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Research paper



The adoption of cloud computing in autonomous vehicle

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Abstract

Cloud computing is a popular disruptive technology that has been pervasively spread around the globe and becoming part of our daily life. Leveraging the ubiquitous nature of cloud platforms, can be value adding approach to the massive data acquired from autonomous vehicles. The data extracted from autonomous vehicle's sensors and actuators, together with other embedded smart devices can be monetized using cloud platforms to enhance reliability, comfort and improve security while driving. This paper focuses on the adoption of the cloud compu-ting in autonomous vehicles. Using Technology Acceptance Model (TAM) and Diffusions of Innovation (DOI), a new conceptual framework is extended to investigate and analyze factors underpinning the adoption.

Keywords: *Autonomous; Cloud Computing; Diffusions of Innovation; Technology Acceptance Model; Ubiquitous.*

1. Introduction

Cloud Computing is becoming an important aspect of our daily lives affecting the way people live and work. Initially the technology started with virtual cloud, where documents, photos and music were stored online and can be accessed from anywhere using smart devices and internet [75]. The emergent of Internet of Things technology, promises users wide range of integration of smart devices using cloud platforms and middleware, from appliances to phones, and now into cars [44]. The days for a driver to hop into the car and popping a mix-tape in a car radio are long behind us now. Most of the people nowadays rely on their smart phones music or web-based applications.

In most of the latest cars, these web-based options are built-in features intended to provision several capabilities in communications, integration with embedded devices, integration with other cars and road infrastructures. [31]. Instead of users, relying on Wi-Fi or their smart phones internet access, by 2015, manufacturers started to enshrine 4GLTE integration capabilities in their cars. This has been the spawn for an enhanced integration between vehicles, surrounding environment and human beings over cloud computing [41]. Not only that, but also underpin the adoption of cloud computing into the autonomous cars for further advancement of the technologies towards more secured and flexible mobility in the future. Where by, cars are expected to be used as a service rather than individual owned property [48]. Cloud computing is a technology service framework, which offers on-demand services over the internet from a shared pool of hardware and applications. The services are offered in four different service models, which are Platform as a Service (PaaS), Software as a Services (SaaS) and Infrastructure as a Service (IaaS) [47]. About autonomous vehicle cloud, it is a technology that provision cloud platforms for vehicles to access and share information to and from other vehicles as well as road infrastructures and related applications to enhance mobility experience, provision flexibility and reliability while driving [24]. Cloud computing has been projected as the technology that will facilitate and enhance automotive transformation in the global market, from an individually owned vehicle to service-based vehicle in the future [48]. Most of global Cars manufacturers are expected to launch fully autonomous vehicles by 2025 [54].

Autonomous vehicles (AVs) are vehicles which can operate independently with or without human interaction. These vehicles are facilitated by sensors, actuators, middleware, radio frequency identification (RFID), embedded devices and other automobiles applications. Making these cars the first truly intelligent robots which can be purchased and used by the people [25].

2. Problem statement

Cloud-AVs integration is still at its nascent stage, which makes it vulnerable and susceptable to further integration towards diversified innovation. Hence, this also raise many concerns regarding security and privacy issues from consumers as well mobility organizations. Understanding factors which will influence the adoption of cloud computing into the AVs will underpin and heighten confidence level towards utilization of the technologies to its optimal anticipation [68]. Many cars manufacutres are currently focusing on their own proprietary technologies and applications which limits integration with cloud computing and also with other cars from different manufactures [43] [27] [77]. As a result, this employing constraints on the AVs integration towards acquiring potential benefits of the technologies integration and operation. Once institutions are able to understand the scale of magnitude and direction of the adoption approach of these technologies, will empower them towards modular integration standards that will facilitate communication between these technologies in a standard platforms where all manufactures and consumers will be able to utilize and experience optmized data monetization through cloud platforms and related technologies.

Autonomous vehicles have been a popular research topic in the automotive industry's for the past ten years. However, upto recently only Mercedez Benz has lauched semi-autonomous trucks that allow autopilot settings on the highway, while the rest of the

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automotive manufacturer is havent yet launched any autonomous vehicle for commercial use. Most of these manufacturers have already started shifting towards prototype designing and testing for autonomous vehicles, and are expected to prone the future of automotive industry [25] [44] [17] [67]. For successfully adoption of cloud computing platforms into the autonomous vehicles, coherent and effective adoption theory must be applied to investigate factors and attributes that will hinder or underpin the adoption approach [48]. Nonetheless, different adoption models have been proposed from various researches [64] [42] [2] [61]. However, none of these models cover the adoption of cloud computing in to the autonomous vehicles, by focusing on consumer's perception and factors which influence the adoption of cloud computing into the AVs. Findings from several researches indicated that consumers are willing to adopt on alternative vehicles innovations which have influence on personal norms as well as environmental welfares. Hence, it was further discovered that these attributes play essential role towards consumer's intention to adopt on the subtitutive vehicles technologies [57] [68]. With the commercialization of autonomous vehicles expected in few years to come, studies into which factors are most likely to influence consumers adoption of autonomous vehicles and use of cloud applications is equally important. This thesis aimed to propose a model, that will assist and support practitioners, organizations, governments and private institutions to effectively understand factors which will underpin or hinder the adoption of cloud computing platforms into the autonomous vehicles and other related automobiles applications.

3. Literature review

The future of automobiles is anticipated to incorporate embedded sensors platforms which provision necessary information to the driver and upload filtered sensor data to the cloud systems [8]. These cloud systems will then share the data among autonomous vehicles and utilize it to enhance a well-defined utility formula, which will be used to ensure consumer comfort and security through-out the driving experience. In other words, all these sensors will be accessible from the sensor web and shared within the internet of things (IoT) [25]. Internet of things (IoT) is a technology paradigm which comprise of objects embedded with sensors and actuators networked together over the internet and make an intelligent use of the data obtained from the sensors and actuators [17]. Likewise, in the modern power grid companies, the IoT formed through a network of components integrated together which manage the power loads in a most efficient and safe approach, leaving operators playing the role of observers [58].

In case of autonomous vehicle, like all other IoT's platforms, once human factor is removed from the control, the autonomous vehicle must proficiently operate to maintain flexible and secured traffic flow in roads and highways [25]. Visionaries believes that AVs will behave much better operations than traditional drivers, by managing more traffic with less delays, less pollution and enhance comfort for drivers and the passengers as well [8] [20] [43] [24]. However, the complexity of the ubiquitous control of hundreds of thousands of vehicles cannot be address lightly. Let say a natural catastrophe suddenly occurs, for example an earthquake, the autonomous vehicle must be able to efficiently communicate and coordinate the evacuation in timely and systematic manner. Moreover, the communications between vehicles must be secured to prevent malicious attack that could be very deadly especially in the case of autonomous vehicles. Hence, there is a pressing need to comprehend consumer perception on the autonomous vehicles and their intention to use the automobile applications over the cloud platforms before the introduction of commercialized AVs [49] [20] [68]. Using technology adoption theories will facilitate investigation on realizing those factors that will influence organizations to adopt cloud computing into the autonomous vehicles from the user perspective. There are many theories used to investigate the adoption of technologies in different industries. Some of which are; technology acceptance model (TAM), diffusion of innovation (DOI), technology, organization and environment (TOE), unified theory of acceptance and use of technology (UTAUT) [56].

Cloud Computing: It is a destructive technology that has pervasively spread over the years and has been adopted in many organizations and other business sectors. As it is believed to offer scalability, agility and cost effective business models [87]. According to [48], cloud computing as a service delivered over the internet together with the pool of hardware and applications responsible to run and deliver those services [47].The National Institute of Standards and Technologies (NIST), "defined cloud computing as model for enabling ubiquitous, convenient, on-demand network access to a share pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction," [60].

The main concept of cloud computing is not new, however, its popularity emerged in 2006 after the terminology was used by the Google CEO Mr. Eric Schmidt, since then many organization has migrated over cloud services [87]. Due to the ubiquitous paradigm of cloud computing, which provision virtual computing, unlimited storage and high processing capability from shared pool of online resources, led global organizations such as Google, Amazon, Facebook, IBM and SAP to leverage cloud computing as tool for servicing their customers [75]. Nevertheless, there are still many security concerns [38], cost [63] and infrastructure support [51], which challenges the adoption scale. Cloud Computing comprises of 5 main characteristics, three service models and four deployment models [60].

Autonomous Vehicle: Autonomous vehicles have a very rich history dated back in the early 1940's and 1950's when the first prototype design and testing promulgated [73]. In 1990s, there was the first demonstration on the potential possibilities to develop vehicles that can be in-control of their own movement in different complex environments. Where by, the initial prototypes were designed for indoor use. AVs operations involves a combination of technologies, which include sensors, cameras, radars, vehicle to vehicle and vehicle to infrastructure communication, GPS and maps so as to acquire data from its surrounding [73]. According to [34], autonomous vehicle is a type of vehicle that can drive its-self from one location to another without any human interaction [34]. Apparently, vehicles have undergone major transformation and developments in area such as performance, reliability, control standardization, comfort, fuel consumption, safety feature and many more. These advancements have contributed to a more appealing and flexible driving experience. Autonomous vehicles are expected to change not only the automobiles industry, but also the roads and infrastructures designs and operations [25]. Currently, some of the latest cars are incorporated with different automated driving options, such as lane switching systems and adaptive driving control. Through these technologies the driver is partially assisted by s computer system in performing some of the driving tasks. These types of autonomous vehicles are in level 1 and 2 according to NHTSA [51]. Google started its AVs project in 2009, it has completed over one and half million miles of test drive. In 2014, Google has shifted its focus onto level 4 prototype design and testing [27]. Several other high-tech automotive company has shown interest into the AVs projects. Volvo is planning to conduct a road test for its Intellisafe autopilot prototype in 2017 [81]. Mercedes Benz has launched new level 3 truck, with capability of semi-autonomous options in the high way using their new app called Highway Pilot [46]. Tesla is another company promulgated its interest in AVs, and has already started to include enhanced autopilot sensor technology in its latest cars [77]. Furthermore, Tesla is also working on the project to develop an automatic car charger which would give an AV fully autonomous feature without any human input [12].

Data Monetization in Autonomous Vehicle: The anticipated growth of the AVs value and shared mobility is expected to reach beyond $1.5 trillion by the year 2030. The milestone is also expected to transform the foreseeable dissemination of new applica-

tions and services which will transform automotive industry perspective. Many new players, especially from the high-tech companies and service providers are seem to be very much interested in this competitive arena. Most of these companies are conscious in data processing and manipulation in order to come-up with applications and services that customers will be willing to pay for. AVs data will be monetized and utilized to enhance and transform business models for automotive industry in close collaboration between automotive manufactures and high-tech giants [45].

Nevertheless, there are several concerns addressed on issues regarding data ownership and privacy, especially, focusing on customer's willingness to share data, which is an important aspect for new era of data, enabled applications and services. Autonomous Vehicle's Cloud: Autonomous Vehicle cloud (AVC) is the core system environment provisioning integration between vehicle and ample contents sharing for optimized user experience [36]. Vehicles with embedded devices, sensors, actuators, cameras and other devices generate massive amount of contents or data. These contents are then processed and stored in the cloud platforms, where they can be consumed to improve and enhance driving experience [37]. As an effort to address vehicle cloud contents, [24] proposed new computing paradigm called, Vehicular Cloud Computing (VCC). The paradigm facilitates network access of mobile nodes with limited access to computing and storage resources, using the cloud platforms. VCC construct a vehicle cloud by leveraging vehicles computing resources to extend interoperability and interactions between vehicles and the surrounding environment [24]. The other essential component of the vehicle cloud is the Information Centric Networking (ICN). ICN is the modular paradigm of communication architecture to acquire efficient data distribution on the internet. The paradigm focuses on the content rather than the host to accomplish requirements from the consumers as well as the service providers. Consumers are more focused on the content regardless of where it is from, while the service providers focus is to efficiently provision contents to the consumers, hence, ICN apply content names instead of IP addresses to decode the content from the service providers as shown in Fig 1 below. Recently, ICN proposed new model architectures in the internet context, which include DONA (Data-Oriented Network Architecture), NDN (Named Data Networking), PSIRP (Publish-Subscribe Internet Routing Paradigm), and NetInf (Network of Information) [3]. Out of all these architecture, only NDN has been extended to vehicular networks [82] [86] [28], as it allows routers to store content in their cache memory and use that content to reply to the consumer once matching request is received. In this way, NDN acquire proficient content dissemination that is very critical for VCC to support its content-based applications.

Anticipated Cloud Service Architecture for Autonomous Vehicle: Most of the vehicles spend considerable amount of time while on the road with high possibility to be in dynamically changing conditions, varying from normal traffic bottleneck, accidents, natural disasters and other related traffic incidents [55]. The mobility factor of vehicle cloud, together with the presence of other vehicles in adjacent proximity with an unplanned scenario that might take place anytime and anywhere on the road, calls for spontaneous support by AVC through these incidents which doesn't have predefined or assigned resource available, hence, AVC must be dynamically and proactive in response to these types of situations. This option is not available in the traditional clouds and turns out to be very essential in characterizing vehicle clouds. The following are three types of cloud computing service model for autonomous vehicle cloud [42].

Network as a Service (NaaS): While some vehicle on the road are anticipated to have internet access ability through their vehicles, but at the moment most of the vehicles do not have such access to the internet through their cars. This create an opportunity for other vehicles with internet access to offer their excess bandwidth to other vehicles on the move that may need internet services. It is prospected that most of the drivers will have internet accessibility while driving through cellular networks and other fixed access points along the road infrastructures. This network service can be shared between drivers or cars that are interested to rent it [42].

Storage as a Service (STaaS): While some vehicles are expected to have sufficient onboard storage capabilities, others are anticipated to require extra storage capacity for their onboard applications or services. These vehicles with more storage capabilities will be able to provide storage as service to other vehicles; even though some of the cloud applications will have their own sufficient storage from cloud platforms this service will be also available as a temporary storage in the event when on cloud storage is not accessible. It is highly anticipated that most of the cars in the future will have multiple of terabytes of storage capacity. This is due to two main justifications. First, storage is becoming cheaper over time, since terabyte nowadays cost less than $40, which way too cheap when compare to the cost of the vehicles itself. Second, cars have a lot of space to accommodate several hard drives especially with technology available today and the optimized size of the storage Equipment's. Hence, having all this storage capacity staying idle is a waste of resources. Therefore, this storage capacity will provision possibility to be used in many cloud-based applications. Provisioning storage as a service in vehicle cloud is different from computing services or network access, as customer expect spontaneous effect on computing and network access, while in case of storage the benefits will be realized after a long period.

Cooperation as a Service (CaaS): Vehicular networks were introduced to provide variety of services to the public travelling with their vehicles. Services ranging from driver safety, traffic info, warnings on hazardous situations, accidents or traffic jams, advertisements as well as internet access. To establish and maintain the infrastructure that will support these vehicular networks is a very costly investment, as it involves setting up ITS infrastructures, towers to support mobile networks including deployment of roadside base stations and other necessary equipment to make the service effective and efficient. All these requirements necessitate massive investment at both network as well as hardware levels. That's where new form of community service called CaaS was anticipated to curb this issue by provisioning a service with very minimal infrastructure, through leveraging V2V communications when no infrastructure is available.

CaaS utilizing hybrid approach where drivers will request for the services through a portal which have other cars subscribed to it, this portal or platform will broadcast the drivers request with necessary info regarding the service requested into the cloud network that was created by the members who subscribed to the service, in other terminology, service providers will facilitate cooperation of moving vehicles by utilizing their network capabilities where no infrastructure is available. CaaS may segment. CaaS may segment the network into clusters and apply content based routing to support intra-cluster communications.

Security and Privacy in Autonomous Vehicle's Cloud: Security and privacy becomes major concerns when multiple users share the same resources or using same application. Most of recently studies has been devoted largely on general security issues in cloud computing, although not related with vehicular networks [22] [55]. The easiest solution is to control access to the cloud infrastructure facilities. This is anticipated to reduced insiders risk [11] [70], proposed a framework to acquire trust in conventional cloud computing, where by a trust coordinator hired by external third party is sent to evaluate the untrusted cloud manager, this allow the existence of a set of virtual machine such as E2C from Amazon accessible to customers. This resolution aimed at enhancing the integrity and confidentiality of the cloud data [70]. [23] suggested a solution to prevent service providers from accessing and manipulating the services at the host [23]. [10] also proposed a parallel solution where by, during every startup of virtual system, the entire system info is recorded and encrypted before transmitting data to the third-party trust center.

This allow trust center to evaluate the trust value of the data [10]. [35], proposed also proposed a third-party trust center to oversee the security of cloud computing between service providers and their clients, so as minimize the exposure from both parties [35].

[82], proposed solution using public key based authentication and random masking to protect cloud data and preserve the integrity of the public cloud information. This approach is made effective through simultaneous audit of multiple users in the cloud virtual machines [82].

However, the security and privacy studies relating to AVC hasn't been mentioned much in the literature, could be due to nascent stage of the adoption scale and for this reason minimal societal impact, security and privacy issues have emerged. AVC is anticipated to open-up to next level of potential security and privacy impediments compared to wireless networks, VANET or cloud computing. Conventional network is designed to avert invaders from entering the system, while in VC all users including attackers shared same privileges [39].The invaders and their target is possible to share the same machine in AVC, and use the loophole available to infiltrate their target confidential information and use it to alter with the integrity of user's information and manipulate resources availability among other things [43].

Factors influencing the Adoption of Cloud Computing in Autonomous Vehicles:

Among the most anticipated outcome of AVs, is the environmental impact which will affect the automotive industry. In our days, most of cars pose a major threat on the heighten level of greenhouse gas and their effects on the climate change. In the USA, the greenhouse emission from the road vehicles has increased for over 25% from 1990-2011, now it contributes to over 22% of the total greenhouse emission of the country [20]. The reduction of greenhouse gas emission from the automotive sectors will foster the efforts on taken by the world to revive the impact of climate change, and for that reason AVs could play an essential role to reduce greenhouse effects on climate change. AVs are expected to reduce traffic congestion for over 60% by optimizing the traffic system [20]. According to [71], U.S. A traffic jams are estimated to burn 3.1 billion gallons of unnecessary fuel usage every year. Moreover, the number is expected to rise in the years to come, and is anticipated to reach to over 4.5 billion gallons by 2020. Traffic jams insert huge impact on air pollution as well, since most of the congestion take place in urban areas [71]. AVs are predicted to reduce fuel consumption up to 20%, as they would travel close to each other just few meters apart while improving traffic flows and reduce air pollution through smart traffic management systems [85] [18]. Between 30-40% of fuel is consumed when drivers are searching for parking slot in heavily congested urban areas [50]. Hence, overall fuel consumption is expected to be as low as 30% compared to similar non-AVs traffic flow [73]. Furthermore, the synergy between electric vehicles (EVs) and AVs is very feasible and anticipated that AVs will adopt EVs technologies especially on urban trips to promote and enhance green cities and cleaner environment [25]

Ownership: On average, cars are only used about 4% of their lifetime [78], and even during peak interval doesn't exceed more that 17% [20]. Cars contribute to the largest purchases on consumer's products and one of the uppermost annual expenses [78]. Consumers are increasingly exploring new options to have access to personal transportation. Services like car sharing and ridesharing have gained more popularity over the past few years. In fact, the membership for car sharing in Europe has triples between 2006 to 2010 [72]. In 2010, the sales drop by 11% for customers grouped between 21-34 of age, this indicates a growing consumer behavior to favor more on-demand access of the service or product rather than full ownership, sometime stated as shared economy [76]. The concept behind shared economy is an approach where by fewer resource are used and operated efficiently. AVs are expected to contribute immensely in the proficiency operation of the resource and sustainability compared to current taxis or privately owned vehicles [25]. Since some of AVs may not require drivers, they could be offered as short term service-base rental possibly as an extended service of current mobility companies such as Uber or Lift. This reduction of cost towards driver's wages may also result to many mobility companies to adopt to AVs. Thus, AVs are anticipated to transform incumbent taxis, rental car and shred car services with new or transformed business models [25] [73]. Simulation conducted by OECD's International Transport Forum suggested that a shared AV could serve a number trips equally to 10 privately owned vehicles. This due to high percentage of 87% of workers in the U.S. who prefer to commute using door to door transportation service mode [78]. Hence developing infrastructures to support shared AVs might be far better investment rather than new enhancing new transportation systems [74]. [76], suggested that an enhancement in shared vehicles business models will provision lower price option to those people who can afford the premium price of buying an AV. The cost of adopting shared AV will be lowered compared to current transportation services (taxes or buses) [73]. Hence, AV will reduce the necessity of infrastructure enhancement as they could systematic operate and coordinate to optimize road utilization and may even lower the number of vehicles on the road due to flexibility and convenience of car-sharing business model [25].

Thus, AV may also reduce the natural resources needed for cars production and the space dedicated to parking slots for cars especially in urban areas.

Mobility: Since AVs are expected to drive with no driver, this will stretch mobility experience towards the group of individual who are currently unable to drive. Due to the current existing features like self-parking, door-to-door chauffeur and automatic refueling, in time the only requirement will be the ability to hop in the car and set destinations [20] [12]. AVs will extend mobility possibility to those individual who are not at the age of getting driver's license or too old to drive [25] [20] [73]. Individual with disabilities or visual impairment could also get access to personal cars and operate it themselves without any assistance from anyone [25] ([73]. For instance, 14% of the population in Canada are recorded as disable while 25% are seniors above 65 and do not have driver's license [25]. This segment of population is anticipated to be twice in numbers by 2050 [26].

Moreover, previously people with disability and visual impairment were exclude in the driving population while with AV, these segments of population would have access to vehicle transportation without reliant on any one to drive them [5] [25]. Finally, AVs, are also expected to shelter users from dangers such as heart attack, fatigue, intoxicated drivers and other unexpected health issues [5].

Road Safety: Road traffic causes over 1.24 million deaths, and 20 to 50 million injuries per annum [84]. Over 90% of road accidents are direct results of human error [51], and 40% of fatal accidents in the USA involve driver's distractions, drunk or drug use [52]. Driver's distraction is a problem that increases exponentially, with all these smart phones and social media hype going on around, releasing the car that can observe traffic and take appropriate smart action and keep you safe while driving, will have positive benefits to the driving experience and road safety. Most of the deaths caused by traffic accidents occur in under developed regions, where the optimal adoption will be experience later than those developed regions of the world. Yet, even in country like U.S, more than two million people are treated in the emergency rooms, while more than 30,000 lose their lives as results of road accidents every year [74]. Youth are among the most affected by these accidents, since, cars accident remains as the primary cause of death for American youth aged 15 to 24 [13].

Among 3500 transport professionals in London, most of them envisaged that AVs would improve safety and security to all users of the roads [9]. According to [20] predictions, once there is more than 10% market penetration of AVs the result will impact on the reduction of road accident by 50% compared to traditional cars, while when the market penetration is over 90%, road accident would also be reduced to 90%. Thus, level [4] AVs are anticipated to drastically reduced both causes and the number of accidents occur through road accidents [20].

Traffic Efficiency: AVs grasp significant potential for enhancing traffic efficiency, as a result, it is most likely to drastically reduce transportation time for users as well as insert huge economic impact to the society. These vehicles are anticipated to run much

faster and efficiently in congested traffic while maintaining proximity between vehicles and hence reduce congestion to up to 60% [20]. Average American commuter waste around 42 hours per year in traffic jams [71], therefore traffic flow enhancement will significant reduce travel time to users. Furthermore, the potential for time saving with AVs is much higher as currently around 30 to 40% of traffic in urban areas is due to drivers seeking for parking lot close to their desired destination [50].

Hence, with AVs, considerable amount of time would be saved as these vehicles could be directed to pick you up and drop you off to your desired destination with minimal time consumption [78], self-parking with optimal parking slot [20], and automatic recharging or refueling [12]. Moreover, AVs could also carry out user's errands, like dropping their children to their soccer practices or picking up their wives or husbands from work [25].

Nevertheless, in addition to reducing time needed by the user to be in the vehicle, AVs will also free up time currently used on driving the car itself. As currently in the U.S, an average of 6-7 hours is spent per week behind the wheels [73]. Having AVs, drive for you may also affect the perception and lead to users being productive by utilizing this freed up time in other important matters, and this can even change people to be more tolerate to long hours of travel as they can work or entertain themselves while on commute. While other may even find it more cost effective, time proficiency and flexible to move their offices in the cars rather than in a building as we are used to it currently [25].

Driving Experience: Currently most of the cars are built to enhance the driver's ability to drive the car; on the contrary, AVs are designed to enhance passenger's comfort while driving, provide entertainment while driving and improve productivity. This will heighten driving experience for many users, making driving more comfortable and stress free [76]. With such advancement in AVs, it is projected that performance in terms of speed and power won't be among the features to attract customers in the future [74]. Furthermore, most of the drivers in our days are more concern on getting to the destination quickly, safely and comfortably, rather than the experience of driving [73]. Advanced content offering and connectivity are anticipated to drastically improved and optimize the value scheme of the car to many users while becoming an optimal approach where by users can monetize their time spent in cars, and this could be accomplished through cloud platforms [73]. Particularly youth are mostly expected to appreciate the new opportunities offered by AVs. As according to [29], found out that more than 39% of youth's commuters using different mode of transportation while multi-tasking compared to 23% for other age population [16].

Factors Prone to Autonomous Vehicles Cloud: The evolution of automotive industry from manual operated vehicles to autonomous vehicles will pose many challenges in the industry. Some of these challenges are the outcome of massive number of sensors and actuators deployed in the AVs, together with an immense amount of data generated by the AVs through these devices. Other challenges can be due to the nature of AVs with self-driving capability which allow driver or user to engage in other activities while driving, resulting to limited time for a driver to respond to immediate danger or emergencies on the route (Gill, et al., 2015). In this section the author reviews challenges and their impact on the AVs protocols and applications while focusing on the AVs cloud architecture design.

Beacons and Alarms: One among essential features for vehicle cloud is the beaconing and alarms. As they play an important role with collaboration of the sensors and actuators to keep the vehicle and passengers out of harm's way while driving. However, sensors and actuators alone are not sufficient to sustain stable operations in high speed with dynamic variations on the road. Hence, it was realized that communications between front and rear vehicles is required to avoid unnecessary collision. Furthermore, V2V (Vehicle-to-Vehicle) communications are essential to avoid the creation of the shock waves in a long queue of AVs while trying to sudden slow down or accidents occurs in front. Nevertheless, intersection collisions won't be a critical issue once most of the cars on the road are AVs, as they adhere to signaling and speed limits and approach intersections with extra wary unlike human (U.S Department of Tansportation, 2012) .

Infrastructure Failure: AVs involve stable and reliable infrastructures (e.g. Wi-Fi access pints, LTE etc.) for optimal operations. In the instance of major infrastructure failure because of natural disasters or accidents, some these AVs functionality must be curb with the presence of human drivers. However, there is still a gray moment, between the time when infrastructure failure occurs until when human takes over the operations, during this time the AVs must be able to neutralize the problems on its own until human take over. This window is very critical and must be address to ensure safety and reliability of the AVs in-route. To avoid another disaster caused by the AVs going out of control, it is essential to maintain V2V propagation support through advanced traffic conditions updates and adjacent maneuver enshrined in the AVs specifically for unexpected and dynamic occurrences on the road. This approach will provide room for AVs to apply intelligent routing decisions and give time for the driver to proficiently take over driving [42].

File and Media Downloading: Reliable and effective downloading of multimedia to drivers and passengers will be among the critical marketing approach for the automated driving experience. Hence, initial studies in this area has proven that in case of crowded wireless access points, the download of the content from the web applications is best done over the bit-torrent techniques through V2V support mechanism [39]. Downloading these contents using Wi-Fi or LTE alone will not be sufficient and might not work effectively. For example, let's take a driver in a convoy bumper to bumper at 60 mph will only be reassured, if the AVs will be able to capture and display the video of the lead car which is the cause or source of the accident. This will give a driver an impression of being in control and heighten his/her confidence level to overcome the accident or natural disasters using smart techniques and maneuver suggested prior by the downloaded video from the scene. The following scenario elucidate a media file propagation in the event of accident, the AVs receive beacon from the front car or road infrastructure as an alert of an accident ahead. Once an AVs need to verify on the condition of the road where the scene took place, AVs will send a request of the content from the scene through NDN, where it will respond with the video or picture of the camera facing the accident, followed by other cameras around the area creating clear situation of the scene and let the AVs or the driver to take a necessary action facilitated by the ITS (Intelligent Transport Systems) [28]. Other vehicles can also join the multicast tree and retrieve the information. However, this podcast can only be facilitated by V2V communications, LTE would involve with too much latency, causing difficulties to scale up with respect to the demand [29]. Hence, effective and proficient communication models must be introduced to address issues of fast and reliable communications between vehicles, infrastructures and the internet.

Virtualization : Virtualization is one of the essential feature of cloud computing and facilitating an important role in VCC especially in the case of AVs. Due to the myriad of sensors embedded in AVs, the vehicle may sometime acquire to conduct data mining process, for example when an AVs receive an alert of the fugitive on the run, and the AVs will need to verify the picture or the person or car from its data obtained from the sensors and cameras, this is when virtualization will come in handy. Virtualization will also be essential in case of driver's privacy as well as the sensitivity of the apps adopted by the AVs. Besides, providing privacy and heighten computing capabilities, virtualization is also very important when it comes to AVs applications where customization is necessary for effective and efficient operations. For example, when the car manufactures will be able to access all CAN (controller Area Network) of sensors and cameras, while other cars around AVs can only access external cameras and alert from sensors beacons [29]. Thus, virtualization is extremely important for optimal success of the ITS and AVs.

Security and Privacy: Despite the common security and privacy concerns of the cloud computing adoption. AVs are even more

susceptible to malicious attacks that may cause significant impact to the security and wellbeing of the passengers, such attack might be disabling brake systems or locking the steering wheel etc. This incident will be extremely dangerous for AVs as sometimes there will be no stand-by driver to take over the wheel, and even if there is, the driver won't be able to take over control as the car is digitally disable from a remote location. For this reason, it is imperative to design and engineer AVs systems with high security algorithm and tools, so as to be free from external and internal vicious attacks. Yet, it is still essential for AVs to have access option from remote operators, in case of the vehicles being out of control or malicious attack, it can be rebooted and controlled remotely and save any anticipated disaster. Services such as On-Board Diagnostics (OBD) and CAN bus controller must be allowed in specific circumstances in order to be able to provide anticipated security and safety of the driving experience with AVs. One of the common research on these security issues is multi-factor protection strategy [39], the figure below illustrates how the data reading take place between vehicles on the cloud. The neighbor car will submit only one type of credential to acquire data from the AV (e.g. image of the accident scene). However, the strategy demands each access to be verified and authorized by two different authorities prior to access, for example AVs manufacturer and municipal authority concern with ITS [42]. In this approach, each AV can prioritize different access request according to their priority level. This might be enhanced by increasing credential factors in the strategy through different protection levels.

4. Theoretical framework

Theory of Reasoned Action (TRA): TRA states that individual conduct is determined by the distinctive intention to perform the behavior, where by individual character and personal standard are subjected to conduct of that behavior. The approach is realized by either positive or negative emotions which might result as an outcome of conducting specific behavior. Individual standard refers to the person's perception on the social pressure exert on them to conduct the behavior [21]. Reason behavior is realized through an evaluation of one's intent with respect to the outcome emerging from a conduct and an analysis of the appealing outcome. The general state of mind can be analyzed through individual results and appealing factors analysis for every outcome of the conduct. Subjective standard is categorized as an individual perception of whether other people susceptible to the conduct that is to be performed. Attitude is determined through personal beliefs and evaluation of one's beliefs towards specific need to use something. While subjective norm is determined through normative beliefs and motivation comply which lead to intention and then behavior to adopt as elaborated in the Fig. [1], [21].

Theory of Planned Behavior (TPB): TPB is a theory based on the individual behavioral norms, which elucidate the behavioral choice process via an individual's behavioral attitude, subjective norm, behavioral intention and actual behavior [4]. Behavioral intention is the power of will for one's intention to conduct particular behavior, which can be determined by the attitude and individual norm. Individual norm is the person's perception on what other important people around him perceived he should or should not do regarding the behavior in question [21]. Behavioral attitude is subjective positive or negative feelings towards performing the specific behavior question [21]. Attitude is envisaged to the result of an individual beliefs regarding the behavior, where by in innovation or technology adoption perspective refers to the individual belief regarding towards the innovations factors as shown in Fig. [2]. [4].

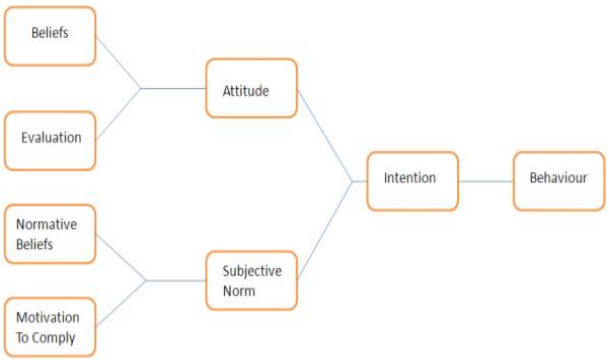


Fig. 1: Theory of Reasoned Action (TRA).

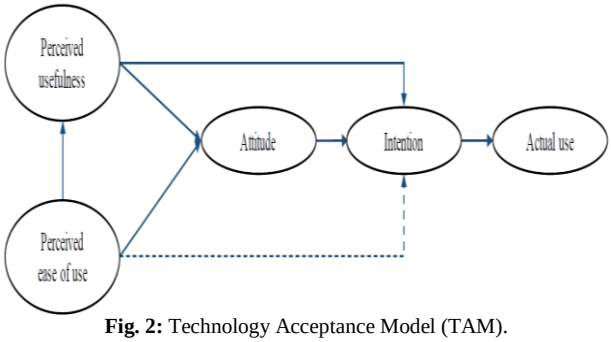


Fig. 2: Technology Acceptance Model (TAM).

Technology Acceptance Model (TAM): Davis introduced Technology Acceptance Model in 1986; it has been applied widely in many studies relating to user's acceptance of the technology. TAM has been very useful in explaining the success and failure of many technologies. To many researchers, TAM is a popular model that not only predicts but also explain the behavior of the use of information technology [79]. The model consists of two main variables; Perceived Usefulness, which means the perception of people towards using a specific technology, how that technology will improve their lives or job performance while using it; and Perceived Ease of Use, means how easy is it to use that specific technology [15]. TAM has been applied in many technology adoption theories in different business sectors. It was used in the investigation of South African SAP ERP user environment and the results concluded that the utilization of technology is directly prone by the behavioral intention to utilize the technology, and indirectly affected by the perceived usefulness [19]. [50], applied TAM to study how can beliefs and attitude of the faculty members influence them to actual use or intend to use the new Learning Management System (LMS) in the Auburn University. The results concluded that perceived usefulness, quality of the system and accessibility were the main factors of the member's attitude towards the new learning system.

Diffusion of Innovation (DOI): DOI was initially developed in 1960s to elaborate the dissemination of innovation in time through social systems [65], and has been utilized in thousands of researches covering the adoption and diffusion of variety of innovations and technologies [82]. The theory comprises of five main entities, which are; relative advantage, compatibility, complexity, trial ability and observability as illustrated in Fig 3. [65]. The theory investigates factors and the rate of penetration of the new technologies through cultures and societies, operating at the individual as well as organization level. According to [65], innovations disseminate through particular channels over certain period and within specific social segments. There are five main segments of the individual willingness to accept innovations, which are; innovators, followed by early adopters, early majority, late majority and laggards respectively [65]. DOI was applied to analyze the adoption of collaborative commerce in Malaysia, where 109 Malaysian institutions were surveyed [14]. It was also used in the adoption of Radio Frequency Identification in Taiwan manufacturing industries, where 133 firms were surveyed through email [81].

Unified Theory of Acceptance and use of Technology Model (UTAUT): Unified theory of acceptance and use of technology is a technology adoption model introduced by [79]. The model facilitates the investigation of user acceptance of innovation or technology with respect to unified perception of the main intentions leading to the use of information system and related conduct. The model has numerous attributes which include; effort expectancy, performance expectancy and social influence determined by the intention behavior to use technology facilitated by the determinate of user behavior described in Fig 3 [68]. The model was introduced as a result of merging eight models previously studies described as the information system usage conduct.

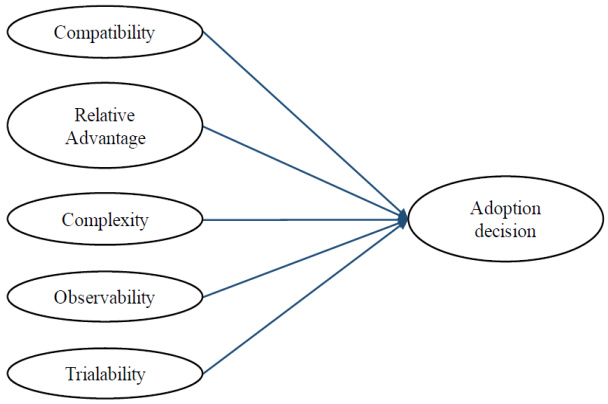


Fig. 3: Diffusion of Innovation (DOI) (Rogers, 1983).

According to several research conducted over the years, it was determined that out of 70% of the variations in behavioral intention to use technology, 50% was the actual use [32]. The main objective of UTAUT is to facilitate the adoption of technology by provisioning a model to underpin the introduction of innovation or technology, which will analyze the user perception towards using such technology [79].

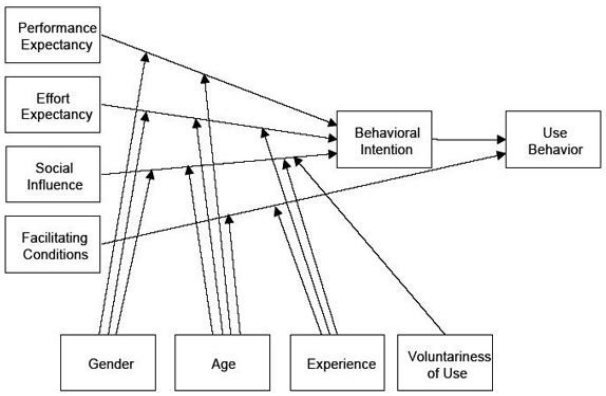


Fig. 4: Unified Theory of Acceptance and Use of Technology.

Key Considerations in the selection of Conceptual Model: The situation where by individual has persona opinion regarding the establishment of procedural setup which is meant to sustain exploitation of a particular innovation. According to Abraham, (2013), there are three theories dominate the demonstration of expectancy notion, perceived ease of use from TAM, complexity from MPCU and compatibility of Use from DOI [1].

Expected Performance: The level which differentiate individual confidence in utilizing a certain innovation or technology that will improve his/her personal development in occupation presentation. The main five behavioral concepts dominate performance expectancy from TAM in collaboration with TPB, extrinsic incentive from the motivational model, job-fit from PC utilization, proportional advantage from DOI and result in expectation from SCT [79].

Effort Anticipation: The standard of easy to use which is related with the deployment of a certain system. The three-main attribute constructed from behavioral theories which dominate the performance expectancy are; anticipated ease of use from TAM and the observability and compatibility from DOI [79].

Social Influence: It is the situation where by the social perception on the confidence of the person or group responsible to deploy specific system. This elucidation prospect three main different concepts in co-existing models; subjective norms from TAM and TPM, social influences from MPCU and perceived image from DOI [79].

Conceptual Model: The proposed model is an extension between two adoption theories, focusing on the factors which will prone consumer's intentions to use autonomous vehicles with cloud applications. The building block of this model is derived from two models which are envisaged to be among the leading model in school of thoughts, which is TAM and DOI. These models have been successfully used in many adoption studies from different region of the world, covering the adoption of several technologies. Perceived ease of use and usefulness from TAM will facilitate the investigation on the factors leading to acceptance behavior towards the technology. Compatibility from DOI, provision an insight on the consumer's intention to use such innovation. These variables will be empirically investigated using secondary studies and surveys over suitable population number as part of further research.

Reelevance for extension of DOI and TAM: TAM and DOI represents the two leading schools of thoughts. These models have been applied to investigate potential consumer adoption intentions and behavior through wide range of products and services [6] [79], including research on consumers' intention to use car innovations [31] [60] and product autonomy [64]. It has been argued that neither TAM nor DOI is adequately reflect the central influences on consumer adoption, yet they contain concepts that could be used to enhance each other's descriptive power [7] [61] [79].

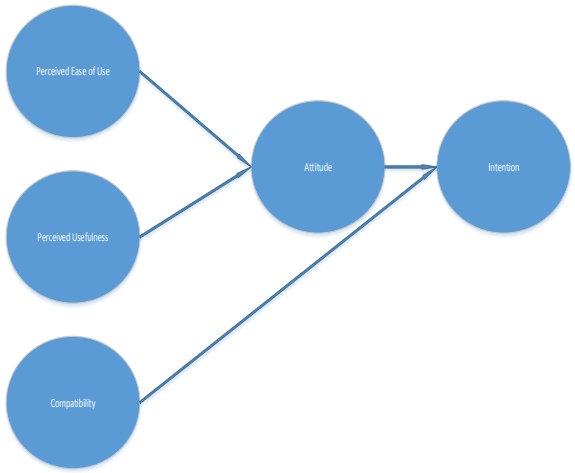


Fig. 5: Proposed Model (Self-Drawn).

In this research, efforts are made to integrate these two models in order to come up with an extension framework which will assess consumers' intention to adopt autonomous vehicles and use the cloud applications based on perceived usefulness, ease of use and innovation compatibility as suggested by TAM and DOI.

5. Conclusion

Finally, the studies on cloud adoption necessitate coherent adoption approach and service model used. Factors influencing the adoption scale differ depending on service model deployed. Issues such as security and compliance have been identified as major impediments that must be considered and overcome for an incumbent IT services to be ready for cloud computing. Hence, empirical covering extensive research on factor affecting adoption of cloud computing across service models are currently insufficient in the literature. As more researches are being conducted, researchers will be in a better condition to identify these factors and

their role and influence in the adoption of cloud computing among different service model. This will also open-up to new techniques and adoption approach towards specific service model within distinctive business architecture.

6. Future work

There is also a wide gap between the adoption of AVs and the legal framework that will assure privacy and security of AVs cloud data. Therefore, as a future work this research will focus on understanding user perception of the AVs and cloud applications while providing a modular framework to underpin the adoption approach for technology firms, automotive manufacturing companies as well as other related institutions. The framework will facilitate a systematic approach by understanding factors influencing the adoption of cloud computing into the AVs and also proposing a conceptual model to support the adoption process.

References

[1] Abraham, G. C. J. &. B. I., 2013. Technological-personal- environment (TPE) Framework, A Conceptual model for technology acceptance at individual level. Journal of International Technology and Information Managemen, 14(10), pp. 585-616.

[2] Adai, M. A.-M., Moamin, A. M. & Mohd, S. A., 2016. Modeling the adoption of internet of things services:A conceptual framework. International Journal of Applied Research, 2(5), pp. 361-367.

[3] Ahlgren, B. Et al., 2012. A Survey of Information-Centric Networking,. IEEE Communications Magazine, 50(7), pp. 26-36.

[4] Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processess. Heidelberg:Springer., 50(2), pp. 179-211.

[5] Araujo, L., Mason, K. & Spring, M., 2012. Self-driving cars: A case study in making new markets. London, Lancaster University.

[6] Arts, J. W. C., Frambach, R. T. & Bijmolt, T. H. A., 2011. Generalizations on consumer innovation adoption: A meta-analysis on drivers of intention and behavior. International Journal of Research in Marketing, 28(2), pp. 134-144.

[7] Bagozzi, R. P., 2007. The legacy of the technology acceptance model and a proposal for a paradigm shift.. Journal of the Association for Information Systems, 8(4), pp. 244-254.

[8] Bec, C., 2015. Driverless cars could reduce traffic fatalities by up to 90%, says report. [Online] Available at: http://www.sciencealert.com/driverless-cars-could-reduce-traffic-fatalities-by-up-to-90-says-report [Accessed 10 01 2017].

[9] Begg, D., 2014. A 2050 vision for London: what are the implications of driverless transport.. S.l., Clear Channel.

[10] Berger, S. Et al., 2006. Virtualizing the trusted platform module. California, USENIX Association, Berkeley.

[11] Blackley, A., Peltier, J. & Peltier, T., 2004. Information Security Fundamentals. Auerbach Publications, 14(1).

[12] Bolton, D., 2015. Tesla unveils its bizarre new 'Snakebot' automatic car charger. [Online] Available at: http://www.independent.co.uk/life-style/gadgets-and-tech/news/tesla-unveils-its-bizarre-new-snakebot-automatic-car-charger-10446120.html [Accessed 07 02 2017].

[13] CDC, 2011. Injury Prevention and Control: Data and Statistics. Atlanta, Center for Disease Control.

[14] Chong, A., Ooi, K., Lin, B. & and Raman, M., 2009. Factors affecting the adoption level of c-commerce: An empirical study. Journal of Computer Information Systems, 50(2), pp. 13-22.

[15] Davis, F. D., Bagozzi, R. P. & Warshaw, P. R., 1992. Extrinsic and intrisic motivation to use computers in workplace. Journal of Applied Social Psychology.

[16] Deloitte, 2014. Exploring consumers' mobility choices and transportation decisions.. S.l., Global automotive consumer study.

[17] Dr. Harald, B., Mark, P. & Jan, V., 2015. The Internet of Things: Opportunities and Challenges for semiconductor companies. New York, mckinsey&Company.

[18] Dumaine, B., 2012. The Driverless Revolution. Fortune, 166(8), pp. 31-32.

[19] Etienne, E., Sebastiaan, R. & Chrizanne, v. E., 2015. A structural model of technology acceptance. SA Journal of Industrial , 41(1), pp. 1-11.

[20] Fagnant, D. J. & Kockelman, K., 2015. Preparing a nation for autonomous vehicles: Opportunities,barriers and policy recommendations. Transportation Research Part A: Policy and Practice, Volume 77, pp. 167-181.

[21] Fishbein, M. & Ajzen, I., 1975. Belief, attitude, intention, and behavior: An introduction to theory and research. Reading, MA. Addison-Wesley.

[22] Friedman, A. & West, D., 2010. Privacy and security in cloud computing. The Centre for Technology Innovation, pp. 1-11.

[23] Garfinkel, T. Et al., 2003. Virtual machine-based platform for trusted computing. ACM Symposium on Operating Systems Principles SOSP.

[24] Gerla, M., 2012. Vehicular Cloud Computing. IEEE Med-Hoc-Net.

[25] Gill, V., Kirk, B., Godsmark, P. & & Flemming, B., 2015. Automated vehicles: the coming of the next disruptive technology.. Toronto, The Conference Board of Canada.

[26] Goguen, F. J. & Connolly, J. D., 2015. Automobiles and the Age of Autonomy. Boston, The Boston Company.

[27] Google, 2014. Google self-driving car project.. [Online] Available at: https://www.google.com/selfdrivingcar [Accessed 07 02 2017].

[28] Grassi, G. Et al., 2013. Vehicular Inter-Networking via Named Data. ACM hotmobile.

[29] Grassi, G. Et al., 2013. Vehicular Inter-Networking via Named Data. ACM hotmobile.

[30] Huang, J. Et al., 2012. A Close Examination of Performance and Power Characteristics of 4G LTE Networks. ACM mobisys.

[31] Iwai, A. & Aoyama, M., 2011. Automotive cloud service systems based on service-oriented architecture and its evaluation. Washington, IEEE International Conference.

[32] Jansson, J., 2011. Consumer eco-innovation adoption: assessing attitudinal factors and perceived product characteristics. Business Strategy and the Environment, 20(3), pp. 116-125.

[33] Kate Magsamen-Conrad, 2015. Bridging the Divide: Using UTAUT to predict multigenerational tablet adoption practices. Media and Communications Faculty Publications, 6(2), pp. 10-43.

[34] Khuram, S., 2016. Cloud Robotics and Autonomous Vehicles. INTECH RESEARCH-ARTICLE

[35] Krautheim, F., 2009. Private virtual infrastructure for cloud computing. IEEE Conference on Hot Topics in Cloud Computing, pp. 1-5.

[36] Kuffner, J., 2010. Cloud-enabled Robots. Nashville, IEEE-Ras International Conference on Humanoid Robotics.

[37] Kumar, S. Et al., 2012. Carspeak: A Content-Centric Network for Autonomous Driving. ACM SIGCOMM.

[38] Kuyoro, S. I. F. &. A. O., 2011. Cloud Computing Security Issues. International Journal of Computer Network (IJCN), 3(5), pp. 247-255.

[39] Laberteaux, K. & Haas, J. A. H. Y., 2008. Security certificate revocation list distribution for VANET. ACM International Workshop on Vehicular Internetworking,, pp. 88-89.

[40] Lee, K. Et al., 2011. First Experience with cartorrent in a Real Vehicular Ad Hoc Network Testbed. VANET MOVE.

[41] Lynn, W., 2014. 4G LTE coming to 15 car makers, which ones, when?. [Online] Available at: http://www.autoconnectedcar.com/2014/09/4g-lte-coming-to-15-car-makers-which-ones-when/ [Accessed 10 01 2017].

[42] Marco, D., 2015. Cloud Computing and the Internet of Things: Service Architectures for Data Analysis and Management.. University Of Pisa:Department Of Computer Science, pp. 6-24.

[43] Mario, G., Eun-Kyu, L., Giovanni, P. & and Uichin, L., 2014. Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds. IEEE World Forum on Internet of Things.

[44] Markus, L. Et al., 2016. Insurers need to plug into the internet of things - or risk falling behind. New York, mckinsey&Company.

[45] Mckinsey, 2016. Car data: Paving the way to value-creating mobility. Perspectives on a new automotive business model.

[46] Mercedes Benz, 2015. Mercedes-Benz Actros with Highway Pilot - world premiere on public roads.. [Online] Available at: http://media.daimler.com/dcmedia/0-921-614341-1-1852861-1-0-0-0-0-0-0-0-0-0-0-0-0-0-0.html [Accessed 07 02 2016].

[47] Michael, A. Et al., 2010. A View of Cloud Computing. Communications of the ac m, 53(4), pp. 1-9.

[48] Michael, M., 2016. Cloud Computing: TOE Adoption Factors By Service Model In Manufacturing. @ Georgia State University, pp. 8-125.

[49] Michele, B. & Dominik, W., 2015. Ten ways autonomous driving could redefine the automotive world. Mckinsey.

[50] Mitchell, J., Borroni-Bird, C. E. & Burns, L. D., 2010. Reinventing the automobile personal urban mobility for the 21st century.. Washington, MIT Press.

[51] Nazir, A. $. M., 2012. Security Framework for Cloud Computing Environment. A review journal of Emerging Trends in Computing and Information Sciences, 3(2), pp. 390-394.
[52] NHTSA, 2008. National motor vehicle crash causation survey. Washington D.C, National Highway Traffic Safety Administration, U.S. Department of Transportation.
[53] NHTSA, 2012. Fatal analysis reporting system. Washington D.C, National Highway Traffic Safety Administration, U.S. Department of Transportation
[54] Nicholas, C., 2015. The hype over driverless cars: Is it overdone?. [Online] Available at: http://fortune.com/2015/02/18/the-hype-over-driverless-cars-is-it-overdone/ [Accessed 05 01 2016].
[55] Olariu, S. & Weigle, E., 2009. Vehicular Networks: From Theory to Practice. Florida, CRC Press/Taylor & Francis.
[56] Oliveira, T. & Martins, M. F., 2011. Literature Review of Information Technology Adoption Models at Firm Level. The Electronic Journal Information Systems Evaluation, 14(1), pp. 110-121.
[57] Payre, W., Cestac, J. & Delhomme, P., 2014. Intention to use a fully automated car: Attitudes and a priori acceptability. Transportation Research Part F: Traffic Psychology and Behaviour, pp. 252-263.
[58] Peter, B. Et al., 2015. The Internet of Things: Mapping the Value Beyond the Hype. New York, mckinsey Global Institute.
[59] Peter, M. & Timothy, G., 2011. The NIST Definition of Cloud Computing. National Institute of Standards and Technology.
[60] Peter, M. & Timothy, G., 2011. The NIST Definition of Cloud Computing. National Institute of Standards and Technology.
[61] Petschnig, M., Heidenreich, S. & Spieth, P., 2014. Innovative alternatives take action - investigating determinants of alternative fuel vehicle adoption. Transportation Research Part A: Policy and Practice, pp. 68-83.
[62] Plouffe, C. R., Hulland, J. S. & Vandenbosch, M., 2001. Research report: Richness versus parsimony in modeling technology adoption decisions: Understanding merchant adopadoption. Information Systems Research,, Volume 12, pp. 208-222.
[63] Prashant, G., Seetharamana, A. & Rajb, J., 2013. The usage and adoption of Cloud Computing by small and Medium Businesses. International Journal of Information Management , Volume 33, pp. 861-870.
[64] Ribeiro Dos Santos Leal, J., 2015. Explaining Organizational Adoption of Technology: The Case of Cloud Platforms for Internet of Things. University of Jyväskylä, Pp. 2-67.
[65] Rijsdijk, S. A. & Hultink, E. J., 2003. "Honey, have you seen our hamster?" Consumer evaluations of autonomous domestic products. Journal of Product Innovation Management, Volume 20, pp. 204-216.
[66] Rogers, E., 1995. Diffusion of innovations, Fourth Edition. New York, Free Press.
[67] Ron, D., 2015. The Internet of Things: Opportunities and Challenges. Brussels, European Union.
[68] Rosenzweig, J. & Bartl, M., 2015. A review and analysis of literature on autonomous driving. The Making-of Innovation, pp. 1-57.
[69] Salim, B., 2012. An Application of UTAUT Model for Acceptance of Social Media in Egypt: A Statistical Study. International journal of Information Science, 2(6), pp. 95-105.
[70] Santos, N., Gummadi, K. & Rodrigues, R., 2009. Towards trusted cloud computing. In Proceedings of hotcloud.
[71] Schrank. D., Eisele, B., Lomax, T. & Bak, J., 2015. 2015 urban mobility scorecard. Texas, Texas A&M Transportation Institue and INRIX.
[72] Sessa, C. Et al., 2013. Blueprint of alternative city cyber-mobility take-up scenarios. S.l., ISIS.
[73] Shanker, R. Et al., 2013. Autonomous cars: self-driving the new auto industry paradigm. Morgan Stanley Blue Paper.
[74] Silberg, G., 2012. Self-driving cars: the next revolution. S.l., KPMG LLP and the Center for Automotive Research.
[75] Spillner, J., muller, J. & Schill, A., 2013. Creating optimal cloud storage systems. Future General Computer System, 29(4), pp. 1062-1072.
[76] Sullivan, B. J. C., 2015. What will Drive the Future of Self-driving Cars?. New York, American Enterprise Institute.
[77] Tesla, 2014. Dual motor Model S and Autopilo. [Online] Available at: http://www.teslamotors.com/blog/dual-motor-model-s-and-autopilot [Accessed 07 02 2017].
[78] Thrun, S., 2010. Toward robotic cars.. S.l., Communications of the ACM.
[79] U.S Department of Tansportation, 2012. Vehicle-to-Infrastructure (V2I) Communications for Safety. New Jersey Avenue, U.S Department of Tansportation.
[80] Venkatesh, V., Morris, Davis & Davi, 2003. User Acceptance of Information and Communications Technology :Toward a Unified View. Management Information System Quarterly, 3(27), pp. 425-474
[81] Volvo, 2014. Autopilot: travel calmer, safer, cleaner. [Online] Available at: http://www.volvocars.com/au/about/innovations/intellisafe/autopilot [Accessed 07 02 2016].
[82] Wang, Y., Wang, Y. & and Yang, Y., 2010. Understanding the determinants of RFID adoption in the manufacturing industry. Technological Forecasting and Social Change, Volume 77, pp. 803-815
[83] Wejnert, B., 2002. Integrating models of diffusion of innovations: a conceptual framework. Annual Review of Sociology, 28(1), pp. 297-326.
[84] WHO, 2013. Global status report on road safety 2013: supporting a decade of action.. S.l., World Health Organization.
[85] Wright, A., 2015. Automotive autonom. Communications of the ACM, 54(7), p. 16.
[86] Yu, Y., Punihaole, P., Gerla, M. & and Sanadidi, M., 2012. Content Routing in the Vehicle Cloud. IEEE MILCOM.
[87] Zhang, Q., Cheng, L. & Boutaba, R., 2010. Cloud computing: state-of-the-art and research challenges. Journal of internet services and applications, 1(1), pp. 7-18.