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Consumer habits and autonomous vehicles

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Abstract: Eco-friendly technologies are everywhere in the world, including in transport. The future belongs to the electric car. Nothing proves this better than the change that has taken place in Hungary since the introduction of the green license plate. Anyone with open eyes and watching the cars standing on the street may have noticed that green license plates have started to appear scattered since 2010. Not much time passed and the rarely seen green license plate became a mass article. Car splitters appeared who, taking advantage of free parking, scattered the city full of electric car fleets. Environmentally conscious transport has become a trend. The aim of our dissertation is to examine these consumer preferences in Hungary. We would like to get a unified picture of the opinions of Hungarian electric and hybrid car users, their user experience and their satisfaction with the extent to which this technology can be used in Hungary today, as opposed to internal combustion motor cars

Keywords: consumer habits, hybrid technology, electric car,Internal combustion engine car

1 Introduction

The automobile has undeniably changed our everyday lives and has become one of the most important technological inventions of the past century. Automobiles have altered our lives so much that it would be impossible to imagine our society without them. Automobile manufacturing companies have gained a significant role in global economic development and now are even considered as macroeconomic indicators of economic growth.

The automotive industry has always been innovation-oriented. It is enough to compare the efficiency of early commercially available models, like the Ford Model T with one of the most technologically advanced cars nowadays, like the Tesla Model X, to understand the incredible level of progress all within a century. Though

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the first flying cars are still a fascinating futuristic idea, it is clear that the present offers opportunities that are no less interesting and innovative. Day by day, car manufacturers are making more and more developments and we are moving more and more towards the development of a truly autonomous vehicle.

Before the new era of autonomous cars begins through commercialization, manufacturers must focus on improving the efficiency of electric cars. The diversification of electric vehicles has allowed manufacturers to create models for narrower price segments, thus enlargening the market and making them more available for the public. Thus, nowadays, anyone can find an electric car for a specific price segment. Nonetheless, people still have a lot of doubts and a lot of questions: Is the range right? Is the compromise acceptable? Isn't charging a problem? Which brand is trustworthy?

These are the questions we will try to find answers to in our research. We'll take a closer look at the segment, its future, and its potential. We will discover the best-sellers in Hungary, find out which batteries produce the best range, and discuss the specificities of charging. We will also discuss the issue of whether the range of an electric car is indeed a conclusive factor in making a purchasing decision. The results reveal that currently order ability and reliability are much more important than either the brand or the range. This is also interpreted as an answer to the many questions that arise in connection with electric cars since if only the scope and the price were the selection criteria, the situation in the market would be significantly -different. In `our research, we will try to shed light on the fact that although the range is important, what is considered to be a decisive factor in purchasing an electric vehicle is brand recognition and prestige.

2 Literature review

Nowadays, autonomous vehicles present the biggest challenges for the automotive industry, as every manufacturer envisions the future of the industry differently. In an autonomous car, the driver no longer has to deal with the operation of the vehicle, as the car will be able to drive following a predetermined route in as efficient, smooth trouble-free, and effective a way as possible.

2.1 Exploration of the concept of autonomous vehicles

In recent years, car manufacturers have developed a wide range of driving assistance systems (DAS) that can already take much of the control from the driver, enhancing the comfort of the ride. Several advanced camera and sensor systems have been developed in the past years that are capable of monitoring the ride and detecting emergencies. Lane departure warning systems, emergency brake assist systems,

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adaptive cruise control, and side assist are all additional features modern vehicles are commonly equipped with. (Daily et al., 2017) The lane departure warning system, for instance, indicates if the vehicle is within the passage between two lanes. If the vehicle slips into another lane, the sensors will indicate it to the central processing unit, which in turn, will adjust the direction of the vehicle, so that it remains within the predefined lanes. (Lee et al.,2017) Even though DASs aid the driver making their ride less stressful and much easier, the complete and undivided attention of the driver is still essential. (Hecht, 2018)

In 2018 the technological development of self-driving vehicles reached the level of automation that would allow a vehicle of a higher level of automation to be driven on the streets. As of now, the only obstacle to this is government regulation, since only under a specifically defined law driver can let go of the wheel even for seemingly insignificant periods. (Badue, 2021) Yet the responsibility of the drivers doesn't decrease, as there is always the possibility of malfunction. In practice, while driving the Tesla Model S electric vehicle, a typical highway ride is much more comfortable, as neither the constant presence of the hand on the wheel nor the foot on the pedal is required to maintain speed and direction of the vehicle although the driver has to grab the steering wheel every three minutes to indicate that they are alert and are controlling the vehicle. (Kim& Park, 2017)

Self-driving cars will continue to develop in the coming years. Sooner or later, we will get to the point where self-driving cars will be common on roads. According to experts, this will first happen on highways, where the drivers will be able to give control to the vehicle in designated sections. (Acheampong&Cugurullo, 2021) Autonomous cars will be equipped with sensors, lasers, and radars that will enable them to get an accurate picture of the surrounding environment and road conditions. The vehicle will be able to steer, brake, and accelerate on its own on designated road or highway sections. (Raue et al., 2019) If the future of automation won't favor the emergence of fully self-driving cars on the roads and highways, it is expected that at the very least future automobiles will be equipped with more advanced DASs than now, so that they will even be able to predict and solve difficult traffic conditions (Borenstein et al., 2019)

Nevertheless, Chet et al., (2017) point out that in about a decade the automotive industry will reach a level where cars will transport us from point A to B on their own. It is further projected that cars will be able to handle traffic not only on certain designated sections of motorways but on the entire motorway network. Neither traffic lights, nor intersections, nor roundabouts will be a problem for the vehicle, as the cars will be in contact with each other, therefore, they will predict and project potential unfavorable traffic situations and be able to avoid them. If there is a traffic jam somewhere, the vehicles will be able to take a detour and choose the best route for the journey. (Gambi et al., 2019) Ndikumana et al., (2020) project that by 2030 there will be models of vehicles devoid of a steering wheel, so the driving experience as such will slowly disappear completely since as soon as we get in the

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vehicle will take us to our destination. The riding experience will be similar to that of a taxi, where the taxi driver doesn't communicate with the passenger.

3 Methodology

The automotive industry has undergone significant change in recent years, as conventional energy sources derived from fossil fuels continue to become more expensive and their impact on the environment continues to be more devastating. We can observe the paradigm shift based on recent news on the count of the so-called "diesel scandal", and a growing number of people looking for alternatives.

In our research, we wanted to find the answer to what extent are consumers familiar with electric vehicles and what is their opinion about them. We further asserted if consumers are willing to pay more for an electric car than for a traditional car and whether the selection criteria are significantly different in comparison with conventional models. Lastly, we evaluate how important the brand is when buying an electric vehicle.

In our primary research, we used a quantitative method in the form of an online questionnaire. The choice of the method was obvious since a questionnaire survey collects information by interviewing a small portion of a group of individuals selected through scientific sampling.

There were several types of questions in the questionnaire. In addition to the open-ended questions, we also used several open-ended and closed-ended questions. As for inquiries that required a spectrum of answers, dichotomous multi-outcome questions were formulated.

We chose the online questionnaire specifically because it was the easiest way to reach as many people as possible, as we only had to share the link for them to complete it. Using this method, we were able to successfully filter out the responses which provided valuable data from those that were irrelevant.

Our questionnaire was completed by 316 people in two weeks. This number is statistically representative, and therefore, statistical inferences can be made about the dataset in question.

4 Results

We strongly believed that it was important to talk about how much money people would realistically spend on an electric car. After asking how much they would

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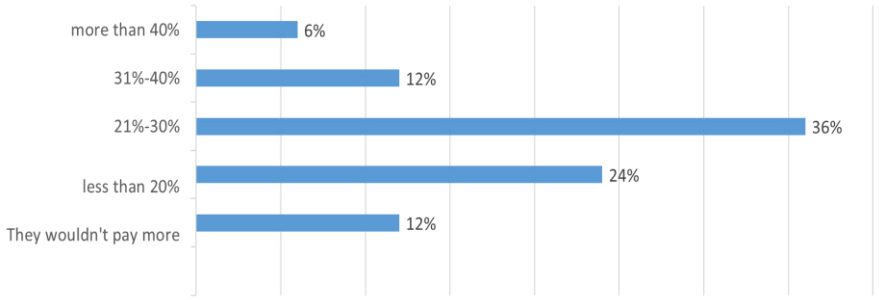
spend on buying a conventional car, we calculated the markup which consumers are willing to pay additionally if the car were electric.

Nearly half of the respondents indicated a range of 21% to 30%, but there were also those who were not willing to pay more for an electric car (Figure 1). This result may be of interest to car manufacturers, as their revenue stems from people's willingness to pay a surcharge. The sales of used electric cars in Hungary have significantly increased in past – this is supported by two arguments: (i) the price of electric vehicles is still significantly higher than that of conventional vehicles, and (ii) the residual value of the electric car is, therefore, also higher.

In addition to general questions about electric cars, we also asked them which brand they would choose, and then explain why they chose it.



1. Figure How much would respondents be willing to pay more for an autonomous vehicle in comparison to a traditional car? (N = 316)
Source own research

Figure 2 illustrates that 35% of the respondents consider Tesla their electric vehicle of choice. It is followed by Renault and BMW in equal proportions sharing 20% of the respondents. The result is interesting from the perspective that Tesla Motors is the only company listed that doesn't sell cars in Hungary at the moment. Though, it is possible to order them from the United States or choose from pre-owned models. Nevertheless, this brand was still nominated by most of the respondents. This choice is most likely attributed to the brand awareness the company gained over the last decade, thanks to its chief executive officer. Another valuable result derived from the research is that Japanese car manufacturers like Nissan have been chosen by the respondents relatively few times, even though, according to statistics, Japanese brands lead the sales in Hungary, followed by Volkswagen, BMW, and Renault.

To have a better overview of the market and to determine the defining reasons for the particular choice of the respondents, we highlight a few open-ended responses.

The criteria that made the respondents choose Tesla included (i) the most efficient batteries, producing the longest range, and (ii) the autopilot functionality. The company has been on the market for years and has been a market leader in driving

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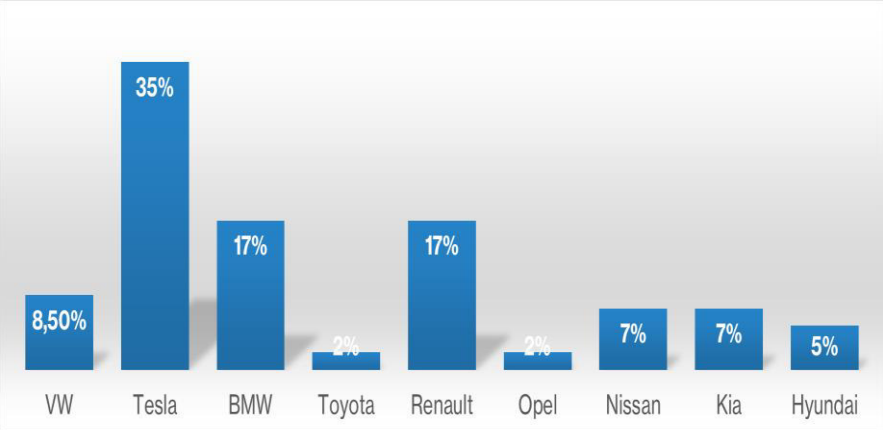
range, and is famous for being a pioneer in autonomous driving. The biggest problem is the price and the long delivery time. Of course, newer models, such as the Tesla Model 3 are now much cheaper than their predecessors (Model S and Model X), yet the delivery time can be up to one year, which for many is unacceptable.

BMW and Volswagen were chosen by respondents mainly because of their association with reliability, a good brand recognition and the nations long-term appreciation of German-made cars.



2. Figure Preferred car brand? (N = 316)

Source: Own research

While the choice of Hyundai and KIA were explained by the reliability of both of the brands, the choice of the French Renault was backed by the concept of value for money. The Renault ZOE model has just won an award in this category, therfore the manufacturer communicates its vision of the future of electric cars quite vividly.

The next two questions cocnerned the average distance traveled per day by respondents and the range expected from an electric car.

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			Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Interval Interval	by	Pearson's R	,260	,078	2,878	,005c
Ordinal Ordinal	by	Spearman Correlation	,226	,091	2,472	,015c
N of Valid Cases			116			

3. Figure Symmetric Measures
Source: Own research

With the help of the SPSS program we examined the two questions through Pearsons't index, which in this case was 0.260. We interpret this as a weak but significant relationship between the two criteria, i.e. it cannot be said that only those who drive longer distances per day on average chose the range as a significant factor. Since the p-value is 0, this statement is definite with a probability of 99.9%.

5 Conclusion

The primary research was planned well in advance, and its execution aimed to get the best possible picture of the consumer market for electric cars. Overall, we obtained the results we predicted in the secondary research. People are still generally reluctant to purchase electric vehicles. From the questionnaire, we can see that the consumers are willing to pay more for an electric motor version than a conventional one.

We believed it to be important to examine which brands and models the respondents were aware of, therefore, we determined the criteria and the reasons for the choice. In the list of possible reasons, the brand was the most common choice. According to the respondents, the brand plays a significantly more important role than the range. The respondents did not choose the most successful brand in Hungary by sales as their electric vehicle of choice, instead, they stood by vehicles with a reputation and good brand recognition. An example is Tesla Motors. While it's impossible to buy a Tesla through a dealership, buying it second-hand is an alternative option exercised by many. Tesla's reputation, its market-leading range, and constant strive for innovation make it instantly recognizable and a popular choice of many consumers.

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Looking ahead, it is evident what kind of cars we will be driving on public roads. The future is indeed electric. This is progress none of the giant corporations can stop, only alter.

Self-driving cars will relieve us from the process of operating the vehicle, thus making our ride more comfortable, stress-free, and as safe as possible. The more cars have the self-driving feature, the more likely it is that a network will emerge. Such a network will enable the vehicle to determine the most optimal route for the journey, avoiding difficult traffic. Autonomous vehicles will not make incorrect turns, won't forget to use the turn signal, and most importantly, they won't get tired and won't make mistakes as a result.

References

[1] Daily, M., Medasani, S., Behringer, R. és Trivedi, M. (2017). Önvezető autók. Computer , 50 (12), 18-23.

[2] Badue, C., Guidolini, R., Carneiro, RV, Azevedo, P., Cardoso, VB, Forechi, A., ... és De Souza, AF (2021). Önvezető autók: felmérés. Expert Systems with Applications , 165 , 113816.

[3] Hecht, J. (2018). Lidar önvezető autókhoz. Optikai és fotonikai hírek , 29 (1), 26-33.

[4] Raue, M., D'Ambrosio, LA, Ward, C., Lee, C., Jacquillat, C. és Coughlin, JF (2019). A hagyományos autók vezetése közben fellépő érzések hatása az önvezető autók észlelésére és elfogadására. Kockázatelemzés , 39 (2), 358-374.

[5] Chen, Z. és Huang, X. (2017, június). Végponttól végpontig tanulás az önvezető autók sávtartásához. A 2017 IEEE intelligens járművek Symposium (IV) (pp. 1856-1860). IEEE.

[6] Gambi, A., Mueller, M., & Fraser, G. (2019, July). Automatically testing self-driving cars with search-based procedural content generation. In Proceedings of the 28th ACM SIGSOFT International Symposium on Software Testing and Analysis (pp. 318-328).

[7] Ndikumana, A., Tran, N. H., Kim, K. T., & Hong, C. S. (2020). Deep learning based caching for self-driving cars in multi-access edge computing. IEEE Transactions on Intelligent Transportation Systems, 22(5), 2862-2877.

[8] Lee, C., Ward, C., Raue, M., D'Ambrosio, L., & Coughlin, J. F. (2017, July). Age differences in acceptance of self-driving cars: A survey of perceptions and attitudes. In International Conference on Human Aspects of IT for the Aged Population (pp. 3-13). Springer, Cham.

[9] Kim, J. és Park, C. (2017). Végponttól végpontig terjedő ego sáv becslés önvezető autók szekvenciális átviteli tanulásán alapul. In Proceedings of the IEEE konferencia a számítógépes látásról és a mintafelismerő műhelyekről (30-38. o.).

[10] Acheampong, R. A., & Cugurullo, F. (2019). Capturing the behavioural determinants behind the adoption of autonomous vehicles: Conceptual frameworks and measurement models to predict public transport, sharing and ownership trends of self-driving cars. Transportation research part F: traffic psychology and behaviour, 62, 349-375.

[11] Borenstein, J., Herkert, J. R., & Miller, K. W. (2019). Self-driving cars and engineering ethics: The need for a system level analysis. Science and engineering ethics, 25(2), 383-398.