Deep Science Publishing
https://doi.org/10.70593/978-93-49307-21-6_5

Chapter 5: The emergence of connected services and their impact on modern vehicle ecosystems

5.1. Introduction

We are on the threshold of the biggest transformation in the automobile industry since Henry Ford started the mass production of the Model T. Within the next couple of years, self-driving cars able to drive around cities without any human intervention will become a reality in a few cities, including Atlanta and Phoenix. Connected cars coming with a factory-installed sim card to enable Internet connectivity and multiple apps such as Google Maps, streaming of music and video services, and traffic, air pollution, and weather information will permeate the car market. Similarly to how mobile devices exploded from the beginning of the smartphone era, more than 90% of new cars sold in 2025 in the U.S. will be connected. Although the self-driving car will be mostly safe from external dangers, it will still be a target for attackers who would want to put people's lives at risk by taking control of the car or for purposes of extortion. Tailgating, how much distance to leave in different situations, or co-existing with pedestrians and cyclists are just some challenges that humans solve without thinking. Car manufacturers have to assure a high level of safety for such functions before deploying them in real-world conditions. Securing such functions is of utmost importance as multiple dented cars would cause the public trust in automated driving to vanish as fast as it erupted.

Despite years of advancement in driver assistance functions, the focus of safety-related standardization activities has been solely on the driver assisting functions and the interaction with the driver. As long as the car merely amplifies the capabilities of the driver and remains the final course of action, this is sufficient. However, non-conventional driving functions represent a paradigm shift in the control of the vehicle. The growing impact of consumer wearable health issues, e.g., drowsiness and seizure control, would also pose new issues. As driving guidelines and the driver assessment are currently not standardized, highly dependent on the manufacturer, and a strong ethical borderline exists, there is a big gap where standardization may address concerns. Standardization efforts cannot sufficiently address system safety to the same level of safety as road traffic scenarios. The task of safety assessment is twofold. First, the manufacturer needs to derive a safety case based on its knowledge and assessment. The manufacturer's assessment, however, can only be evaluated through an independent third party and has to be documented. As a benchmark for a safety impact assessment, the basic building blocks, and potential test cases for the evaluation are derived.

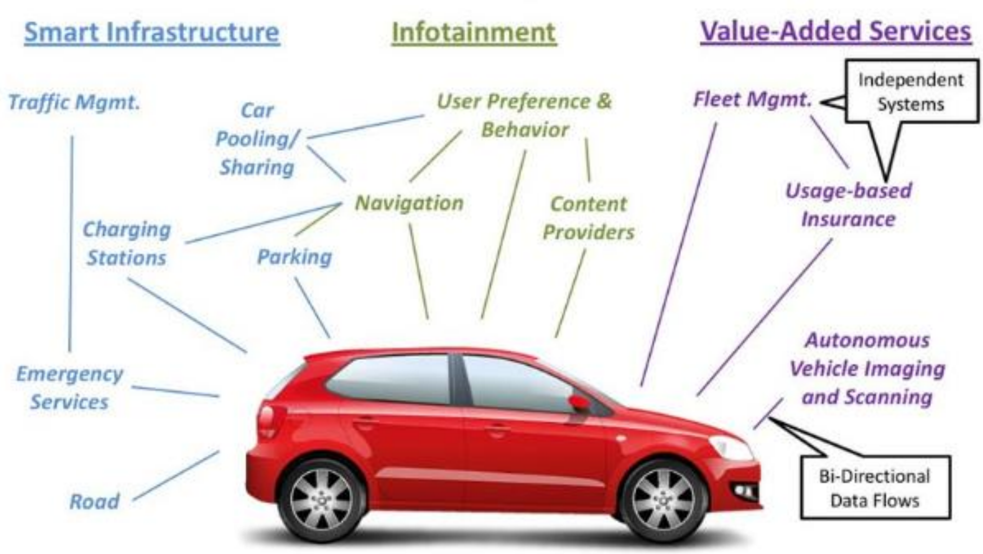

Fig 5.1: Connected and Autonomous Vehicle Data Ecosystem

5.1.1. Background and Significance

Modern vehicles are now equipped with a multitude of sensors and software applications that constantly generate vast amounts of data considering physical, environmental, and social situations. There is a growing need for a vehicle ecosystem in which vehicles will have a vehicular data cloud service-based collective intelligence to improve safety, comfort, mobility, and entertainment via a data sharing approach. To grasp this opportunity, manufacturers must collaborate to share the vehicular data clouds to provide enriched connected services. Connected services can be categorized into intelligent convenience, mobility, and safety services. All these predominantly examine the vehicular data to find driving behavior, on-road situation, vehicle state, and communication with a cloud service provider. For the connected services to be useful, many additional services such as road navigation, construction prediction, traffic management, information, entertainment, and business intelligence services have to be developed and deployed based on the vehicular data clouds. Some of these services mainly deal with the information from the vehicular data clouds, while others make the clouds more useful to contribute to a smarter city . However, numerous challenges hinder the success of vehicular data clouds. Security and privacy are still major issues that need to be addressed so that non-vehicular data cloud participants can provide diverse useful services without harming vehicles, drivers, and passengers' well-being. Vehicular data clouds are likely to be huge and may expand exponentially. Scalability will therefore be an obstacle that should be handled appropriately. The reliability of service requests and responses is critical for developing successful vehicular data clouds. To guarantee a certain quality of service, requested services should meet the required service quality standards. Also, there is a lack of global standards for the automotive cloud service and vehicular data cloud system. Moreover, another challenge is how to combine and organize the diverse vehicular data clouds from different automobile companies. These challenges depend on an appropriate approach that takes both technical and social aspects into consideration. To address this challenge, a systematic approach is suggested that is composed of three merged actions: Content scheme, Privacy scheme, and Social standard. Users should have a choice of how much data they want to share for what purpose.

5.2. Understanding Connected Services

Connected services are defined as automated, digitally delivered services from a mobile operator or third-party service providers that require a managed mobile connection. Accordingly, the connected services function as a prerequisite for realizing the connected vehicle environment, and they facilitate automated or efficient data gathering, processing, and a related application service for vehicles. Connected services comprise four categories, namely vehicle point services, vehicle services, fleet services, and data services. The definitions and service features of each connected service category are also introduced. Vehicle point services, which are the basic connected services, include vehicle-based services that refer to telematics and service operations based on in-vehicle or field data. These services are directly provided by the OEM or authorized service providers, while the related values are more focused on vehicle management or driver satisfaction. Vehicle services comprise aggregated vehicle point services or access other connected vehicle services that provide driving safety-focused value-added services such as route optimization services or vehicle malfunction monitoring services. Fleet services are the vehicle service orientation focusing on fleet or commercial financing. These services are the professional solution provider-involved service mode for vehicle fleet management or transportation. Data services provide the analytics services on data once it is collected, or stored data and share info for vehicle technologies with another vehicle or telematics service providers.

The connected services can be provided as integrated services, in which authorized third-party service providers or application companies can operate upon client data or integrate vehicle services and individual mobile applications, or can be deployed as divided functions, in which connected services are composed as separated execution functions. This service system component or fragmentation implies a higher difficulty in service design and an incentive danger for related stakeholders. Therefore, the anticipated service category fragmentation by OEM customization determines the resulting level of data exchange between vehicle service providers. In terms of system integration, the connected services should provide development to implement system-level service operations or local domain data gathering and processing. In addition, for viewing service status or inspection, connected services may provide a diagnostic client application to invoke status of service module or view service event logs.

5.2.1. Definition and Scope

In modern vehicle ecosystems, a new technology emerged: connected vehicles and connected services for vehicles (Automotive World 2024; Khambholja, 2024; MMC Gbl 2024). Significant communication capability was added in vehicles, enabling vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. Various services are being offered by third-party information and service providers using data harvested from vehicles via such communications. In this section, these connected vehicles and connected services for vehicles are defined. Also, scopes, kinds, and targets of connected service systems for vehicles are described. Connected services for vehicles are categorized by two indices: the service kind index and the service target index. The service kind index gradually expands from basic information services to complicated assisting services. The service target index of the connected services for vehicles can be divided into three categories: services for drivers, services for passengers, and services for vehicles. In each index, possible connected services for vehicles and their information requirements are presented. Connected vehicles and connected services for vehicles are defined, and scopes, kinds, and targets of connected vehicle services are described. This taxonomy will allow researchers a structured overview of this research domain and make it easier to identify possible future research topics . The automotive industry in a broad sense comprises not only the manufacturers of vehicles but also their suppliers (parts and equipment) and organizations of whole societal systems like traffic control as well as navigation systems. Connected vehicles are described as vehicles that can communicate with each other (vehicle-to-vehicle communication), with roadside operations (vehicle-to-infrastructure communication), and with portable devices like phones (vehicle-to-device communication). Connected vehicles are considered here in a narrower sense, i.e., vehicles that can communicate using short-range communication in the 5.9 GHz band. Connected services for vehicles are defined as services for vehicles in which drivers and/or passengers can receive information via communications with other vehicles, infrastructures, or information service stations. Such advanced vehicle-information services (AVIS) include both inter-vehicle services, such as cooperative collision warning and cooperative route guidance, and infrastructure to vehicle communication (I2V) services such as traffic state information service.

5.2.2. Types of Connected Services

Various connected services can be categorized into two categories according to the scope of service provision: basic services and extension services. Basic services are pre-selected services that service providers offer as a package. In general, these services are designed for the purpose of safety and security, and thus cannot be refused and revoked by users. Extension services are optional services that users can subscribe to. To cope with the broader revenue streams for the connected service business, numerous contestable services are available. They can be used to provide diverse infotainment services, and thus can vary depending on service providers. On the other hand, the violation of privacy caused by these controversial services has been raised as a serious concern.

An example of basic services is crash notification. This service involves the detection of a vehicle crash and a notification of the event along with the information on the driver's location to service operators. The connected vehicle checks whether pre-defined conditions of a crash event are satisfied by frequently collected traffic information. If any evaluation condition is met, the vehicle prepares a notification message on the crash event and sends it to the operator. To ensure a timely handling of the crash notification, voice clips or text operations are excluded from message content. Compared to the basic services, extension services have more diverse service activities. A subscription to connected vehicle services requires a registration of a different type of software based on the user's intention to use this service. Depending on her subscription, the user receives an activation notification message to set up her desired extensions.

An example of a travel time estimation service is given. This service has been distinguished between service requests and service responses. To check the traffic condition on a specific road section, the user sends a request message to the service provider. The service provider collects the traffic history of this road section from the connected vehicles passing through this road section. Based on this data, the provider estimates the travel time for this road section and sends it to the user as a response message. To minimize the treatment time of this service request, only the pre-computed raw data are transmitted to the client. Typically, service requests and responses are encapsulated in XML format.

5.3. Technological Advances Driving Connectivity

The emergence of connected services in connected cars can be attributed to a combination of technological advances and societal pressure for companies to develop management systems to organize and secure all services surrounding the vehicles. In this study, the focus is on the technological advances that have brought about the rise of connected services in vehicles. It is first explained what technological advances or implementations worldwide can be observed, after which a few examples are elaborated on through specific cases of companies. This separate analysis allows for converging analyses comparing the companies' approaches to connected services.

Within the automotive community, advances in technology have enabled connectivity from the smartphone to the car as well as new vehicle systems capable of processing various data. Smart sensors have been developed, which can scan and assess data within their environment. These developments create the foundation for implementing connected services within the vehicle. Furthermore, large technological corporations have programmed and gathered capabilities of actively processing vast amounts of data through cloud platforms. After a bit more than a decade, the automotive society is facing challenges regarding the implementation of these cloud-based services. Connected services heavily depend on the infrastructure, and so far, the platform has not proven reliable enough. Multiple hacks are ongoing, and nation-states appear to be working on closing their infrastructures. Additionally, new privacy legislation is ongoing. Another important development is the evolution of C-V2XC as a networking technology. What started as Darwin-based devices and WiFi-compatible Car-to-Car (C2C) communications has evolved into C-V2X, which utilizes mobile telephony cellular networks for even cheaper and more reliable communications.

Society has witnessed the advent of social networks and during the recent pandemic, streaming services have completely transformed the media industry with companies joining and competing for user's time. The same is poised to happen in the automotive domain. Players in this space are aware of this and compete to avoid the loss of data and user contact. Society's platform has penetrated and is now drilling down to the automobile domain. Navigational platforms are a first kind of service poised to penetrate the personal mobility system. These navigation platforms can process data to augment realism. The next applications will concentrate on providing new contact points to impact price, lead time, and time. Such platforms will start as in-place connected services but will eventually drill up into the digital cockpit in a multi-layered paradigm.

5.3.1. Internet of Things (IoT) in Vehicles

The Internet of Things (IoT) is starting to affect the automobile industry (Vemuri et al., 2023; KnowledgeAgent 2024). There are numerous efforts underway to make vehicles smarter and more connected with their surroundings, and early prototypes are already being developed. Smart, connected devices are enhancing the modern approach to vehicle design and improving the driving experience. To create a better understanding of what IoT means for the current vehicle ecosystem, how IoT is adding connectivity to vehicles, how consumers benefit from this connectivity, and what the future may look like, it is important to study how IoT is used in vehicles.

A number of IoT-enabled vehicle applications are examined. The automobile industry is still in the early stages of implementing IoT so actual implementations are not yet widespread. Researching prototypes that are close to real products and the practical designs leads to a better understanding of brands, platforms, and devices that are potentially relevant in the automotive market. As for non-automotive companies, many technology companies have entered the automobile and connected vehicle arena. Examining why this is happening, which technology companies are pursuing the automotive market, and how this is occurring will add one more point of view to better understand the current vehicle ecosystem.

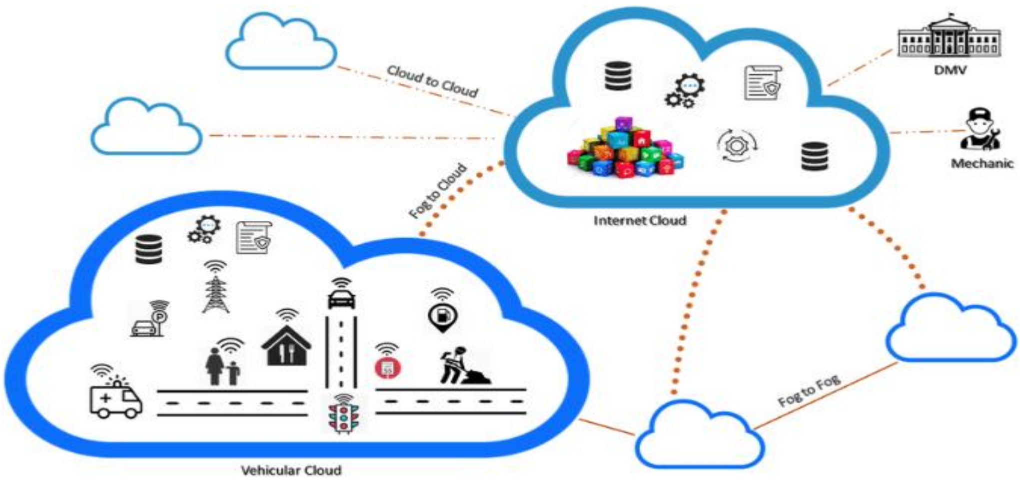

Fig 5.2: Connected Cars and Internet of Vehicles Ecosystem

The Internet of Things (IoT) refers to the phenomenon of increasing connectivity and communication capability between everyday objects through the Internet and standard communication protocols. In the IoT, even devices that inadequately exhibit standard input/output standardization or mechanisms can become a smart device and exchange data with other connected devices. IoT is opening up new markets and radically changing existing businesses. The Invisible Internet is established through the omnipresent Internet and the blossoming of low-cost sensors, actuators and microprocessors.

5.3.2. 5G and Vehicle Communication

Today, vehicle communication is increasingly relied upon as safety becomes paramount. Modern vehicle ecosystems use this technology to assist with connected services and smart driving. Connected services are applications that leverage onboard vehicular data and external information gathered from telematics or the cloud, and blended with advanced intelligence data analysis techniques. Various vehicles communicating and sharing Sensor Data (SD) such as Global Navigation Satellite (GNSS) coordinates, speed, and acceleration can create a vehicle-based sensor network, leading to the development of vehicular data sharing services. The ability to sense the use of in-vehicle sensors and perception technologies, share data across manufacturers, crowdsourced data, and create a more trusted environment will create a compilation of consumer behavior that attracts broader insights into traffic behavior and vehicle diagnostics. Because of these efforts, data-centric ecosystems can be created with concrete value in pre-collision check, reckless driving detection, or for insurance examination.

Furthermore, smart vehicle navigation capability will reduce accidents and ease traffic congestion. This driving style method will aggregate GNSS tracks to reconstruct the road maps and be used as the basis to compute the vehicle navigation state. As an extension to the vehicular data sharing, multiple vehicles with GNSS sensors can cooperatively navigate to track vehicles. By exchanging the latest GNSS locations, multi-vehicle navigation can provide a cleaner map database to enhance the positioning performance. Most pedestrian tracking and navigation systems only leverage a single mobile sensor. To accommodate both multiple-walking people and low-power watching sensor networks, this system considers an extensible pedestrian sensing framework to integrate both mobile and static sensors. Static sensors are deployed to monitor walking paths and generate the assistance location, while mobile sensors are used to mapping and tracking users.

5.4. Impact on Vehicle Design and Manufacturing

The growing access to connectivity changed the landscape of customer expectations and demand. Vehicles now are believed to be user extensions, and they are expected to work on behalf of the user even when unattended. Connectivity allows taking into account the user and the driving context. Like an intelligent personal assistant, the vehicle should facilitate actions, recommend choices, and intervene if necessary. A vehicle cooperative effect could be reached if the user takes part in the vehicle biosphere in an easy and natural way. Connected services intervene in the lifetime of the vehicle when it becomes an object and are viewed with a return on purchase investment. This perspective is reasoned as it enables sundry technologies that could shake the basic operating product model of the vehicle and enable new applications. Automotive manufacturers still develop basic solutions devoted to their own vehicles. Usage-based insurance, traffic or parking information, and user preferences storage are such applications. Those services tend to facilitate user experience alteration. Ground dimension answers to safety and pollution problems. Cars turn to active elements in the environment where they evolve. Bus and truck fleets are monitored to ease transport organization. Safety will be managed on a wider base; vehicles as well as the infrastructure can interact to ensure more efficiency.

Car connectivity creates new interactions with objects. Vehicles monitoring and remote personal assistance will be connected to intelligent objects in order to ease individual implementation on board and an enhanced vehicle function transfer. The vehicle will monitor the context of conduct: data fusion from sensors will enable the assessment of the quality of the environment surrounding the vehicle. This estimation and the degradation of driving conditions will trigger new changes in operation. Applications efficiently sail through all vehicle bio-refuge because of the higher amount and the dump of the car and environment status are virtual. Car designers and manufacturers are expected to shake vehicle surrogacy, the space where an application and its guidelines are created, though the forecasted user-friendly experience, the hidden parts of the vehicle status. A model is proposed to sum up the new surrounding actors, operating and environmental difficulties, heat, wind, rain, surface quality, and lights changes or stop and go. Complexities are connected together at different intermediate levels in the feedback loop.

5.4.1. Integration of Software and Hardware

As emerging technologies from the consumer electronics and IT technology fields crossover to the automotive domain, modern vehicles are being equipped with powerful sensors and networking and communication devices that can communicate with other vehicles and exchange information with the external environment. A connected vehicle is evolving to have devices that can be connected to other devices within the vehicle itself and/or devices, networks, and services outside the vehicle. The way we interact with our vehicles is rapidly changing, driven by the increased use of mobile devices, cloud-based services, and advanced automotive technology. The machine interface between automobiles and humans must allow for the seamless integration of several types of personal devices that support various software and hardware standards. Therefore, the future vehicle will have the capability of surround sensing, and can form connections between vehicles, as well as between vehicles and surrounding infrastructure. This will lead to increased requirements for information and communication technology, and ultimately, cars will become a part of the Internet in the near future.

The future mobility of the automotive industry requires new applications and technologies related to electric powering, automation, and connected services. The advances in cloud computing and the Internet of Things (IoT) have provided a promising opportunity in vehicular software and services in the automotive domain. In recent years, the demand for high-speed mobile internet services has dramatically increased; hence, the requirements and market demand for IoT device-connected cars will continuously increase. However, IoT-based vehicular data clouds must be efficient, scalable, secure, and reliable before they can be deployed on a large scale. IoT-based vehicular data clouds are expected to be the backbone of the system, with the goal of making driving safer and more enjoyable. Modern cars consist of complex embedded and networked systems with steadily increasing requirements in terms of processing and communication resources. Novel automotive applications, such as automated driving, raise new needs and design challenges that cover a broad range of hardware/software engineering aspects.

5.4.2. New Manufacturing Processes

A shift in the structure of vehicle manufacturing is a major challenge. The automotive sector is high tech and high volume—that is, highly automated. Extensive advances in technology have been made to reduce costs per unit produced, drive variability down, and produce high-quality products. Automotive manufacturing is very different from its consumer electronic and aerospace cousins. When a decision is made to manufacture a new laptop computer or an aircraft, a plant is built from the ground up to faithfully operate a specific series of processes that have successfully been run in pilot plants. Bills of materials that specify the right parts, and their suppliers; workstation layouts that specify the right machinery, and the right sorting, cleaning, assembly and inspection processes; volumes of data logging, monitoring, test and inspection plans; and modifications to suppliers' processes to reduce variability are all planned securely before production starts. By contrast, in the automobile business, each new product is the first of its kind. Stripped-down vehicles get produced for a protracted period and statistical process control is used to ensure quality as the product and processes are dialed in. And once robust, it's the production processes that get re-engineered for efficiency, rather than the products. So, the current level of process variability remains. This affects calculations of warranty costs, and mitigation of liability to the customer, and leads to fixed costs burdens on OEMs. These business-process-centric software vendors find themselves at a disadvantage over their pure-play competitors whenever the latter take interest. The commodification of manufacturing software rapidly unfolds and incumbents suffer the fate of turkeys immunized against avian flu.

Producing mostly the same vehicle for 20 years, the automotive sector is also famed for design invariance. However, this inertia is not a feature; it's a bug that is being repaired by new entrants with completely different design philosophies. The vehicles coming through are semi-autonomous and connected. They wirelessly capture all kinds of data from their environment, paving the way for completely new services. At the same time, flooding the cloud with data, they also expose themselves to competitors and threats unthinkable only a few years ago.

5.5. User Experience and Connected Services

Emerging connected services are largely focusing on the areas of Vehicle Operations, Context Data, In-Car Hardware, and Documents. Vehicle Operations include remote start, lock/unlock, battery status monitoring, odometer reading, and latest firmware updates. Context Data consists of construction zone alerts with detailed navigation guidance, and last departure reminder stored on the cloud server and sent as push notification. In-Car Hardware has in-vehicle Wi-Fi hotspot service and hardware module to enable smartphone mirroring with info-graphic display. Documents represent the retrieval of Continuous Data, Traffic Data, and Obstacle Data from the cloud server. Continuous Data has hazard events, traffic status, detection of the vehicle stuck in traffic, or a parking ticket fine notice. Traffic Data is composed of real-time speed of motorways, Lattice Information and map data or Environmental photos. In this regard, there are three types of service scenarios: the vehicle with no service; the service is running, but weak; and/or the service gets quality suddenly improved. The vehicle is sensitive to the waiting time, and meanwhile, it becomes more tolerant of the waiting time after a short delay of service response. With the growing demand for IT-based or Internet-based automotive services, scenarios for connected vehicle services along with recent research achievements, issues, and challenges of connected vehicle technology are overviewed. Connected vehicles are composed of smart vehicles, smart roads, and smart clouds, and their architecture is designed based on the service layer. Using theirs, car-to-home service is described, and effective implementation of smart vehicle manipulating vehicular IoT data cloud is provided as a use case. In addition, major research issues and possible resolutions such as automobile manufacturer's involvement, global standardization, V2X security, privacy, cloud service reliability, mobility, massive data management, etc. are highlighted. In order to be useful, vehicular data clouds need to develop and deploy numerous services such as road navigation, traffic-management, remote monitoring, urban surveillance, information, entertainment, and business intelligence, regardless of cloud service providers.

However, it is not easy to connect vehicles, which are inherently mobile, and to build a traffic management authority that handles vehicle cloud computing. Even though the cloud computing and IoT paradigm is rapidly evolving, the vehicular data cloud concept must be established at the forefront of the connected vehicle services. The growing integration of various intelligent transportations systems into vehicles indicates a certain level of connectivity or computing power from their adoption. However, the broad adoption of such cloud services is still limited, and many vehicles remain 'stupid' as stand-alone devices unable to utilize cloud services.

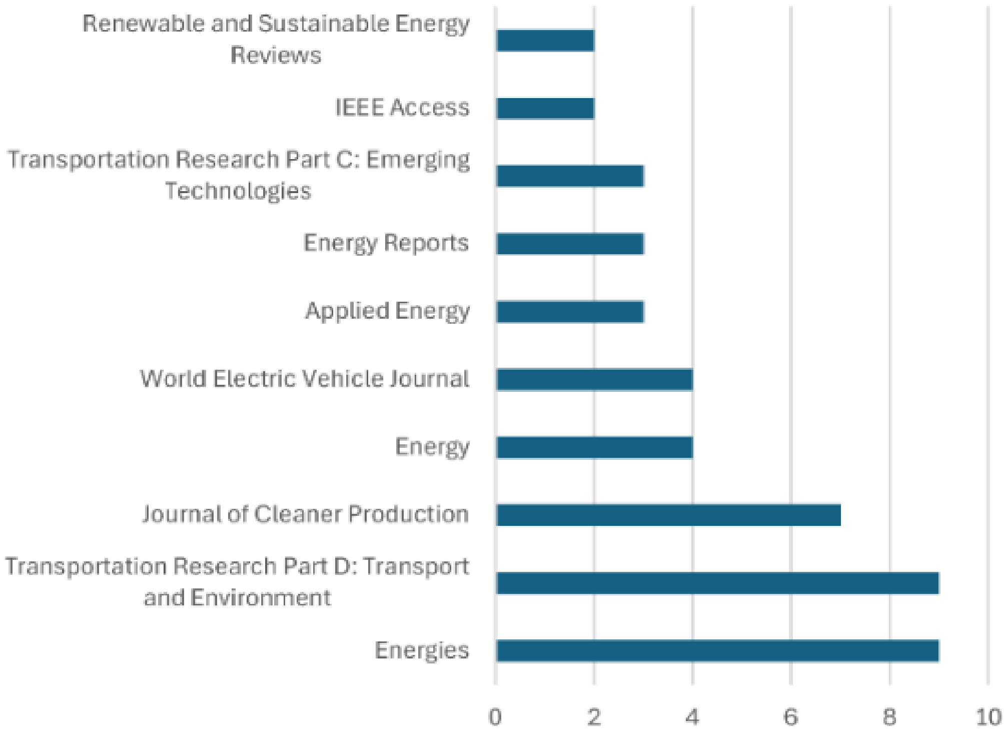

Fig : Electric Vehicle Adoption

5.5.1. Enhanced Navigation Systems

Navigation systems are expected to see significant advancements as a result of the connected services offered by the next-generation of connected vehicles. Equipped with integrated connectivity capabilities, connected vehicles have made it possible to provide navigation services at a whole new level. In the near future, traffic control and management centers will be able to access traffic data from vehicles on the road in real-time, enabling a drastic improvement of navigation systems. On the other hand, real-time communications regarding traffic accidents, large shipments, etc. will be delivered to vehicles on the road in real-time. Furthermore, an advanced satellite-based vehicle positioning system is anticipated to follow the advancements in the connected vehicle paradigm. Moving forward, the geographic information system is expected to evolve significantly by employing an elaborate spatial database. There is growing demand for home Internet of Things (IoT)-connected vehicles, which not only bring Internet access into vehicles, but also allow seamless interconnection with other IoT devices at home and services outside of vehicles such as buildings, businesses, etc. Access to data generated by vehicles is a necessity in order to derive valuable insights for next-generation services or corresponding transportation policies.

5.5.2. In-Car Entertainment and Connectivity

The emergence of in-car entertainment and automotive connectivity began in the early 1970s with the advent of FM Radio, AM Radios which became widely available as standard fitment in vehicles. Later, the automobile industry saw the introduction of multi-CD changers (up to 10 slots) into the vehicles, FM Radio Turners, and DVD players (which could be connected to display screens) in the second and third row of vehicles. There have been attempts by various auto manufacturers to incorporate streaming and playback of audio files, through phone connections such as Bluetooth, Auxiliary-in, USB port, etc. However, these still involved the user connecting their phone to the vehicle and starting the connection mode through different menus or buttons.

People now expect connectivity between vehicles and home and surrounding smart devices. Developing a smart vehicle connectivity system offers numerous prospects. Connected vehicles are influenced by the development of smart homes and wearable personal networks. Connected vehicles place enormous demands on mobile networks. The connected vehicle has an enormous amount of data to exchange with its companions. To deliver data to other connected devices, it is impossible to avoid using a mobile subscriber network. To make vehicles smart and provide continuous awareness of surroundings, knowledge management should be performed, which can change the scenario of the changing environment. Significant computing power is needed to synthesize available knowledge and deliver it to the vehicle so that driving mechanisms can adapt to the changing situation. In real-time request-requirement auto-expandable cloud and fog computing are needed. We expect that in-car entertainment includes a comprehensive package of safety, comfort, lifestyle, and infotainment expectations and should use technologies like Internet of Things (IOT) convergence, Cloud compatibility, and artificial intelligence.

5.6. Conclusion

Innovations in vehicle design and manufacturing have focused on improving safety, performance, and comfort through the integration of more sophisticated and automated control systems. On the other hand, the transportation paradigm has also changed dramatically. More devices, networks, and services are connected to our vehicles, and these connected services, aided by its connected devices, surrounding networks, and cloud systems, are becoming more and more intelligent. In these smarter ways of transportation, innovative connected services can be provided, where some cloud systems provide and evaluate data requested by other systems. However, the integration of such connected services usually requires tight cooperation between various stakeholders involving high development and operation costs and legal issues. Correspondingly, vehicle manufacturers have difficulties in quick and consistent service provision.

In the future, timeless connection is expected to be the fundamental property for a vehicle, which has a huge opportunity of data collection and sharing, whether it is actively connected to external environments or not. Moreover, vehicles will also be moved towards the cloud with a comprehensive architecture where a vehicle, its connected services, and associated networks are viewed as a physical pool rather than a simple device. In this way, devices and networks can be automatically connected, and its associated services are automatically enrolled and transparently provided, enhancing vehicle connectivity.

However, ensuring car security is important in modern vehicles. This security concern has been intensified by the development of connected services. In the future, vehicles are expected not only to be connected to the Internet but also capable of constructing a personal network of various devices with or without the direct help of its user. Intelligent connected vehicles can be formed, where driving can be controlled and coordinated via surrounding information from other vehicles and infrastructure. In this scenario, exchanging safety-critical driving information between vehicles is essential and emphasizes the importance of secure and trustworthy communications. Nevertheless, careful architecture and systems design are still necessary for the comprehensive use of the above technological advancements in completely new applications.

5.6.1. Emerging Technologies

Emerging Technologies are new technological artifacts arriving in a field, with significant disruptive potential, social interest or expectations, thus influencing future competences of actors, organizations or sectors. Many emergent technologies are expected and foreseen, some arrive unexpectedly or too fast for actors to adapt, either creating hype or postponing major contributions. The Sociology of Expectations considers emerging technologies as social objects where a multitude of actors articulate, challenge and enforce expectations aimed at shaping the future trajectories of a technology. But as time passes and the technologies arrive on the market or the new products are announced, expectations get adjusted to the consequences and impacts of the technology; some old futures may stay alive while others will be forgotten. This process is interpreted from two points on the implementation dimension of a technology. On one hand, they can observe the defeated futures of a technology, and on the other hand, they can also look into how old predicted futures can be co-opted and revived.

Connected vehicles are a powerful convergence of smart vehicles engulfed in the Internet-of-Things or Internet-of-Everything (IoT). In a connected vehicle environment, the surrounding traffic environment, including the vehicles within it, is virtually represented so that new drivers or vehicles enter into the area. A connected vehicle is an emerging heterogeneous network system of vehicles, vehicles with vehicles, vehicles with roadside infrastructure, as well as vehicles with the Internet. For many vehicle manufacturers, the connected vehicle environment is a new vehicle ecology, where various new connected services can be provided. A connected vehicle is a vehicle where in-vehicle devices/vehicles can communicate with outside devices/services through telematics devices or mobile devices, and vice versa. To build a connected vehicle ecosystem, many outside systems/services need to be established so that various connected services can be provided. A connected service is a service provided to a vehicle through a wireless connected infrastructure.

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