

Park, Jiyou; Nam, Changi; Kim, Hye-jin; Kim, Seongcheol

Conference Paper

What are the relative importance of smart car utilities from consumer perspective and who will lead them?

22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Park, Jiyou; Nam, Changi; Kim, Hye-jin; Kim, Seongcheol (2018) : What are the relative importance of smart car utilities from consumer perspective and who will lead them?, 22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/190334>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

What are the relative importance of smart car utilities from consumer perspective and who will lead them?

Jiyoun Park¹, Changi Nam², Hye-jin Kim³, Seongcheol Kim⁴

Abstract

The long-standing signification of car is expected to accompany a big change, which results in the concept of smart car that can not only improve traffic safety by driving and controlling themselves like robots, but also entertain passengers and support their productive activities through connection to the Internet. Many related companies are seeking to enter the smart car market to take a leadership in the growing smart car market. While there are some researches regarding advanced technologies regarding smart car, there are relatively few efforts that focus on the standpoint of market demand. This study thus aims to understand customer value on upcoming smart car through evaluating the relative importance of idiosyncratic key services of smart car based on analytic hierarchy process analysis. In addition, this paper also evaluates firms and industries that are expected to perform well the preferred services through expert survey. The results show that the most important service is driving assistance, followed by infotainment, and IoT hub. Furthermore, Samsung Electronics ranked the highest, followed by Hyundai Motor, Naver, and SKT. In terms of industries, the rank is in the order of IT equipment manufacturers, platform providers, automobile manufacturers, and network providers.

¹ Department of Business and Technology Management, Korea Advanced Institute of Science and Technology, Korea, N22, 291 Daehak-ro, Yuseong-gu, Daejeon 305-701, Republic of Korea (jeeyunpkr@kaist.ac.kr)

² Department of Business and Technology Management, Korea Advanced Institute of Science and Technology, Korea, N22, 291 Daehak-ro, Yuseong-gu, Daejeon 305-701, Republic of Korea (cgnam@kaist.ac.kr)

³ Department of Business and Technology Management, Korea Advanced Institute of Science and Technology, Korea, N22, 291 Daehak-ro, Yuseong-gu, Daejeon 305-701, Republic of Korea (hyejinkim@kaist.ac.kr)

⁴ School of Media and Communication, Korea University, Korea, 145, Anam-dong, Seongbuk-gu, Seoul 136-701, Republic of Korea (hiddentrees@korea.ac.kr)

This analysis could help companies diagnose their capabilities and recognize their strengths and weaknesses.

1. Introduction

Traditionally car has been recognized as a mean of transportation to support movement of human-beings. This long-standing signification of car is expected to accompany a big change (Aoyama, 2012; Buckl et al., 2012; Mitchell, Borroni-Bird, & Burns, 2010). The change is taking place in every aspect of car such as driving mode, power source and usage pattern resulting in a new imagination of future car which is explained as autonomous, connected, electric and shared (ACES) vehicle by McCarthy & O’Keeffe (2016) and Underwood (2014) and as shared autonomous electric vehicles (SAEVs) by Collie, Rose, Choraria & Wegscheider (2017). Following the introduction of this kind of new concept car, some related studies name this future car as ‘smart car’ and describe it as car that can not only improve traffic safety by driving and controlling themselves like robots, but also entertain passengers and support their productive activities through connection to the Internet (Huang, Chen, Chou, Hwang, & Lee, 2016; James, 2012; Y. Zhou et al., 2013). In this regard, introduction of smart car is “compelling us to reimagine how transport is delivered and promising a new era of safe, secure, and enjoyable transport” (McCarthy and O’Keeffe, 2016).

In the era of the smart car, automobile will be equipped with state-of-art technologies over autonomous driving, electric battery, artificial intelligence and internet connection (Huang, Chen, Chou, Hwang, & Lee, 2016; James, 2012; Wang, Zeng, & Yang, 2006). Although these functions are partially realized in the present, this study is conducted based on the future state when they are fully realized. In particular, autonomous driving without any driver’s intervention and vehicle connectivity with the large amount of real time data will be reality in the future. Based on these sophisticated future technologies, smart cars will be equipped with various functions, and this study focuses on the ones that customers directly use and benefit from them in order to investigate the market aspects of smart car.

As automobile evolve into smart car and embrace various related technological fields,

not only traditional automobile manufacturing and developing companies, but companies from other related fields including new entrants are competing one another to take a leadership in the smart car market. Since the technology of various fields such as machinery, Information and Technology (IT), and operating system is combined, companies involved in those technology groups are entering smart car industry through expanding their fields. For instance, a traditional vehicle manufacturing company, Hyundai announced to reform itself to Information Technology (IT) firm. BMW and Daimler also agreed to cooperate together on IT field, recognizing its importance in the upcoming vehicle model. IT and platform companies are, on the other hand, heading toward automobile field. For instance, Samsung embarked on automobile hardware device field; Apple and Google have been applying patents on automobile field and developing Apple and Google car separately. Moreover, new entrant, Tesla, founded by Elon Musk with no experience in automobile but in IT and aerospace, boosted automobile industry's transition toward smart car.

While various related companies are introducing advanced technologies and concepts to realize smart car, there are relatively few researches and efforts that focus on analyzing smart car from the standpoint of market demand. Technology-oriented development should be accompanied by market-oriented studies to become finally successful in the market (S.-E. Lee, Choi, & Kim, 2017; Wind & Mahajan, 1997). Focusing on customers and satisfying them is important (Drucker, 1954), especially in new product development (Salomo, Steinhoff, & Trommsdorff, 2003). Understanding customer can not only improve financial performance (Narver & Slater, 1990), but it can also result in competitive advantage through delivering superior customer value (Woodruff, 1997).

This study thus aims to understand customer value on upcoming smart car through evaluating the relative importance of idiosyncratic key services which can be provided by smart car to its customers. First, categorizing functions developed to be newly equipped with smart car, this paper measures consumer's preference over idiosyncratic functions of smart car based on analytic hierarchy process (AHP) analysis. Next, the paper evaluates firms and industries that are expected to perform well preferred functions through expert survey.

The remaining part of this paper is organized as follows. Section two discusses research

background and literature survey to develop research questions, and the explanation of research model is section three. Section four analyzes the relative importance of key functions from customer perspective, and evaluating possible leading firms and industries is in section five. Finally, conclusion is in section six.

2. Research Background and Literature Survey

2.1 Conceptualizing smart car

The common lexicon for future cars is autonomous and connected (CAR, 2017; IEEE, 2018). Telefonica (2014) forecasts that 90% of new cars will be connected by 2020. ITSJPO (n.d.) of United States of Department of Transportation (USDOT) describes connected car as a life-saving automobile that shares information with other vehicles, roads, infrastructure, and devices to enhance the safety of driving. Foley & Lardner LLP (2017) explains that communication-enabling sensors support this communication. And CAAT (n.d.) categorizes communication types into vehicle to infrastructure, vehicle, the cloud, pedestrian and everything. All of them encompass autonomous and connected attributes; however, their meaning represents that autonomous driving is one of the properties obtained through connectivity. Moreover, the technical studies on smart car establish connectivity attribute as a *fait accompli* (Kong, Kim, & Hong, 2016; Lajmi, Kammoun, & Alimi, 2015; Satam, Pacheco, Hariri, & Horani, 2017). In this sense, we assume connected car as a superordinate concept of autonomous driving and thus simply define smart car as connected car. Since connected car shows different functions depending on the connected target; we divided these functions into three categories of driving assistance, infotainment, and Internet of Things (IoT) Hub as shown in Table 1.

First, driving assistance function implies intrinsic role of automobile to support movement and driving. Connected to all the constituents of traffic system such as vehicles, pedestrians, obstacles, and traffic infrastructure, smart car can recognize surrounding subjects and traffic signal, properly recognize stop and acceleration point and carry them out by itself (Chen et al., 2017; Gora & Rüb, 2016). This function is expected to carry benefits of safe driving, efficient driving and accident prevention (Siemens, 2015).

Second, infotainment function refers to the automobile’s ability to enhance the comfort and enjoyment of passengers while driving. Connected to the Internet and the cloud, passengers can instantly utilize diverse services or search information (Amadeo, Campolo, & Molinaro, 2012; J. Kim, Kim, & Nam, 2016). Moreover, connectivity with passengers based on artificial intelligence allows smart car to communicate with passengers (Gkikas, 2016). Smart car can communicate with passengers to recognize and execute commands and it can also support passengers to experience various services such as watching movies, working with documents and managing financial activities, thereby improving enjoyment and convenience of time spent in the car.

Third, IoT Hub function represents linkage between automobile and existing IoT system to utilize embedded services through controlling the system in the car (He, Yan, & Da Xu, 2014; I. Lee & Lee, 2015). Connected to existing IoT hub and devices, smart car will improve the quality of life for passengers. It can remotely control and manage devices at work or home, and monitor itself and besides passengers.

Table 1. Definition of smart car

Major Connectivity	Function	Explanation	Benefit
V2Vehicle V2Pedestrian V2Infastructure V2Everything	Driving Assistance	- supporting movement and driving	- safe driving, efficient driving and accident prevention
V2Cloud V2Driver	Infotainment	- enhancing the comfort and enjoyment of movement	- experiencing various services during the most of time spent in the car
V2Device V2Home and Office	IoT Hub	- utilizing embedded services of existing IoT system	- improving quality of life by remotely controlling device

			at work or home
--	--	--	-----------------

* V2 stands for Vehicle to

2.2 Customer's perspective of smart car market

Importance of understanding new market from customer perspective has long been emphasized. Business profitability shows positive relationship with market orientation (Kohli & Jaworski, 1990; Narver & Slater, 1990), which specifically indicates necessity to understand customer, to provide better value accordingly, and to satisfy them (Day, 1998; Jaworski, Kohli, & Sahay, 2000; Slater & Narver, 1999). Understanding customer perspective is emphasized especially in new product development (Gaynor, 1990), because it determines success or failure (R. G. Cooper & Kleinschmidt, 1987) and establishes superiority of the new product (Maidique & Zirger, 1985). In this sense, several new product development studies focused on discovering customer needs (Bonner, 2010; Lau, 2011; Salomo et al., 2003).

Automobile is commonly manufactured by companies and sold in the market to general consumers. Since the intrinsic purpose of company is to make a profit in general (R. Cooper & Kaplan, 1991; Magretta, 2002), they manufacture automobiles, develop technologies, and plan advanced models in order to make profit (Sisodia, Wolfe, & Sheth, 2003; Zott & Amit, 2008). For profitable operation of company, these activities should be designed to secure marketability by attracting customer selection (Krasnikov, Jayachandran, & Kumar, 2009). Therefore, up until now in in the existing automobile industry, a number of social science research have been actively conducted to understand the market. For instance, some automobile attributes which were considered to be related to customer purchase decision were explored by Byun (2001) . He arranged the process and factors composing customer's vehicle purchase decision and analyzed the background for selecting specific vehicle model in the actual market. In addition, factors affecting automobile market demand were analyzed in order to form adequate market strategies and increase marketability by several studies (Fantazzini & Toktamysova, 2015; Korenok, Hoffer, & Millner, 2010; Löffler & Decker, 2012; Pauwels, Silva-Risso, Srinivasan, & Hanssens, 2004).

However, in the upcoming smart car research, only technical field has been actively considered such as smart car hardware to support autonomous and enjoyable driving (Broggi et al., 2013; Isenberg, Goebel, & Baumgarten, 2012), and software installed not only inside the vehicle to support smart operation (Mammeri, Zhou, Boukerche, & Almulla, 2014; Ruiz, Juez, Schleiss, & Weiss, 2015) but also outside the vehicle to support communication (Hansini, Elizabeth, Hemapriya, & Kavitha, 2016). And thus, in this paper we recognize the necessity of understanding smart car market on the basis of customer's perception. Customer analysis can support forecasting and planning promising technologies through understanding customer satisfaction (Noh, Song, & Lee, 2016) as well as planning technology that meet customer's future needs (Ju & Sohn, 2015). In this sense, we try to add a meaningful implication to provide the direction of developing future technology for the successful introduction of smart car in the market by analyzing what kind of future smart car technology should be needed to cope with customer's requirements in the market.

2.3 Research questions

Even though smart car is introduced in the market with advanced technologies, generating revenues in the market is not guaranteed unless it is marketable. Understanding customers is, therefore, necessary to improve marketability of smart car, and this study attempts to understand customers through analyzing utilities that they desire to enjoy through smart car, which would guide how smart car should evolve. Moreover, this paper evaluates how participating firms in smart car business are expected to well realize utilities based on expert's perception, which could provide relative ranking among participating firms by the way of integration with customer's perception of various utilities of smart car attributes. This study thus raises two research questions.

- 1) What are the customer utilities of the key services of smart car?
- 2) Who will fit better to realize the key utilities among participating companies?

First, we will investigate customer needs for smart car. In detail, preferred services and degree of the preference will be analyzed. This study restricts the research scope to services provided through technologies embedded in smart cars rather than smart car

technologies themselves in order to focus on customer preference on benefits they enjoy through smart cars. Thus, we summarize idiosyncratic services provided through smart car in AHP model and conduct customer survey accordingly. Since customers will actually select and utilize smart cars, customer survey investigating their utilities is suitable to judge key services they want to enjoy.

Secondly, we will try to predict which participating firm could become a leading company in the future smart car market by deriving companies that are expected to well realize the key utilities. Since this requires technical understanding of the smart car and related companies, expert survey is conducted.

3. Research Model

3.1 Analytic hierarchy process model

Analytic hierarchy process (AHP) is a technique for organizing decision-making process that forms hierarchical structure (Saaty, 1980). It can capture intuition of evaluators through pairwise comparison (Y. Lee & Kozar, 2006), thereby measuring relative importance and priority weights (Álvarez, Moreno, & Mataix, 2013). Weight is measured through comparison between the elements in the same level and the final weight can be obtained through multiplying the weights obtained at each of the upper and lower level⁵. In many literatures, AHP is used in measuring priorities over market choices. For

⁵ For example, if we compare three factors in the same layer pairwise, there are three pairs of comparison (${}_3C_2=3$). Survey respondents mark from 1 to 9 in either direction considering the relative importance of factor A or B. The example of survey question is as follows;

Please read the conceptual definition of each factor, and check the one you prefer when choosing smart car. 1 means two factors are equally important, 3 means slightly more important, 5 means important, 7 means more important, and 9 means most important.

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		
Factor A																			Factor B

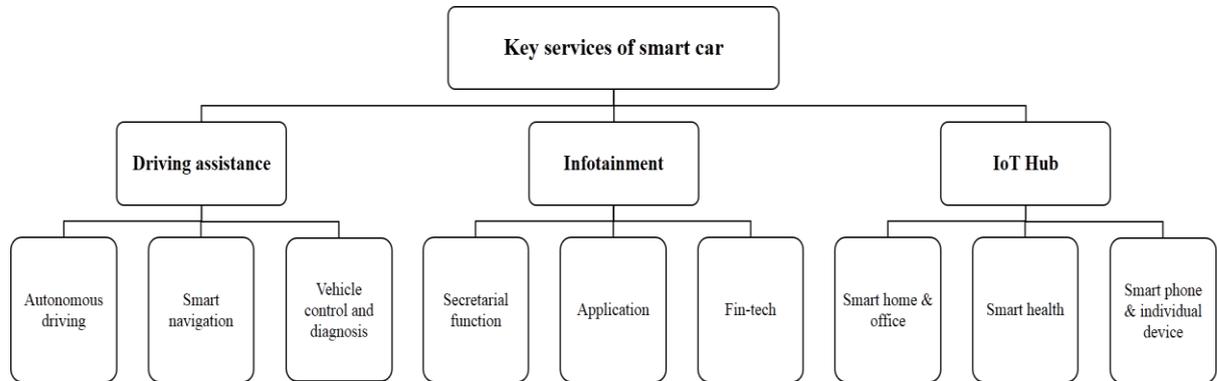
instance, Vargas and Saaty (1981) analyze whether it is better to buy and capitalize or to lease the goods that the company needs. Structuring various economic and noneconomic factors affecting purchase decision through AHP structure, they try to find out the best purchase solution. Bahmani et al. (1986) organize the hierarchy of complicated and diverse criteria that customers worry about choosing airline. This study also uses AHP methodology to predict customer's airline choice behavior based on the investigation of customer's preferences on decision criteria.

In applying AHP to the case of smart car, it should be addressed first what kind of elements should be placed in hierarchical structure. This study only considers utilities that are added as car evolves into smart car, and therefore instead of the smart car body itself⁶, it concentrates on the utilities that are mounted on smart car. Smart car, defined as connected car, provides various utilities depending on where it is connected to, this study has largely divided utilities into three categories based on the connected targets. Since this study is focusing on what kinds of smart car utilities should be delivered in the future, it excludes functions that were traditionally installed in the automobile. More specifically, it organizes utilities expected to be provided additionally as the car evolves into smart car, and investigates the customer preference over them based on the AHP model.

This study proposes AHP model of key utilities of smart car in two levels. Each element of the model should be independent and more specific as hierarchy gets lower. Thus, the first level is composed of the major utilities provided by smart car to customers and the second level is composed of sub-utilities that make up each major ones. Major idiosyncratic utilities of smart car and their subordinates are shown in Figure 1. The first level is composed of driving assistance, infotainment, and IoT hub. In the second level, nine subordinate functions are organized under each major function: autonomous driving, smart navigation, vehicle control and diagnosis, secretarial function, application, Fin-tech, smart home and office, smart health and smart phone and individual device.

⁶ This study assumes that smart car is well manufactured such that technical features are well materialized, transmission speed of the connectivity is stabilized, and security technology is advanced enough.

Figure 1. AHP model for key services of smart car



3.1.1. Driving Assistance

The smart car implies the future version of the automobile, and therefore, it will inherit the original role of movement for transportation. Connected with other vehicles and subjects on the roads as well as traffic systems, smart car is expected to provide optimal transportation (Siemens, 2015). Smart car can drive itself without driver intervention (Funk, 2015), determine the best route (Wu & Horng, 2017), and monitor and diagnosis itself (Yun & Choi, 2014). As car evolves into smart car, the movement function is expected to lead innovation of the automobile industry as one of the major advanced services.

3.1.1.1 Autonomous Driving

Autonomous driving refers to the service to allow the vehicle to run on its own without driver intervention by recognizing other vehicles, pedestrians, obstacles, traffic signals and speed limits, and so on. Technologies to recognize environmental and traffic conditions and to make prompt and appropriate responses through critical decisions are being developed (Koesdwiady, Soua, Karray, & Kamel, 2017). National Highway Traffic Safety Administration (NHTSA) of U.S.A. divides the degree of automation into five levels, among which level five, the highest level, implies vehicle being able to perform all the driving functions under all the conditions without driver's help. The Advanced

Driver Assistance Systems (ADAS) technology currently being developed belongs to level two and three. Since it can only support drivers to make less accidents through providing alarm or restricting car movement when it seems to get out of the lane or get close to other vehicles, driver must be ready to take control of the movement in the level two and three. However, the role of the driver is reduced from level four, and it is almost gone at level five. And therefore, the meaning of autonomous driving in this paper is that smart car will be able to detect traffic sign or speed limit and to take the driver's role (Mammeri, Boukerche, Feng, & Wang, 2013), and consequently the passengers will not have to intervene in driving, but be able to take their time and use other services in the vehicle while moving.

3.1.1.2 Smart navigation

Smart navigation means a guiding service that grasps the optimal route in consideration of real-time traffic information such as congestion zones and accidents, and driver's preference. As the smart car gets connected to the traffic system and traffic subjects, it will be able to provide intelligent navigation service by recognizing instant traffic system information (Ruiz et al., 2015). It will also optimize driving algorithm through extracting necessary traffic information (Yuan Yuan et al., 2013) and autonomously adapt to changing traffic context (Wu & Horng, 2017).

Moreover, human-machine interaction (HMI) navigation is being developed that recognizes the intention of the passengers (Lopes, Nunes, Vaz, & Vaz, 2010; Ross & Burnett, 2001; Vasilijevic, Omerdic, Borovic, & Vukic, 2012). According to them, navigation service will, in the future, be able to determine the best appropriate route considering passenger's intention and real-time traffic situation. For example, if the driver prefers to watch the night view at night time, smart car sets up a route to arrive at the destination at a suitable time while seeing the night view in a comprehensive manner considering the congestion zone point and the destination position in the evening.

3.1.1.3 Vehicle control and diagnosis

Vehicle control and diagnosis service means the ability of smart car to check the vehicle condition in real time so that the vehicle can move safely. In detail, it can detect a problem and notify it with solutions through a car display or connected devices. Vehicle condition monitoring technology is progressing day by day. It can not only diagnose states of car such as battery states (You, Park, & Oh, 2017), motor torque (H. Zhou, Liu, & Yang, 2018), and tire force (Jung & Choi, 2018), but it can also detect broken parts of motor (Otero, de la Barrera, Bossio, & Leidhold, 2018) and malfunctions (Su & Chen, 2016).

Automotive connectivity can improve the monitoring technology and provide new knowledge and service through enabling the interaction among network participants (Varshney, 2004; Y. Wang, Taher, & van den Heuvel, 2012). For example, on-board diagnosis system supporting vehicle maintenance and safety has been developed to detect vehicle conditions beyond malfunction (Hu, Yan, Tian, Wang, & Cao, 2010). As connectivity technology being adopted, on-board diagnostic system became able to transmit information to the cloud computing server and realize more accurate diagnosis (Jhou, Chen, Tsay, & Lai, 2013) As such, smart car equipped with connectivity technology will be able to continuously accumulate data, monitor it, diagnose the problem, and provide appropriate solution.

3.1.2. Infotainment

Infotainment is a compound terminology of information and entertainment. For instance, in-vehicle infotainment (IVI) utility refers to the automobile's ability to enhance the comfort and enjoyment of passengers while driving, which shows significant industrial growth and customer demands (J. Kim et al., 2016). As the electrical system installed in the vehicle secures connectivity, it becomes able to provide a variety of infotainment systems (D.-h. Kim & Lee, 2016). Specifically, connectivity with the Internet and the cloud allows passengers to instantly utilize diverse services or search information (Amadeo et al., 2012). Moreover, connectivity with passengers based on artificial intelligence provides interactive system supporting communication between passengers and car based on former's needs (Gkikas, 2016).

3.1.2.1 Secretarial function

The secretarial service allows the vehicle to recognize the command of the passengers and perform it based on the human-machine interaction (HMI) and artificial intelligence (AI) technologies that support communication between vehicle and passengers. For example, if the smart car is settled to introduce weather when the clap is recognized twice consecutively, each time the passenger claps twice, the car will search for the weather today and tomorrow and will deliver weather information. Moreover, if the passenger is supposed to travel to another area tomorrow, the car will identify the schedule and check the weather on the trip area to deliver additional weather information.

HMI is developing toward vehicle's substituting passengers' action and creating relationship with them beyond just supporting service usage (de Visser, Pak, & Shaw, 2018). For example, Amazon's Alexa, a voice-enabled AI system, is already built in BMW. Moreover, various vehicle manufacturing companies such as Hyundai, Mercedes-Benz, and Volkswagen have introduced connected car system equipped with interactive artificial intelligence platform in the Consumer Electronics Show (CES) 2018.

3.1.2.2 Application

Application service means that the vehicle passengers can use various functions such as game, communication, music appreciation, document work, etc. through the applications installed in the vehicle without the help of a separate device such as a smart phone. Smart car customers expect to be productive and entertained while moving (James, 2012). And Huang et al. (2016) predicts that personalized service will be provided through downloading applications to smart car. As smart car gets equipped with an operating system like a smart phone, passengers can listen to music or use the Internet through the basic function set. Moreover, certain individually preferred services can be downloaded separately as application can be conveniently used in a personalized form. In other words, the application attribute has the characteristic that connected technology and operating system are integrated to form optimized infotainment space for passengers. With this feature, it can be said that the smart car possesses the role of an individual IT

device beyond that of movement supporting machine. These applications are known to support various infotainment activities such as multimedia services (Jiau et al., 2015), games (Telefonica, 2014), and e-book (Hartwig et al., 2000).

3.1.2.3 Fin-tech

Fin-tech service means that a car becomes a customized financial space for passengers to carry out financial activities such as settlement, remittance, and investment. When the passenger asks fin-tech service to send his/her brother a bill, the car recognizes the voice, transfers the amount from the connected account, and notifies the passenger that the remittance has been completed through the screen or voice of the smart car. In addition, the purchase amount can be automatically charged after passing the payment section of drive-through stores.

Recognizing the importance of fin-tech service of smart car, technical problems over security and network is now being solved for a long time to realize vehicular commerce (W. Li, Wen, Su, & Jin, 2012; Varshney, 2005). R. Morgan (2017) predicts that vehicle in the future will have the ability to make payments and support other banking services. And now manufacturers are designing automobiles with payment service such that GM has introduced connected car with e-commerce system to provide Internet payment services, and Ford introduced blueprint for car commerce market designed with card makers.

3.1.3 IoT Hub

Internet of Things (IoT) means that most of intelligent objects used in everyday life are connected to the Internet based on the global network infrastructure and exchange information one another (S.-E. Lee et al., 2017). The IoT hub supports seamless management of other smart objects at the edge of multiple networks and increases network capacity (Cirani, Ferrari, Iotti, & Picone, 2015; Yu Yuan, 2012). As upcoming smart car is regarded as emerging IoT hub (Khan & Ghamri-Doudane, 2015; Yaqoob et al., 2017), it will be interlinked with the existing IoT systems, utilize embedded services

through controlling the systems in the car, and finally increase the utility of IoT era (He et al., 2014; I. Lee & Lee, 2015).

3.1.3.1 Smart home and office

Smart home and office utility means the ability of smart car to remotely control and manage devices at home and work. On the way home from work, passengers can double check whether air conditioner at office is turned off and turn on air conditioner at home to cool the house in advance. Additionally, rice cooker can be remotely settled to complete cooking around the time passengers arrive at home. Smart car enables customized individual interaction through harmonizing several environments of car, home, and office (Cook & Das, 2007). Transferring information from smart car to workplace and home and vice versa, smart car is evaluated to increase the utility of smart home (Urry, 2004).

3.1.3.2 Smart health

Smart health refers to the smart car utility to monitor passengers' health status and to provide high-quality healthcare services through wearable devices such as smart watches and in-vehicle sensors. Smart car can be equipped with healthcare service through connection with IoT device through which it can secure huge amount of health data (I. Lee & Lee, 2015). Moreover, it can monitor passengers' biological signal through in-vehicle sensors especially installed on a chair (Baek, Chung, Kim, & Park, 2012; Walter, Eilebrecht, Wartzek, & Leonhardt, 2011). Based on connectivity, smart car would be a hub to support smart hospital and improve health through supporting interaction with health care centers, immediately responding to health problems and suggesting appropriate schedule to visit. For example, sending information to health monitoring center, smart car can support smart hospital system where healthcare information is updated in real time base through connected objects (Khalid, 2016; Shah & Yaqoob, 2016).

3.1.3.3 Smart phone and individual devices

Smart phone and individual devices will be connected to smart car. If this is the case, songs, telephones, internet windows, documents, etc., which have been carried on a personalized device, can be continued without a lag and car can be remotely controlled via personalized devices. Like Bluetooth technology, automobiles have been linked to mobile phones and other device. (Leen & Heffernan, 2001). In detail, services such as remote control, vehicle inspection and automatic version upgrade are provided (B.-H. Lee, An, & Shin, 2011). This connectivity can not only broaden value proposition through availing various applications (Porter & Heppelmann, 2014) and but also improve the quality and scope of vehicle communication through enriched communication capabilities of other devices (Abid, Chung, Lee, & Qaisar, 2012; Lu, Cheng, Zhang, Shen, & Mark, 2014).

4. Analysis I : The relative importance of key services from customer perspective

4.1 Data collection and analysis

The proposed AHP model was tested for the potential customers of smart car market through on-line survey. The survey questionnaire is sent only to driving license holders with individual car and intention to use smart car in the future. The survey was conducted through three steps. First, definition of smart car and detailed description of the upcoming utilities are provided in order to support respondents' understanding on the context of the smart car we have defined. Next, AHP model and brief technical explanations for twelve utilities were provided. Real-life examples about future experience of smart car passengers based on each utility are provided additionally for the better understanding. Finally, pairwise comparisons are conducted based on consumer preference over idiosyncratic utilities provided by smart car in order to analyze what kinds of utilities increase the value of smart car.

Reliability of survey response was measured through calculating consistency ratio (CR).

Consistency ratio less than 0.1 is generally assured; however, less than 0.2 is also considered tolerable (Saaty, 1983). Since CR between 0.1 and 0.2 is generally accepted in social science studies (S. Kim & Kim, 2016; S.-E. Lee et al., 2017; Yang, Kim, Nam, & Min, 2007), this study also regarded responses with CR less than 0.2 as acceptable.

After filtering response reliability through measuring CR value, 428 out of 553 survey responses were found to be adequate. Among those respondents, 211 were male and 217 were female. Since respondents were restricted to driving license holders, all the respondents were aged above twenty. 89 respondents were aged between 20 and 29; 95 between 30 and 30; 87 between 40 and 49; 80 between 50 and 59; 77 were above 60s. Most of the respondents had university degree and distribution of respondents was high in the order of high school, college, graduate school and elementary and middle school. 111 respondents spent less than an hour to drive a car in one week; 115 spent one to three hours; 80 spent three to five hours; 122 spent more than five hours. Among 428 driving respondents, 138 had less than five years of driving experience and 290 had more than five years of driving experience. And among those 428 respondents, 174 used internet less than five hours in one week and 254 used more than five hours. Table 2 provides description of the respondents' profile.

Table 2. Respondents sample profile

Gender	Male	211
	Female	217
Age (year)	20-29	89
	30-39	95
	40-49	87
	50-59	80
	Over 60	77
Education	Elementary/Middle school	2
	High school	69
	College (2-year degree)	51
	University (4-year degree)	263

	Graduate School	43
Driving time (in one week)	Less than 1 hour	111
	1-3 hours	115
	3-5 hours	80
	More than 5 hours	122
Driving experience	Less than 5 years	138
	More than 5 years	290
Internet usage time (in one week)	Less than 5 hours	174
	More than 5 hours	254
Total		428

4.2 Result

As described in Table 3, driving assistance is the most important criterion in the first level of the AHP model with the weight of .559. The weights of infotainment (.231) and IoT hub (.211) are similar to each other and show large gap with driving assistance. The highest preference for the driving assistance utility represents that vehicle's indigenous function of movement, which is inherited from the main function of existing car, is also considered to be important in the smart car market. In other words, consumers still perceive that the main function of smart car is driving.

There are two kinds of perception about smart car. One could regard smart car as the next-generation smart device and the other as the next-generation car. Based on the fact that consumers focus more on driving assistance than on infotainment and IoT hub, it can be inferred that customers still perceive smart car more as the vehicle that provides utility of transportation movement than the device that provides personal utilities like smart phone. Therefore, it might be possible to view smart car in the form of a futuristic vehicle.

Sometimes, it is mentioned that the expanding the driving role of smart car increases traffic safety, meanwhile, there is also strong concern about the increased driving role of smart car in the real life due to the hot news that human accidents caused by Tesla and Uber autonomous vehicles have appeared frequently. Nevertheless, consumer preference

shows that they do not significantly consider the negative impression but welcome increased role of the automobile.

Local weight represents customer's preference bounded under the certain one utility on the first level. In terms of local utility score of driving assistance, the weight of vehicle control and diagnosis (.403) is the highest, followed by autonomous driving (.360) and smart navigation (.237). Under the superordinate infotainment level, the weight of secretarial function (.477) is the highest and those of application (.297) and Fin-tech (.226) do not show any big difference. In terms of IoT hub criteria, even though smart home and office (.371) shows the highest weight, it does not show much difference with the second highest criterion, smart phone and individual device (.366). The weight of smart health (.263) is the lowest.

The global weights of nine utilities on the second level represents ultimate priority in the preference of each utility in total, which can be calculated through multiplying the weight of superordinate criterion and that of subordinate. Over all, the preference for the three subordinates of driving assistance utility are higher than others. Because the weight of superordinate criterion, driving assistance, is much higher than the other two, three subordinate services of driving assistance, vehicle control and diagnosis (.225), autonomous driving (.201), smart navigation (.132) all rank top three services consecutively. This implies that the most preferred service is vehicle control and diagnosis because it is directly related to the safety of driving. Next, autonomous driving is perceived to be important because it is indirectly support safety through conducting idealistic driving in the future. In sum, vehicle's indigenous function of movement still shows importance in the future's smart car market.

Under the criteria of infotainment and IoT hub, secretarial function (.110) rank highest, followed by in the order of smart home and office (.078), smart phone and individual device (.077), application (.069), smart health (.055), Fin-tech (.052). The relatively lower scores of those subordinate services represent that the utilities obtained from the convenience of passengers and their quality of life under the umbrella of infotainment and IoT hub are lower than those from the three subordinates of driving assistance of vehicle control and diagnosis, autonomous driving, and smart navigation.

Finally, the utilities of smart health and Fin-tech are ranked lowest. These two utilities

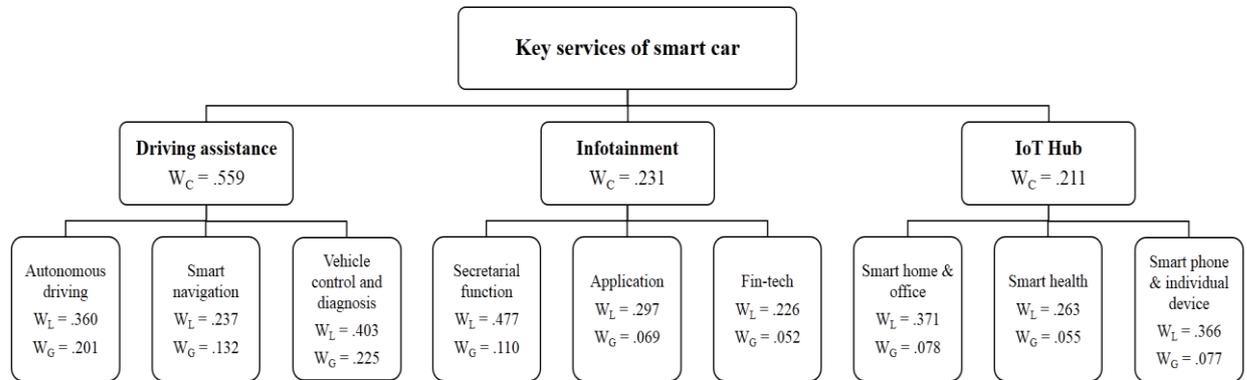
are related to the possibility to infringe on privacy issues which specifically require higher security level and could cause troubles that are particularly vulnerable to privacy and sensitive to monetary problems. Even if we assumed full technologies, consumers are less willing to use these utilities through smart car. In sum, the overall ranking of global weight shows that consumers desire that they could enjoy convenient driving first, and next life pattern in a way that does not infringe on their privacy.

The utility preference from smart car may differ according to age, driving time, driving experience, and internet usage time. The aged may be more interested in healthcare, and prewise complex technologies. Additionally, the more driving time, the greater the preference for driving convenience and enjoyment; the higher Internet usage time, the higher the preference over internet usage utilities. However, even if the preferences are classified by those criteria, there is no significant difference in preference degree and ranking.

Table 3. AHP criteria weights and ranks

Criteria	Weight (W _C)	Sub-criteria	Local weight (W _L)	Global weight (W _G =W _C × W _L)	rank
Driving assistance	0.559	Autonomous driving	0.360	0.201	2
		Smart navigation	0.237	0.132	3
		Vehicle control and diagnosis	0.403	0.225	1
Infotainment	0.231	Secretarial function	0.477	0.110	4
		Application	0.297	0.069	7
		Fin-tech	0.226	0.052	9
IoT hub	0.211	Smart home and office	0.371	0.078	5
		Smart health	0.263	0.055	8
		Smart phone and individual device	0.366	0.077	6

Figure 2. AHP scores in the preference model



5. Analysis II : Evaluating leading parties from expert perspective

5.1 Data collection and analysis

We have derived relative importance in the utilities that consumers desire to enjoy with smart car through consumer survey based on AHP model. Those with high utilities represent the consumer's preferred value that the participating companies in the smart car market should pursue. Companies well realizing them might be able to satisfy customer needs, get selected by customers, and finally become the leading parties in the future's smart car market. In this sense, we try to evaluate, among those who seek to enter the smart car market, which company could well provide preferred utilities.

Evaluating the abilities of those companies requires background knowledge of smart car technologies and related services, and besides it requires understanding of associated companies. However, due to the fact that customers have low level of technical knowledge (Reinhardt & Gurtner, 2011), expert analysis is required to provide better quality of new product development (Wind & Mahajan, 1997). Ozer (1999) and Tiilikainen (2011) mention that experts can provide prospects of new product based on technological understanding. Moreover, Eris and Leifer (2003) and P. Li (2016) adjusted expert analysis in developing products. For these reasons, expert survey is conducted in this paper to evaluate the perceived ability of such companies in the future.

The scope of the experts is set to include researchers, practitioners, and professionals who at least completed doctoral course and who have been engaged in smart car research. Due to the fact that bias or preference toward certain companies could affect the survey response, we excluded experts who were closely related to the companies or who were conducting projects with them. In order to integrate the expert opinion without compromising on one side, a number of experts are contacted over various fields converged in smart cars.

The survey questionnaires were sent to 84 experts via e-mail or in person, and 52 of them replied. As shown in Table 4, among 52 experts, 15 are affiliated to public research institutes, 35 to universities and 2 worked for public enterprises. Respondents' specialties are distributed in the order of Machinery, Telecommunication, Technology Management, Computer Science, Electronics and Media.

Table 4. Respondents profile and background as expert

Affiliation	
Public Research Institute	15
University	35
Public Enterprise	2
Specialty	
Machinery	13
Electronics	6
Computer science	8
Technology Management	11
Telecommunication	12
Media	2
Total	52

The expert survey is conducted twice, first, based on the company, and next on the industry. The former can comprehensively consider company's strategy, knowledge, and capabilities, however, due to the fact that it is based on a particular company, it may have

limitation in generalization. Therefore, the evaluation based on the industry is performed once again to control company specific consideration. In detail, how well each of the company or industry could implement the nine utilities of the smart car is evaluated. The 10-point Likert scale was used. The scores evaluated for each utility was multiplied by the global weight, and summed up by companies and industries separately. And consequently, we could obtain the score and rank for each company and industry separately.

Related industries are categorized into four industries. The first two industries of IT device and automobile could be related to smart car hardware part. The remaining industries are associated with software part. The third industry of platform supports task commitment and various services based on the Operating System, and the fourth industry of communication supports the connected function of the smart car. Moreover, the biggest and leading Korean companies that seek to enter smart car market in each of the four industries are selected as the representative companies in the future's smart market: Samsung Electronics, Hyundai Motor, Naver, and SK Telecom (SKT).

IT device manufacturing companies desire to interpret smart car as the next-generation smart device. Since smart car is viewed as connected IT machine rather than vehicle, they are worth participating in competition. In other words, they believe that IT device, that they have been developing so far, is just changing its form into the rolling form. The automakers are developing an improved version of vehicle to step into the next paradigm of the market, as they have been doing so far as leaders in the market based on the rationale that they have the best understanding of the automobile. Platform companies consider that smart car is the product that can best be realized through their capabilities. Because smart car cannot work without an operating system, they could think the capabilities of the platform company are essential. On the other hand, smart car cannot actualize its utilities unless it is connected. As a result, a network company that supports connectivity is also entering the market with its existing competitiveness.

5.2 Result

When it comes to evaluation based on companies, Samsung Electronics ranked the

highest, followed by Hyundai Motor, Naver, and SKT. In terms of industries, the rank is in the order of IT equipment manufacturers, platform providers, automobile manufacturers, and network providers. Comparing the results of the expert survey in the aspect of company and industry, the first and the fourth rankings are parallel; yet the second and the third rankings are slightly different.

Samsung Electronics and IT equipment manufacturing industry are marked the first places in all utilities except for the driving assistance sector and Fin-tech utility. Both Hyundai Motor and the automobile manufacturing industry are ranked high in the driving assistance sector. The scores for utilities that are directly or indirectly associated with automobile operation such as autonomous driving and vehicle control and diagnosis are especially high; however, the scores for other utilities are inferior to those of others. And platform and network industries and the companies belonging to each of them, Naver and SKT, are placed in the middle rank overall. And generally platform industry and the company are marked higher than network industry and company.

This analysis shows that IT device manufacturing companies are most likely to lead the smart car market among the four types of companies entering smart car business. Smart car becomes close to IT device that delivers and receives information through connected networks, and performs mechanical processing and commanded mission. Since IT device manufacturers have been developing and introducing similar infotainment and IoT hub utilities through other devices, they are already filled with required technical capabilities and manpower. However, the result shows that their competency is low for the utilities that are regarded as the most important from customer perspective, driving assistance sector. Therefore, their weakness on the most important sector implies that even though IT device manufacturing companies are most likely to lead the smart car market, it might be necessary to cooperate with vehicle manufacturing companies.

Vehicle manufacturing companies understand the basic functions of automobile the best. They are, thus, evaluated to well realize utility related to vehicle hardware such as vehicle control and diagnosis, and autonomous driving. However, they might lack experience and manpower over other utilities. A high degree of understanding the basic functions of automobile may be advantageous in the evolution toward smart car, however, the traditional values limited to the existing paradigm of the vehicle may interfere the change

toward next paradigm⁷. Thus, strong concentration on existing know-how and capability could prevent them getting along with the evolution to the next paradigm, smart car.

While both platform operating system and 5G communication are key technologies to actualize smart car, the analysis shows that retaining these capabilities is not enough to lead the smart car market. Thus, the companies in these industries would better find cooperative partners in IT device or vehicle manufacturing industries.

Table 5. Evaluation based on the company

	Hyundai	Samsung	Naver	SKT
Autonomous driving	67.1 (1)	51.1 (3)	55.1 (2)	50.0 (4)
Smart navigation	42.8 (3)	38.9 (4)	48.0 (2)	50.3 (1)
Vehicle control and diagnosis	91.4 (1)	53.3 (2)	46.8 (3)	45.0 (4)
Secretarial function	27.1 (4)	41.3 (1)	36.1 (2)	33.7 (3)
Application	15.2 (4)	26.4 (1)	24.9 (2)	22.2 (3)
Fin-tech	8.4 (4)	18.5 (1)	17.2 (2)	15.3 (3)
Smart home and office	15.1 (4)	29.3 (1)	23.2 (3)	25.4 (2)
Smart health	10.8 (4)	19.8 (1)	15.6 (2)	15.2 (3)
Smart phone and individual device	17.8 (4)	32.2 (1)	24.0 (3)	25.3 (2)
Total	295.7 (3)	310.6 (1)	290.9 (3)	282.4 (4)

Table 6. Evaluation based on the business group

	Vehicle manufacturing	IT device manufacturing	Platform	Network telecommunication
Autonomous driving	62.7 (1)	57.5 (2)	55.9 (3)	55.9 (3)
Smart navigation	45.9 (3)	47.7 (2)	45.1 (4)	48.2 (1)

⁷ For example, due to this kind of lock-in phenomenon, Nokia died out in the smart phone market.

Vehicle control and diagnosis	92.9 (1)	53.6 (3)	54.7 (2)	50.0 (4)
Secretarial function	26.8 (4)	38.7 (1)	38.7 (1)	30.3 (3)
Application	15.5 (4)	25.7 (1)	25.6 (2)	21.0 (3)
Fin-tech	8.4 (4)	17.1 (2)	17.8 (1)	14.9 (3)
Smart home and office	15.2 (4)	28.8 (1)	26.8 (2)	26.5 (3)
Smart health	11.0 (4)	19.4 (1)	17.9 (2)	16.7 (3)
Smart phone and individual device	20.0 (4)	31.5 (1)	26.9 (3)	27.4 (2)
Total	298.5 (3)	319.8 (1)	309.5 (2)	290.8 (4)

6. Conclusion

Automobile industry which has incrementally progressed in the fixed boundary as a rolling machine with engine for a long time without big changes is drawing great attention with upcoming disruptive innovation toward smart car. In addition, the related companies are seeking to enter the smart car market to take a leadership in the growing smart car market. While they are introducing advanced technologies and concepts to realize smart car, there are relatively few researches and efforts that focus on analyzing smart car from the standpoint of market demand.

This study thus aims to understand customer value on upcoming smart car through evaluating the relative importance of idiosyncratic key services which can be provided by smart car to its customers. Therefore, this paper first measures consumer's preference over idiosyncratic functions of smart car based on analytic hierarchy process (AHP) analysis, and next, evaluates firms and industries that are expected to perform well the preferred functions through expert survey.

The results show that the relative importance is in order of driving assistance, infotainment, and IoT hub. The highest preference for the driving assistance utility, with large gap with the other two, represents that vehicle's indigenous function of movement is still considered to be important in the smart car market. In other words, the findings implies that consumers are focusing more on driving assistance than on infotainment and

IoT hub, and thereby, it can be inferred that customers still perceive smart car more as the vehicle that provides utility of transportation movement than the device that provides utilities like smart phone. Thus, it might be possible to view smart car in the form of a futuristic vehicle.

The results of evaluation on the firms through expert survey show that Samsung Electronics ranked the highest, followed by Hyundai Motor, Naver, and SKT. In terms of industries, the rank is in the order of IT equipment manufacturers, platform providers, automobile manufacturers, and network providers. This analysis shows that IT device manufacturing companies are most likely to lead the smart car market since smart car becomes close to IT device that delivers and receives information through connected networks, and performs mechanical processing and commanded mission. While vehicle manufacturing companies understand the basic functions of automobile better than others, they might lack the competitive edge in other utilities. Finally, although platform operating system as well as 5G communication are key technologies to actualize smart car, retaining these two capabilities is not enough to lead the smart car market.

This analysis suggests that companies need to diagnose their capabilities and to recognize their strengths and weaknesses. In this way they would be able to take advantage of their strengths and overcome weaknesses through complementing vulnerable utilities. This study would provide guidelines for companies entering smart car market to diagnose themselves and accordingly design strategies for the future. Moreover, it also raised the importance of researching smart car market based on the perceptions of consumers and experts.

This study has some limitations. First, it does not encompass the possibility of a new entrant. Because smart car demands a high level of skills, manpower, and infrastructure over wide range of departments, initial entry would not be easy. Yet, there is a possibility that innovative subjects such as Tesla could emerge. Second, there may be a discrepancy between the predicted and the actual reality in the future. As no one knows exactly what the future holds, the results of this study may not be parallel to the actual reality in the future in term of preferred utilities and leading company. However, this study could have its implication on understanding market at the present point of time regarding the market movement toward future evolution. Finally, this empirical analysis is limited to Korean

market. The different results might be possible in other countries depending the condition of their smart car markets. The global comparison could be included in further study

Reference

- Abid, H., Chung, T. C., Lee, S., & Qaisar, S. (2012). *Performance analysis of LTE smartphones-based vehicle-to-infrastructure communication*. Paper presented at the Ubiquitous Intelligence & Computing and 9th International Conference on Autonomic & Trusted Computing (UIC/ATC), 2012 9th International Conference on.
- Álvarez, M., Moreno, A., & Mataix, C. (2013). The analytic hierarchy process to support decision-making processes in infrastructure projects with social impact. *Total quality management & business excellence*, 24(5-6), 596-606.
- Amadeo, M., Campolo, C., & Molinaro, A. (2012). Enhancing IEEE 802.11 p/WAVE to provide infotainment applications in VANETs. *Ad Hoc Networks*, 10(2), 253-269.
- Aoyama, M. (2012). Computing for the Next-Generation Automobile. *IEEE Computer*, 45(6), 32-37.
- Baek, H. J., Chung, G. S., Kim, K. K., & Park, K. S. (2012). A smart health monitoring

- chair for nonintrusive measurement of biological signals. *IEEE transactions on Information Technology in Biomedicine*, 16(1), 150-158.
- Bahmani, N., Javalgi, G., & Blumberg, H. (1986). An application of the analytical hierarchy process for a consumer choice problem, *Dev. Mktg Sci.* IX.
- Bonner, J. M. (2010). Customer interactivity and new product performance: Moderating effects of product newness and product embeddedness. *Industrial marketing management*, 39(3), 485-492.
- Broggi, A., Buzzoni, M., Debattisti, S., Grisleri, P., Laghi, M. C., Medici, P., & Versari, P. (2013). Extensive tests of autonomous driving technologies. *IEEE Transactions on Intelligent Transportation Systems*, 14(3), 1403-1415.
- Buckl, C., Camek, A., Kainz, G., Simon, C., Mercep, L., Stähle, H., & Knoll, A. (2012). *The software car: Building ICT architectures for future electric vehicles*. Paper presented at the Electric Vehicle Conference (IEVC), 2012 IEEE International.
- Byun, D.-H. (2001). The AHP approach for selecting an automobile purchase model. *Information & Management*, 38(5), 289-297. doi:[https://doi.org/10.1016/S0378-7206\(00\)00071-9](https://doi.org/10.1016/S0378-7206(00)00071-9)
- CAR. (2017). Planning for connected and automated vehicles [Online] Available at: <http://www.cargroup.org/wp-content/uploads/2017/03/Planning-for-Connected-and-Automated-Vehicles-Report.pdf>
- CAAT. (n.d.). *Connected and Automated Vehicles* [Online]. Available at: http://autocaat.org/Technologies/Automated_and_Connected_Vehicles/
- Chen, S., Hu, J., Shi, Y., Peng, Y., Fang, J., Zhao, R., & Zhao, L. (2017). Vehicle-to-Everything (v2x) Services Supported by LTE-Based Systems and 5G. *IEEE Communications Standards Magazine*, 1(2), 70-76.
- Cirani, S., Ferrari, G., Iotti, N., & Picone, M. (2015). *The IoT hub: a fog node for seamless management of heterogeneous connected smart objects*. Paper presented at the Sensing, Communication, and Networking-Workshops (SECON Workshops), 2015 12th Annual IEEE International Conference on.
- Collie, B., Rose, J. Choraria, R., & Wegscheider, A. (2017, December 18). The reimagined car: Shared, autonomous, and electric. *Bcg.com*. Retrieved from <https://www.bcg.com>

- Cook, D. J., & Das, S. K. (2007). How smart are our environments? An updated look at the state of the art. *Pervasive and mobile computing*, 3(2), 53-73.
- Cooper, R., & Kaplan, R. S. (1991). Profit priorities from activity-based costing. *Harvard business review*, 69(3), 130-135.
- Cooper, R. G., & Kleinschmidt, E. J. (1987). New products: what separates winners from losers? *Journal of product innovation management*, 4(3), 169-184.
- Day, G. S. (1998). What does it mean to be market-driven? *Business Strategy Review*, 9(1), 1-14.
- de Visser, E. J., Pak, R., & Shaw, T. H. (2018). From “automation” to “autonomy”: The importance of trust repair in human-machine interaction. *Ergonomics*(just-accepted), 1-33.
- Drucker, P. F. (1954). *The practice of management: A study of the most important function in America society*: Harper & Brothers.
- Eris, O., & Leifer, L. (2003). Facilitating product development knowledge acquisition: interaction between the expert and the team. *International Journal of Engineering Education*, 19(1), 142-152.
- Fantazzini, D., & Toktamysova, Z. (2015). Forecasting German car sales using Google data and multivariate models. *International Journal of Production Economics*, 170, 97-135.
- Foley & Lardner LLP. (2017). *2017 connected cars & autonomous vehicle survey* [Online]. Available at: <https://www.foley.com/files/uploads/2017-Connected-Cars-Survey-Report.pdf>
- Funk, J. L. (2015). IT and sustainability: new strategies for reducing carbon emissions and resource usage in transportation. *Telecommunications Policy*, 39(10), 861-874.
- Gaynor, G. H. (1990). Selecting projects. *Research-Technology Management*, 33(4), 43-45.
- Gkikas, N. (2016). *Automotive Ergonomics: Driver-Vehicle Interaction*: CRC Press.
- Gora, P., & Rüb, I. (2016). Traffic models for self-driving connected cars. *Transportation Research Procedia*, 14, 2207-2216.
- Hansini, V., Elizabeth, N. E., Hemapriya, R., & Kavitha, S. (2016). *Secured backscatter*

- communication between smart cars in a vehicular ad-hoc network*. Paper presented at the Intelligent Systems and Control (ISCO), 2016 10th International Conference on.
- Hartwig, S., Luck, M., Aaltonen, J., Serafat, R., & Theimer, W. (2000). Mobile multimedia-challenges and opportunities. *IEEE Transactions on Consumer Electronics*, 46(4), 1167-1178.
- He, W., Yan, G., & Da Xu, L. (2014). Developing vehicular data cloud services in the IoT environment. *IEEE Transactions on Industrial Informatics*, 10(2), 1587-1595.
- Hu, J., Yan, F., Tian, J., Wang, P., & Cao, K. (2010). *Developing PC-based automobile diagnostic system based on OBD system*. Paper presented at the Power and Energy Engineering Conference (APPEEC), 2010 Asia-Pacific.
- Huang, S.-C., Chen, B.-H., Chou, S.-K., Hwang, J.-N., & Lee, K.-H. (2016). Smart Car [Application Notes]. *IEEE Computational Intelligence Magazine*, 11(4), 46-58.
- IEEE. (2018). IEEE connected and automated vehicle summit [Online]. Available at: <http://vehiclesummit.ieee.org/>
- Isenberg, S., Goebel, M., & Baumgarten, U. (2012). *Is the Web ready for in-car infotainment? A framework for browser performance tests suited for embedded vehicle hardware*. Paper presented at the Web Systems Evolution (WSE), 2012 14th IEEE International Symposium on.
- ITSJPO. (n.d.). ITS Research 2015-2019 connected vehicles. Retrieved from https://www.its.dot.gov/research_areas/connected_vehicle.htm
- Jackson, J. (2001). Prioritising customers and other stakeholders using the AHP. *European Journal of Marketing*, 35(7/8), 858-873.
- James, T. (2012). Smart cars. *Engineering & Technology*, 7(6), 50-51.
doi:10.1049/et.2012.0606
- Jaworski, B., Kohli, A. K., & Sahay, A. (2000). Market-driven versus driving markets. *Journal of the academy of marketing science*, 28(1), 45-54.
- Jhou, J.-S., Chen, S.-H., Tsay, W.-D., & Lai, M.-C. (2013). *The implementation of OBD-II vehicle diagnosis system integrated with cloud computation technology*. Paper presented at the Robot, Vision and Signal Processing (RVSP), 2013

Second International Conference on.

- Jiau, M.-K., Huang, S.-C., Hwang, J.-N., & Vasilakos, A. V. (2015). Multimedia services in cloud-based vehicular networks. *IEEE Intelligent Transportation Systems Magazine*, 7(3), 62-79.
- Ju, Y., & Sohn, S. Y. (2015). Patent-based QFD framework development for identification of emerging technologies and related business models: A case of robot technology in Korea. *Technological Forecasting and Social Change*, 94, 44-64.
- Jung, H., & Choi, S. B. (2018). Real-Time Individual Tire Force Estimation for an All-Wheel Drive Vehicle. *IEEE Transactions on Vehicular Technology*, 67(4), 2934-2944. doi:10.1109/TVT.2017.2779155
- Khalid, A. (2016). Smart applications for smart live. *International Journal of Computer Science and Mobile Computing*, 5, 97-103.
- Khan, J. A., & Ghamri-Doudane, Y. (2015). *Car rank: An information-centric identification of important smart vehicles for urban sensing*. Paper presented at the Network Computing and Applications (NCA), 2015 IEEE 14th International Symposium on.
- Kim, D.-h., & Lee, H. (2016). Effects of user experience on user resistance to change to the voice user interface of an in-vehicle infotainment system: Implications for platform and standards competition. *International Journal of Information Management*, 36(4), 653-667.
- Kim, J., Kim, S., & Nam, C. (2016). User resistance to acceptance of In-Vehicle Infotainment (IVI) systems. *Telecommunications Policy*, 40(9), 919-930.
- Kim, S., & Kim, S. (2016). A multi-criteria approach toward discovering killer IoT application in Korea. *Technological Forecasting and Social Change*, 102, 143-155.
- Koesdwiady, A., Soua, R., Karray, F., & Kamel, M. S. (2017). Recent Trends in Driver Safety Monitoring Systems: State of the Art and Challenges. *IEEE Transactions on Vehicular Technology*, 66(6), 4550-4563.
- Kohli, A. K., & Jaworski, B. J. (1990). Market orientation: the construct, research propositions, and managerial implications. *The Journal of marketing*, 1-18.

- Kong, H.-K., Kim, T.-S., & Hong, M.-K. (2016). *A Security Risk Assessment Framework for Smart Car*. Paper presented at the Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2016 10th International Conference on.
- Korenok, O., Hoffer, G. E., & Millner, E. L. (2010). Non-price determinants of automotive demand: Restyling matters most. *Journal of Business Research*, 63(12), 1282-1289.
- Krasnikov, A., Jayachandran, S., & Kumar, V. (2009). The impact of customer relationship management implementation on cost and profit efficiencies: evidence from the US commercial banking industry. *Journal of marketing*, 73(6), 61-76.
- Lajmi, H., Kammoun, H. M., & Alimi, A. M. (2015). *Advanced control units' diagnostic based on Ethernet for smart cars*. Paper presented at the Advanced Logistics and Transport (ICALT), 2015 4th International Conference on.
- Lau, A. K. (2011). Supplier and customer involvement on new product performance: contextual factors and an empirical test from manufacturer perspective. *Industrial Management & Data Systems*, 111(6), 910-942.
- Lee, B.-H., An, S.-H., & Shin, D.-R. (2011). *A remote control service for OSGi-based unmanned vehicle using smartphone in ubiquitous environment*. Paper presented at the Computational Intelligence, Communication Systems and Networks (CICSyN), 2011 Third International Conference on.
- Lee, I., & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, 58(4), 431-440.
- Lee, S.-E., Choi, M., & Kim, S. (2017). How and what to study about IoT: Research trends and future directions from the perspective of social science. *Telecommunications Policy*, 41(10), 1056-1067.
- Lee, Y., & Kozar, K. A. (2006). Investigating the effect of website quality on e-business success: An analytic hierarchy process (AHP) approach. *Decision support systems*, 42(3), 1383-1401.
- Leen, G., & Heffernan, D. (2001). Vehicles without wires. *Computing & Control Engineering Journal*, 12(5), 205-211.

- Li, P. (2016). The New Product Online Evaluation by Expert Based on the Analytic Hierarchy Process Method. *Asian Social Science*, 12(8), 265.
- Li, W., Wen, Q., Su, Q., & Jin, Z. (2012). An efficient and secure mobile payment protocol for restricted connectivity scenarios in vehicular ad hoc network. *Computer Communications*, 35(2), 188-195.
- Löffler, M., & Decker, R. (2012). Realising opportunities in the premium automotive market via context-oriented new product positioning. *Journal of Marketing Management*, 28(5-6), 716-732.
- Lopes, A. C., Nunes, U., Vaz, L., & Vaz, L. (2010). *Assisted navigation based on shared-control, using discrete and sparse human-machine interfaces*. Paper presented at the Engineering in Medicine and Biology Society (EMBC), 2010 Annual International Conference of the IEEE.
- Lu, N., Cheng, N., Zhang, N., Shen, X., & Mark, J. W. (2014). Connected vehicles: Solutions and challenges. *IEEE internet of things journal*, 1(4), 289-299.
- Magretta, J. (2002). Why business models matter.
- McCarthy, J. & O’Keeffe. (2016). Autonomous, connected, electric and shared vehicles: Reimagining transport to drive economic growth [Online]. Available at: file:///C:/Users/acl/Downloads/ACES_Final_A4%20Final.pdf
- Maidique, M. A., & Zirger, B. J. (1985). The new product learning cycle. *Research policy*, 14(6), 299-313.
- Mammeri, A., Boukerche, A., Feng, J., & Wang, R. (2013). *North-American speed limit sign detection and recognition for smart cars*. Paper presented at the Local Computer Networks Workshops (LCN Workshops), 2013 IEEE 38th Conference on.
- Mammeri, A., Zhou, D., Boukerche, A., & Almulla, M. (2014). *An efficient animal detection system for smart cars using cascaded classifiers*. Paper presented at the Communications (ICC), 2014 IEEE International Conference on.
- Marti, S., Rao, R., & Park, I. (2015). *41.4: Invited Paper: Advances to In-Car Human Machine Interface Systems*. Paper presented at the SID Symposium Digest of Technical Papers.
- Mitchell, W. J., Borroni-Bird, C. E., & Burns, L. D. (2010). *Reinventing the*

- automobile: Personal urban mobility for the 21st century*: MIT press.
- Morgan, P. L., Voinescu, A., Williams, C., Caleb-Solly, P., Alford, C., Shergold, I., . . .
 Pipe, A. (2017). *An Emerging Framework to Inform Effective Design of Human-Machine Interfaces for Older Adults Using Connected Autonomous Vehicles*.
 Paper presented at the International Conference on Applied Human Factors and Ergonomics.
- Morgan, R. (2017). The Top Fintech Trends Driving the Next Decade. *American Bankers Association. ABA Banking Journal*, 109(5), 22.
- Narver, J. C., & Slater, S. F. (1990). The effect of a market orientation on business profitability. *The Journal of marketing*, 20-35.
- Noh, H., Song, Y.-K., & Lee, S. (2016). Identifying emerging core technologies for the future: Case study of patents published by leading telecommunication organizations. *Telecommunications Policy*, 40(10-11), 956-970.
- Otero, M., de la Barrera, P. M., Bossio, G. R., & Leidhold, R. (2018). A strategy for broken bars diagnosis in induction motors drives. *IEEE Latin America Transactions*, 16(2), 322-328.
- Ozer, M. (1999). A survey of new product evaluation models. *Journal of product innovation management*, 16(1), 77-94.
- Pauwels, K., Silva-Risso, J., Srinivasan, S., & Hanssens, D. M. (2004). New products, sales promotions, and firm value: The case of the automobile industry. *Journal of marketing*, 68(4), 142-156.
- Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard business review*, 92(11), 64-88.
- Reinhardt, R., & Gurtner, S. (2011). Enabling disruptive innovations through the use of customer analysis methods. *Review of Managerial Science*, 5(4), 291.
- Ross, T., & Burnett, G. (2001). Evaluating the human-machine interface to vehicle navigation systems as an example of ubiquitous computing. *International Journal of Human-Computer Studies*, 55(4), 661-674.
- Ruiz, A., Juez, G., Schleiss, P., & Weiss, G. (2015). *A safe generic adaptation mechanism for smart cars*. Paper presented at the Software Reliability Engineering (ISSRE), 2015 IEEE 26th International Symposium on.

- Saaty, T. L. (1980). The analytic hierarchy process: planning, priority setting, resources allocation. *New York: McGraw*, 281.
- Saaty, T. L. (1983). Priority setting in complex problems. *IEEE Transactions on Engineering Management*(3), 140-155.
- Salomo, S., Steinhoff, F., & Trommsdorff, V. (2003). Customer orientation in innovation projects and new product development success-the moderating effect of product innovativeness. *International Journal of Technology Management*, 26(5-6), 442-463.
- Satam, P., Pacheco, J., Hariri, S., & Horani, M. (2017). *Autoinfotainment Security Development Framework (ASDF) for Smart Cars*. Paper presented at the Cloud and Autonomic Computing (ICCAC), 2017 International Conference on.
- Shah, S. H., & Yaqoob, I. (2016). *A survey: Internet of Things (IOT) technologies, applications and challenges*. Paper presented at the Smart Energy Grid Engineering (SEGE), 2016 IEEE.
- Siemens. (2015). Vehicle-to-X (V2X) communication technology [Online]. Available at: http://www.middleeast.siemens.com/pool/news_press/siemens-vehicle-to-x-communication-technology-infographic.pdf
- Sisodia, R., Wolfe, D., & Sheth, J. N. (2003). *Firms of endearment: How world-class companies profit from passion and purpose*: Pearson Prentice Hall.
- Slater, S. F., & Narver, J. C. (1999). Market-oriented is more than being customer-led. *Strategic management journal*, 1165-1168.
- Su, J., & Chen, W.-H. (2016). *Fault diagnosis for vehicle lateral dynamics with robust threshold*. Paper presented at the Industrial Technology (ICIT), 2016 IEEE International Conference on.
- Telefonica (2014). Connected car industry report 2014. [Online]. Available at: <https://iot.telefonica.com/blog/the-many-faces-and-advantages-of-connected-cars>
- Tiilikainen, A. (2011). Integrating Consumer Understanding into New Product Development. *Practical Approach for Integrating Consumer Understanding into Technology Push-originated NPD Processes*.
- Underwood, S. (2014). Automated, connected, and electric vehicle systems: Expert

- forecast and roadmap for sustainable transportation [Online]. Available at:
<http://graham.umich.edu/media/files/LC-IA-ACE-Roadmap-Expert-Forecast-Underwood.pdf>
- Urry, J. (2004). The 'system' of automobility. *Theory, Culture & Society*, 21(4-5), 25-39.
- Vargas, L. G., & Saaty, T. L. (1981). Financial and intangible factors in fleet lease or buy decision. *Industrial marketing management*, 10(1), 1-10.
- Varshney, U. (2004). Vehicular mobile commerce. *Computer*, 37(12), 116-118.
- Varshney, U. (2005). Vehicular mobile commerce: Applications, challenges, and research problems. *Communications of the Association for Information systems*, 16(1), 15.
- Vasilijevic, A., Omerdic, E., Borovic, B., & Vukic, Z. (2012). Acoustically aided hmi for roV navigation. *IFAC Proceedings Volumes*, 45(5), 49-55.
- Walter, M., Eilebrecht, B., Wartzek, T., & Leonhardt, S. (2011). The smart car seat: personalized monitoring of vital signs in automotive applications. *Personal and Ubiquitous Computing*, 15(7), 707-715.
- Wang, F.-Y., Zeng, D., & Yang, L. (2006). Smart cars on smart roads: an IEEE intelligent transportation systems society update. *IEEE Pervasive Computing*, 5(4), 68-69.
- Wang, Y., Taher, Y., & van den Heuvel, W. (2012). *Towards smart service networks: an interdisciplinary service assessment metrics*. Paper presented at the Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2012 IEEE 16th International.
- Wind, J., & Mahajan, V. (1997). Issues and opportunities in new product development: An introduction to the special issue. *Journal of Marketing Research*, 34(1), 1-12.
- Woodruff, R. B. (1997). Customer value: the next source for competitive advantage. *Journal of the academy of marketing science*, 25(2), 139.
- Wu, H.-T., & Horng, G.-J. (2017). Establishing an Intelligent Transportation System With a Network Security Mechanism in an Internet of Vehicle Environment. *IEEE Access*, 5, 19239-19247.
- Yang, D.-H., Kim, S., Nam, C., & Min, J.-W. (2007). Developing a decision model for

- business process outsourcing. *Computers & Operations Research*, 34(12), 3769-3778.
- Yaqoob, I., Ahmed, E., Hashem, I. A. T., Ahmed, A. I. A., Gani, A., Imran, M., & Guizani, M. (2017). Internet of things architecture: Recent advances, taxonomy, requirements, and open challenges. *IEEE wireless communications*, 24(3), 10-16.
- You, G.-W., Park, S., & Oh, D. (2017). Diagnosis of electric vehicle batteries using recurrent neural networks. *IEEE Transactions on Industrial Electronics*, 64(6), 4885-4893.
- Yuan, Y. (2012). Relationship Between the Internet of Things and Consumer Electronics [Internet of Things]. *IEEE Consumer Electronics Magazine*, 1(2), 23-23.
- Yuan, Y., Gu, J., Luo, L., Jin, C., Liu, Y., Xu, Y., & Yang, H. (2013). *Optimal trajectory control of smart cars based on a simple servo algorithm*. Paper presented at the Natural Computation (ICNC), 2013 Ninth International Conference on.
- Yun, H. J., & Choi, J. D. (2014). *Enabling safe & secure connection to an in-vehicle network (IVN)*. Paper presented at the Information and Communication Technology Convergence (ICTC), 2014 International Conference on.
- Zhou, H., Liu, Z., & Yang, X. (2018). Motor Torque Fault Diagnosis for Four Wheel Independent Motor-Drive Vehicle Based on Unscented Kalman Filter. *IEEE Transactions on Vehicular Technology*, 67(3), 1969-1976.
- Zhou, Y., Xu, G., Qin, F., Xu, K., Wang, G., Ou, Y., . . . Zhang, Q. (2013). *The prospect of smart cars: Intelligent structure and human-machine interaction*. Paper presented at the Robotics and Biomimetics (ROBIO), 2013 IEEE International Conference on.
- Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic management journal*, 29(1), 1-26.