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Understanding 5G Intelligent Transportation System on Road Transport Users: A Conceptual Framework

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Abstract

The aim of this study is to develop a conceptual framework on perceptions of the 5G Intelligent Transportation System (ITS) for road transport users among consumers in Malaysia. The conceptual framework is based on the safety, user-friendly and technology dimensions towards the adoption of 5G ITS. The development of the conceptual framework is based on reviewing previous literature that relates to the dimensions. Three propositions are established in the literature review. Once the framework is established, the actual study will be targeting those consumers that wish to implement 5G ITS. The development of the framework is based on the previous literature review that covers the scope of safety, user friendly, technology and 5G ITS relationship. The framework will be used to conduct a field study on road users in terms of levels of perceptions towards 5G ITS in Malaysia. The study provides insight into practical implications for the road transport manufacturer.

Keywords: *5G, Road Transport, Intelligent Transport System, Safety, User Friendly, Technology*

1.0 Introduction

The rationale of this paper is to develop a conceptual framework for perceptions of the 5G Intelligent Transportation System (ITS) in automobiles among consumers in Malaysia. The conceptual framework is developed through a literature review. Guidance for the literature review is based on the problem statement, research questions, research objectives, scope of the study and the importance of the study.

In the present year, the internet has grown rapidly and the development of the rise of 5G technology has been a recent hype topic which has made almost everybody talk about it. 5G

has significance to strengthen the linkage of information between substances and society's growth. By looking at the perspectives of the development of 5G technology, it is crucial to alleviate road traffic challenges in the process of urbanization and to raise awareness of information on the traffic network. It's also crucial to boost the traffic network's information growth by combining 5G technology with intelligence transportation, which is now being developed **(**Deng, 2021). The research of Guevara and Cheein (2020) mentioned that the number of private automobiles on the roads has been booming in recent years. According to Statista data, the number of the forecasted sales volume of all the automobiles in Klang Valley, Malaysia is predicted to double their number of users between 2021 and 2025 (see Figure 1). Figure 1 supports a study from Nawi et. al (2013) that Malaysians have a great demand for vehicles.

Figure 1: Forecasted Sales Volume of all Vehicles in Klang Valley, Malaysia from 2021 to 2025 (in units) ***Source: Statista.com (2021)***

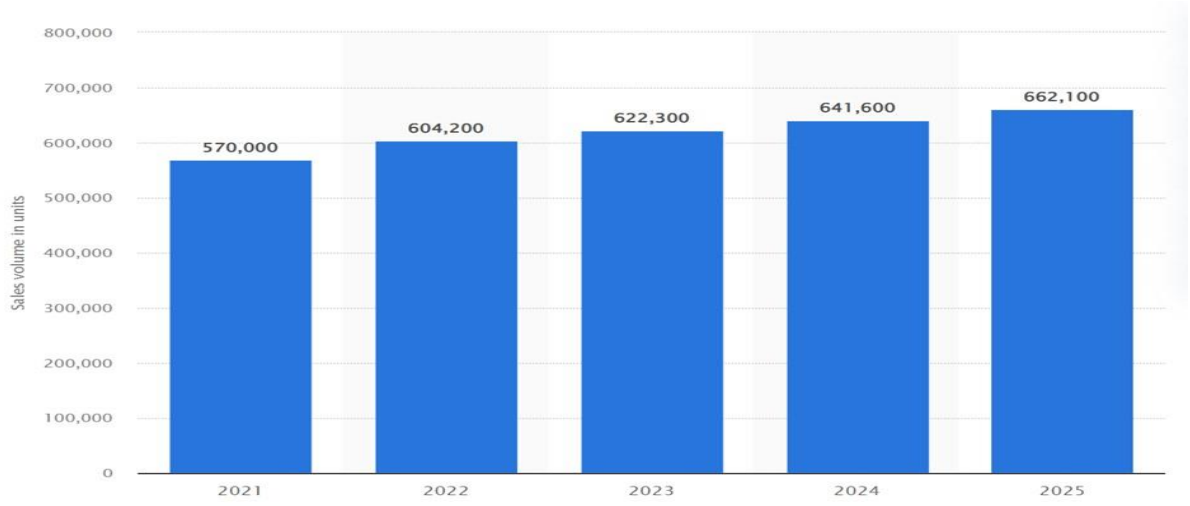


Figure 1 shows the forecasted sales volume of all automobiles in Klang Valley that are expected to gradually increase from years 2021 to 2025. In 2021, the total automobile sales are expected to reach 662 thousand units. In 2020, around 529 thousand automobiles were sold, meaning that the automotive market will increase vehicle sales by 8% overall in 2021. It is obvious that there is a trend of more and more people purchasing automobiles in the next 5 years. This means that through the years there will be more advanced vehicles such as 5G will be launched. It is also commonly assumed that connectivity would be a critical supporting technology for autonomous driving (Miucic, 2019).

Due to the high sales volume of automobiles, serious issues will be faced by drivers such as the rising number of fatalities caused by traffic accidents. Therefore, Intelligent Transportation Systems (ITS) are crucial in applying ICT to tackle transportation problems (Mylonas et. al, 2020), to emphasize applications that have the potential to increase safety, fuel efficiency, traffic efficiency, and riding comfort. In other words, riding comfort also refers to the user friendly in terms of operation of the automobile (Tokody & Mezei, 2017). Modern 5G-enabled Intelligent Transportation System (ITS) offers end users comfort and safety by utilizing numerous models and methodologies, the majority of which are based on machine learning-based techniques (Sirohi et. al, 2020).

A modern automobile has evolved into a sensor platform that gathers information from its surroundings. To be specific, the sensor platform refers to the technology that uses 5G. The data is processed by an onboard computer, which is then used for navigation, pollution control, and traffic management, among other things. Quick data processing involves the utilization of a powerful onboard computer. This is why luxury cars with advanced driver-aid systems are so pricey. To avoid the need for costly equipment, data should be able to be sent to the cloud through the internet to complete huge processing operations.

As a result, in addition to the data already acquired by autos, the Internet of Things (IoT) can aid in the collection of additional data for traffic management centres. With this premise, the Vehicular Cloud Computing paradigm provides a tough context to evaluate future 5G capabilities (Ge et. al, 2017). To be interpreted, if the 5G network can become more common, apply in the automobile industry. Hence, every citizen in Malaysia can experience the benefits that are brought by the 5G ITS system. On the contrary, if the 5G network is still not widely used in Malaysia Valley, Malaysia. Then only very few users can experience the benefits brought by the 5G ITS system. Those small ranges of users will be forced to enjoy the benefit by paying a high price.

1.1 Research Problem

Nowadays, countries such as China, South Korea and the United States have adopted and implemented 5G in their daily life, especially ITS. 5G offers at least one gigabit per second for connection speeds, a shorter delay than the 5G technology and a millimetre-wave (mmW) band for supporting applications requiring large capacity. However, Malaysia is still stopping at the 4G technology, which is one step slower than the first county. The adoption of using 5G ITS is still unfamiliar to the public, especially the potential user. Thus, the primary purpose of this empirical research study is to provide insight into consumer perceptions towards adopting 5G ITS system automobiles in Malaysia, whereby it would enlighten the industry players to select the right paths and tasks in future work performance in the automobile market. Road traffic challenges and traffic accidents are the main issues among automobile users in Malaysia.

Majority of automobile users are looking forward to solving these issues (Deng, 2021). The reason they want to enable 5G in automobiles is because it can reduce traffic accidents and optimize road maintenance. Additionally, road safety and maintenance can be improved by enabling the 5G network. For example, the services can enhance data on weather by image-based recognition such as snowing, heavy rain and strong wind situations. Besides that, the sensor data will also be able to detect icy and slippery roads.

In the case of consumers in Malaysia, there is a potential future study on how their perceptions towards the 5G ITS. Hence, enabling the 5G network can help academicians to study the safety, user-friendly and technology from the perceptions of Malaysian consumers. The data may enhance road safety and prevent road accidents. Furthermore, safety control and low latency are used in increasing the safety of autonomous driving. The theory of Reasoned Action (TRA) is used as a guide for developing the conceptual framework **(**Azjen & Fishbein, 1977). From the above background of the study, a proposed research question is developed: Do safety, user-friendly and technological dimensions influence the perceptions of 5G Intelligent Transportation Systems (ITS) in automobiles among consumers?

2.0 Literature Review

2.1 The Theory of Reasoned Action (TRA)

The Theory of Reasoned Action or TRA is used as an underpinning theory. It defines the links between the beliefs, attitudes, norms, intentions, and behaviour of the individual (Montaño & Kasprzyk, 2015). According to this model, a person's behaviour is determined by the person's attitudes and subjective norms towards the behaviour. TRA has 4 key concepts which are attitude, subjective norm, behaviour intention and behaviour. To be interpreted, when doing an intentional action, a person's behaviour intention (BI) is directly impacted by that person's attitudes (PA) and social norms (SN) concerning that conduct (BI= A+SN) (Goldenhar & Connell, 1992).

Based on TRA theory, attitude is defined as a person's positive or negative feelings about performing a specific behaviour. To be interpreted, an individual's attitude is characterized by their perspectives on the results or attributes of executing the behaviour, as weighted by assessments of those outcomes **(**Montaño & Kasprzyk, 2015). An individual who has strong ideas that the behaviour in issue will result in positively valued results will have a favourable attitude toward the behaviour. A person with strong beliefs that negatively valued results would arise from their behaviour, on the other hand, will have a negative attitude. Subjective norm is defined as beliefs about what others will think about the behaviour. A positive subjective norm is held by someone who believes that certain referents expect him or her to do a certain behaviour and is motivated to meet those expectations. Furthermore, behaviour intention can be defined as "an individual's perceived probability of performing a specific behaviour.". Next, behaviour can be defined by four components which are action, target, context, and time.

The TRA's goal is to identify an individual's conduct by considering the influence of personal feelings and perceived social pressure. Furthermore, the TRA may be used to better understand the factors that influence human behaviour in circumstances when people have a choice (Chang et. al, 2009). Therefore, it is important to imply The TRA to this study as it shows the level of the intention of the targeted population, explains the cause of the actual specific behaviour including both inside and outside factors and the reason for the change behaviour. On the other hand, TRA also has disadvantages which are cognitive deliberation, misinterpretation of survey results and moral factors. To be interpreted, the misinterpretation of survey results is possibly due to attitudes and the intention of respondents. One of the most crucial disadvantages of TRA is the issue of the usage of voluntariness. For instance, the researcher asks the respondent to fill in the questionnaire. The respondent is not interested in the topic, so the respondent will just simply fill in the questionnaire and thus the result will be not accurate (Taherdoost, 2018).

As TRA is a theoretical reference with the goal of understanding and predicting human behaviour, its application can occur in a variety of fields of knowledge, including the deployment of 5G ITS. Meanwhile, 5G ITS automobile is a field of knowledge in which the knowledge created reverts to human safety. As a result, the profession must do research to discover the determinants and causes of specific behaviours to develop intervention techniques backed up by consistent theoretical models that promote technological adherence to 5G (de Sousa et. al, 2018). This is because TRA has been used widely as a theoretical framework to study human behaviours regarding the use of information and communication technology (Buabeng-Andoh, 2018). Hence, we can get more understanding of why some people intend to adopt 5G and why some will not toward it.

TRA can be developed to comprehend human behavioural patterns in decision-making strategies and eventually to build ICT applications such as 5G networks (Shareef et. al, 2013). The key element of the perception of 5G networks in ITS automobiles is to raise awareness among potential users. To be illustrated, the end user gets to know the application of innovation, key factors, issues, fundamental paradigms of the 5G system and the system's overall degree of safety. According to Parikh and Basu (2020), the Internet of Things (IoT) network will be supported by huge Machine Type Communication (MTC). They also stated that traffic handled by 5G, which will also offer a much-improved performance for traditional voice, data, and video applications.

2.2 Safety, User Friendly and Technology Dimensions

The society may be partially or completely aware of ICT's strategic function. Awareness provides prospective users with tools to build hints, notions, or subjective beliefs about the experiences. Based on the theory of reasoned action (TRA), the belief of consumers will affect their attitude toward using 5G ITS automobiles. Thus, the awareness of knowing the 5G ITS automobile is crucial at the initial stage of developing a consumer's belief. By applying the TRA to this study, a conceptual framework is developed to associate the dimensions which include safety factors, user-friendly factors, and technology factors for the perception to adopt 5G ITS automobiles, since awareness is the main factor of creating belief (Narasimha & Pinheiro, 2020).

For the safety dimension, this paper suggests the TRA. This is because there are many hidden safety hazards in automobiles due to an absence of suitable 5G and ITS knowledge, thus this has led to the happening of road accidents (Zhu et. al, 2022). Thus, by applying TRA this paper can gain more understanding of the perception of consumers to adopt 5G ITS toward safety dimension in automobiles. In future, a field study can select respondents who are willing to adopt 5G in association with safety.

In the context of the user-friendly dimension, the application of TRA will associate users with obtaining a great deal of information about adopting 5G ITS in automobiles. Thus, it will concurrently increase the user satisfaction level and boost their intention to adopt 5G ITS in automobiles (Rehman et. al, 2019). Furthermore, for the technology dimension, the TRA is associated with technology which can bring convenience to automobile users. For example, some technologies related to 5G in transport are automated driving, intelligent navigation, road safety and traffic efficiency service. Therefore, it is essential to know the perception of respondents toward 5G ITS in automobiles (Gohar & Nencioni, 2021).

2.3 Proposition Development

2.3.1 Safety Dimension

Based on a study by Yu et. al (2021), the real-time reliability and accuracy of autopilot control should be increased to ensure the safety of the mixed traffic system. Hence, automatic recognition of manual automobiles can minimize the chances for drivers of being involved in road accidents, especially during mixed traffic (Zhou et. al, 2020). Furthermore, based on research done by Zhang et. al (2020), clearly mentioned that data-driven ITS has seen significant use of AI-based techniques and deep learning models to enhance the degree of safety and security. The reason is that artificial intelligence (Al) techniques can increase the real-time reliability and precision of autopilot control although ITS data and deep learning techniques

are still in numerous ground-breaking works. However, the research team still needs to pour in more effort to conduct more experiments in terms of increasing the level of safety in ITS applications.

Berndt et al. (2008) proposed that the intention inference mechanism can identify the driver's intention and decrease the chances of dangerous accidents while the automobile is moving. Li et. al (2016) have explored the brake intent recognition formed on fuzzy inferences through various characteristics. Based on their findings, the results show that the braking intent model may be recognized with a high level of accuracy and reliability. Lei and Liu further explained that braking intentions can enhance the safety of an automobile's driver.

According to Amsalu et. al (2015), an automobile innovation can avoid collision with another automobile by being able to detect approaching vehicles in the intersection road. In short, the combination of 5G and ITS is still in the developing stage. Hence, it will cause some issues such as lack of safety and insufficient real-time effects in ITS. Thus, it is a must to enhance the safety factor and real-time performance of ITS (Yu et. al, 2021). Therefore, the first proposition for the conceptual framework is intended to mitigate the above research gap about the perceptions of 5G ITS in automobiles. The proposed proposition is:

There is a positive relationship between safety and perception of 5G Intelligent Transportation Systems (ITS) in automobiles among consumers in Malaysia.

2.3.2 User-Friendly Dimension

As stated by Akour (2010) in his research, user-friendly refers to the user's ability to use 5G technology and specifically to use 5G ITS among automobiles. Moreover, another researcher stated that automobile users are more willing to try new technology when they feel that they are skilful enough and capable of using the service or device (see Osakwe et. al, 2017; Al-Khayyal et. al, 2020). According to Venkatesh et al (2003), the term “user friendly ” refers to how much the user trusts the technology such as 5G can improve their performance. This term can be supported by another study. A study from Davis (1989), explained that the extent to which a person thinks adopting a particular technology would be effortless. Meanwhile, Wang et. al (2014) has also defined that UFF means the simplicity of use is crucial in the early stages of technology practices as users are expected to pour in some effort to use the technology. In other words, the user can enjoy 5G technology effortlessly.

Several literature sources have disclosed that intelligent navigation applications can make users feel easier and effortless by using 5G ITS automobiles. The Waze, Google Maps and Maps.Me are examples of currently existing intelligent mobile applications that can make the driver feel effortless. To be interpreted, automobile drivers can receive notifications with personalized information regarding their interest points, such as parking places, gas stations, restaurants, theme parks and others (Tamma et. al, 2018). In addition, drivers will receive navigational assistance from autonomous vehicles using digital maps and geo-positioning. This can be seen by selecting the best routes based on real-time traffic information available online, these guiding services increase driving efficiency and bring convenience to the driver.

The information would be generated by using data from nearby vehicles, local road infrastructure, or traffic management infrastructure. In other words, all these can be known as vehicle-to-everything (V2X). With the help of 5G, more usable data will be gathered because of the IoT and big data. Since they will enable the delivery of more value-added services and complete the navigation (Amer et. al, 2019; Handte et. al, 2016; Flügge, 2017). In short, the

intelligent mobile application is easy to use, and it will bring convenience to drivers while using this technology. Hence, it will make the driver feel effortless and a user-friendly can be achieved in terms of ITS. With that, this paper is intended to mitigate the research gap to examine the perception of 5G ITS in automobiles. Thus, the proposed following proposition is developed:

There is a positive relationship between the user-friendly and perception of 5G Intelligent Transportation Systems (ITS) in automobiles among consumers in Malaysia.

2.3.3 Technology Dimension

Based on Yu et. al (2021), there are six main subsystems based on the traffic architecture of the mixture of autonomous and manual automobiles. The six subsystems are 5G networks, intelligent traffic management system, data collection system, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V21) communication system and global positioning system (GPS). Furthermore, Zhou et. al (2021) found that the 5G network is capable of ensuring mixed traffic system security, privacy, real-time communication, smooth network transitions, and other service needs.

Additionally, Yu et. al (2021) also mentioned that 5G technology enables three other important capabilities. One of the capabilities is 5G technology to ensure V2V communication can be directly communicated between short-range devices. When a vehicle in front decided to make a sudden turn. Then, the vehicle behind it can detect the turn signal sent from it. Thus, the control system of the vehicle behind can respond immediately and have enough time to slow down the vehicle itself. The researcher, Yu believed that short-range data exchanges within V2V will be more common in the driverless era. Benefits such as reducing average latency and overall stress on the network can be achieved once the implementation of autonomous communication between V2V is successful. Next, 5G networks also act as a crucial role in V2I communication. For instance, infrastructures include bus stops, traffic lights, roads, and others. By using the connection, it can reduce the chances of traffic accidents occurring, improve traffic flow, and increase vehicle response time. Another capability is 5G networks can help the intelligent traffic management system to transmit all the important data in a traffic system at a higher speed and low latency (Zhou et. al, 2021).

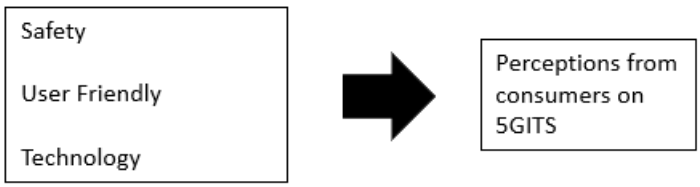
According to Guevara and Cheein (2020), the findings of their research showed that there are different levels of autonomous driving. The level can be categorized into 6 different levels, which have been recognized by the Society of Automotive Engineers (SAE). The 6 different levels can be further explained by Skeete (2018), which are no automation (level 0), driver assistance (level 1), partial automation (level 2), conditional automation (level 3), high automation (level 4) and full automation (level 5). In short, which are starting from no automation to full automation.

Shahzad and Zak (2016) mentioned that autonomous driving can still function without the help of vehicles-to-everything (V2X) in principle. On the contrary, Marletto (2019) stated that autonomous driving is impossible without V2X communication. To further explain, uncertainty is a must to be considered because it cannot be assured what will happen within the next seconds. For example, the automobile's driver cannot predict what will be done by a pedestrian or vehicle next. To reduce uncertainty, it is necessary for all vehicles to share their available information. Hence, autonomous driving can be resulting in receiving benefits from local communication V2V, preventing collision between vehicles, and reacting faster to manoeuvres. Thus, the proposed proposition is:

There is a positive relationship between technology and perception of 5G Intelligent Transportation System (ITS) in automobiles among consumers in Malaysia.

These three propositions are thus used to develop the conceptual framework (see Figure 2).

Figure 2: The Proposed Conceptual Framework



3.0 Research Methodology

The methodology used for this paper consists of a library search and evaluation of previous literature reviews about 5G ITS and consumer perceptions. The library search encompasses online materials articles journals and book chapters. References are based on online databases such as Web of Science, Scopus, Science Direct and Google Scholar. References are only taken from articles from journals, chapters from a book and full-text documents. The 5G ITS references are not restricted to the Malaysian perspective but also taking into consideration global 5G ITS progress from 2017 to 2022.

4.0 Discussion

The development of the literature review will provide some insights for society, academicians as well as transport planners to assimilate the application of 5G ITS in Malaysia. In addition, it helps the automobile industries further improve on the 5G development in automobiles which will affect the perception rate among consumers. Furthermore, it also provides benefits to the broader public, notably automobile investors. Within the scope of safety, user friendly and technology dimensions, they can get to know whether these dimensions influence the end users to adopt 5G ITS in automobiles. The findings of future field research will help the researchers to uncover any critical area in the 5G ITS in automobiles, especially for the perceptions of consumers.

From the development of the literature review, an operational definition is developed from the propositions:

5G - The 5G network is the 5th generation mobile phone action standard. In other words, 5G network also refers to 5th generation mobile communication technology. The 5G network is powerful as it has core competencies. Low network latency and fast transmission speed are the main characteristics of the 5G network**.**

Intelligent Transportation System (ITS) - The Intelligent Transportation System (ITS) is an advanced transport management and service system that intends to deliver new transportation management services. The most notable characteristic of ITS is that it mixes high technology

and advancements in information systems, communication, sensors, controllers, and complex mathematical approaches with the traditional world of transportation infrastructure.

Automobile - Automobiles refer to a product that requires fossil fuel to operate. The number of automobiles is rising rapidly in developing countries in Asia. Gasoline hybrid electric vehicles and pure battery electric vehicles are examples of automobiles.

Safety Dimension - Safety Dimension refers to the ratio of effective and reliable measurement in terms of traffic monitoring, management, and control to prevent traffic accidents that happen on the road. It also measures pedestrian safety by altering the driver to pedestrians in a crosswalk.

User-Friendly Dimension - User–Friendly Dimension explains the individual could benefit from the 5G advanced ITS in terms of friendly and easy operation toward the automobile. The user can freely operate the automobile without any hassle due to the advanced technology system like vehicle platooning, remote driving and advanced driving.

Technology Dimension - Technology Dimension is the application of 5G network. It can upload traffic accident information in a real-time manner. One of the technology systems which is the traffic command centre can re-generation and release new information to automobile users. Vehicles can avoid traffic jams and shorten travelling time due to technology.

5.0 Conclusion

The primary purpose of this paper is to review the theory that previous related studies to develop a comprehensive literature review. Safety, user friendly and technology are the selected dimensions used to support the literature review. Furthermore, the propositions have been incorporated into the conceptual framework. The content of this paper does consist of a list of articles that have been explained or summarized. In future, a strong literature review will demonstrate synthesis and area understanding. It contributes to the development of future knowledge of intellectual capacity and practical skills.

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