens, smartphone pairing, integrated navigation systems and many others (Sabadka, et al., 2019).

Although consumers may be reluctant to purchase new vehicles due to the financial uncertainty they are currently facing, dealers have enticed people to purchase cars through the implementation of deals such as 0% APR financing and cash discounts, as well as introducing no-penalty payment deferrals.

Although dealerships still play a critical role in the car buying process and a large number of car shoppers still want to engage with vehicles as they would at a dealership, there is an emerging trend of car shoppers wanting the buying experience to be closer to home and often from their home through the use of services such as online car buying, at-home test drives and vehicle delivery. To meet these customer requirements dealerships are increasing their online capabilities with the aim of executing a full vehicle sale online by offering services such

as online showrooms and virtual shops through the use of augmented and virtual reality (Keogh & Rampersad, 2020).

The Volvo's Polestar brand is one of the leaders in this field as its latest models are only available online. The entire buying experience is based around the smartphone with collection and home delivery service coordinated by the brand, which can be booked by the driver via a mobile app. It will therefore be possible for drivers to have no human contact and do everything digitally (OroCommerce, 2020).

Although the change in sale process could be detrimental to companies as some consumers require a degree of human interaction for a major purchase like a car and on some occasions also build long-term relationships with dealerships, the several advantages for manufacturers far outweigh the disadvantages. This change will allow manufacturers to reduce the substantial amount of paperwork to be completed when vehicle purchases involve part-exchange while also increasing direct interaction with consumers due to less or no involvement of franchises and dealerships (Walton, 2019).

Volvo has also been investing heavily in online sales platforms for its own brand. It has been selling cars online as part of its Care by Volvo subscription offering, which offers a convenient care package that includes service, warranty, roadside assistance as well as insurance, since 2016. However, the recent announcement of all pure electric Volvo models only being available online is a clear sign that this new trend is here to stay (Volvo Car Group, 2021).

The online sales approach is also likely to simplify the customer journey by allowing faster transactions during vehicle purchases. Despite this approach Polestar will still rely on showrooms, but these will only have just a few vehicles for exhibition purposes (OroCommerce, 2020).

The recent coronavirus outbreak has also changed customer preferences for in vehicle features as current trends show an increase in demand for in vehicle health related characteristics such as air conditioning systems with germ filters and interior use of antibacterial materials (Ipsos, 2020).

Although consumers interest on health related features is increasing they are still keen on innovative characteristics such as auto emergency braking, blind spot alert and built-in navigation systems, and willing to pay more for additional safety related features and alternative engines.

Another trend that cannot be ignored and must be taken into consideration by automakers when making innovation strategy decisions is the increase of the average age of new car buyers. In 2021 the average age of new car or truck buyers is 53 years old (Hedges & Company, 2019).

To satisfy the needs of older buyers companies must design and develop cars with features that an older target group will find useful, which means including ergonomic designs, loading and seating solutions, visual aids and easy to use functions (Oliver Wyman, 2015).

Despite vehicle sales slowing down in recent months due to national lockdowns and less travel, customer interest is still very strong. However, the market climate is still uncertain as people are adopting new behaviours that may not remain in the long term.

An increasing number of people are now accepting remote working as a permanent solution and not just a temporary solution to prevent the spread of COVID. This trend has affected both the production and sales performance of automotive companies but also vehicle requirements going forward from a consumer point of view.

As people are expected to work from home indefinitely, city centres are likely to be abandoned causing relocation to outskirt locations. This is likely to favour the use of cars as opposed to public transport services, which are not as efficient in urban areas (Laya, et al., 2020).

Another trend that could revolutionise the automotive market is the decline in public transport usage in favour of personal mobility, caused by fear of viral infections such as COVID-19 as well as restrictions set by authorities (Tiikkaja & Viri, 2021). This trend and the decline of traditional car ownership, could be the catalyst for a paradigm shift from vehicle ownership to vehicle usage as more people rely on shared mobility (James, 2020). Fast forward

to 2021 and there are over 40 car sharing organizations operating worldwide, including Zipcar in the United States, EvCard in China, City Car Club in the UK and many others.

Car-sharing should not be confused with ride-sharing and car-rental. Ride sharing involves finding people with compatible paths which can travel together in the same car, while car sharing involves driving a car now, and someone else driving it later. Despite similarities with car renting, it has several additional advantages such as last minute booking, 24/7 availability, automated key collection and locations distributed near homes and offices (Herraiz, 2019).

Another emerging trend is that of increasing numbers of 18 to 24 year olds showing interest in cars, and increasing number of 17 year olds choosing to get a provisional licence as opposed to a train pass. Although there were already pre-Covid trends showing an increase in demand for used cars, both the growing interest from the younger age group, which are more likely to purchase used cars more than five years old, and the semiconductor shortage experienced in recent months, which has caused delays in new models, have resulted in an overall increase in demand for second-hand cars (Fleetnews, 2021).

4.2 Marketing strategies

Meeting and often exceeding customer expectations has been at forefront of automakers agendas, which have been focusing on increasing the perceived value of their products by offering the best performance and efficiency (Miño Avila, 2008).

However, despite the ultimate aim being the creation of solutions that satisfy the varied needs of diverse consumers, this task has become very complex as the mobility experience is not only being driven by the shape, comfort and performance of a car, but also by new technologies and additional digital features. It is therefore crucial for automotive manufacturers to understand the needs and requirements of the different groups of consumers and their interests so that when positioning a product within a market more targeted solutions can be developed to address each group's need.

Automotive consumers can often be grouped by interest to simplify and differentiate requirements. There are consumers that are not interested in novel features or the driving experience as their only focus is to move from point A to point B. These type of consumers tend to favour concepts related to safety and convenience. However, there are also groups that focus on the best driving experience, in car entertainment features and new digital technologies (Laya, et al., 2020).

There are several marketing approaches that have been adopted by manufacturers in recent years to overcome global competition, maintain sales volumes, guarantee profits for investors all while meeting customer requirements. The approaches include expanding product portfolios, targeting specific market segments and repositioning products at different stages in the product life cycle, which will be explored in more detail.

4.2.1 Expansion of product portfolios

Buyers in developed countries have been willing to pay higher prices for additional features and new platforms, which has pushed manufacturers to create more and more derivatives and expand their portfolios. As companies expand their portfolio, particular attention must be paid to how this affect brand performance, and how business and marketing goals are met (McKinsey & Company, 2013).

In order for a firm's product portfolio to have a positive impact on unit sales and market share it must be innovative. This aspect is often more important than the variety of products offered as it enables companies to outperform their competitors by satisfying various customer needs while keeping pace with changing consumer preferences. Firms that adopt this approach are also able to dominate the market by increasing entry barriers for competitors (UKEssays, 2018).

It is also evident that a large product portfolio coupled with a large brand portfolio, or in other words a large number of brands owned and marketed by the same organisation, weakens unit sales. This tends to occur when product offerings are in the same market segment as it can create competition within the same brand portfolio. Companies with a large brand or product portfolio must therefore ensure that when expanding their product portfolio or repositioning their products in different markets they do not create competition within the same brand portfolio (McKinsey & Company, 2013).

A large product portfolio has several benefits such as that of allowing firms to meet fragmented customer needs and increase brand sales substantially. Providing a large number of products is most beneficial when managed under multiple brands since each brand can target a specific customer segment with products tailored to the client's requirements. It also has positive effect on sales when the portfolio has a high-quality brand positioning, meaning that it is marketed as a premium or luxury product, as it creates higher perceived quality and a sense of exclusivity for buyers (Manoukian, 2019).

Managing product portfolios is a very complex task because it requires a continuous assessment of new and existing product portfolio, as well as the branding portfolio of the firm and interaction between product and brand portfolio strategies becomes even more critical when a parent brand owns more than six brands in its portfolio because, as previously mentioned, it can create internal competition (Kirca, et al., 2020).

Despite the numerous benefits, expanding product offerings often requires costly investments and can have a negative impact on customers by leading to confusion. For this reason, manufactures must carefully position their products in the marketplace to avoid product overlap and information overload, which can negatively affect purchase decisions. However, as long as extending product lines results in an overall net gain for automotive companies, carmakers will continue to pursue this strategy (Kirca, et al., 2020).

The Volkswagen group is an example of individual entity with twelve brands operating as independent entities on the market. Despite the large number of brands, it has been able to manage internal competition and not be a victim of brand dilution, which occurs when a company has too many brands and thinly spreads its resources trying to support them all.

VW has successfully managed its brand portfolio through international presence, as it has a worldwide presence, and through a large product portfolio that caters for the needs of a diverse customer group ranging from upper end and premium customers to mid class consumers. Although the VW brand is mainly associated with premium, luxury and sports cars such as Audi, Skoda, Porsche and Lamborghini, it also produces bikes and commercial vehicles, as well as passenger cars for the lower end market, which attract customers with diverse requirements (Pratap, 2018).

As buyers pay higher prices for additional features and new platforms, the automotive premium segment has grown at an above-average level. Although this approach has delivered growth and profits due to higher margins for automotive suppliers it is becoming more difficult for premium OEMs to differentiate themselves unless they focus on new features in infotainment and innovations directed at safety and comfort (McKinsey & Company, 2013).

This is the case of the Chinese automobile market which in 2017 had already been the world's largest for nine years in a row. Following this period of explosive growth in sales volume, the rate of growth started to slow down and manufacturers must now start to differentiate and innovate in order to maintain growth (Kleiner & Chong, 2019).

German suppliers have benefitted the most from the latest trend in the premium segment as they produce approximately 75% of premium cars globally (Fricke, 2014), while Japan-based OEMs, such as Toyota, Honda, and Nissan, which have superior “lean production” processes, have been producing higher quality vehicles at lower cost for the value segment of the market (Kirca, et al., 2020).

The significant growth of the luxury segment suggests that cars are still being perceived as a status symbol. This does not only apply to the older generation that is purchasing premium vehicles, but also to adolescents and the younger generation that despite being aware of sustainable transport issues and understanding the negative effects of pollution and congestion, are often attracted to high performance vehicles. This means that younger people awareness of environmental issues are not necessarily associated with weaker intentions to purchase cars as they often value more enhancing their social status. This represent a threat for the future goal of transport sustainability that must be challenged and addressed to obtain a long-term socio-cultural and personal behavioral change (Poiani, et al., 2018).

4.2.2 Product repositioning

In mature markets OEMs competition is at its highest levels and therefore in order to remain competitive automakers must adopt carefully planned marketing strategies when positioning their products in the marketplace. Three of the often adopted strategies to prevent the decline of products are product innovation, repositioning the product into a new market segment and removing very mature products from the market.

Many companies often reposition their product from the mature stage of the product life cycle into the growth stage by either stripping away attributes that consumers expect in a mature product or supplementing the car with one or more carefully selected attributes that will give the perception of a new product to potential customers. As well as repositioning the product in a different stage of the product life cycle manufacturers also tend to reposition products in different or new market segments to increase sales and volumes and profits (Encyclopedia.com, 2021).

Toyota, with their Lexus brand, are an example of a company that has repositioned their product for growth in a different market segment by associating their cars with the premium category. This has allowed them to embrace and overcome consumer resistance and the perception of their product as inferior in value when compared to other luxury brands. A key

factor in their success has also been the decision to employ a pricing strategies aimed at sustaining profit margins rather than sales volume (Miño Avila, 2008).

Seat, which is part of the Volkswagen group, has adopted a similar strategy to Lexus but in a different market segment, to improve the image of its struggling brand across Europe. This was achieved by focusing on awareness and image of the brand since too many customers outside its home market in Spain were not aware of the brand. Seat's brand awareness team pushed the image of a sportive and economical range of vehicles that replaced its previous reputation as a low-cost car.

This new strategy did not prove successful in the early stages of adoption as the company lost customers because of their price increase and failed to attract new buyers that would pay a premium for its sporty offerings (Stein, 2006).

However, the company persevered with this approach and formed CUPRA, a new brand known as the performance brand, which has its own distinct identity and targets a new market segment. The target market lies between the mass market and the traditional premium market and includes younger buyers and first time buyers. This strategy resulted in an exponential growth since its inception in 2018 and has prospects to establish itself as a strong brand (SEAT, 2020).

4.3 Innovation in the automotive industry

Automotive companies must continuously innovate to remain competitive in today's global market. Innovation, however, can be achieved through several different approaches and therefore it is important that companies pursue and adopt innovation strategies that are aligned with both market and industry requirements as well as their profits targets.

Since innovation often requires large investments in R&D, in order to have a positive return on investment manufacturers must focus their innovation efforts on a very limited number of promising projects by carefully assessing the potential and risks of the technologies and areas of improvement they want to explore and regularly review them.

A closer analysis of R&D spending on innovation projects of both OEMs and suppliers show that 40% of innovation investments are not implemented into cars due to a lack of market acceptance, while only 20% of R&D innovation spending represents profitable innovation investments. The remaining 40% of innovation spending is for serial developments and compulsory innovations to meet legal requirements (Oliver Wyman, 2015).

R&D spending is a key area that requires particular attention not only because of the large proportion of investments that are not accepted by consumers or do not even materialise into profitable innovations, but also because it allows businesses to develop new products and services that allow them to survive and thrive in global competitive markets.

Automotive companies must therefore focus on improving their capabilities to optimize R&D spending. It is imperative that companies choose the right technologies to pursue and select targets that are aligned with both customer and legislative requirements. Until recent years' tools for evaluating future market potential and make timely decision on innovation projects were not always available, however, with the advent of new technologies such as big data that allow consumer data and trends to be captured in real time, there are vast opportunities for companies to optimise spending and maximise profits. Most innovations in the automotive industry are developed by suppliers and are often optional equipment or features in new cars. As it is hard for suppliers to adequately estimate how often their products are ordered, it is imperative for both OEMs and suppliers to measure the success of innovation by gaining more knowledge about customer acceptance (Oliver Wyman, 2015).

The lack of adequate attention to the level of innovation adoption by consumers is one of the main reasons innovations fail. Although it can be difficult for suppliers to understand the level of adoption of their innovations due to the lack of feedback and information sharing with dealerships, OEMs have had the tendency of knowing too little or not paying enough attention to customer requirements and adoption (Oliver Wyman, 2015).

Although OEMs and suppliers are to blame for often not explaining innovations properly to franchises, dealers themselves are also at fault for not transferring the knowledge they possess to end consumers and create enough attraction. Licenced car sellers remain the primary information source in the sales process and therefore particular focus should be paid to expand their product knowledge in a quickly developing and changing automotive market. This need is also confirmed by the growing trend of fewer and fewer drivers knowing about all functions in their cars (Oliver Wyman, 2015).

Product and process innovation have been the most adopted strategies in the automotive industry for several decades as companies tend to align their innovation strategy with their business goals. Organisations manufacturing for the mass market will focus more on strategies that allow reducing cost, while producers in the premium segment will focus predominantly on strategies that provide more functions or features to the consumer.

Product innovation has been driven by companies continually trying to remain competitive in a growing market, while process innovation is often driven by companies cost reduction activities goals. Despite both product and process innovation being the most sought types of innovation in the industry, the innovation drivers are now governmental policies, and the race towards sustainability and carbon neutrality (Pichler, et al., 2021).

4.3.1 Product innovation

Organisations manufacturing for the mass market have often approached product innovation strategies with the aim of increasing profits through cost reduction activities and implementing features that increase comfort and safety as they strive to remain competitive. Despite this approach being profitable due to the resulting increase in sales volumes and prices, product quality is no longer the strongest selling point. Technological innovation and costs of ownership, which includes expenses such as fuel, maintenance, insurance and also depreciation in car value, have become key criteria considered by consumers when making buying decisions. This trend has caused manufacturers to shift their innovation focus towards new functions and features that do not necessarily increase performance but contribute towards a better driving experience and allow meeting stricter policies and regulations around safety and fuel emissions (Gnamm, et al., 2018).

Incremental product innovation has dominated OEM's innovation output for many decades with the most common example being the introduction of new platforms and new models. Although it has been very profitable for companies it has many risks that must be managed.

4.3.1.1 New platforms and platform sharing

Although there are new technologies and opportunities for carmaker to introduce product innovations such as restyling current models, manufacturers often opt to increase product variety by launching new vehicle platforms.

Almost all carmakers support the maturity and saturation stage of the product life cycle with new version and often lower prices, rather than with product innovation. Despite sales trends showing that proliferation of new platforms is not as effective as product innovation, manufacturers tend to adopt this policy because it can have significant effects on profits (Volpato & Stocchetti, 2008).

When introducing new platforms automakers tend to share platforms not only between models of the same company but also with partners in the same industry and market. This can have significant benefits as it gives the opportunity for manufacturers to reduce development costs by streamlining parts sourcing and purchasing, reducing complexity with modular systems as well as improving quality due to common processes (Abolhassani, et al., 2019).

Companies are also able to market the products with higher prices and brand them as luxury as most consumers don't realise the platforms are shared with much cheaper versions. However, this approach is not always favourable as it can erode the reputation of a luxury car if people notice too many similarities with a cheaper version.

The variety of regulations and requirements worldwide can also make global platform sharing more difficult because companies must design the entire architecture of platforms to be compliant with the rules in every market it intends to sell the vehicle, which is not always possible. Toyota's Takata airbag recall is a great example of the post sales stakes of platform sharing being problematic and costly. Since a variety of vehicles were built with the same part, the costs for the recall were much higher (National Highway Traffic Safety Administration, 2021).

There are several examples of platform sharing, cooperation and collaboration throughout the automotive industry. Some of these are: Geely, a Chinese leading automobile manufacturer developing and sharing platforms with Volvo under the R&D banner of China Euro Vehicle Technology (CEVT), and the Alliance, Renault, Nissan, Daimler and Mitsubishi, sharing both vehicle design platforms and manufacturing sites, and therefore sharing tools and processes to keep up speed and security in an environment with diverse applications (McKinsey & Company, 2013).

Even companies like Honda, which in the past has generally preferred proprietary technology and in-house engineering, has agreed to join with General Motors' Cruise Automation unit on autonomous vehicle (AV) development as well as working together on advanced batteries for electric vehicles (EVs) (Wilk, et al., 2019).

The platform sharing trend is likely to continue until the cost of modifying is greater than making new and is no longer profitable for manufacturers (Palmer, 2019).

4.3.1.2 Partnerships and branding

In the last three decades most efforts of automotive firms have been directed towards advertising and price reduction rather than product innovation. This is a contributing factor to the rise in acquisitions, alliances and partnerships that has caused a reduction of independently operating automakers as well as shortening automobiles product life cycles (Sabadka, et al., 2019).

Although partnerships allow automakers to increase profits by forming synergies and sharing manufacturing capabilities they can also be detrimental to companies. When alliances are managed across multiple segments they can cause internal competition, and negatively impact customer loyalty and market share as consumers no longer associate a brand with a specific product due to very similar products being offered by other brands (Kirca, et al., 2020).

Some of the biggest brands partnerships are Volkswagen Audi group, General Motors and FIAT. These groups tend to own brands that operate in multiple markets and segments, being different regions or different customer types, to prevent internal competition as previously mentioned. However, this strategy is not always successful.

General Motors is a good example of how not to manage multiple brands targeting different market segments. With a brand portfolio including Chevrolet, Pontiac, Buick and Cadillac that targeted different customer segments, General Motors made the decision to use the same chassis, engine and other significant parts across the different platforms with the aim of reducing costs. Although the company thought people wouldn't notice or make a big deal out of it this approach totally backfired. The cars not only had the same look but also shared common performance characteristics. As a result, General Motors not only destroyed its brand reputation and that of other brands within the same brand portfolio, but was also forced to declare itself bankrupt in 2009 and discontinue the Pontiac brand.

Although other companies operating within the same market, such as Ford, were also harmed by a drop in sale volumes during the same period due to the economic recession, unlike General Motors, they were able to avoid bankruptcy and remain in competition. General Motors exists today thanks to the government-backed turnaround plan that saved the company (Bigman, 2013).

Despite being an example of failing strategy, General Motors is also exemplary for its approach of re-establishing its brand image. The company was reorganised, values realigned

and the internal culture was transformed to embrace emerging digital technologies. The American automaker also learnt its lesson by reforming its brand architecture and focusing on fewer but stronger brands operating in different market segments and distanced from the parent company, and therefore acting as standalone brands. The brand is now perceived as a reliable and affordable car and remains the largest market shareholder in the United States, controlling 17% of the industry's total sales as of 2020 (Palmer, 2021).

Despite General Motors example of a large brand portfolio being the downfall of an automotive company there are also examples of companies that were able to make this a success, such as the Volkswagen Audi group. Although the Volkswagen Audi group has 12 brands within its portfolio, each brand maintains its own individual identity. One of the reasons of its success is that it does not only understands the importance of adopting different strategies on brand image and market positioning, but it has also been able to do this successfully for many years. Thanks to this approach it has been able to maximize the market potential while minimizing overlap so that no two brands are in direct competition. The brand image of the individual divisions has also helped the company overcome the shock from the diesel scandal in 2015, which tarnished the image and reputation of the VW brand. Differentiation can be a really successful strategy when adopted as an alternative to not being able to dominate in cost and volume. However, VW has combined this strategy with already excellent sales volumes performances and it is not surprising that the company plans to increase differentiation even further amongst its different brands.

4.3.2 Technological innovations

In recent years the car industry has been trying to be more innovative also by developing and incorporating technologies that add value to its products and create the appearance of radical innovation (Gerbeau, 2019).

The introduction of infotainment and active safety systems, which mitigate crashes and accidents by providing advance warning or additional assistance to drivers, are some examples of manufacturers trying to innovate their products as well as keeping up with increasing safety requirements (eurostep, 2018).

4.3.2.1 Infotainment and augmented reality

The introduction of numerous safety features has also highlighted the noticeable trend of more automotive functions becoming interlinked. Previously, one device used to have one single function, but recently more and more devices are being used with multiple purposes. An example of this advancement is the pre-safe system adopted by Mercedes-Benz that links crash sensors and the Electronic Stability Programme (ESP), which improves vehicle's stability, with seat controls, seatbelts and the sunroof. This trend also represents a shift from single innovations to system innovations, which can be observed across the industry with technology companies becoming system providers and in some cases even supplying automotive solutions.

Infotainment systems is an example of systems innovation adopted across the whole spectrum of the automotive market. These systems have been on the market for almost two decades and have evolved from simple interfaces created in-house by suppliers to customized touch-screen layouts that have the ability to download apps. Although most features such as internet, Bluetooth and smartphone connectivity are now considered basic, this field is in constant evolution. Most car brands plan to invest heavily and introduce more digital services, which means that infotainment systems can be expected to increase both in numbers and functions (Kenia, et al., 2013).

The market for infotainment systems is not the only digital technology innovation category that is set to boom in the coming years. Augmented reality (AR) technology, which is currently being adopted in virtual showrooms to showcase vehicle features and allow customers to take virtual test drives, is also set to gain traction and most likely dominate the auto industry in the not so distant future (Fahmi & Alwy, 2020).

AR is already in our current cars as it is integrated with common safety features. These are features such as 'smart' rear-view mirrors programmed to access the back-up camera and provide a clear view of the road behind them or smart displays with driver alerts for mileage, fuel levels, oil life, tire pressure and other safety alerts.

Although there are vast opportunities to increase the use of AR in vehicles through the implementation of smart capabilities that detect potential threats to keep drivers safer on the road or functions such as displaying essential information on windshields and projecting cues and navigation instructions on the road, AR will also play a significant role in other aspects of the automotive sector.

The use of AR applications on mobile devices or smart glasses/headsets can provide hands-free access to data, and when paired with image recognition technology it can automatically determine either the equipment model or the problem with it. This technology could therefore also aid service technicians in the maintenance and repairs of vehicles, reduce training time for technicians and even allow car owners to carry out self-service repair or maintenance (Martinetti, et al., 2016).

There are numerous cases of companies already using AR applications for repair and maintenance in different sectors reporting a decrease in overall service time. Porsche is an example of automotive company that has been using this technology successfully for at least three years. Porsche's system, known as 'Tech Live Look', connects dealership technicians to remote experts via smart glasses for a live interaction and has reported and proven to shorten service resolution time by up to 40% (Porsche, 2020).

4.3.2.2 Connectivity, infotainment and telematics

Automotive connectivity involves connecting cars with the world surrounding them, including people and smart devices, by establishing a wireless transmission of data. The ultimate aim of this technology, such as that of many innovations in the automotive sector, is to give a better and safer driving experience. Due to this technology being software and data driven, technology companies and software developers are leading the radical transformation in the field by partnering with automotive manufacturers to embed their software into vehicles. Although the concept is simple, vehicle connectivity relies on advancements in multiples fields such as infotainment, telematics and infrastructure (Quinn, et al., 2020).

As previously mentioned, infotainment systems are already widely adopted in the industry. However, innovations in infotainment will increase as cars get connected to each other, to people and to the wider infrastructure, and speed up the progress of connectivity (Beiker, et al., 2016).

Telematics allows gathering and sharing data on driver's behaviour and car function by connecting the car to the cloud. The assessment of driver behaviour and car function that is possible via this technology has several potential practical uses. The gathered data can help insurance providers determine a more accurate insurance premium and give dealerships the ability to monitor vehicle diagnostics and offer smart or predictive maintenance services that ensure optimal performance by incentivising drivers to bring the vehicle into the dealership or automatically scheduling services.

Although these innovations are not as attractive to consumers when compared to improvements that offer more functions to the user and therefore are perceived to be of better value, particular attention must be paid to the marketing approach, which must focus on long term benefits, such as increase in reliability, durability and resale value of vehicles, rather than immediate advantages.

With driver's safety and environmental issues being two of the most important factors driving innovation, connectivity with the infrastructure cannot be underestimated. While telematics focuses on data and long term benefits, connectivity with the infrastructure will produce immediate benefits as it will allow the vehicle to perceive the presence of pedestrians and traffic lights, which will not only help avoid crashes, but also ease traffic congestion and consequently improve the environment (Jabil, 2018).

Despite connectivity offering significant advantages such as making the driving experience safer and lowering the environmental impact of cars, it will also be key for the complete realization of autonomous vehicles. It will be the foundation for the communication between vehicles and the surrounding world enabling human attention to be diverted away from driving.

As connectivity evolves in-vehicle security will become a real concern. Hackers and cyber criminals that could gain accesses could not only tamper with essential security and safety mechanism but could also steal sensitive or personal data. In extreme cases this could represent even a greater threat due to the risk of gaining full remote control of the car. The increase in popularity of connectivity features also means that developers must consider improving in vehicle data security by building anti-hacking mechanism that prevent cyber-attacks and guarantee the security and safety of customers. If companies fail to address these risks, connectivity could have a catastrophic effect on consumer confidence, privacy and brand reputation (PwC, 2013).

Although technological trends such as infotainment and augmented reality are experiencing a significant rise in popularity within the automotive industry, the trends that are impacting the automotive industry the most are connectivity, electrification and autonomous vehicles (Gao, et al., 2016).

4.3.2.3 Autonomous vehicles

Autonomous vehicles, also known as self-driving cars, and their integration with developing fuel technologies is the ultimate goal for many automotive companies and society as it has the potential to improve on road safety (Ahmed, et al., 2020) and reduce environmental issues by reducing accidents, congestion, energy consumption and emissions (Marr, 2020).

The development of self-driving cars relies on technologies that are currently under development, such as a connected infrastructure and accurate road mapping using remote sensing methods, which are considered essential by most companies in the race to commercialize self-driving cars.

Companies such as Ford Motor, General Motor and many others have recognized that the future of the industry is likely to be within the electric and autonomous vehicle market and as a consequence are hiking R&D investments in these fields (Calcea, 2021). However, current automotive companies do not possess the necessary technological capabilities to develop these vehicles on their own and are therefore adopting an open innovation approach by focusing on partnerships, collaborations, acquisitions and joint ventures with tech companies with the purpose of accessing their technical and scientific competences (Keilaf, 2020).

Leading tech companies such as NVIDIA, Google, Luminar and Tesla, have invested heavily in self-driving projects and the development of autonomous vehicle technologies, but despite the significant progress made in the last decade it is very unlikely that these cars will be widely accepted any time soon (Nasdaq, 2021).

Although the development of fully autonomous vehicles is expected to last at least another 10-15 years, manufacturers have grasped the importance of pursuing incremental innovation while striving towards fully autonomous vehicles technology and are transitioning steadily from manual to fully automated vehicles by developing and launching vehicles with different levels of autonomy. However, it must be highlighted that automotive and tech companies are not the only parties with a major part to play in the development and wide acceptance of self-driving cars as there are key ethical and safety issues that must be address first (Hansson, et al., 2021).

Although it has been widely acknowledged that moral decisions currently made by drivers, such as the decision to swerve or brake suddenly to avoid hitting a pedestrian crossing the road illegally and put vehicles passengers in danger, will be made by algorithms, the added complexity occurs when considering the choices and people opinions on the subject (Abu-Khalaf & Haskell-Dowland, 2021).

Survey results show that moral principles guiding driver's decisions are not universal but vary by country. In scenarios in which a pedestrian and passengers would die in a collision, people from relatively wealthy countries were less likely to spare a pedestrian who stepped illegally into traffic. However, this was not the case for poorer countries (Abu-Khalaf & Haskell-Dowland, 2021).

Different solutions have been proposed such as that of fitting self-driving cars with an "ethical knob" that lets the driver control how the vehicle will behave during an accident but a general consensus has not been agreed on the topic (Verma, 2018).

While the dilemmas mentioned above need to be addressed prior to autonomous vehicles being widely accepted there are also conflicting customer requirements that must be taken into consideration. People wanting autonomous vehicles to protect pedestrians even if it meant sacrificing its passengers, wouldn't buy self-driving cars programmed to act in this way (Maxmen, 2018).

Despite these conflicting views, it must also be taken into consideration that people don't always do what they say in surveys and although their stance should be held in high regard, policy decisions will not and should not be made based on those opinions alone.

These issues have been on the table for several years and are being discussed in several countries. Although a universal rule has not been agreed, Germany has taken the initiative to regulate automated driving within a legal framework by publishing an Ethics Code for Automated and Connected Driving. The Code published in 2017 prohibits distinctions based on personal features in the case of unavoidable accidents and mandates that algorithms do not discriminate based on age, gender, race, disability, or any other discernible factor. Despite this code violating overall public opinion, which for instance dividedly supports saving children over adults, companies developing algorithms for vehicles to be sold in Germany must follow the established guidelines (Luetge, 2017).

Since different national regulations represent an additional challenge for automotive organisations, as they would be required to tailor their products specifically for each country, companies such as Daimler are advocating for an internationally harmonized legal framework for automated and autonomous driving. Although since 2016 the international legal framework for national road traffic safety permits automated systems, autonomous driving is still unregulated and there is currently no regulatory framework for the registration of automated vehicles (Daimler, 2021).

However, as mentioned above, individual countries are stepping forward and proposing regulations for self-driving vehicles to be adopted in their own territories so Germany is not the only example of nation laying the groundwork in preparation for the wide adoption of this technology. In December 2020 the UK has also announced a proposal for a new legal framework that has the aim to ensure the safety of self-driving vehicles and emphasises the need of clearly defining the responsibility of drivers, owners and manufacturers (Gov.uk, 2020).

It is important to define the responsibility of the different parties involved in autonomous driving but is equally as important defining the liability in the case of an accident. Although autonomous driving has the potential to improve safety on the roads and lead to an overall decrease of accidents and number of claims, the insurance industry will play a crucial role in giving drivers the confidence to use this technology (ABI, 2021).

Self-driving cars will undoubtedly complicate the legal framework surrounding insurance policies as manufacturers and software companies will also be parties involved in the claim process when the vehicle or the technology is found to be at fault. However, insurance companies are welcoming the development of autonomous driving technologies as they reduce the number of vehicle collisions and therefore result in profit increases. An example of autonomous driving technology widely welcomed within the insurance industry is the Autonomous Emergency Braking (AEB), which has reportedly reduced the number of vehicle collisions between 20 and 40% (ABI, 2021).

These are clearly several key ethical and safety dilemmas that undermine public trust in autonomous driving technology and cannot be underestimated as they do not only require governmental support through the publication of regulations and policies, but societal involvement and possibly a radical mind-set change is imperative if the vehicles are to gain public acceptance.

4.3.2.4 Ethanol and methanol

Due to regional legislation making it harder for car makers to meet stricter emissions targets with traditional internal combustion engines manufacturers have been looking at alternative fuel sources.

Ethanol and methanol, both derived from alcohol, have been considered alternative fuels for many decades. Ethanol fuelled cars were first experimented more than hundred years ago, while methanol's use as vehicle fuels became widespread in the early 90s in countries such as the United States, Brazil, and China (Bromberg & Cheng, 2010). The use of methanol as an alternative fuel did not reach mass adoptions as it declined substantially since the early 1990s. Automakers gradually reduced the production volumes of these types of vehicles (US Department of Energy, n.d.).

Despite advantages such as reduced emissions of greenhouse gases, increased thermal efficiency and increased power output than diesel, its use as vehicle fuel has been phased out in the US and worldwide (US Environmental Protection Agency, n.d.).

Although it has many advantages it also has some drawbacks such as being very corrosive. Recent studies, which have questioned earlier findings, have also found that it also provides little environmental advantage as its fuel economy is not as observed initially (Sands, 2015).

The decline of alcohol based fuels can also be attributed to the fact that it did not require subsidies or government assistance in making it economical and as a consequence it was not appropriately championed and users were not encouraged to adopt these vehicles. The rise of methanol fuelled vehicles was also considerably hindered by plummeting oil prices, which greatly reduced the economic incentive for pursuing methanol programs (Bromberg & Cheng, 2010). However, with oil prices rising significantly in recent years and advances made in many automotive industry related fields, researches and manufacturers could reconsider investing in this technology and therefore its reintroduction should not be completely ruled out.

4.3.2.5 Electric vehicles

As fuel efficiency requirements increase and emission standards are aiming towards net-zero emissions, more alternative powertrain technologies that have been experimented in the past have seen a resurgence of interest and remarkable investment.

Due to growing concerns on carbon emissions and air pollution many countries have begun tightening their regulations to reduce fuel emissions. As a consequence, in the not so distant future, people will no longer be allowed to purchase traditional internal combustion-engine vehicles in several countries around the world. These policies have forced global manufacturers to look at alternative options and they have realised that the transition to electrified vehicles is not only inevitable but the only way to compete. Almost every major car maker has invested significantly in this technology and either has electric vehicles already available to buy or plan to make them available for consumers in the next few years (Wappelhorst, 2021).

Despite the remarkable growth of electric vehicles in the last decade, they currently make up only around 2% of global vehicles sales. However, future estimates on market share by 2030 for these types of vehicles vary between 10% and 60% (Assis, 2021).

The primary explanations for the uncertainty of both timing and level of adoption of electric vehicles relates to unanswered questions surrounding advancements in the technology itself, the implementation of new policies, funding required for electric vehicle infrastructure and consumer preference. For electric vehicles to dominate the automotive market the industry requires technology advancement that will enable the supply of cheaper batteries that last longer and are faster to recharge, as well as both public and private charging points available for drivers (Assis, 2021).

Although increasing number of consumers in both Europe and Asia are considering buying an electric vehicle, the preference towards electric vehicles is considerably higher in China due to the stronger policy incentives and drivers tending to have shorter commutes (Hirschberg, et al., 2019).

To boost sales of electric vehicles in China, manufacturers have tried new business models including battery leasing plans by offering schemes that allow consumers to buy the vehicle and lease the battery on a monthly basis. The battery leasing model along with the added service for drivers to replace their empty batteries with a fully charged one at a service station, which mitigates the problem of slow recharging, are increasing people interest as the business model appeals to many drivers currently put off by the price and charging time (Huang, et al., 2021).

The Chinese market is the largest worldwide and is expected to remain the leading market for the adoption of electric vehicles not only due to the consumer preference towards the technology but also because Asian suppliers have a know-how advantage compared to automotive supplier around the world. The country is an ideal destination for manufacturers to market their products, and understand consumer preference and demand. As well start-ups and tech companies, established automotive organisations are taking advantage of this opportunity. General Motors, through a joint venture with two Chinese car manufacturers, is one of those companies seizing the opportunity as it is currently producing the best-selling electric vehicle in the country, while Renault is also set to follow the footsteps of General Motors by partnering with Geely to tap into China's rapidly growing electric and hybrid car market (Dabelstein, et al., 2021).

Despite the copious opportunities for automotive companies targeting the Asian market, which can benefit from the higher demand in the region but also understand how the electric vehicle's market evolves, they must be aware that trends occurring in China may not materialise in other regions due to the culture and lifestyle differences and therefore a different approach may be need when marketing to other countries (Huang, et al., 2021).

European countries are adopting similar strategies to incentivise the adoption of electric cars by allocating public funds and investing heavily in the installation of charging infrastructure. However, most European countries are failing to meet recommended targets electric vehicle supply equipment (EVSE) for publicly accessible chargers set by the Alternative Fuel Infrastructure Directive (AFID), which recommended that countries aim for one public charger per ten electric vehicles in 2020 (IEA, 2021).

Although some countries have reached and surpassed the recommended levels, the installation of charging infrastructure doesn't seem to be evenly spread across European countries as three quarters of all the electric vehicles charging points in western Europe are located in just four countries, being Netherlands, Germany, France the United Kingdom. This disparity in availability of charging points between European countries will undoubtedly hinder the adoption of electric vehicles unless actions are taken by governments to address the issues (Noyens, 2020).

Despite many European countries investing heavily in public infrastructure by installing publicly accessible charging points, only 12 countries, mostly in western Europe, offer private incentives such as payment subsidies or tax incentives to buyers of electric vehicles. Private incentives range from purchase grants to tax incentives but also include the opportunity to reclaim a portion of vehicle charging costs and free parking (Noyens, 2020).

The UK government has taken a similar approach to other European countries incentivising electric vehicles. As well as investing heavily in the charging infrastructure, the UK government offers grants for workplace charge points but also to individual buyers of plug-in electric vehicles by covering up to a portion £350 of the installation cost for a home wall box charger. It also offers tax benefits such as the exemption from annual road tax for purely electric vehicles costing less than £40,000 (Noyens, 2020).

Despite the several incentives available for buyers of electric vehicles and battery capacity increasing from roughly 250 miles per charge to 400 miles in the last 5 years, there is a widespread reluctance to buy fully electric vehicles. Drivers still do not always feel confident they can get to their destinations with their remaining charge so until charging infrastructure becomes more available or battery capacity increases significantly fully electric vehicle will struggle to reach mass adoption (IEA, 2021).

The adoption of electric cars for private individuals is growing slowing and the trend is completely different when considering the demand for the vehicles from delivery companies around the world. Companies such as Amazon, DHL, FedEx and many others are taking steps towards zero-emissions by placing orders for thousands of fully electric vehicles for their commercial fleet, which is pushing OEMs towards a quicker development of electric vehicles (IEA, 2021).

4.3.2.6 Hydrogen or FCEV

Most national investment and incentives have been stimulating the adoption of fully electric vehicle, however, due to the lack of infrastructure and technological advancements required in the field, manufacturers and consumers are progressively opting for hybrid vehicles rather than fully battery powered vehicles (Pheby, 2021). The hybrid technology has been successfully adopted by many companies as a solution to tighter emission standards but also to combat industry disruptors such as Tesla, and allow more time for incumbents to maximise the value from their existing assets (HM Government, 2021).

Hybrid vehicles, which combine electrical energy stored in batteries with a combustion engine, range from those that use the combustion engine as generator with the added assistance of an electric motor when accelerating, which are known as mild hybrid electric vehicles, to those capable of travelling only on electric power for longer distances and require plugging in for recharging, which are known as plug-in hybrids (Evans Halshaw, 2021).

Although hybrid options offer improved fuel economy in comparison to traditional combustion engines there are several different types of hybrid vehicles offered on the market, which can result in a complex portfolio for manufacturers to manage but also confuse consumers when making buying decisions (Mitchell, 2020).

Despite many manufacturers battling for dominance in the electric vehicle market there is already a fierce competition underway for market share in the hybrid market. Mild hybrids, also known as hybrid electric vehicles (HEV) have seen the largest growth within the hybrid sector (Sanguesa, et al., 2021). This is mainly due to the relatively short range of battery electric vehicles and limited availability of charging points, as well as the lack of a comprehensive strategy for an adequate charging infrastructure (Wills, 2020).

Sales trends are showing exponential growth of hybrid cars and enormous potential for manufacturers to increase their revenue while electric vehicle technology and infrastructure is still under development. However, manufacturers must not forget that hybrid technology is an interim solution and should not shift their focus entirely into this direction (Sanguesa, et al., 2021).

Although hybrid cars reduce greenhouse emissions during their lifetime, the production cycle is more energy intensive and emits more carbon dioxide than internal combustion engines. Their production process, as admitted by Toyota, not only require the same highly automated assembly lines as traditional vehicles but they also include more advanced components such as a second electric motor and heavy battery packs (Roos, n.d.).

Despite experts estimating that only 10 to 20% of a vehicle's total lifetime greenhouse gas emissions are released during the production stage, automotive manufacturers should not be satisfied with the overall reduction of their products emissions while accepting a detrimental effect on their carbon footprint but should focus and devote more resources into the development of more energy efficient production and assembly methods for hybrid vehicles (Roos, n.d.).

With declining prices and increasing availability, electric vehicles are unquestionably gaining momentum. However, manufacturers are also investing increasingly in fuel cell electric technology, commonly known as hydrogen vehicles, which involve an on-board generator that uses hydrogen to power a fuel cell and produce electricity. Like electric vehicles, hydrogen fuel cell systems offer a cleaner alternative than internal combustion engines as they do not emit any harmful gases, but only water. However, the main advantages of hydrogen cars over electric cars are the fast re-filling times of hydrogen tanks compared to charging the battery of an electric vehicle, and the faculty to overcome the limitations of needing batteries. Despite these advantages, investments in fuel cell technology are not as extensive as those for electric vehicles (Singh, 2021). However, due to their higher weight and longer ranges they tend to be more attractive for buses and commercial vehicles (Cornet, et al., 2019).

Asian countries, including Korea, China and Japan are currently leading the deployment of fuel cell electric vehicles, with only a few other countries outside of the Asian region, such as Germany and the US, focusing on this technology by investing a significant amount of resources in both the production of hydrogen vehicles and the installation of hydrogen refuelling stations (Singh, 2021).

China has followed this approach as over 95% of its hydrogen vehicles are buses and trucks, while Korea and Japan have opted for the introduction of this technology for light duty vehicles (IEA, 2021).

Hydrogen vehicles are also, to some extent, popular in US, but only in regions where there is a presence of publicly accessible hydrogen refuelling stations such as in California and Texas. These two states are not only set to lead in the adoption of this technology due to their position as a hub for the production of commercial hydrogen but also because of the laws and incentives related to the use of hydrogen (Magill, 2021).

In Europe, despite the efforts of the Hydrogen Mobility Europe project, which aims to give drivers of fuel cell electric vehicles access to hydrogen refuelling stations and improve hydrogen production techniques, fuel cell technology is still unpopular (Hydrogen Mobility Europe, 2021). Germany is the only European country with an extensive network of hydrogen refuelling stations due to their large state funded investments in hydrogen projects and their ambition to become a hydrogen country (Green Car Congress, 2021).

Despite the limited adoption of hydrogen vehicles worldwide there are some large automotive brands focusing on this technology. Toyota and Hyundai are currently the only automotive manufacturers with hydrogen vehicles on the market, as they are selling respectively the Toyota Mirai, which is a mid-size vehicle, and the Hyundai Nexo, which is a small SUV (Morris, 2020).

In recent years, several other automakers have started to invest in this technology. Companies such as BMW, Honda, Ford, Nissan and Mercedes all developing hydrogen cars, which are set to arrive on the market in the next few years (Lilly, 2021).

Despite many high profile companies investing in this technology there are various concerns that cannot be ignored. First of all, hydrogen power is not totally green as 95% of hydrogen is currently generated from fossil fuel sources. Its transportation is also dangerous as highlighted by the explosions of the hydrogen fuel station in Norway and the storage tank at a government research project in Gangneung, South Korea. Although two explosions don't mean that hydrogen is unsafe, these events certainly raise safety concerns that cannot be overlooked (Jin & Chung, 2019).

The green and safety concerns are not the only reasons making hydrogen less attractive than battery electric vehicles. When all the steps between power generation and vehicles propulsion, such as the production of electricity, its storage, re-charging of batteries and waste from running electric motors are considered, the efficiency of battery electric vehicles is almost twice as much as that of fuel cell electric vehicles (Morris, 2020).

Hydrogen has also the disadvantage of being quite expensive. The running cost of a hydrogen powered vehicle is much greater than that of an electric vehicle since, for example, the cost of a full tank of hydrogen on a Toyota Mirai is almost £50 compared to roughly £8 for fully charging an electric vehicle. More importantly the range with a full hydrogen tank and a full charge is very similar (Naylor, 2021).

As previously mentioned, there are also benefits to this technology that must be considered, such the advantage of quick refuelling and the lightness due to no presence of batteries, however, with sustainability goals driving innovation in this field the inefficiency of hydrogen technology could be a potential stumbling block for its worldwide adoption.

4.3.2.7 ICE opportunities

Despite growing popularity of electric vehicles, hybrids and fuel cell electric cars, and internal combustion engines being on the decline, there are still many innovation opportunities in current vehicles that are set to continue. Innovations such as the shift from port fuel injection to direct injection, the implementation of software features in engine management for better control of emissions and the likely increase of the number of gears to optimise engine power and gear ratio are only some of the changes companies can introduce not only to improve the overall driving experience but also to enable the reduction of emissions (Cornet, et al., 2019).

Increasing numbers of automotive manufacturers are relying on the growing popularity of hybrid vehicles, which are set to stay for the next decade, to guarantee a return on investments that will enable pursuing innovation of ICE engines and vehicles. However, with current internal combustion engines slowly disappearing and the uncertainty of the speed of adoption of fully electric vehicles, manufacturers must carefully evaluate the costs versus benefits of investing in this area and aim for a faster payback period than previously accepted (Cornet, et al., 2019).

4.3.3 Sustainability - the green race

Since 2014 certain large European companies are required by law to disclose non-financial performance information not only to help investors, consumers, policy makers and other stakeholders evaluate businesses but also to encourage the development of a responsible approach to business. As a result of this mandatory reporting that tracks companies' sustainability strategies and goals, product innovation in the automotive industry is largely fuelled by organisations being made accountable to their stakeholders and to public opinion based on how they operate and manage social and environmental issues. The transparent and responsible behaviour that companies must adopt to achieve sustainable growth, also known as Corporate Social Responsibility, has driven more and more companies to make social responsible investments, meaning that investing is not only about profitability, but the emphasis is now also on the positive impact an investment would have in society and on the environment (European Commission, n.d.). As a consequence of the new policies and regulations, almost all major innovations currently being pursued in the automotive industry have one common denominator, sustainability.

The major trend rushing through the automotive industry is clearly the shift towards electrified vehicles, which is viewed as the sustainability solution for the industry from many automakers and policy makers. However, the vast majority of electricity generated worldwide is still from non-renewable sources such as fossil fuels and nuclear energy. Despite the use of renewable energy for electricity generation growing continuously and equating to a third of electricity generated worldwide in 2020, electricity cannot yet be considered an entirely clean energy source due to the greenhouse gases emitted during its production (IEA, 2020).

Questions regarding the sustainability of electric vehicles are not only due to the greenhouse gases emitted during the production of electricity but also due to the resources required for the production of batteries. The environmental and social costs of mining and processing minerals that are critical for the manufacture of batteries such as lithium, cobalt, graphite and nickel also represent a great concern (Whiteaker, 2021).

There have been a number of issues reported worldwide, which are linked to the extraction of the above mentioned minerals. Cobalt mining in the Democratic Republic of Congo has been widely reported to cause environmental damage and toxic pollution, which leads to child birth defects (Whiteaker, 2021), while Chile, once the leader in the production of lithium, has seen recent opposition to lithium production activities from activist worried about its environmental impacts (Sherwood, 2021).

The environmental concerns surrounding the extraction of battery minerals are not only local to the countries mentioned above but widely recognised. However, with growing conviction from governments and manufacturers about vehicle electrification being the future it may be too late to reverse this trend. Despite the concerns there are still numerous opportunities for manufacturers to transform their operations into sustainable processes through research and development of new battery technologies and activities such as repurposing and recycling batteries (Casper & Sundin, 2020).

The repurposing concept, which involves using the batteries after the in vehicle life in stationary applications such as on the grid, has the potential to reduce costs and greenhouse gas emissions. Although retrofitting lithium-ion batteries would require extensive testing and refurbishments to ensure a reliable performance in their new application, companies such as General Motors are investing into this area with the aim of creating a circular supply chain for electric vehicle batteries and reduce their environmental footprint by designing battery packs with a second-life application in mind (Pyper, 2020).

Recycling batteries could be a potential answer to the sustainability issues as high recycling rates would reduce battery production volumes and the extraction of raw materials required. Although, after their 10-15-year life span in vehicle, batteries still retain roughly 80% of their capacity and therefore can often be effectively reused for other applications, this is not always possible as refurbishing complexity varies due to the lack of battery standardisation as they are designed by the manufacturer to be best suited to a specific electric vehicle model. However, despite the complexity of refurbishing batteries it is often a cost effective solution when compared to the cost of mining those materials and building new batteries (Whiteaker, 2021).

Recycling batteries will require building recycling infrastructure and therefore upfront investments for companies. As the value of end-of-life batteries is predicted to be low, it is important for organisation to utilise funding available to ensure a positive return. However, as half of all electric vehicles batteries will only reach the end of their life in the next 10-15 years, manufacturers have plenty of time to plan these investments and allocate resource in advance (Whiteaker, 2021).

Companies are incentivised to pursue battery recycling strategies also by environmental protection, resource efficiency and closed-loop supply chain policies that assigns the responsibility to recycle battery packs to manufacturers (Whiteaker, 2021).

The EU has shown signs of proactivity on this subject matter by introducing the Batteries Directive in 2006, which stated that collection rates of waste lithium-ion batteries had to reach 25% in 2012 and 45% in 2016, and most recent attempts to modernise legislation on batteries, as announced in the new Circular Economy Action Plan. These policies not only state that batteries should be produced with the lowest possible environmental impact and should be repurposed or recycled at the end of their life but also stipulates that the materials should be obtained in full respect of human rights (European Commission, 2020).

As the biggest producer of batteries worldwide, China has also issued several legislations that direct and normalize the recycling of waste batteries, with policies assigning the responsibility to manufacturers or importers for the collection and use of electrical waste, guiding companies on the design, production and recycling of electric vehicle battery, as well as promoting the protection of the environment and human health from battery powered vehicles (Sun, et al., 2021).

Despite both Europe and Asia facing up to the challenges of electric vehicles by introducing policies and legislations that ensure environmental factors are not overlooked, the US is considerably behind in regards to the implementation of strategies for managing the sustainability aspect of the innovation in electric vehicle technology. However, as the focus in US is shifting to new policies aimed at regaining market share in the production of lithium-ion batteries that will power electric vehicles it will soon need to tackle the concerns relating to the safety of battery production and the challenges of end-of-life waste management and recycling (Sun, et al., 2021).

4.3.4 Process innovation

As explained above, in recent decades the top innovators in the automotive industry have been focusing mostly on areas including services and processes, as well as products. Product innovation is also almost always linked with process and supply chain innovation due to OEMs attempting to improve processes and make products more affordable for consumers. However, in today's automotive market dominated by disruptive technologies, process innovation seems to have taken the back seat (PwC, 2013).

At various stages of industry evolution, some types of innovation are more important than others. During the current period of disruption product innovation has been the focus of attention for many companies. This is because early in the technology lifecycle companies face high uncertainty in both market and technology due to consumer needs being often unclear, and have the tendency to use product innovation to reduce these uncertainties. However, as customer needs become clearer firms tend to focus more on improving efficiency and therefore process innovation becomes more important (Chopra, 2020).

Despite innovation of manufacturing processes not being as popular as product innovation, in recent years' there have been other innovation strategies being increasingly adopted in the industry such as business model and supply chain innovation. These innovations have the aim of reducing time to market while also maximising profits (PwC, 2013).

4.3.4.1 Supply chain

The supply chain for both raw materials and parts for manufacturing cars is one the most complex due to the large number of individual components in a car, around 30,000 individual parts on average. For over a third of automotive suppliers, supply chain is one of the key areas holding them back from achieving faster time to market (Jabil, n.d.).

Although platform sharing and the use of modular systems have streamlined the supply chain, globalization has created further difficulties for automotive suppliers by widening the supply base of automakers. Changes in manufacturing processes, consumer demands and new/disruptive trends have also contributed to these difficulties. Better visibility and routing of parts within the supply chain are key areas that require improvements to allow early identification and possibly prevent delays during new product launch and mass production. The use of predictive analytics and AI (Artificial Intelligence) modelling to understand and forecast future requirements based on changing consumer demands will also be a key factor for both achieving faster time to market (Blume Global, 2021).

In order for OEMs to achieve faster time to market, tier 1 supplier must also overcome their challenges and improve their time to market capabilities to keep up with market demand. Up to 80% of a car is pre-manufactured by the supply chain and therefore tier 1 suppliers and companies further down the supply chain play a significant role in the development and launch of new products. According to a recent survey more than a third of tier 1 suppliers are facing increasing manufacturing complexity due to the many regulatory, technological and quality requirements (Jabil, n.d.).

High levels of automation can help automotive suppliers meet increasing technological and quality requirements. However, the considerable capital investment and time required for its implementation often means that the returns on the investment may not appear for many years.

Many suppliers have historical ties to a carmaker's R&D operations that can be leveraged with alliances and mergers between suppliers. Combining Calsonic Kansei, a supplier with historical links to Nissan, and Magneti Marelli, previously owned by Fiat Chrysler, into Marelli is an example of an integrated supplier able to expand its customer base by providing multiple systems such as electrified powertrains and lighting (Harrison & Ludwig, 2020).

A recent and increasing trend is also that of lower tier suppliers taking over more product design, manufacturing and service areas by integrating their engineering and production of complete modules rather than 'building to print', where OEMs supply the IP and direct the supply.

Although suppliers can innovate products and processes, there are market determinants that they cannot control such as innovation and technology outpacing regulations. An example of this is the technology enabling autonomous cars. Although public wariness of this technology may be seen as the reason holding back self-driving cars this is not entirely true. Many vehicles have remote parking capability, emergency avoidance technology and self-driving technology but without governments support through funding, incentives and regulations to build the required infrastructure these systems cannot be widely rolled out (Shirokinskiy, 2021).

Tier 1 suppliers are also being held back from being successful in areas such as shared mobility by their inability to monetise connectivity and data. Despite technology companies being the favourites to lead in this sector with the right investment and skills acquisition in software development areas, automotive suppliers could improve their product offerings (Harrison & Ludwig, 2020).

4.3.4.2 Business model innovation

The innovation and exploitation of different business models could be key for allowing companies in the automotive industry to maximise their profits.

Business model innovation can be the difference between the failure and success of a company as proved in the late 90s by the introduction of the OnStar information system by General Motors'. By transforming its value proposition and offering safety and security features on a subscription basis General Motors was able to increase customer demand from 100,000 to 2.2 million generating a turnover of more than \$1 billion (Oliver Wyman, 2015).

In today's market, business model opportunities for companies involve the provision of data and analytics not only to consumers but also to insurance companies and OEMs suppliers. Companies should fully utilise the data in their possession and monetise it by making it available to the parties mentioned above, where possible, through business models such as pay per use, subscriptions or one time payments by developing an understanding of consumer preference on how they would like to pay for these features (Laya, et al., 2020).

Manufacturers should pursue this strategy not only because features such as energy usage insights, GPS tracking, data analytics for store location and opening hours, and many other characteristics could be potentially retrofitted in existing cars, but also because they can have a high level of confidence that all consumer groups are showing interest as there is concrete data highlighting the attractiveness of these attributes in the consumer trends of the automotive industry 2020 report (Laya, et al., 2020).

4.3.5 NPD lifecycle

Although sharing platforms and resources allow manufactures to reduce costs and increase profits, companies need to focus on reducing timeframes for development and launch to remain competitive in a market that innovates every 2-3 years. Companies such as Mazda and Mitsubishi can achieve product development lifecycles under 2 years; however, this needs to be coupled with the ability to plan and set up processes faster, which is a stumbling block for many other companies (Dušan Sabadka, 2014).

Platform sharing and utilising pre-existing modular system often result in a reduction of testing requirements, which could help further reduce new product introduction timescales as testing cycle times have been identified by over 40% of surveyed automotive companies as one of the areas holding them back from achieving faster time to market (Jabil, n.d.).

Suppliers also play an important role in the product development cycle as they need to develop and supply components in the same time frame. In recent years the focus on automotive suppliers has increased even further as more development work is being offloaded by OEMs (eurostep, 2018).

5 ANALYSIS

5.1 Customer requirements

Automotive companies are always striving to retain market share by attempting to meet customer requirements and the ever rising expectations.

Although overall demand and sales of new vehicles has reduced significantly, mainly due to the recent pandemic, which has caused changes in consumer lifestyle and behaviour, some segments within the automotive industry have experienced a significant increase in demand.

Demand for SUVs have increased significantly as they are being chosen by consumers not only because of their size and versatility, which tend to suit families, but also because of their styling and the perception and feeling of safety they transmit to drivers due to their raised seated position. Despite increasing the perception of safety of the vehicle owner, data from safety tests show that SUVs are not so safe as they put other road users at a higher risk of severe injury in the event of collisions.

The luxury segment is also relishing an increasing demand as well as profits due to brands such as Lexus becoming more common not only amongst the older generation, which have a tendency of purchasing new vehicles, but also younger generations.

Consumer demand in terms of powertrain type also varies across European regions. Internal combustion engines are still in high demand in countries such as UK and Germany, while hybrid vehicles seem to be more popular in countries such as Italy and Spain. However, when analysing the global landscape consumer preference varies significantly.

While China is leading the introduction of electric vehicles due to the stronger policy incentives and drivers tendency to have shorter commutes, which favours the use of electric vehicles, the US is lagging behind its counterparts both in the innovation in electric vehicle technology and implementation of strategies for managing the sustainability aspect.

Consumer demand for technological innovation is also rising considerably with features such as integrated navigation systems, blind spot alert and emergency braking becoming ubiquitous. Technology requirements have also been affected by recent events such as COVID, which has caused an increasing demand for characteristics and features that make the driving experience safer such as germ filters and antibacterial materials, while also causing a reduction in public transport usage due to fear surrounding the virus.

5.2 Market trends and behaviour change

Automotive companies have had to adapt to changes in consumer behaviours and offer alternatives to maintain a high consumer interest. However, this is a very complicated task as manufacturers must consider the numerous trends and data available, which can often be inconclusive and therefore difficult to act on.

Remote working is an example of a societal change that could result in both an increase and decrease in vehicles sales. Although it could cause an increase of vehicle sales due to workers relocating from cities to outskirts where public transports are not as popular, it could also cause a reduction of vehicle sales due to many companies moving towards a remote working policy. Remote working reduces workers requirement to travel to work, which in some cases may not justify purchasing a vehicle. The increase in popularity of shared mobility is also likely to have a negative impact on vehicles sales despite the significant growth in sales of electric and hybrid vehicles.

An emerging trend that automakers cannot ignore is that of the average age of car buyers increasing, which is currently 53. If manufacturers are to satisfy the needs of the older generation they must tailor their products to the older audience by introducing ergonomic features such as senior friendly loading and seating solutions as well as visual aids.

Despite the older generation tendency of buying new vehicles, younger age groups are also showing increasing interest in vehicle ownership, especially those aged between 18 to 24. However, it must be noted that this age group tends to be more interested in second hand cars rather than new models.

Manufacturers are also trying to simplify customers buying journey to maintain high sales volumes with the introduction of virtual dealerships and at home test drives that use new technologies such as augmented reality, which allows the entire buying experience to be online. Volvo is currently leading in this sector with its Polestar brand being available only online and recent announcements that Volvo is also planning to make some electric models available for purchase only online. Although this trend might seem to apply only to a few brands it is evident that this approach is set to be adopted across the entire automotive landscape with companies such as Porsche, Mercedes and Skoda already following Volvo's footsteps.

Despite forecasts of automotive revenue nearly doubling in the next decade, revenue from recurring services are predicted to experience the largest growth. It is estimated that by 2030 about 20% of total revenue will be generated by services such as shared mobility and data-connectivity. This growth will be at the expenses of one-time vehicle sales, which only six years ago was representing nearly 80% of automotive revenue, while revenue from new services was only 1%.

Automakers are already trying to capitalise on this growing trend by partnering with technology and software companies as well as implementing business models to allow the monetization of recurring services (Gao, et al., 2016).

5.3 Disruptive technology

Currently, different countries, and in some cases different regions within the same country, appear to have different priorities and expectations with regards to alternative fuel vehicles. However, current trends are highlighting that countries with significant renewable energy or nuclear power potential and a lifestyle that favours shorter journeys are more inclined towards purchasing battery electric vehicles or plug-in hybrid vehicles.

Germany, which has an automotive industry centred around higher value vehicles and long driving distances, as well as having recently identified the need to store excess electricity generated from renewable sources, has a stronger association with fuel cell electric vehicles running on hydrogen compared to its European counterparts (Nieuwenhuis & Wells, 2012).

Current technological development seems to be leading towards the end goal of autonomous vehicles. However, due to the need for a connected infrastructure, accurate road mapping sensing methods and advancement of other technologies such as computer science and data analysis, it is very unlikely that we will see a widespread acceptance and production of autonomous vehicles in the next decade. Moral and ethical implications surrounding decisions that will be made by self-driving vehicles represent another major barrier that must be overcome to enable autonomous vehicles to become mainstream. Conflicting views and in some cases opposite opinions based on regional and cultural backgrounds are already highlighting the difficulties that government will need to face when introducing policies aimed at regulating this field and potentially reach a general consensus. Despite the numerous obstacles preventing the universal adoption of autonomous vehicles in the near future companies should not stop investing in the technologies as a long term vision and strategy is imperative due to the speed of technological advancement constantly increasing.

5.4 Process innovation

In periods of high technological advancement process innovation tend to take the back seat in favour of product innovation, especially in the manufacturing industry.

New technologies that enable improved safety for vehicles drivers and passengers, and the introduction of vehicle connectivity, infotainments and augmented reality systems have increased consumer interest and demand of new vehicles. Despite the numerous new technologies enhancing current vehicles, there are also a number of innovations that are likely to revolutionise manufacturing processes and reduce time to market such as 3D printing, which will drastically reduce prototyping times, and big data, which will optimize the supply chain as more devices and manufacturing process become part of the 'Internet of Things.

5.5 Sustainability

With consumer's awareness on social and environmental issues constantly increasing, sustainability has become the key factor of many business and personal decisions. Sustainability is driving innovation not only in the automotive industry but across many different sectors as companies are realising that investing is not only about profitability, but the focus should also be on the positive impact an investment can have in society and on the environment.

Polices and regulations requiring business to discloses non-financial performance data have not only forced companies to become more accountable to stakeholders but have also incentivised manufacturers to make investment decisions that are socially and environmentally friendly.

Although manufacturers have been forced to reduce emission by new standards and legislations, vehicle electrification can be considered an attempt by companies to produce more sustainable products. However, despite the numerous sustainability benefits of electric vehicles compared to internal combustion engines, many questions have been raised regarding the sustainability of battery vehicles.

These relate to the greenhouse gases emitted during the production of electricity, and the environmental and social costs of mining and processing minerals required for the production of batteries. Although many electric vehicle batteries may find alternative applications or be recycled after their lifecycle in vehicles, there are also environmental concerns surrounding their disposals.

6 CONCLUSION

The automotive industry is facing many critical challenges that companies must address to remain competitive in today's global market.

Decision makers within organisations such as managers must develop their capabilities as the need to quickly analyse data and trends, and implement strategic solutions is key not only for companies to maximise investments returns and survive the current uncertain climate but also to protect themselves from new competition.

Due to the complexity of the market and the fast paced technological advancements, companies must not only deal with product innovation challenges while reducing development and production costs, but also threats from various market entrants.

The shift in demand from vehicle ownership to vehicle access, which has given the opportunity to ride sharing firms to capture consumer interests and threaten the status of established automotive manufacturers, is an example of a threat that manufacturers must tackle and overcome to maintain their status.

Automotive companies are also facing rising competition from digital and software companies due to the huge amount of data generated by new vehicles that must be stored, transferred, analysed and used to make strategic decisions to allow companies to improve their product offering and production efficiency.

Despite the sophisticated marketing strategies that have been widely adopted, companies must also increase their digital and software capabilities whether this means partnerships, joint ventures or acquisitions of companies with expertise in the sector or become more proficient in this field by hiring more software engineers.

Although manufacturers are facing numerous challenges there are also several opportunities that companies could exploit.

Monetisation through the provision of data and analytics, not only to consumers but also to insurance companies and suppliers, could become an important revenue stream for companies after the one-time vehicle sale.

With regulations forcing automakers to become more environmental friendly, sustainability has become a key factor.

Manufacturers are becoming more socially responsible and the focus on sustainability, rather than increasing profit, is often the key driver in the most recent companies' strategic decisions.

While consumer increasingly factor sustainability when making buying decisions, the affordability of greener solutions remains a key issues despite incentives such as grants.

The findings of this research confirm that electric vehicles are set to become more popular. However, hybrid vehicles are the preferred choice by consumers while the infrastructure for electric vehicle is still under development and they represent a significant market opportunity for companies to capitalise on.

Despite sales of both electric and hybrid vehicles predicted to increase, overall vehicle ownership is likely to decrease in the long term due to trends such as shared mobility and remote working. However, this should not be seen as a cue for halting investments in new technologies aimed at improving current products, such as internal combustion engine vehicles, as demand for greener solutions will only increase.

Greener electricity production from renewable energy and the repurposing batteries after in vehicle lifetime are fundamental areas that require attention by both manufacturers and governments if electric vehicles are to become a long term sustainable solution for the automotive industry.

Automotive manufacturers may need to diversify their products and service offerings to maintain their competitiveness due to new market entrants such as Tesla, who is not only becoming a leader in the manufacture of electric vehicles but also establishing itself as a licenced provider of electricity.

The shortening product life cycle and the increased speed of technological innovation means that manufactures are and will continue to face several challenges to keep up with this trend.

To reduce time to market companies may also need to change their approach by focusing more on branded design and marketing of vehicles while outsourcing technology development to companies that are digital natives (Wilk, et al., 2019).

Although investing in technologies such as connectivity is likely to produce significant improvements in productivity due to the insightful data that can be gathered, it is not a guarantee of performance improvements. It is imperative that manufactures have a clear strategy and roadmap on how the data is going to be used to ultimately achieve business goals.

Due to uncertainty surrounding the adoption of electric vehicles and increasing investments in hydrogen technology it's still not clear which vehicles customers will prefer in the coming years. For this reason, established automakers must not only consider trends and technologies when making strategic decisions regarding their fuels and powertrains for the future, but should aim to align their strategy with company and brand values perceived by consumers.

It is clear that with many innovation opportunities on the horizon automotive manufactures cannot pursue all avenues but must focus on a limited number of areas. However, more important than choosing technologies in high demand, it is crucial that innovation strategies are coherent with companies' strategic vision.

7 LIMITATIONS AND FURTHER RESEARCH

Although innovation in different companies and regions was considered in this study and the automotive industry was analysed from both a local and global perspective, there may be some possible limitations. This research may suffer from cultural bias due to perspective on innovation of the researcher. Western regions perceive innovation and sustainability as a key factor for company's longevity, while developing countries may have other priorities. Further studies on this topic from researchers with different backgrounds may offer additional insights that could highlight challenges and/or opportunities overlooked in this report.

This report focuses on the challenges and opportunities for incumbent automotive companies, however, there are numerous new market entrants and start-ups in this field to which the findings of this study may not apply directly. Limited data and information is available about these companies as they are still at the early stages of the product development and launch process. Further research may be required to understand the path being pursued by these start-up companies and the possible threats they may face by the constantly changing the technological trends, and new policies and regulations. Recommendation offered in this study may not apply to start-ups that do not possess the know-how of globally recognised OEM that have been manufacturing cars for several decades.

The rise of acquisitions, alliances and partnerships between OEMs and system providers such as tier 1 suppliers and technology companies will require the adoption of more sophisticated IP management strategies. Both OEM and technology companies contribute towards the monetisation of data and connectivity, however ownership of this technology can dictate who profits from future revenue streams resulted from the sale of data but also where liability lies in the event of data loss or theft. Further research is needed in this subject area to understand the implications regarding to IP (Intellectual Property) for companies that pursue this business model.

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