

CURRENT DEVELOPMENT OF PERSONAL VEHICLES – PERCEPTION OF SELECTED ASPECTS

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Súčasný vývoj osobných vozidiel – vnímanie vybraných aspektov

Abstract: *This paper deals with the latest important trends in automotive industry, which are currently developed and heavily tested by all car manufacturers and their suppliers. The focus is concentrated on the implementation of new generation of human – machine interface, car-to-car communication, advanced electronic driving assistants or autonomous driving systems as the most important disruptive innovation representative example in this industry category in the close future. Moreover, a special emphasis is dedicated to the development of alternative engines (plug in or hybrid electric cars and testing of new forms sales forms and consumer – manufacturer commercial relations. Part of the study deals with the environmental issues and social responsibility associated with the car industry, especially with the usage and production of diesel engines and their pollution impact. All the above mentioned issues and questions are part of the primary quantitative research, which brings the results describing the public perception and views of all these important changes, which are going to have sooner or later an impact on all of us.*

Keywords: *autonomous car, automotive industry, alternative engines, car ownership, plug-in electric car*

JEL Classification: M 30, M 31

1 Introduction

A passenger car is a commodity, which represents alongside real estate and housing-related expenses, usually one of the most important investments in the case, when talking about the purchase of one or more new cars more often in a person's life, or in families.

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The amount of investment in the vehicle acquisition to some extent depends on the family life business cycle, the aggregated and available free financial investments that the family can or wants to invest, but it is also the brand, model, power, equipment, and other attributes that significantly influence the price. Of course, many financial models can refinance the car. These are offered not only by financial institutions, but also by leasing companies cooperating with automobile dealers or brand sales networks.

In summary, the central focus of this paper is to test some of the latest innovative trends in the development and management of car driving systems, trust and expectations related to them and other related issues, car ownership preferences, etc. To justify the need for the development of new types of engines, an important initial part of the paper deals with the use of diesel engines and the situation, which arose in connection with the crossing of the emission limits of these types of engines.

The next few years are important for the automotive industry to the extent, which will determine the survival of some of the existing automobile producers, by their ability to implement new technologies in areas as for instance:

1. The new or upgraded engine types, which will limit the excessive loading of the environment life-threatening emissions, which is currently higher than permitted and to be able to fulfil the ever-tightening emissions standards and legislation associated with them;
2. Advanced driving assistance systems until the level of the fully autonomous control (autopilot function) with or without the presence of the driver, which provides not only increased convenience of travel, but even saves more than a million human lives a year who are victims of road accidents;
3. The change of “driver – car interface or cockpit” and its information range, online car communication among cars together, (e.g. information about of sudden and not distant accidents) and with their off-road information sources (Horning, [2]);
4. The development and implementation of new structural composite materials to ensure better car crew protection, lower vehicle weight, lower energy requirements for day to day car operation and many others requirements.

A competitive edge of leading car manufacturers will be the ability to offer their customers new commercial alternative forms of ordering and selling of cars, which respect the rapidly changing shopping habits and preferences of consumer decision making.

It is highly likely that in a relatively short time (e.g. from two to five years) there can take place an important repositioning of existing car brands,

the emergence of new car producers and new brands as described above. As the natural development, disappearance of some already established manufacturers is highly possible.

Since the automotive industry faces many challenges mentioned above, it is important to note that there is a strong need for the change in the legislative environment, which will enable the practical implementation of many of these technologies, including the adoption of the regulation. These, in turn, will address many ethical and moral questions and dilemmas, and which simply did not exist in the road traffic legal framework.

The aim of this paper is not to comprehensively cover and discuss all issues in the field of almost exponentially accelerating increasing development of electronic systems in the production of passenger cars and forms of their ownership, but to provide selected views, opinions and responses of the Slovak population to some of the above-mentioned areas.

1.1 Methodology and data collection

The fieldwork was conducted by means of the quantitative method of research with face-to-face method with a structured questionnaire, and in few cases, assisted questionnaire self-filling method was used.

The sample contains a balanced representation of men and women and as well as a balanced participation of respondents from different regions of Slovakia. The total of 278 questionnaires were delivered, of which 250 completely filled were used for further processing purposes. Each structured questionnaire contains more than 30 content and 9 socio-demographic questions. As an “additional expert panel”, we used 10 In-Depth Interviews, which was carried out with managers from the automotive industry (car producers, importers, etc.) for deep trend discussions, the fine tuning of the questionnaire, better understanding of the car industry, etc. The data collection took place in November 2016 and data processing in the months of December 2016 and January 2017. The requirement for participation in the survey for a respondent was the ownership of a driving licence and an active use (driving) of a passenger car at least once a week.

2 The current situation in the automotive market and acceptable conditions for the purchase of plug-in electric car in Slovakia

Before answering the question about the plug in electric car purchase, based on many previous discussions on this topic, let us briefly describe part of the context. The situation regarding conventional drives has become dramatic in recent years and especially since 2015, when the New York Times reported that the US government required at that time the second largest car manufacturer of the world of Volkswagen to withdraw about half a million

vehicles the company sold in the US market between 2009 and 2015. The reason was the EPA (US Agency for Environmental Protection) said, that in the diesel engines of these vehicles there was installed an “illegal” software that enables the vehicle to fulfil the corresponding emission norms values during the emissions test. However, in everyday usage and driving (outside the laboratory tests), the emission values exceeded the norm by 40%. Given the huge number of cars involved in this case, the total fine of the VW was proposed at that time at \$18 billion. The market reaction was quick and it was reflected in the decline of VW shares on the stock exchange of \$26 billion.

It is highly probable that if this fraudulent software has been installed in vehicles in the US for vehicles with engines 2.0 TDI and 3.0 TDI V6, the suspicion that it was installed in these engines in other countries has been confirmed. The Italian Competition Authority levied the VW highest possible fine of EUR 5 million, South Korean authorities fined the VW 15 million and started criminal proceedings against the VW, and further investigations are also underway in other countries, such as Australia, Poland, etc. Various sources estimate the total cost of the solution of the case for 20 billion euros (teraz.sk [7]), including fines, costs callout events, “editing software”, compensation for customers in the US and the cost for the purchase of vehicles that will be adjusted to meet the required standards. Volvo representatives claim that long-term use of fraudulent software solutions in the VW car factory and automobile line of work was an “open secret.”

Worldwide, the fraud relates to 11 million cars of the VW Group including 1.2 million Skoda brand cars, as well as other brands of this group, such as the SEAT, Audi and VW, of course.

In this critical situation of the risk level of emission contamination of the world’s large cities, a number of capitals or cities (Paris, Oslo, etc.), or even the entire countries (for instance, the Netherlands) are considering to stop the sale of the diesel engine, or plan to limit or stop their entry to certain locations or cities. Even Germany itself has prepared a list of more than 30 cities, in which in case of extremely critical situation caused by harmful air pollution, it will gradually ban on entry of vehicles with diesel engines.

Everything points to the fact, that diesel engines produce markedly increased NOx emissions of air pollutants, especially in slow urban traffic, even up to three times the outdated Euro 3 standard; and there is also a suspicion about other types of not so far monitored and unmeasured air pollutants. Based on a growing requirement of Euro 6 emission standards (currently in force) and the forthcoming EURO standards 7 ... Several automakers admitted that in near future it will be extremely difficult, if not impossible to fulfil them, so that there are increasingly heard considerations to halt the development and production of diesel engines.

The problem of nitrate emissions to meet the current Euro 6, for example, has been dealt with “Selective Catalytic Reduction” system, which uses urea injection system, which is used by Peugeot. (Peugeot.sk/2017)

Probably, one of the few car producers that can meet the Euro 6 standards without the injection of urea or other legal means of reducing emissions, is the Mazda, which cars Mazda 6 at relatively high performance of more than 120kW met the Euro 6 standards as early as 2013, without any legal or illegal reduction systems. (Mazda.sk/2016)

In this situation, accelerating the development of alternative engines sounds logically, as far as possible with the production of zero emissions that are harmful to humans and the environment. There is a version of the so-called hybrid drives, in which the cooperation between the main power units (usually gasoline) with an electric motor with a lower power enables the car to take off the crossing or a parking lot. This combination of engines, many experts refer to as unpromising, because in this configuration the vehicle really “owns” two mutually complementary separate engine units, which increases the complexity and mostly still produces harmful emissions. Despite the undeniable benefits such as slow moving in a traffic jam, in which hybrid vehicle delivers economic performance, its range on electric power is only operation of a just a few kilometres (2 – 3 km) and at the maximum speed to 50 km/h. Of course, there is also a version called “plug-in hybrid” in that a larger capacity of battery usually enables a reaching a range of distance of 40–50 km and with the possibility of recharging the battery, e.g. during night at home. However, at this point we focus on pure electric “plug-in” electric car recharged with a special quick charger for example, at the gas or special charging station, but at home by means of a regular household power supply.

Not to confuse the research sample with more engine options, like micro hybrid, hybrid, plug in hybrid, etc., the research respondents were asked just to answer the following two questions.

The wording of the first one was as follows: “What would you consider an acceptable increase in the price of a pure electric car versus the current ‘conventionally powered’ vehicle with the same driving comfort and equipment?” It was important to the issue mentioned “the same drive comfort and equipment” as it is now part of the electric dimensionally wheelbase and slightly smaller range of optional equipment and cargo capacity. As an example, the Nissan Leaf is used, which has been on the market since 2010 and is the best-selling EVs on the planet. Acquiring basic price of the latest version of the vehicle Nissan Leaf, even after the deduction of the newly established government grant of EUR5000 in the Slovak Republic in February 2017, the price for the basic model starts at EUR27,000 (lowest gear, weaker battery), up to EUR 34,500 for the better model (highest trim, stronger

battery). In both cases, there is possibility of buying equipment worth several thousand euros (navigation, metallic paint, warranty upgrades, etc.). (Nissan.sk [4]) **A polling of the target group of the above formulated question concerning the increase in prices compared to conventional drive was 19.09%.**

The second issue, or rather the condition is expected electric range, if the respondents had to pay the above-mentioned increase in the cost of a new electric vehicle on a single charge.

Before presenting respondents' replies and to better illustrate the issue, as an example we would like to mention the most recent version of the now upgraded Nissan Leaf model, which comes in with two battery capacities, the difference being of course reflected precisely in the range of the vehicle distance range. The declared range with a smaller battery of 24kW is up to 200 km and with higher capacity battery with 34kW is up to 250 km. However, the actual range for both vehicles is based on the tests guaranteed up to 150 km, and the vehicle with higher capacity achieved in tests often range up to 200 km (Podkapotou.sk [6]). A real range of an electric car is influenced by many factors that consume electrical capacity of the battery, as the vehicle lights, especially heating and air conditioning, sound system and so on. On the other hand, there is a significant impact on the distance range of extremely high or low temperatures. **Respondents' replies concerning the expected range of an electric vehicle on a single charge was approximately 473 km.**

To complement the image and awareness of the issue of plug-in electric vehicles provides that the costs of operating and particularly electricity consumption per 100 kilometres is about 1.3 euros (podkapotou.sk/2017) in the above model, which is a significant difference between the current consumption and cost of passing a 100km distance, either on petrol or diesel engines. It goes without saying that when selling a model electric car in the world, the range expected by the target group of respondents will not be achieved; however, many carmakers declare an early arrival of electric cars to run the system up to 500 km, and of comparable size and comfort. However, the price of these vehicles, the speed of construction and the density of fast charging stations, and so on remain questionable. It is a fact that there are now electric cars with a realistic range of around 500 km, but at an incomparable price of a new vehicle (e.g. Tesla Model S P 100D has a declared range of 613 km, acceleration of 2.6 seconds and a European price of EUR118,000). (hybrid.cz [5])

Picture 1

Nissan Leaf



Source: www.nissan.sk

Picture 2

Tesla S



Source: www.hybrid.cz

3 Confidence in autonomous car driving control

Almost all major car manufacturers such as VW, Mercedes-Benz, Tesla, BMW, Toyota etc., but also technology companies, for instance NVidia or Google (the autonomous car of which had passed already in 2015 in a row over 1.6 million kilometres without any accident) are currently intensively developing the so called “autonomous driving system = autopilot”. After an oral entering of a target destination, this system allows, fully autonomous driving of this vehicle in road traffic and thus replaces, or, later “deliberately for security reasons eliminates” a human driving to the target destination.

One of the manufacturers, which is currently a very successful brand mainly in the US, is Tesla Motors, which first officially started selling vehicles with declared “fully autonomous driving management” marked as “Tesla Autopilot”. The first state that officially permitted the driving of autonomous cars was the State of California in the USA. After a series of several published articles of collisions caused by Tesla vehicles (spontaneous car starting without the presence of the owner and causing the subsequent road traffic collision, etc.), the car producer communicated amendments of the definition of the current autonomy of the advanced driver assistance system, which is not replacing the driver in the car at 100%. They recommended paying full attention and concentration to the driver’s driving, even when the system works. After an independent analysis of “Tesla autopilot 1.0”, carried out by experts on autonomous flying control from the aircraft company Boeing, the group came to the same conclusion.

It should also be noted, that there are many videos posted on the Internet, in which there is clearly traceable and sometimes completely irresponsible, provocative and gambling behaviour of drivers in the autopilot active mode

(releasing the steering wheel on a crowded highway in speeds above 160 km/h and moving to the passenger seat in the back row, etc.).

On the other hand, it is necessary to compensate the negative partial information associated with deaths or collisions by the case, in which “Tesla autopilot” monitoring unusual physiological responses of the driver saved his life by autonomous driving to the nearest 30 km distant hospital for an acute pulmonary embolism of the driver. The vehicle stopped directly in front of the hospital and allowed medical intervention much earlier than it would be possible after the arrival of the ambulance. (Auto.sme.sk [1]).

Another case when the Tesla autopilot saved the vehicle crew at least from serious injuries, or from multiple deaths comes from the Netherlands. The Tesla system automatically generated a series of warning sounds of a possible accident on the highway in front of the vehicle at a speed of 113 km/h. The autopilot predicted correctly, a severe accident actually occurred within few seconds, and the Tesla autopilot vehicle stopped at a safe distance in front of wrecked vehicles. Splicing of many other records of active preventive interventions of Tesla autopilot can be seen in the sources listed in references. (Youtube.com, [9, 10]).

Due to the extremely high sensitivity and moral responsibility for human lives, the Tesla company (and all others), are constantly developing this comprehensive management software and try to avoid any collision situations caused by autonomous drive management. The latest version of this control system has been installed in Tesla vehicles since the beginning of January 2017. This version is generally known and called as Tesla Autopilot 2.0 among professional and public; and its official name is Tesla Enhanced Autopilot Firmware 8.0 (2.50.185) that includes hardware extension of further 8 cameras and 12 supersonic sensors (hybrid.cz [3]), which enhance the sensitivity and predictive power compared to all existing autonomous management solutions.

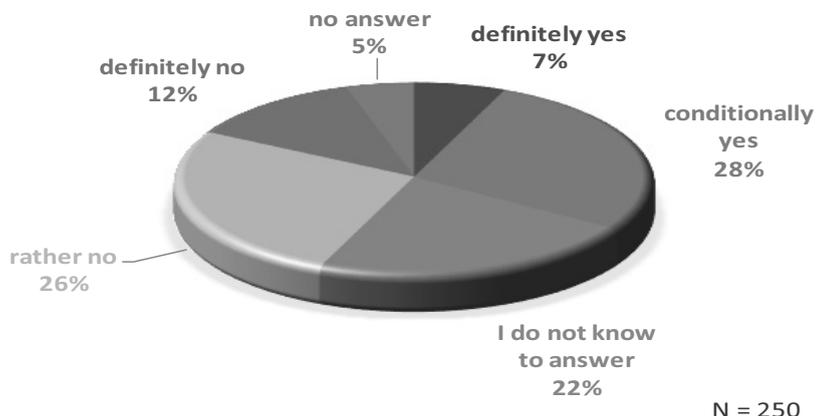
Albeit with some delay, also European automakers work intensively on the development of drive management autonomy (e.g. Mercedes Benz fairly regularly publishes its state of development and testing of its very advanced system). The Volvo company issued a press release in which it expresses the state of development of its autonomous management with a very high degree of confidence. The Volvo takes over on his side all the costs and consequences due to the potential collision caused by the operation of the Volvo car autopilot (including death).

Before showing the research results of Slovak respondents, it should be noted that the wording of the question concerning “the level of trust towards the autonomous driving” contained also a statement, that the “system would

be put on sale only with an extremely powerful computer and software tested for many years and millions of kilometres without a collision

Figure 1

Confidence in autonomous control in the car



Source: based on the results of the author’s own survey.

As can be seen from the results of the survey by Slovak respondents, there prevails a considerable caution as the share of the so-called “Early adopters”, e.g. that part of the population that would enthusiastically try this novelty immediately after launch, is still only 7 percent. On the other hand, the results can be interpreted in a positive way, whereas a further 28% of answers would buy the autopilot system after having more information, tests, real price conditions, experienced by people testing such a system in different types of traffic operations.

Picture 3

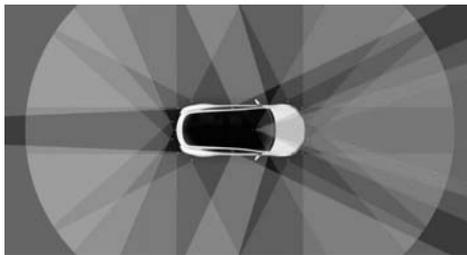
Tesla S Cockpit



Source: www.google.sk

Picture 4

Tesla S Autopilot 2.0 Sensors



Source: www.hybrid.cz

4 Interest in new forms of borrowing a car directly from the manufacturer

Several studies and calculations show that the loss of the sales value of a particular private passenger vehicle due to its gradual (annual) moral obsolescence is greater, than the costs associated with its use – fuel, service, etc. The car parameters would stay of course the same (except for natural abrasion of parts and components).

Current needs, interests and aspirations of families may be changing across time, and may be so diverse, that one particular model of car owned by this family obviously cannot satisfy all these various needs. For this reason, mainly car producers (as well as dealer networks or different types of financial institutions) prepare new delivery, loan or usage models, for the vehicles and the customers.

By such a new “producer – customer relationship model”, would be a medium or long-term contract signed NOT for the usage of a specific model, but for the pre-agreed models portfolio of the manufacturer of the car brand or brands. This means the driver and his family could have several models available, always according to the current and planned needs of the family.

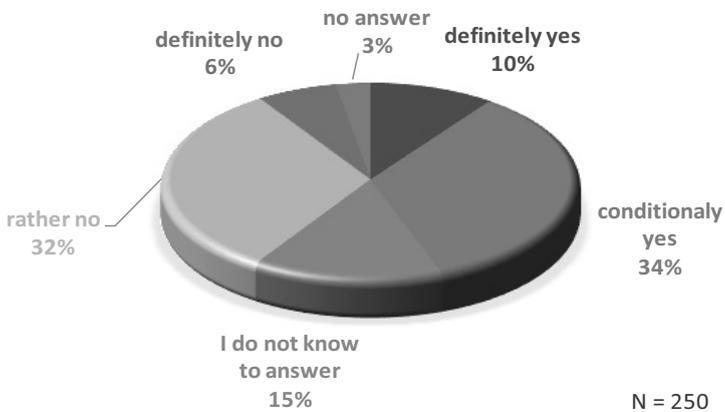
In practice, the functioning of such a flexible contract is shown in Figure 5. (Used car examples are not fully autonomous, they are not electric vehicles, the selection is just for an illustrative purpose in terms of car typology and the selection of the particular car brand does not aim to promote this car brand in any way).

For instance, during the whole week, , a regular autonomous urban electric car will be available for all the family members at an agreed time and place according to the family requirements; for example, the compact class car for the distribution of children into schools and parents into work and back. During the day, if necessary, the car would recharge itself at the programmed time, later it will pick up the children and parents and drive them back home or to any other destinations (trainings). In case of need or interest, according to the needs of families, at a certain time, for example during the weekend or for a holiday, this family will use another type of an electric car, such as large space van with seven seats for vacation, or use a sports convertible with high performance for individual relaxation.

A complete care of the car’s condition and services would be provided by the contracted company.

Figure 2

Interest in new forms of borrowing a car directly from the manufacturer



Source: based on the results of the author’s own survey.

Picture 5

A new form of car renting directly from the manufacturer

Car Producer or Dealer



Source: based on the results of the author’s own survey.

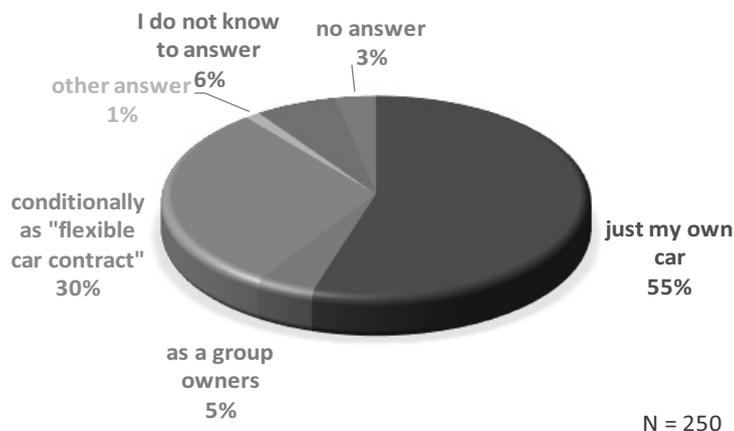
Based on the survey results, we can assume that given the modest information provided, there is currently only 10% of those who are now definitely happy with this concept. Again, we have to add the 34% of respondents who would decide for the concept, but after a closer look, and probably with more precise price conditions of such a flexible user model. We can say that almost half of respondents reacted positively to this model of cooperation, in which personal (or family) based ownership of a certain specific car model is not important, but creating a variable relationship with a specific carmaker and the use of more of its model types, according to the family or individual changing needs.

5 Interest in passenger car group ownership

“Sharing Economy” or an economy based on sharing is not a new concept, but has recently an increasing trend. Its essence is that people need to possess much less property and goods compared what they own now. Also owing to the current information technology, this property and goods owned by somebody can be used much more frequently and by others. Typical examples are the cars and real estate usage. In these cases, the mentioned car (or a flat) has its actual owner. But if possible, it is used in terms of sharing the cost of travel (and accommodation), by more users, for example, who might even not know each other. The aim is a more economical use of these resources, as the cost of transportation from point A to point B will be literally “shared” by more than one person. Equally, the property may be empty (but also the presence of its owner is probable) and by agreed terms and conditions might be used by several rental candidates as well, so again there is a sharing of the costs of its operation and maintenance. (Urban [8])

Our main intention and interest in posing the following question is related to the previous question in Chapter 4, and exploring so-called “Car proprietorship sentiment” of Slovaks. The previous case is not about a direct purchase of a specific car, but essentially about a rental contract with the manufacturer. In Figure 5, one can observe two strong, contradictory trends when a clear majority of respondents prefer “to have their own vehicle”, as part of their even emotional property); on the other hand, there is a very strong 30% large group that feels addressed by the described flexible hiring models of different car types, by an acceptable terms and conditions.

Figure 3

Interest in the passenger car group ownership

Source: based on the results of the author's own survey.

6 Conclusions and policy implications

Solely on the basis of the results and answers received from 250 respondents to several questions in this article, it is clear that the automotive industry will have to deal with such fundamental challenges and changes in the next few years, which basically so far have not existed.

These “disruptive innovations” are the most radical kind of innovations, and they will affect every element that the car is made of. If finally the engine type is based on electric, hydrogen, hybrid, air or some not yet published efficient technology is not important. Also new autonomous driving systems, car information technologies, new, lighter and stronger structural materials must be developed and implemented as soon as possible. All the above-mentioned developments have to be oriented to the most critical goal, which is the radical increase of the safety and protection of human health, since each year about 1.2 million people die in road accidents and 2.5 million are injured – these numbers do not need further comments.

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