DRIVING THE DIGITAL TRANSFORMATION IN A TIER 2 COMPANY: BIG DATA CUSTOMER CENTRAL PRODUCT MANAGEMENT OF A VEHICLE AUTONOMOUS SYSTEM ENTERPRISE ARCHITECTURE BASED

by

Kathrin Kind-Trueller MSc. Software Engineering, MA Leading Innovation and Change

DISSERTATION

Presented to the Swiss School of Business and Management Geneva

In Partial Fulfillment

Of the Requirements

For the Degree

DOCTOR OF BUSINESS ADMINISTRATION

Directed by: DR. MARIO SILIC

SWISS SCHOOL OF BUSINESS AND MANAGEMENT GENEVA

In cooperation with the

FACULTY OF ECONOMICS & BUSINESS, UNIVERSITY OF ZAGREB, CROATIA

July 14th, 2023

DRIVING THE DIGITAL TRANSFORMATION IN A TIER 2 COMPANY: BIG DATA CUSTOMER CENTRAL PRODUCT MANAGEMENT OF A VEHICLE AUTONOMOUS SYSTEM ENTERPRISE ARCHITECTURE BASED

by

Kathrin Kind-Trueller

APPROVED BY

Dr. Minja Bolesnikov

<Chair's Name, Degree>, Chair

<Member's

Dr. Mario Silic, Mentor

dr. Jaka Vadnjal

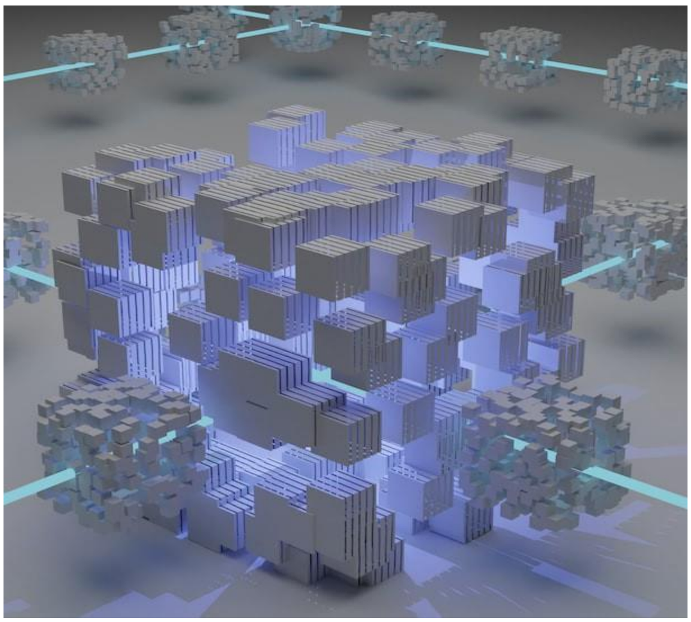
<Member's Name, Degree>, Committee Member

RECEIVED/APPROVED BY:

<Associate Dean's Name, Degree>, Associate Dean

Dedication

To my daughter, for all the days I could not be a mum to you. May all your dreams come true. Mine have, among others, been achieved, this dissertation.



Acknowledgements

I would like to thank mostly Dr Mario Silic:
For supporting me throughout the dissertation process and reminding me over the past three years: "how is the paper going." For supporting me throughout the writing process. For supervising my paper and providing constructive and invaluable feedback throughout the writing process of my DBA Thesis.

I would also like to thank my VW ex-colleagues from the central “Konzern Gesamt Entwicklung Software” K-GES, for their valuable feedback and support along the creation of the first years of this dissertation. I would also like to thank all the people in my network, that help me fill-in the questionnaires and participated kindly in the interviews. Also, many thanks go to Rask Ebba and Dr Håkan (Fungby) Sivencrona for allowing to present my dissertation at the VECS 2023.

Also, to Dr. Koh, Dr, Wong, Jace and Dr. Alan, for being a source of inspiration and laughter as great buddies and support during those arduous dissertation writing days, it has been so much fun learning and sharing this DBA journey with you during our cohort.

DECLARATION OF AUTHENTICITY

I hereby declare that the material contained in this project is the result of my own work and that due acknowledgement has been given in the bibliography and references to ALL sources, be they printed, electronic or personal.

The word count of this draft thesis is 40794 words long, excluding tables, references and quotations.

SIGNED :

DATE : July 14th, 2023

ABSTRACT

DRIVING THE DIGITAL TRANSFORMATION IN A TIER 2 COMPANY: BIG DATA CUSTOMER CENTRAL PRODUCT MANAGEMENT OF A VEHICLE AUTONOMOUS SYSTEM ENTERPRISE ARCHITECTURE BASED

Kathrin Kind-Trueller

2023

Dissertation Chair: <Chair's Name>

Co-Chair: <If applicable. Co-Chair's Name>

This study evaluates how a Tier-2 company operating across the vehicle autonomous system industry can use blockchain-based QA strategies efficiently, particularly when managing large datasets for customer-centric product areas to focus effectively. The subject case-study company looks towards optimizing SW production workflows by embracing all benefits of blockchain technologies. Namely a strategic approach intent on improving enterprise architecture - eventually improving the autonomous vehicle system efficiency resulting in more informed decision-making processes and justifiable allocation of resources. At the same time researching through mixed methods if such a system improved the product quality, for this both the managers of such Tier-2 companies were interviewed, and as well as potential customers were surveyed.

The researcher interviewed managers of Tier-2 companies in Germany, and within the United States, surveyed potential customers and evaluated their perceptions, experiences, and attitudes towards integrating blockchain technology for QA purposes.

The findings uncovered valuable insights into potential impacts resulting from driving digital transformations enabled by this technology when implemented with QA effectively in this industry sector's customer-centric product management-specific areas. Attitudes among managers towards applying blockchain-based QA strategies remain positive due to benefits, such as ensuring data integrity, security, and other trustworthiness features throughout the software development process. Potential customers expressed interest in having blockchain technology integrated within their autonomous vehicle systems because of the confidence instilled - deriving from reliable performance backed up by verifiable secure data.

It was found that automation enabled through improved verification processes by using blockchain technologies along the SW lifecycle, may provide greater efficiency levels while reducing manual intervention instances effectively, providing simplified product management unencumbered by a wide range of data sources, that can be trusted while optimising decisions with accessible resource allocation programs. Within the survey process were several challenges and limitations encountered regarding Blockchain technology implementation. As per feedback from both managers along with prospective customers, these covered concerns surrounding scalability, interoperability issues along Regulatory Compliance requirements. It was observed that rigorous research/investigation needs to explore these encounterments remedies effectively.

The research reveals that adopting a blockchain-based software quality assurance methodology could prove invaluable towards unlocking powerful Digital Transformation benefits hidden within Tier-2 organizations trading unreservedly within autonomous vehicle systems industries displaying adherence to strict data accuracy/integrity protocols and incorporating steadfast security measures inspiring consumer confidence inevitably. The results from survey data thus provide insights heavily guiding future corporate resolution-making phases using custom-centric product management, whose outlook is geared towards promoting steady long-term growth via collaborative efforts harnessing vast software engineering expertise in dealing with autonomous vehicles within the robotaxi marketplace.

Nevertheless, making headway in tackling the challenges, there were limitations identified, which are a matter of the utmost priority while executing Blockchain technology integrations into the enterprise architecture. Further research aimed at mitigating risks while optimising blockchain technology utilisation in software quality assurance initiatives involved, driving Digital Transformation may lead this research forward.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AV: Autonomous Vehicles

BT: Blockchain technology

C2C: Car-to-car connectivity, a mobile form of IoT in transport that requires special infrastructure.

CAV: connected and autonomous vehicle systems

CF: click fraud.

CS: customer satisfaction

E/E: electric/electronic, the software and hardware electrical or electronic components of a system.

GDP: Gross domestic product

HW: Hardware, can be mechanical or mechatronical in nature.

I4.0: Industry 4.0

IoT: Internet of things

MaaS: Mobility as a service, e.g., ride-sharing services

OEM: Original equipment manufacturer, usually a vehicle manufacturer is referred.

PoW: Proof-of-Work

PuBs: Public Blockchains

QA: Quality assurance

SC: supply chain

SQ: service quality

SW: Software

V2X: Vehicle to infrastructure connectivity

VI2: Vehicle-integration-to everything, a form of extending the vehicle system functionality outside the car. E.g., high-definition maps via GPS.

ZKPs: zero-knowledge proofs

CHAPTER I: OVERALL INTRODUCTION

Digital transformation, while an increasingly ubiquitous reality of the 21st century, remains an intricate and multifaceted process for many organisations. As industries grapple with the rapidly changing business landscape, the drive towards digitalisation demands significant strategic and operational shifts. This transformation has the potential to revolutionise businesses by generating new products, services, and business models. Yet, the complexity of this transition is particularly accentuated within Tier 2 companies, which typically possess a limited digital footprint compared to larger, more technologically advanced enterprises. One critical area of digital transformation is the adoption and utilisation of Big Data and autonomous systems, a field that offers extraordinary opportunities and equally profound challenges.

The focus of this dissertation lies at the intersection of digital transformation, Big Data, customer-centric product management, and autonomous vehicle systems within the context of a Tier 2 company. It specifically explores how such a company can leverage Big Data to drive a customer-centric product management strategy in the development and deployment of autonomous vehicle systems.

The vast volumes of data generated and consumed by autonomous vehicle systems offer a goldmine of insights that, when harnessed appropriately, can drive an effective customer-centric product management approach. However, effectively utilising this data to inform product development and management strategies remains a complex task. This dissertation delves into the development of a robust enterprise architecture that enables the effective integration and utilisation of Big Data to drive the digital transformation of a Tier-2 company in the autonomous vehicle sector.

This introductory chapter establishes the context and significance of the study, presents the research problem and questions, and outlines the methodology and the organisation of the dissertation. The overarching objective of this research is to provide a detailed exploration and understanding of the challenges and opportunities presented by the utilization of Big Data in product management within the context of an autonomous vehicle system's enterprise architecture. It seeks to provide a roadmap that will guide Tier- 2 companies in leveraging Big Data to drive their digital transformation journey, focusing on customer-centric product management in the development and deployment of autonomous vehicle systems.

Given the nascent and rapidly evolving nature of this field, this research will contribute valuable insights to the academic discourse on digital transformation, specifically within the realm of autonomous vehicle systems. Furthermore, the findings from this research will provide practical strategies and guidance to industry professionals who are navigating the complexities of digital transformation within Tier-2 companies, thereby bridging the gap between academia and industry.

1.1 Introduction to the research topics

External factors like globalisation, demographics, and sustainability, impact a company’s competitive strategy and position which are crucial determinants of business success (Gurbaxani & Dunkle 2019). To foster productivity organisations must leverage advanced digital technologies such as artificial intelligence (AI) the Internet-of-Things (IoT) and machine learning (Shah et al., 2019). Significant technological advancements in the automotive industry have made vehicles safer, affordable, and more convenient

(Bissell et al., 2020; Behrendt, 2016). The transportation sector has realised that driver error is a significant cause of road accidents, driving the transition from automated to autonomous driving systems.

Autonomous driving has numerous benefits such as improving traffic flow, and mobility while enhancing road safety (Lee et al., 2018; Yigitcanlar et al., 2019). Digital transformation strategies are used to prioritise, orchestrate, and implement digital transformation endeavours.

These strategies integrate seamlessly with existing functional strategies, while taking an all-encompassing approach towards the issue at hand (Arndt et al., 2019; Chanias & Hess 2016). The automotive industry has undergone profound digitisation resulting in disruptive product innovations, such as autonomous driving, while creating new business models such as MaaS or pay-as-you-go services with promising financial prospects (Dremel et al., 2017; Wintersberger et al., 2017; Watson et al., 2017).

The significance of this industry for many industrialised nations' GDP growth was highlighted by Winkelhake (2018). As the sourcing of vehicle components happens globally making the industry have one of the most complex supply chains which is a challenging endeavour worldwide.

Some of the technological trends that have been predicted to lead the revolution and transformation of the industry include electrification, autonomous driving, shared mobility, car multimodality, and car connectivity. Digitalisation is one of the essential features of the automotive industry (Kessler and Buck, 2017). Therefore, the topic of transformation is necessary since it highlights, how digitalisation changes operating models and business in the automotive industry. It is essential to study this topic since it may enable us to understand the technological application in the automotive sector. Moreover, since technology adoption differs across actors in the automotive sector, it becomes novel to understand this topic. Most commonly, multinational OEMs and Tier-1 companies in the sector drive digitalisation since they are aware of the transformation opportunities. While most OEMs and Tier-1s are aware of these benefits, some small and medium-sized Tier-2 organisations are new to the transformation process. Therefore, this topic will benefit the Tier-2 automotive business world as organisations may understand the effects of transformation on different operational and innovation practices.

1.2 Research Problem

A shift towards comprehensive digital platforms has led to a transition in transportation practices by incorporating robot-assisted assembly and testing techniques (Jović, 2019). The aim behind this change is to tackle mobility challenges that are erratic and arduous in nature, concerning their impact on accessibility- and quality standards, as well as space utilisation issues. Moreover, it addresses issues pertaining to regional or global sway on health & living conditions respectively (Smetsers 2016). Although Naujoks et al. (2017) & Trček's(2019) studies acknowledge disengaging from constant monitoring responsibilities, while using these tech advancements, Roblek et al.'s (2020) research suggest no such marked enhancement in public trust towards self-driving cars or autonomous vehicles, despite significant progress being made through AI & sensory networks. Even stakeholders' business productivity face challenges due to such trust issues. Hence, this research's main objective, is to study how digital transformation affects the business productivity of autonomous driving functions and analyses how it impacts business cases, product architecture as well as big data utilisation.

1.3 Purpose of Research

This research will aim to explore how the digital transformation of autonomous driving influences business productivity in a Tier-2 company. Since artificial intelligence and robotics are emerging fields that underlie autonomous driving, this study will also aim to investigate how the US public, as a potential market and German managers' perception of Tier-2 companies towards these technologies, influences in travel costs, changes in convenience, reliability, quality, comfort, and flexibility associated with automated or mobility as service opportunities. As well as technological tools to support the autonomous ride-sharing service as a MaaS business case.

1.4 Significance of the Study

The digital transformation of autonomous driving depends on technologies, such as artificial intelligence, to make decisions (Abraham et al., 2017). Unlike prior studies focused on the effects of automation on labour markets, this research seeks to investigate how the digital transformation of autonomous driving influences the productivity of vehicle manufacturers, transport companies, and the perception of road users towards autonomous driving (Genzorova et al., 2019). Due to the ever-changing passenger needs, this research will serve as the basis upon which vehicle manufacturers could develop products that meet the market expectations (Devarajan, 2018; Gupta, 2018). For instance, it may help automobile manufacturers and transport organisations identify human driving flaws and, consequently, establish measures that could mitigate the drawbacks while enhancing passenger experience and general productivity (Devarajan, 2018; Noble et al., 2019).

1.5 Research Questions

1) How could the digital transformation of a Tier-2 company Enterprise architecture based, thrive the product management process-based business cases?

2) Does the use of customer-central Big Data in a vehicle's autonomous system function support the digitalisation thriving of product management-based business cases?

3) Does the use of Big-Data for the support of enterprise architecture-based product management-based business cases aid as a framework for the successful digital transformation of a Tier-2 company?

1.6 Objectives

To investigate how digital transformation of autonomous driving functions helps facilitate and simplify the processes involved in creating the related business cases. To explore how digital transformation barriers and vulnerabilities compromise autonomous driving functions MaaS business cases and general productivity within the transport industry. To suggest measures that may need to be implemented to enhance the productivity of autonomous driving functions business case creation, especially in dynamic environments.

1.7 Hypothesis – mapped to research questions.

1) ***How could the digital transformation of an Automotive company, Blockchain-Enterprise architecture based, could thrive the product management process-based business cases?***

***Hypothesis 1** : Digital transformation in Tier-2 companies facilitates improved operational efficiency, customer experience, agility, and data-driven decision-making in product management, and can streamline software development processes in the automotive industry, enhancing collaboration, optimizing resources, improving reliability and safety, and enabling futureproofing against emerging technologies.*

2) ***Does the use of customer central Blockchain Process tracking via Big Data of a vehicles autonomous system function support the digitalization thriving of product management-based business cases?***

***Hypothesis 2** The use of customer-central big data can inform product development and marketing decisions, improve customer experience, and support digital transformation in Tier-2 companies by providing insights into customer needs, trends, and behaviours, which can be utilized to optimize business processes, drive strategic initiatives, and enhance services, while ensuring ethical data usage and compliance with relevant laws and regulations.*

3) ***Does the use of Big-Data for the support of Blockchain enterprise architecture-based product and process management-based business cases may aid as a framework for successful digital transformation of an automotive company?***

Hypothesis 3 *Utilising big data and implementing measures such as blockchain-based cybersecurity can enhance the productivity of autonomous driving functions business case creation, optimise robotaxi services, and support the digital transformation of a Tier-2 company's enterprise architecture and product management processes.*

Chapter II: REVIEW OF LITERATURE

2.1 Theoretical Framework

Digitalisation has significantly impacted the system architecture of vehicles in terms of functionality, as indicated in the study of Alvarez-Coello et al. (2021). As noted by Alvarez-Coello et al. (2021), the new changes are focused on supporting data-driven-functionalities, meaning that the operations of the newly developed vehicles are designed to use data. Consequently, the latest models of vehicles with software tools are supported by big data and analytics tools that facilitate communication and decision-making. Furthermore, Ebert and Duarte (2018) agree with Labrado et al. (2016) by asserting that the automotive industry witnesses' significant changes by adopting disruptive technologies to increase productivity and software APIs (application programming interfaces) from their new system architecture. Moreover, Ebert and Duarte (2018) supported the findings of Labrado et al. (2016) by stating that the automotive industry must conduct a holistic change of business models in redesigning the products and services as well as interactions with suppliers, partners, and customers. In this case, to adapt to the new changes Ebert and Duarte (2018) agreed with Labrado et al.. (2016) that software technologies, big data analytics, and advanced solutions such as the internet-of-things and artificial intelligence are essential. Hence, it can be inferred that the digital transformation in the automotive sector is associated with significant changes in operations, technologies used, and interaction with third-party stakeholders.

In recent years, the significance of data has been recognized among multiple stakeholders due to important insights. Labrado et al. (2016) argued that the volume of data is growing exponentially, and more advanced technologies and big data analytics tools, algorithms, and storage solutions are being implemented to support data-driven decision-making and development. Similarly, Kashlev et al. (2017) agreed with the findings of Alvarez-Coello et al (2021) by stating that big data is growing rapidly. However, contrary to the findings of Alvarez-Coello et al (2016), Kashlev et al. (2017) asserted that the variety, velocity, and volume of big data are major challenges that hinder the capability of organisations to leverage the opportunities created by the large volumes of data to gather important insights. Consequently, the findings of Kashlev et al. (2017) correlate with the suggestions of Ebert and Duarte (2018) and Alvarez-Coello et al. (2021) by recommending that complex big data analytics technologies and a big data workflow management system, will help to address the limitations of big data and support an organisation’s business case if used accordingly. One of the proposed big data storage solutions is cloud computing (Kashlev et al., 2017). Integrating multiple technologies in the big data management of autonomous vehicles results in a more complicated architecture. Therefore, the digitalisation implementers must ensure that all the integrated components are synchronized to work collaboratively, and efficiently in data flow management and analytics.

Due to the uncertainties encountered on the roads, the system architecture must accommodate real-time data transmission systems for processing and accurate decision-making. As noted in Al Najada and Mahgoub's (2016) study, autonomous vehicles' system architecture is designed to accommodate big data mining and analytics tools to collect and process real-life accident data and real-time data transmitted from other cars. The real-time information is processed and analysed, and the vehicles make safe trajectories without the intervention of humans (Al Najada & Mahgoub, 2016). Similarly, Traub et al. (2017) supported Al Najada and Mahgoub (2016), claiming that autonomous vehicle architecture design must not be based on isolated control units. Furthermore, Reddig et al. (2018) agreed with Al Najada and Mahgoub (2016) that an autonomous vehicle architecture must be designed to process every route of information and make accurate decisions while on the roads. According to Reddig et al. (2018), the system architecture must be designed to automatically receive and process real-time traffic information and concentrations and determine the best possible route with no congestion.

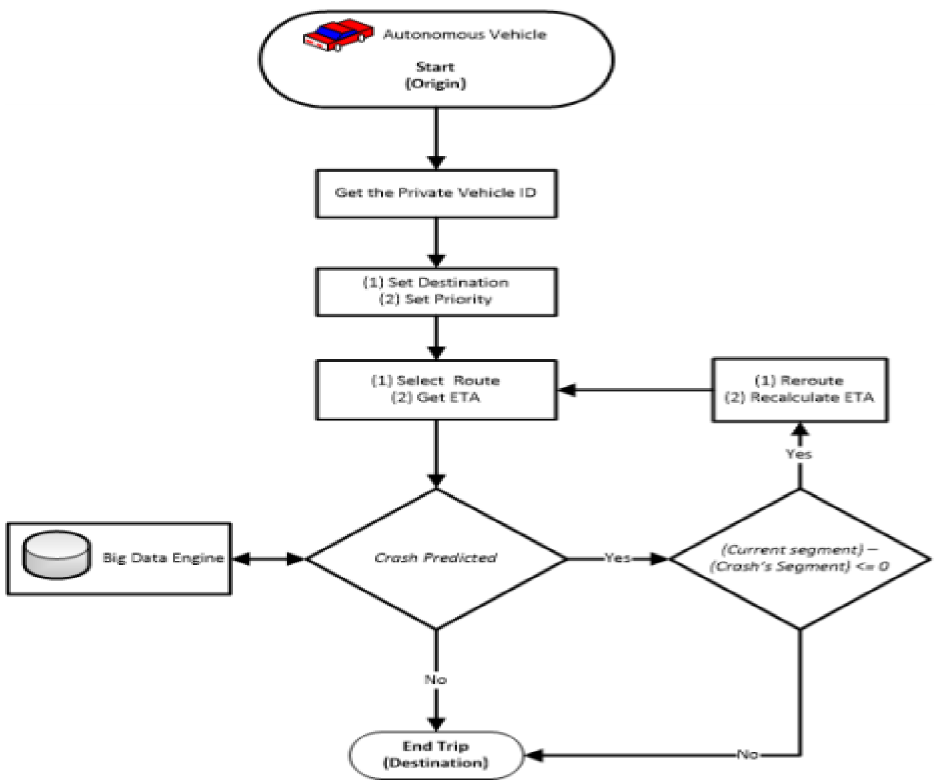


Figure 1: Autonomous vehicle architecture with big data analytics (Al Najada & Mahgoub, 2016)

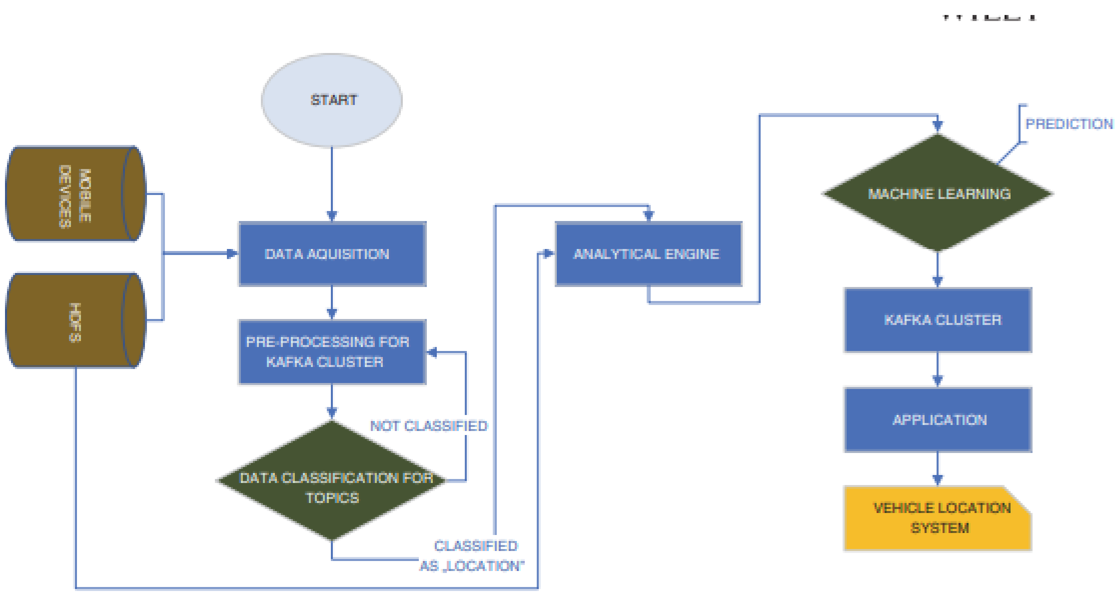


Figure 1: Autonomous vehicle architecture with big data analytics algorithm (Reddig et al., 2018)

As shown in Figure 1 and Figure 2, the only similarity between Al Najada and Mahgoub's (2016) and Reddig et al.'s (2018) autonomous system architecture is decision-making, and prediction based on big data obtained from different sources. The differences between the two architectures and big data analytics approaches are different in that Reddig et al.'s (2018) architecture includes advanced tools such as the Kafka cluster algorithm, data classification systems, an analytics engine, and machine learning that helps in the automatic prediction of routes with or without congestion. The suggestions of Reddig et al. (2018) agree with those of Alvarez-Coello et al. (2021), in which advanced analytics algorithms and AI-based solutions are proposed to determine vehicle location and automatically detect the best routes. On the other hand, Al Najada and Mahgoub's (2016) architecture is reliant on a single source of big data (big data engine) (Figure 1), in which all the data used in the prediction of the route taken by the vehicle is extracted from and has a simple route prediction algorithm based on crash information.

2.2 Technology in autonomous vehicles and its support of vehicle business cases

The continuous evolution of networked cars towards IP-based communication networks and big data processing requires establishing a new network that accommodates all the devices and features used in data collection for autonomous vehicles (Knieps, 2019). Further, Knieps (2019) suggested introducing a big data virtual network that operates by integrating different self-driving vehicle applications and devices such as cameras and sensors. The networks allow processing of data extracted from multiple sources such as cloud computing systems and local processing applications. On the other hand, Darwish and Bakar (2018) suggested that in-vehicle networks, vehicular ad hoc networks, and vehicle-mounted mobile internet can be integrated as sources of big data processed by autonomous vehicles. Contrary to the arguments of Knieps (2019), Darwish and Bakar (2018) identify multiple sources of data that require a more complex system architecture that also accommodates mobile devices and sensors in big data collection.

The study of Zhang et al. (2017) supports the later findings of Darwish and Bakar (2018) by suggesting the implementation of a vehicular network that allows vehicle-to-vehicle communication and supports vehicle-to roadside objects communications. Additionally, Knieps (2019) agrees with Zhang et al. (2017), that fog computing systems can also be integrated into the autonomous vehicle system architecture to enhance big data collection and promote accurate automatic processing of autonomous vehicle communications with and users. Jameel et al. (2019) supported the findings of Zhang et al. (2017) and Knieps (2019) by stating the fog computing systems play a critical role in promoting real-time data analytics by collecting and processing data from closer vehicles. As a result, establishing a virtual network involving the interconnection of mobile devices, cloud servers, and fog networks could enhance big data collection and processing to transform the efficiency in the functionality of autonomous vehicles.

Big data is used in extracting information from the data collected from vehicles, sensors, and other tools that control vehicular networks. Apart from facilitating communications between vehicles and users as noted by Zhang et al. (2017) and Knieps (2019), Jameel et al. (2019) argued that besides velocity, variety, veracity and volume, validity, visibility, and viability must be included as significant components of big data and its benefits in autonomous vehicles. As a result, it can be inferred that big data integrated with the system architecture promotes more control of autonomous vehicles. Similarly, Amini et al.'s (2017) findings concur with those of Jameel et al. (2019) by stating that transformation of the system architecture to establish more complex networks and connected technologies (created by ubiquitous digital devices) improves the performance of intelligent transportation systems (ITS). Notably, Amini et al. (2017) asserted that big data analytics systems inform the control logic that enables vehicle systems to make accurate decisions based on the current traffic information.

Furthermore, Daniel et al. (2017) agree with the assertions of Amini et al. (2017) and Jameel et al. (2019) by stating that big data analytics enhances the reliability of real-time information generated from the sensor (data collection tools) data. Consequently, based on the findings of Daniel et al. (2017), Amini et al. (2017), and Jameel et al. (2019), it is inferred that the utilisation of large volumes of real-time data and big data analysis is intended to improve the functions of self-driving cars. However, a framework such as Hadoop is necessary to ensure efficient data classification and optimal usage of the big data for effective operation, real-time communication, and decision-making in autonomous vehicles, as noted by Daniel et al. (2017) and Nathali Silva et al. (2017).

2.3 Digital Transformation and Autonomous Systems/Vehicles

Since the emergence of autonomous vehicles, significant digital transformations have been made to achieve the current status of autonomy. Guerra (2016) argued that autonomous vehicles used cameras, sensors such as the LIDAR and GPS (global positioning service) to establish the vehicles' location, avoid obstacles, and maintain a specific route in the early stages. Kocić et al. (2018) agree with Guerra (2016) on the initial digital features used in autonomous vehicles but indicated that with continued digitalisation, sensor, and camera data, are being used in mapping and localization for better environment perception than the LIDAR and RADAR data.
Furthermore, Kocić et al. (2018) argued that sensors are used in modern autonomous vehicles and are continuously improved in the digitalisation process. On the other hand, Jung, and Agulto (2021) concur with Kocić et al. (2018) that current sensors and cameras have improved, and IoT-based cameras are implemented in autonomous vehicles. Similarly, Jha et al. (2018) assert that the conventional technologies noted by Guerra (2016) cannot be used in modern autonomous vehicles because of faults and potential vulnerabilities of manipulation that could negatively impact the motion control of the autonomous vehicles. Hence, modern autonomous vehicles with complex architecture and multiple interconnected technologies indicate the significant digital transformation of the systems.

Apart from the digital transformation in the automotive sector and system architecture, autonomous vehicles have significantly witnessed digital transformation by adopting various other technologies to improve performance, decision-making, and manage big data being generated (Kumar & Goel, 2018). Some of the technologies mostly integrated into autonomous vehicles are cloud computing, the Internet-of-things, and artificial intelligence (Kashlev et al., 2017; Jameel et al., 2019; Alvarez-Coello et al., 2021). Corcoran and Datta (2016) stated that most Internet-of-things (IoT)-based systems are supported by cloud-based infrastructure. These findings imply that IoT technology could not be independently used in autonomous vehicles. Cloud computing technology is also used in the digital transformation of self-driving vehicles. Additionally, Corcoran and Datta (2016) argued that cloud computing platforms are limited in applications that require high-quality service and real-time operations.

Hence, since autonomous vehicles require real-time data processing, advanced solutions such as mobile edge computing and IoT could address the problem. On the contrary, Gružauskas et al. (2018) noted that the integration of multiple technologies, such as big data analytics, IoT, cyber-physical, and cloud computing, could enhance the performance and effectiveness of autonomous cars. Chen et al. (2017) agree with Gružauskas et al. (2018) that effective digitalisation of autonomous vehicles requires more technology solutions such as artificial intelligence, machine learning, cloud computing, and cyber-physical systems. Consequently, it is inferred that the continuous evolution and digitalization of autonomous vehicles are dependent on the improvements made in the technologies integrated with the functional features.

Autonomous vehicles with intelligent transportation systems could significantly reduce congestion and road accidents, (Li et al., 2019; Dixit et al., 2016). Li et al (2019) argued that the digitalisation of autonomous vehicles is supported by continuous research and development using modern technologies including 5G technology and the Internet-of-things for enhanced connectivity, as also stated by Chen et al. (2017). Li et al (2019) also supported the assertions of Gružauskas et al (2018) by concluding that cloud computing is necessary and plays a critical role in mass storage, real-time interaction, security authentication, and virtualization. These features enhance autonomous vehicle communication with other vehicles on the roads. Conversely, Martínez-Díaz and Soriguera (2018) stated that cloud computing systems are used to digitalise autonomous vehicles to add robustness to the systems and ensure continuity of operations even after the vehicle systems have failed. Martínez-Díaz and Soriguera (2018) supported Chen et al.'s (2017) assertions that collaborative solutions play a critical role in improving the performance of autonomous vehicles. For instance, Martínez-Díaz and Soriguera (2018) indicated that deep learning algorithms are highly helpful in enabling cloud-based platforms to collect and store accurate information, such as the vehicle's location. Therefore, advanced technologies play a critical role in supporting computing tasks in autonomous vehicles.

A collaboration of multiple technologies manage the modelling and control of large autonomous vehicle systems. Labrado et al. (2016) stated that the collaboration of uncrewed ground vehicles, unmanned aerial vehicles, and autonomous underwater vehicles is used to digitalise autonomous vehicles for accurate navigation, interaction, and completion of various missions in unknown areas. The findings of Labrado et al. (2016) agree with Martínez-Díaz and Soriguera (2018) that, the efficient operation of autonomous vehicle systems can be improved by using a team of technologies with cloud computing being the computational backbone of all the vehicle functionality and big data storage. Moreover, Kang et al. (2019) supported Labrado et al.'s (2016) assertions by stating that the computing units, communication modules, storage devices, and onboard sensors are integrated into autonomous vehicles to improve the driving experience. However, Kang et al. (2019) argued that integrated technology reduces traffic pressure and enhances road safety, as Li et al. (2019) noted. Hence, digitalisation improves autonomous vehicle capability to navigate both known and unknown areas based on accurate information processing.

Autonomous intelligent vehicles and intelligent transportation infrastructures are being integrated to achieve the digitalisation of the transportation system (Tokody et al., 2018). Tokody et al. (2018) argued that integration is necessary to address operational risks and safety concerns. However, Normann (2018) argued that full digitalisation of autonomous vehicles and the transport system could not be achieved in some countries, such as the United States, where public road legislation controls the transportation system development and digital transformation.

For instance, Normann (2018) noted that the US National Highway Traffic Safety Administration requires that autonomous vehicles have a brake controlled by foot, implying a human driver must control the autonomous vehicle while the robotaxis need to achieve complete L4 autonomy as referred to in figure 2 below. According to the findings of Normann (2018), the operational and safety risks noted by Tokody et al. (2018) could not be solved by digitalisation as assumed by public roads legislations.

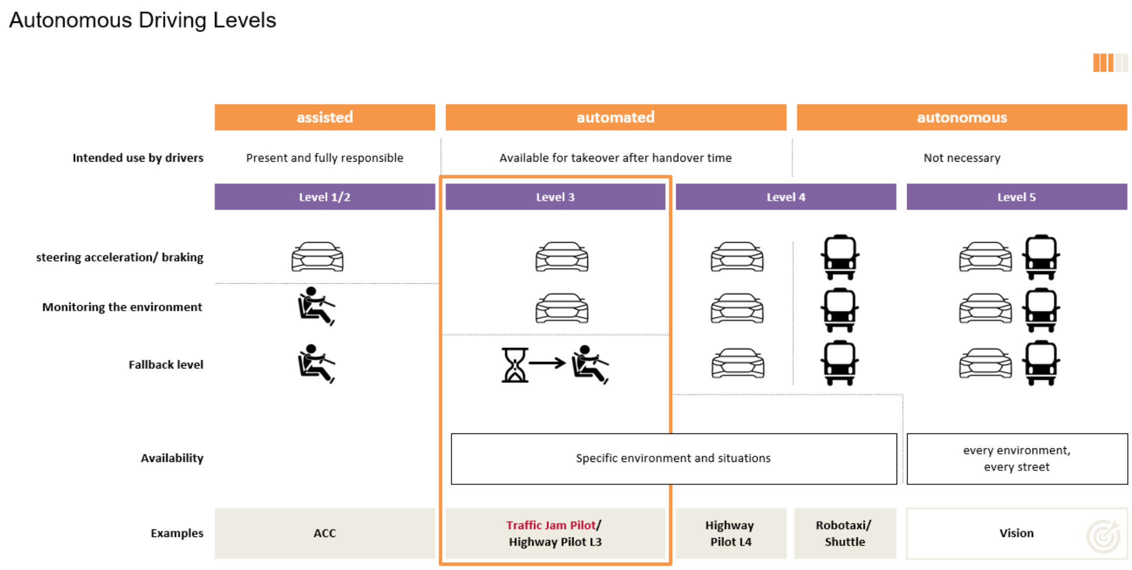


Figure 2 Autonomous driving levels as per standard SAE J3016- picture source student

On the other hand, Almeaibed et al. (2021) agree with Tokody et al. (2018) that the safety concerns in autonomous vehicles can be addressed by design. However, rather than integrating the digital transport systems and autonomous vehicles as indicated by Tokody et al. (2018), Almeaibed et al. (2021) suggested that the design should use a data-driven technique that enhances the capability of cars to reduce accidents. Hence, big data storage and processing are essential for the digitalisation of autonomous cars and systems.

2.4 Literature Gap

Based on the above review of literature studies, the most evident literature gap is the lack of a clear illustration and explanation of how big data helps in the successful digital transformation of Tier-2 companies (such as suppliers) of autonomous vehicle functions into their business cases. Most of the above literature indicated how big data has contributed to the digitalisation of the automotive industry, autonomous vehicle system architecture, and systems (Tokody et al., 2018; Grieger and Ludwig, 2019; Guerra, 2016). However, the literature has insufficient information on how digital transformation could be achieved with big data in the supply chain of autonomous vehicles and systems and derived into profitable business cases product management product architecture based. Therefore, the predominant literature gap identified serves as a motivation for investigating digital transformation from business cases, specifically focusing on Tier-2 companies.

2.5 Major Contributions of the Literature

The literature review helped examine digitalisation in the automotive industry, autonomous vehicle architecture, and autonomous vehicle systems. The various technologies and tools such as machine learning, advanced deep learning algorithms, the internet of things, cloud computing, and artificial intelligence have been identified and noted how they contribute to the digitalisation of autonomous vehicles. Furthermore, the literature review offered an opportunity to evaluate how big data is collected, stored, and processed in autonomous vehicles. The review uses enhances user experience, reduces accidents, and improves communications between autonomous vehicles on the roads. The literature also indicated how digital technologies used in autonomous vehicles work collaboratively to ensure effective performance by processing big data in real-time. Consequently, the literature helped identify the existing gap in literature requiring further investigation as per the main focus of the study on understanding how big data promotes a successful digitalisation framework for Tier-2 companies.

2.6 Conclusion

Autonomous vehicles and their architecture have constantly maintained digitalisation transformation due to continuous innovation and new technologies that show the potential in enhancing functionality and performance. Following the continuous increase in the volumes of big data generated by multiple devices and sources, and the emergence of advanced technology solutions (such as cloud computing, big data analytics, and artificial intelligence), the automotive industry can leverage the opportunities to build more autonomous vehicles. This study's research topic on the digital transformation of autonomous driving focused on business cases such as Tier-2 companies is important to expanding the literature in explaining how digitalisation with big data can also benefit suppliers and other stakeholders involved in the autonomous vehicle supply chain. Finally, by addressing the gap in the literature, the study could help explain the link between enterprise and product management based on insights extracted from big data analytics in autonomous vehicles. The study's findings could facilitate develop of a successful digital transformation framework for suppliers in the automotive industry.

Literature Review about the business case of THE use of blockchain processes to help increase customer satisfaction during a driverless vehicle service ride

2.7 Introduction

The chapter has examined the extant works around Blockchain technology and its application in advancing customer satisfaction (CS) during a driverless vehicle service journey. The knowledge, information, and experience gained from the chapter offered an overall understanding of the influence of BT on the automotive sector, autonomous vehicles development, and the business industry. In turn, a literature gap was identified after an analysis of the prevailing literature, which the present study hopes to fill. Finally, a summary section was provided to highlight the main concepts, notions, and ideas touching on the Blockchain process and CS when using the technology in the automotive industry.

2.8 Blockchain Technology (BT) and its Characteristics

Initially, a term employed in computer science, blockchain suggests the way data can be exchanged and structured. Blockchain is an all-covering scheme being integrated across the world, networks, and hardware because it is a ledger supporting organisations to track all transactions already confirmed (Boukis, 2019). Casino et al. (2018) argue that BT is promising since it inspires various industries owing to its exceptional combination of features, for instance, immutability, decentralisation, and transparency. This view was supported by Fosso Wamba et al. (2020), who acknowledged blockchain to be the primary infrastructure that supported the revolution of Bitcoin. In agreement with Casino et al.'s (2018) contention, Javaid et al. (2021) defined blockchain as a decentralised, disseminated directory inspiring smart conventions and offering the prospects traceability support, management of records, supply chain (SC) computerisation, payment requests, and other commercial trades.

However, Knirsch et al. (2019) described BT as a trustless and copiously decentralised peer-to-peer (P2P) system of data storage spreading over all users using nodes. In agreement with Casino et al. (2018), Knirsch et al. (2019) believe distribution, decentralisation, and immutability are the main characteristics of this new and developing technology. Wood (2017) adds that blockchain is a state of the machine in some applications. Unlike Knirsch et al. (2019), Croman et al. (2016) argue that BT spreads trust across several users, depending on the agreed-upon consensus algorithm. The assertion suggests that the integrity of data within the system is controlled by several decentralised entities. Various research shows that Blockchain characteristics allow it to permanently and immutably keep data once the data is committed to the system (Eyal and Sirer, 2014; Javaid et al., 2021; Rejeb et al., 2019).

Recent studies have demonstrated that blockchain is overtly observable to all participants but limits data access by having extra strata, such as zero-knowledge proofs (ZKPs) (Ben-Sasson et al., 2014) or require commitment scheme (Unterweger et al., 2018). Papadopoulos (2015) adopts a broader perspective to examine the features of BT and argues that this technology depends on a cryptographic procedure and rules for transaction processing. This is because BT utilizes consensus mechanisms, timestamping, hashing, and asymmetric encryption having private and public keys. In agreement with Papadopoulos (2015), Treiblmaier (2019a) contends that the cryptocurrency model has solved double-spending issues. However, Clohessy et al. (2019) indicate that BT developed a new standard to perform and exchange transactions and value in an online setting.

Münsing et al. (2017) affirm that transactions activated on the blockchain consider a set of predefined guidelines grounded on verifiability, security, and peer accord to safeguard transaction validity. Accordingly, all the exchanges are time-stamped, captured in datasets referred to as a block, and chronologically bound to establish the ledger. Fosso Wamba et al. (2020), in agreement with Javaid et al. (2021), hold the view that blockchain is a system within a circulated register technology class. Research has exposed BT as a new strategy for authenticating assets employed in transactions and applicable in various business functions and activities (Ertemel, 2018; Rejeb et al., 2019).

These are the features that have made blockchain applicable in several industries, such as autonomous vehicles.

2.9 Types of Blockchain

Public Blockchains (PuBs): These are large circulated systems, which run via an instinctive token (Sharma, 2020). Such a chain allows entry of anyone and everyone who desires to contribute to the network. In the same view, Xu et al. (2017) hold that PuBs allow participants to write, edit, and review the undertakings within the public blockchain network (PBN). PBN works on an incentivizing structure encouraging new members to join and have the network responsive. One of the advantages of PuBs is that it offers great solutions from the decentralisation, democratised, and authority-free process standpoint (Tschorsch & Scheuermann, 2016). An example of PuBs is Ethereum (Wood, 2017) and Bitcoin (Crosby et al., 2016). However, one of the weaknesses of PuBs is that it relies on substantial power consumption, which is required to sustain the distributed public ledger (DPL). Other disquiets touching on PBN, due to the lack of complete anonymity and privacy, which may result in a weaker system of security and participants' identity.

Private Blockchains (PrBs): These are often smaller and do not utilize tokens (Sharma, 2020). However, one of the strengths of PrBs is attributable to restricted and controlled membership, which enhances data security and privacy compared to PuBs (Sharma, 2020; Sabah et al., 2019). Accordingly, a person can only join PrBs via genuine and substantiated invitation. However, it is only the PrBs operator who has the right to edit, delete, or override the basic admissions on the blockchain when deemed obligatory.

Permissioned Blockchains (PBs): PBs support a mixture of PrBS and PuBs and many customization opportunities (Vukolić, 2017). These may include permitting anyone to join the PBs after identity verification and apportionment of designated and select permission to undertake only some activities on PBs. An example of BPs is a ripple that supports permission-based roles for partakers. Such Blockchains have been created to grant special permission to each member. Hence, this allows participants to have the aptitude to perform particular functions such as accessing, reading, and writing information on the network (Androulaki et al., 2018).

2.10 Drivers of BT for Industry 4.0 (I 4.0)

Smart products, smart solutions, SCs, and smart factories are some of the quality enablers employed in the development of BT for their special services from an industrial viewpoint. Various research has established product quality, utmost CS, productivity, and special services as significant characteristics of BT towards I 4.0 applications (Leng et al., 2021; Christodoulou et al., 2018; Çağlıyangil et al., 2020; Alladi et al. 2019). Blockchain has various applications and incessantly introduces innovative applications. Javaid et al. (2021) suggested that BT utilization has inspired the manufacturing industry. One of the strengths of BT is that it embraces all cryptocurrencies utilized to forecast future requirements. However, further research is needed to encourage the remarkable use of Internet networks in industries. Other scholars believe that the Blockchain type has advanced owing to the drastic evolution of the internet networks, which has promoted its use as a distributed ledger technology (DLT) (Lu, 2018; Mondragon et al., 2018). A DLT is built on a chain of data and information gathered and validated within a block. The blocks are added and checked in previous blocks within the knowledge and transaction string (Lu, 2018). Javaid et al. (2021), on the other hand, submitted a need to develop a new way of thinking and a determined and agile strategy to exploit the full potential of BT.

However, some researchers have proposed that BT technology can be more helpful when several transactions are connected (Kasten, 2020; Alcaraz and Rubio, 2020; Anjum et al., 2020). Others, such as Close et al. (2019) and Hartmann et al. (2020), believe that companies' ability to optimise the end-to-end SC management, including data gathered from Internet of Things (IoT) sensors and commercial logic, can reduce fraud, and increase trust. As a result, BT advances efficiency and accountability across the SC, which has witnessed its evolution in other sectors. The demand for BT is increasingly growing in several sectors, including the automotive industry, which is now more persuaded to initiate the use of BT.

2.11 Customer Satisfaction as a Concept in Marketing and Service Delivery

Globally, CS is becoming an essential dynamic because a firm might not get the chance to recreate the service experience if it is recognised as unsatisfactory by the consumers (Fatah & Ali, 2018). Narteh and Kuada (2014) argued that banks only offer satisfactory and quality customer service if the procedures, values, and guidelines for service quality (SQ) are active. This is because SQ serves a great role in advancing and attaining CS. Kotler and Armstrong (2010) defined CS as the extent to which a good's perceived performance equals a consumer's anticipations. However, Ilieska (2013) defined CS as a concept relating to some characteristics of a service or product or relating to the whole service or good. For instance, the unfriendliness of attendants in service provision may result in dissatisfaction concerning the service as a whole, even if the gratification regarding other characteristics was extremely high. Despite the differences in the definitions, satisfaction regarding the service or product as a whole necessitates attention, given that this contentment has a strong influence on the future buying behaviour of shoppers (Ilieska, 2013). In a similar view, Munari et al. (2013) confirm that CS is the most crucial driver in evaluating the performance of banks and other institutions providing services. Noteworthy is that CS is more multifaceted in the service industry compared to the goods sector.

A review by Haq (2018) revealed that price is a factor considered in determining clients' satisfaction. They established that high prices of goods and services caused dissatisfaction, which made consumers reluctant to purchase a particular company product. However, Tien et al. (2021) found that responsiveness, reliability, service capacity, tangibility, and empathy influence CS in the delivery of services in commercial banks in Vietnam. Prasetyo et al. (2021), in agreement with Tien et al. (2021), exposed hedonic motivation (HM) to have the greatest influence on CS followed by price, quality of information, and promotion. It is believed that most consumers using services buy them to gain enjoyment and pleasure as well as experience. Aliata et al. (2016), on the other hand, reported SQ to have a considerable contribution to CS. Nevertheless, the highest substantial connection was that between CS and assurance (Aliata et al., 2016). Although Felix (2017) agrees with Aliata et al. (2016), Felix (2017) believes that there are still obstacles to SQ and product differentiation leading to customer dissatisfaction. However, Felix (2017) acknowledges that factors such as SQ, culture, customer response, and product differentiation serve an impactful role in CS. Nguyen et al. (2020), in direct opposition to Prasetyo et al. (2021), admit that CS depends on two factors, namely SQ and operational efficiency.

2.12 Blockchain as a New Model of Marketing to Improve CS

Blockchain has inspired customer-centric marketing, which is vital in competitive business-to-consumer (B2C) backgrounds. Despite the shortage of academic studies on BT to support marketing practices, Ghose (2018) affirms there are various benefits associated with BT. In agreement with Ghose (2018), Rejeb et al. (2020) reported that BT is grounded on P2P communication that changes the structure of the market by encouraging disintermediation. In a similar view, Nieves and Diaz-Meneses (2016) argued BT has developed a virtuous cycle to allow extra collaboration with consumers leading to the accumulation of information and improved content incorporation. Besides supporting trades and customers by personalising their products and brands, BT enables companies to lock their consumers into their exclusive platforms.

A review by Kshetri (2019) reported that organisations have focused on delivering high-value products and services to shoppers. Kshetri (2019) suggests that blockchain can help them achieve this by reducing product costs and advancing the perceptions of customers concerning product benefits, which is in line with the contentions of Haq (2018) and Prasetyo et al. (2021). Another study by Harvey et al. (2018) established that retailers pay with credit card corporations a plus 3% for processing of payment while several online platforms charge listing subscriptions or sales commissions, which may increase the price of the end of a product or service. Rejeb et al. (2020) argue that BT can help organisations reduce the cost resulting from high product prices affecting the CS. BT reduces such costs by eliminating non-value-adding activities at the intermediation strata. Research has revealed that click fraud (CF) is one of the factors increasingly affecting marketing and CS in the modern business environment (Wiatr et al., 2020).

In a similar view, Juniper Research (2017) reported that CF is a hazard to online advertising likely to cause extra costs of about $44 billion by 2022. Alauthaman et al. (2018) hold the view that losses attributed to CF range from financial to brand reputational harm, especially on a network extensively utilised to exchange and control data. Accordingly, combating CF can help managers to reduce the cost and losses linked to online advertisement. In line with this, businesses need to embrace strong protection mechanisms as the online atmosphere is becoming filled with traffic botnets. Rejeb et al. (2020) demonstrated that BT alleviates some threats linked to the overwhelming CF effects by establishing a more trustworthy digital marketing context for brands and consumers. In agreement with Rejeb et al. (2020), Chartier-Rueg and Zweifel (2017) pointed out that a blockchain-based platform stimulates stakeholders in the promotion sector to work in an open and collaborative context where every entity works with veracity and honesty. For instance, unevenness of information is one of the incentives for CF that blockchain networks can handle. Much of this development is attributable to the transparent, immutable, and auditable nature of the transaction provided by BT. “Ubex” is one of the novel advertising platforms harnessing BT along with neural networks and artificial intelligence (AI) to realise precise data for marketing for promoters, target consumers, and publishers (Ubex, 2019).

In such a model, blockchain supports the elimination of irrelevant adverts and permits better management of data clicks, revenues, and impressions for any website linked to the system, hence assisting promoters in adjusting their budgets. However, Yanik and Kilic (2018), in direct opposition to Chartier-Rueg and Zweifel (2017), believe that features such as distributed and decentralised storage of data allow sufficient security during interactions of data. In turn, improving CS given that consumers are happy to buy goods from companies with a sophisticated system to preserve the confidentiality and privacy of their information.

A report by Roland Berger (2018) reveals that companies embracing blockchain use are working in a decentralised and self-directed context, which is managed by smart contracts. Blockchain is anticipated to upset prevailing models of business while generating new prospects for start-ups. Recent investigations have revealed that BT is influencing several industries (financial, insurance, SC management, e-commerce, digital knowledge management, public sector, and e-business) as mentioned by Glaser et al (2017; Friedlmaier et al., 2018), which illustrates the potential usage of BT in nearly every sector. However, owing to the doubt regarding the pros and cons and scarcity of knowledge on the blockchain, the practical influence of BT is still in need of research.

2.13 Blockchain and Automotive Industry (Autonomous Vehicles (AVs))

AVs have been broadly discussed in the past decades in both academic and industry reports. AVs will be incorporated into people's lifestyles in either one or more designs, namely driverless cars, autonomous drone delivery systems (ADDSs), autonomous gadgets for home-based use, and autonomous electric vehicles (AEVs) (Jain et al. 2021). AVs have significantly improved transportation and made substantial development in healthcare, space computing, military, agriculture, food delivery and SC management (Rathee et al., 2019). However, various research has acknowledged though AVs are assisting humans in performing several tasks, they are prone to mistakes, and many accidents have been observed over the years (Wiggers, 2020; Huang et al., 2019). Roland Berger (2018) reported that BT has various applications supporting secure communication, both vehicle-to-object and vehicle-to-vehicle. The authors added that BT might allow AVs to converse with other vehicles, unauthenticated gadgets, and traffic lights.

In a similar view, Jahan et al. (2019) confirm that BT ensures private communication entities, which are vital in the implementation of AVs. In agreement with Roland Berger (2018), Jain et al. (2021) posit that applications such as AVs are adopting blockchain to ensure data security and succeed the prevailing centralised security and systems of storage. Such developments have been inspired by the aptitude of blockchain to offer data immutability, transparency, and a decentralised system of storage. Huang et al. (2019), on the other hand, believe that the employment of robust hash functions, the interaction between AV systems, cryptographic primitives, and privacy management may make AV Zone safer. Accordingly, the probabilities of threats, susceptibility, loopholes, and attacks are minimal in an infrastructure supporting the operations of AVs.

Boucher (2017) argues that instigating BT in public administrations may result in efficient internal processes, more confidential data interactions, decreased transaction costs with institutions and governmental silos, and enhanced protection against cyber-attacks. In an investigation into the utilisation of BT in AVs, Jain et al. (2019) found that manufacturers have begun integrating autonomous technology in AVs to enhance CS, customer retention, and the overall experience of drivers. In agreement with Jain et al. (2019) and Boucher (2017), Rathee et al. (2019) suggested that BT allow vendors, agencies, and executives to authenticate and use certificates, which enhances the protection of data during exchange and transactions. The assertion was similar to that of Patel (2021), which contends that BT will require owners to digitally or tangibly present their credentialed data to confirm the trustworthiness of the records. Policymakers believe this development will significantly reduce the difficulty linked to managing several physical documents as well as mitigate fraud.

Recently, new research has suggested the incorporation of BT with AVs in the coming years (Shivers et al., 2019; Pokhrel & Choi, 2020). Pokhrel and Choi (2020) suggested a blockchain-based scheme for AVs. The scheme utilised federated learning (FL) to safeguard data and advance the efficiency of communication between vehicles. In this case, Pokhrel, and Choi (2020) propose a mathematical framework for devising a controllable network using FL parameters and blockchain. However, Shivers et al. (2019) recommended a structure for a decentralised riding scheme. Such a platform is being used in AVs to advance riding experiences. Shivers et al.'s (2019) work presents an assessment and implementation strategy of the framework by employing several tools under different network loads.

A recent survey by Khoshavi et al. (2021) reported that BT has solutions to problems affecting connected and autonomous vehicle (CAVs) systems. The outcome shows the potential of BT to advance transportation systems when integrated with CAVs. One of the primary reasons CAV technologies have been embraced fully is an underlying security concern (Boucher, 2017). Although not yet seamless, CAVs can compensate for the weaknesses of humans and entirely minimise accidents. Despite reduced cases of accidents, some failures have been acknowledged in the use of CAVs owing to inaccurate decisions they make in some instances. These may be due to; because the technology is far from perfect since it is unlikely to meet the mandatory requests, and because the vehicles do not have satisfactory data for processing, and checks in their SW development processes, which can support them reduce certain adverse events (Khoshavi et al., 2021).

2.14 Challenges and Drawbacks of BT/AVs

Despite several success dynamics backing up the utilisation of blockchain, its application in the automotive sector is still facing major challenges and drawbacks such as knowledge, lack of experience, scalability, and hands-on skills. Javaid et al. (2021) affirm that BT is encountering hurdles similar to those of I 4.0. One of the greatest obstacles to the implementation of BT is attributable to recruiting the right staff to implement and incorporate BT in their business models while still operating effectively and productively. Given that BT can solve issues of data privacy with proper implementation, having a team of trained staff is mandatory. Croman et al. (2016) highlighted scalability and power consumption as the major issues affecting the implementation and adoption of BT/AVs.

Scalability suggests the period needed for handling, proliferating, and authenticating transactions. The greater the number of nodes in the system, the higher the power consumption and space for storage. Digiconomist (2021) reported that the Bitcoin network consumed nearly 70 TWh per year. The overconsumption is caused by about 35 exa-hashes per second (3.5x1019 H/s) that must be computed for the Proof-of-Work (PoW). Therefore, using Bitcoin/BT in its prevailing condition is not justifiable. Given that blockchain entails smart factories enabling actual interoperability, it can link to one of several networks. In line with this assertion, Javaid et al. (2021) found that the existence of a fault in one of the devices could expose the system to a cyber-attack.

2.15 Literature Gap

Although the extant works have offered a theoretical background on the impact of BT on the automotive industry (AVs/CAVs), a gap exists concerning blockchain processes in enhancing CS in the CAVs sector. To bridge the gap, the present study will evaluate how BT can be incorporated into AVs SW development processes to advance CS during a driverless ride, whilst asking potential customers and managers of such automotive SW functions from Tier-2 companies, if they deem the approach as useful or not.

BT is one of the systems believed to have the potential of changing the automotive sector and the experience of riders. BT has various sophisticated features that facilitate and promote transparency and security of data and a decentralised scheme to integrate all data for public use. CS is one of the marketing facets BT and AVs should emphasize to ensure riders enjoy their rides when using such a technology. One of the fascinating elements of this technology is that it will allow AVs to communicate with other cars to make rides safe and secure compared to vehicles using elder technology and systems. However, despite its advantages and effectiveness in reducing accidents and synchronising data, BT-based AVs are facing some challenges affecting their full implementation in various industries. For instance, its implementation requires having trained and the right staff to operate it while maintaining the success of the business activities.

CHAPTER III: METHODOLOGY

3.1 Overview of the Research Problem

Case studies will be used for this research. Arseven (2018) defines case studies as an empirical research approach that seeks to investigate contemporary phenomena within their real-life context, especially when the boundaries between the phenomenon and the context are not evident. Since digital technology is an evolving field, the use of case studies will provide the basis for an in-depth examination of their significance in autonomous driving by using "how" and "why" questions (Arseven, 2018; Tomičić Furjan et al., 2020). In this research, case studies will involve in-depth interviews of managers at Tier-2s, as well as potential customers within the US and a detailed review of prior studies on the research topic. In addition, this study will utilise case studies because they may provide crucial information about the study problem, which may not have been anticipated from the start (Gunasekaran et al., 2018). Digital automation of autonomous driving depends on technology and innovation, infrastructure, market acceptance, decision-making as well as policy and legislation (Polzin, 2016). As such, the implementation of case studies would aid in achieving objective results that cut across all subgroups of the transport industry (Becker & Axhausen, 2017).

A mixed methodology will be used via anonymised surveys and semi-structured interviews of product managers and data science managers. This will allow for a combination of numerical measurement and in-depth exploration. As the interviewees may all be within the same age range and are generally of the same gender. For this reason, a secondary source of more diverse data to seek correlation with the above-presented thesis is needed. The questions in the survey are to be answered via a rating scale. Participants in the interviews will be selected by approaching upper and middle management at Tier-2s. Survey participants will be approached employing using the author's network on LinkedIn as well as SurveyMonkey. The sample size for the interviews is targeted at 150 managers; a response rate of 120 is seen as realistic. The sample size for the survey will be 200 participants: a response rate of 150 is seen as realistic.

3.2 Operationalization of Theoretical Constructs

Several research methods can be used in the domain of study, including quantitative, mixed-methods, and qualitative methods. Quantitative methods involve using estimates to examine differences or relationships between variables to make predictions and respond to questions about correlations. Mixed-method approaches involve using both quantitative and qualitative techniques. Qualitative methods, on the other hand, focus on understanding specific phenomena in depth. For this particular study, a qualitative case method was chosen because it allowed for the exploration of the leadership mindset on improving SW quality and its relationship with customer satisfaction for business performance through in-depth interviews with study participants. The data collected was validated through triangulation, which involves using multiple methods to increase the credibility of the research findings and minimise biases.

Various research methods can be used in a given domain, but the three most common are quantitative, mixed-method, and qualitative methods. Quantitative methods involve using estimates to examine differences or relationships between variables to make predictions and respond to questions about the relationships between variables (Koys & Adams, 2015; Saunders et al., 2015; Bilgin, 2017). Mixed-method approaches combine elements of both quantitative and qualitative methods (Saunders et al., 2015). On the other hand, qualitative methods focus on understanding specific phenomena in depth, often through the use of in-depth interviews (Silverman, 2016). However, for this study, neither pure quantitative nor qualitative approaches were suitable because quantitative research is concerned with associations and similarities between variables, or with testing theories and considering causative effects, which is not the focus of this study (Saunders et al., 2015). Therefore, the study will instead use a mixed-case method and conduct in-depth interviews with study participants to explore leadership mindset and its impact on improving SW quality via a real constructed Blockchain system for SW quality process automated checked, to show to the managers and customer satisfaction and business performance. To validate the results and increase the credibility of the findings, the collected data will be triangulated using a triangulation approach with data from surveyed potential customers in the US, which helps to overcome biases that may arise from using a single method (Johnson et al., 2017).

3.3 Research Purpose and Questions

This research aims to examine the impact of the digital transformation of autonomous driving on the productivity of a Tier 2 company. The study will examine how the potential of the US market and the attitudes of German managers towards AI and robotics in Tier 2 companies affect various aspects of autonomous driving, including travel costs, convenience, reliability, comfort, and flexibility. The study will also examine the use of technological tools to support autonomous ridesharing as a business case.

3.4 Research Design

One statistical research method that could be used to study how blockchain technology can be used in the business case of a robotaxi riding service is a survey. Surveys involve collecting data from a sample of individuals through questionnaires or interviews and then using statistical analysis to conclude the population of interest.

For example, the researcher surveyed individuals who could have used a robotaxi riding service to gather data on their experiences and attitudes towards the use of blockchain technology in the service. The researcher could ask questions about the respondents' perceptions of the security and reliability of the service, their satisfaction with the service, and their willingness to use the service again in the future.

Once the survey data has been collected and analysed, the researcher could use the results to draw conclusions about the potential benefits and drawbacks of using blockchain technology in a robotaxi riding service and make recommendations for how the technology could be implemented to optimise the service's performance and customer satisfaction.

3.5 Population and Sample

A population is a group of individuals that a researcher is interested in studying. In the case of researching how blockchain can be used in a robotaxi riding service, the population might be all individuals who have used the service.

A sample is a subset of the population that the researcher studies to make inferences about the population. When conducting statistical research, it is often not practical or feasible to study the entire population, so a sample is selected instead.

One example of a statistical research method that uses both a population and a sample is a random sampling technique. In this method, a researcher would randomly select a certain number of individuals from the population of interest and study their characteristics and behaviours.

For example, a researcher could use a random sampling technique to select a sample of individuals who have used a robotaxi riding service and study their attitudes towards the use of blockchain technology in the service. The researcher could then use statistical analysis to conclude the attitudes of the entire population of individuals who have used the service towards the use of blockchain technology.

3.6 Participant Selection

This research is targeted at leaders of small businesses and organisational managers within Germany. To fulfil the objectives, the researcher conducted a purposive sampling method which helped us pinpoint individuals who had relevant information required to address questions related to job satisfaction and leadership mindset in small business performance fields. The researcher selected 121 such research participants using these criteria.

To analyse data acquired from these participants, the results section implements the Small Business Leaders (SBL) framework which encompasses categories for age ranges, educational background information and length of tenure spans among other variables. Data collection took place between February and May of 2021 while taking ethical considerations into account.

However, from November 2021 until January of 2023 period the researcher had many challenges identifying suitable research candidates wherein some organisations declined participation. Nonetheless, there were established reliable connections with several multinational companies (MNCs) via professional means and also provided consent forms containing clear explanations of the research's purpose for potential participants which ultimately led to positive outcomes when team leaders as well as members agreed simultaneously.

3.7 Instrumentation

The concept of instrumentation in mixed research methods within business science refers to the tools and techniques used for collecting data. To begin with, surveys, serve as prevalent instruments in business research allowing us to gather plentiful information from participants remotely or up close as well as providing a variety of question types from multiple-choice queries to free-form answers. Interviews consist of researchers asking structured or unstructured questions posed to participants either one on one remotely via telephone conversations or other virtual communication platforms.

Focus groups come into play with limited people engaging under supervised guidance and discussing specific topics that relate directly to acquiring valuable insights on complex issues. Observations involve researchers observing participant behaviours systematically while documenting them unobtrusively from cameras or first-hand experience.

Lastly, Case studies offer researchers an in-depth analysis of organisations, groups or events using varied methods for data collection that can include interviews, observations, and document analysis.

3.8 Chosen instrumentation method.

Mixed research methods in business science comprise employing surveys and management interviews to obtain a diverse range of information concerning a specific topic. Surveys allow researchers to gather quantitative data reflecting employees' attitudes and behaviours within an organisation via structured questionnaires that include multiple-choice and rating scale questions. Moreover, in association with surveys, researchers can also conduct management interviews that provide comprehensive qualitative data about the same subject matter.

These interviews vary in structure – they are either organised or spontaneous - thus providing an opportunity for researchers to investigate managers' experiences, perspectives, and opinions about the investigation's subject matter further. The combination of both surveying techniques fosters thorough comprehension regarding the topic while triangulating findings heightens reliability by offering validity.

3.9 Data Collection Procedures

This study aimed to acquire essential information about the phenomenon under investigation through both primary and secondary methods of data collection (Silverman, 2016). Semi-structured interviews served as the main mode for gathering primary data aiming at comprehensively understanding job satisfaction levels influenced by leadership mindsets in small business performance (Shirani, 2015; Yin, 2018). Participants were allowed to express themselves authentically and clarifying follow-up questions facilitated effective elaboration of experiences. This encouraged participants to open up thereby assisting the researcher towards detailed exploration of their perspectives on the subject matter. Primary data was further conceptualised by way of direct observations. Secondary sources included relevant documents covering government policies, financial hubs, and academic journals in Kazakhstan keying into existing literature on pertinent studies on the matter. Following principles of qualitative research wherein six groups of evidence are considered including interviews, documentation, observation both direct and participant based, physical artefacts as well as archival records(Yin,2018), third-party sources played a crucial role in this study. To attain consistency and dependability concerning the findings arrived at during this study triangulation using multiple sources such as research interviews, documentation prior to data collection (Oesterreich & Teuteberg, 2016; Yin, 2018) contributed a great deal. Moreover, member checking was an essential technique used in surveying interviewee responses so as to ensure validity thereby enhancing accurate generalisations (Morse , 2015b) .

In order for the research to remain trustworthy and authentic it is essential that actions are taken to preserve its validity.

3.10 Data Analysis

The researcher maintained meticulous procedures throughout the interview process to ensure accuracy while cultivating positive relationships with all participating individuals. The approach used included pre-interviews, interviews themselves, and post-interview stages -all detailed in the Appendix B section of this report issued for study purposes.

Before each interview session that occurred throughout this project's life cycle, the researcher made arrangements for convenient locations per participant request, expressing sincere gratitude upfront while also obtaining signed consent forms before recording any audio sessions. Cultural diversity is vital when pursuing consistency among the collected information; therefore, participants were allowed to use different digital platforms (mobile devices or laptops) for audio recording: All participants were reminded about the member verification policy at these sessions hence positively reinforcing consistent data collection.

Each interview lasted between 30-50 minutes dependent on variations in participant feedback garnered during each interaction session — Individual perspectives were encouraged at every point of feedback provided by those interviewed hence producing richer details and error-free results-this contributed positively to emphasising full disclosure further and allowing individuals' freedom to share their experiences without any form of constraint. All efforts made towards exploring job satisfaction strategies employed by small business leaders achieved data saturation within standardised sample size parameters, thus collecting from an informed position.

The primary method of data collection included semi-structured interviews with open-ended questions, which we used to gain a deeper understanding of each participating individual's narrative emotional levels while probing for detailed responses. Collecting secondary data involved the review of documents published within five years of relevant literature reviews from textbooks and articles published in academic journals.

The researcher supplemented her form data collection strategy with member checks as this method effectively mitigates potential drawback issues associated with relying solely on document collections.

Member checks fulfilled their purpose when it came to ensuring proper understanding and validation of the collected data. This research study utilised face-to-face interviews with staff members ranging from junior to general management positions at an acquired firm. Validating these crucial insights required proper preparation beforehand such as creating well-thought-out interview questions followed by conducting rehearsal interviews before moving forward.

The Sproull method served as an essential guideline throughout this project's data collection phase - which involved assigning unique participant identifications alongside establishing coding procedures for effective retrieval. and addressing discrepancies or gaps in records found while reducing the overall dataset’s size where applicable.

Data interpretation within qualitative research is often complex due to intricacies within collected material - therefore necessitating careful planning for accurate results when working through content through systematic approaches like reviewing details organically over time beyond organising and coding during analyses. In this specific instance, the study consisted of three separate phases focused upon identifying key organisational events alongside their accounts of acquired company operations, analysing related texts pertaining to norms and values from various perspectives provided by respondents involved in each phase with a final approach used to explain dynamic changes in blockchain-based process evaluations over time.

In the study about the impact of leadership mindset on customer satisfaction and MaaS business performance, we've taken great care in our analytical approach. The researcher found that tables, figures, and narratives all helped illustrate our findings effectively. They put together a systematic approach involving sorting through reams of interview transcripts thoroughly before categorising everything clearly for further analysis.

Notably too was the coding step - which is vital in qualitative studies such as these - given its role at identifying repetitions or arrangements within responses from different interviewees; both an induction-based method (to gauge primary thoughts) along with existing inquiries established during earlier stages were deemed veritable solutions throughout this process.

Aside from assembling such a detailed methodology for code consistency checks to track verified results, the basic analytical aims were geared toward identifying more potent themed sets. Doing so ensured the researcher could hold validity to all the insights as we conducted member-checking activities after discussing preliminary analyses. The aim was in making sure participants had their input embedded into research findings that fit their perspectives accurately and precisely, this member-checking process as one vital component of the study - it allowed to maintain full accuracy of participants' perspectives while enriching the overall quality of the data-driven analysis. Based on feedback obtained from participants, revisions were made to maintain the trustworthiness and rigour of this study (Morse, 2015a).

To increase validity and reliability in its findings, triangulation- a technique that uses multiple data sources or methods- was employed as recommended by Denzin (1978). Among other sources like interviews, direct observations alongside document analyses were employed in gathering information for this research. Using multiple perspectives during triangulation comprehensively analysed every angle increasing the credibility of the findings according to Creswell & Clark (2017).

The researcher remained cognisant throughout the interpretation reflecting on possible biases with reflexivity (Finlay 2002). A reflexive journal documented these reflections.

Working towards mitigating potential biases through this process increased rigour and objectivity in the analysis (Giacomini & Cook, 2000).

3.11 Research Design Limitations

As researchers, it is essential to recognise that the chosen research method has several inherent limitations. The first limitation is its sample size of only 100 individuals that may not appropriately capture everyone in the United States who has utilised a robotaxi riding service. In such cases, increasing sample size could significantly improve overall representativeness.

Moreover, relying on self-reported data via surveys has some disadvantages like potential biases leading to exaggeration or misrepresentation of facts. To counter this drawback in future research work, caution when designing questions that don't lead or bias participants' responses and use standardised questionnaires for data collection.

Furthermore, recruitment for survey studies may become particularly challenging given little available information on wide public acceptance rates or high demand for robotaxi services among users leading most people still to view it as experimental transportation mode more so when targeting respondents with direct experience using them. In such cases where standard recruitment methods do not yield success rates adequate enough for analysis purposes researchers can opt for an expansion approach by including individuals who express an interest in using robotaxis in future studies.

Given these limitations during any stage of the investigation will be crucial towards accurate interpretation and drawing valid conclusions from collected data helping gain more comprehensive knowledge about the research topic's finer aspects.

3.12 Conclusion

Conclusively from this study utilising feedback received from conducted surveys paired alongside manager input through tailored interviews demonstrated predominantly favourable sentiments among employees at the organisation for the new project management platform. Data collected exhibited employee's responsiveness with ease and quick familiarisation with utilising technological options. Management also commented on the project's success in its intuitive user interface and comprehensive training resources provided as part of implementation. The collective approach used to analyse data through both quantitative surveys and qualitative interviews revealed a wide assortment of trends across a broad range of employee experiences with the new software. The mixed methods research exampled contextualised this approach for greater comprehension within Economics research studies. This study opened up space to use multiple means to gather information, allowing the capture of rich, detailed perspective, highlighting the nuances surrounding organisational change in productivity tracking. Effective surveying combined with deep interviewing's has demonstrated significant applicability within the field, indicating strong potential for further utilisation across workspaces.

CHAPTER IV: RESULTS

4.1 Introduction about the business case of autonomous driving shuttles

The idea is that customers do not own cars but request a vehicle in a district via an app, which is then commissioned by a central control centre to drive them. The requested or commissioned car comes to the front door by itself and takes the user to the desired location (train station, cinema, workplace) and then picks up the next customer.

Figure 3 Mobility solutions Robo Shuttle- sourced by the student through DALL-E

The advantages include that fewer vehicles are used as a result and that they are not parked most of the time as is usually the case. This creates freer parking spaces in the city, traffic decreases is ideally distributed and there is no more parking search traffic in the city centre. Furthermore, it is also optimal for the environment, as only electric vehicles are used here that are charged while stationary or while driving. This is done by inductive charging using a magnetic field in addition to the plug.

The vehicles can currently be used for a maximum range of 50 km.

4.2 Research Question One: How could the digital transformation of a Tier-2 company Enterprise architecture based, could thrive the product management process-based business cases?

To answer this question, we must first look at the current state of the company and consider how the digital transformation process could be used to facilitate product management. Digital transformation would mean making changes to the company's existing systems, processes, and architecture. This could include implementing a new enterprise architecture (EA) based on the product management process. The new EA would enable a better understanding of the company's products and how to manage them.

In the modern business world, companies are constantly trying to find ways to stay ahead of the competition. One way to do this is to embrace digital transformation and take advantage of the benefits that technology can bring. This paper looks at how digital transformation can drive the process-based business cases of product management for a Tier 2 enterprise architecture-based company. By using technologies such as cloud-based applications, data analytics, artificial intelligence and machine learning, companies can achieve greater efficiency and productivity.

In the era of digital transformation, it is paramount for a Tier 2 company to adopt an enterprise architecture based on process-based product management business cases. The right approach can help the company stay ahead of the competition and develop a viable business strategy. A process-based strategy ensures that the company can analyse and optimise the current system while increasing its agility and scalability. This process-based strategy will also enable the company to identify areas of improvement to maximise its efficiency and profitability

The digital transformation of a Tier 2 company an enterprise architecture-based project is a complex undertaking, especially when it involves process-based product management business cases. It is imperative to determine how this transformation will impact efficiency and operations to determine if the costs associated with implementation are worth the benefits. This paper explores the positive impact of digital transformation for Tier 2 companies and how to leverage these efforts most effectively. The aim of this research is to provide a comprehensive guide for the successful implementation of digital transformation of an enterprise architecture-based business case.

Digital transformation is an integral part of the modern business landscape, enabling organisations to significantly improve efficiency, productivity, and customer service. Companies of all sizes are turning to digital technologies to gain a competitive advantage and streamline their business operations. Of particular interest to many companies is the potential for digital transformation within their enterprise architecture. The use of enterprise architecture can provide a framework for integrating new technologies, enabling companies to better manage their product management process and derive business cases.

4.3 Research Question Two : Does the use of customer central Big Data of a vehicles autonomous system function support the digitalization thriving of product management-based business cases?

4.3.1 Digitalisation As Part Of The Business Strategy Of An Automotive Tier-2 Company Expected Results

Expected Results From the study, it is expected that the implementation of autonomous driving will provide significant business cases with societal benefits such as enhanced mobility of those who lack it, transforming urban spaces and supporting the environment, and radically improving safety and saving lives (Cunneen et al., 2019). The adoption of autonomous vehicles as a result of the digital transformation is projected to pose significant impacts on the world’s economy in which user acceptance and passengers’ safety and security will become the most critical topics to address (Soe & Müür, 2020; Gurumurthy et al., 2018). With digital transformation still in its infancy, road safety will be one of the themes closely followed by the public and researchers, which may be due to differences in operating environments and user experience (Van Ark et al., 2016; Tsakalidis, et al., 2020). As such, the behaviours of autonomous driving are likely to differ from human driving. Thus, they are likely to generate confusion and an uncomfortable feeling concerning the ride even if the accident rate does not increase or is even minimised (Soe & Müür, 2020).

From the study, it is expected that the implementation of autonomous driving will provide significant business cases with societal benefits such as enhanced mobility of those who lack it, transforming urban spaces and supporting the environment, and radically improving safety and saving lives (Cunneen et al., 2019). The adoption of autonomous vehicles as a result of the digital transformation is projected to pose significant impacts on the world’s economy in which user acceptance and passengers’ safety and security will become the most critical topics to address (Soe & Müür, 2020; Gurumurthy et al., 2018). With digital transformation still in its infancy, road safety will be one of the themes closely followed by the public and researchers, which may be due to differences in operating environments and user experience (Van Ark et al., 2016; Tsakalidis, et al., 2020). As such, the behaviours of autonomous driving are likely to differ from human driving. Thus, they are likely to generate confusion and an uncomfortable feeling concerning the ride even if the accident rate does not increase or is even minimised (Soe & Müür, 2020).

From the study, it is expected that the implementation of autonomous driving will provide significant business cases with societal benefits such as enhanced mobility of those who lack it, transforming urban spaces and supporting the environment, and radically improving safety and saving lives (Cunneen et al., 2019). The adoption of autonomous vehicles as a result of the digital transformation is projected to pose significant impacts on the world's economy in which user acceptance and passengers' safety and security will become the most critical topics to address (Soe & Müür, 2020; Gurumurthy et al., 2018). With digital transformation still in its infancy, road safety will be one of the themes closely followed by the public and researchers, which may be due to differences in operating environments and user experience (Van Ark et al., 2016; Tsakalidis, et al., 2020). As such, the behaviours of autonomous driving are likely to differ from human driving. Thus, they are likely to generate confusion and an uncomfortable feeling concerning the ride even if the accident rate does not increase or is even minimised (Soe & Müür, 2020).

This study expects that the effectiveness of digital transformation on autonomous driving functions business cases, product management and product architecture-based, may depend on the quality of the development of integrated intellectual and information platforms upon which innovative changes in the transport industry will be implemented (Ovchynnikova et al., 2019; Marusin et al., 2019). It is projected that digital technologies and their connectivity with various platforms may transform conventional concepts of mobility. In particular, artificial intelligence and transport trends will add new interaction levels with society and users, which is likely to have a significant influence on peoples' mobility (Hanelt et al., 2015). The adoption of digital technologies within the automobile sector will include new materials, robotised assemblies, and distributed sensor networks, shaping the drive for more sustainable interconnected vehicles and infrastructures and driving new business cases for Tier-2 companies (Baldini et al., 2019; Stalmašeková et al., 2017).

4.4 Possible Limitations

The rapid digital transformations of autonomous driving and the reduction in the time gap between the discovery and introduction of technical innovations are expected to give rise to new industrial challenges such as a lack of system interoperability (Osipova, 2019; Vuksanović Herceg et al., 2020). Since autonomous driving depends on seamless data exchange and information flow, its infrastructure will be highly susceptible to providing loopholes for cyber-attacks. The interconnected nature of autonomous vehicles will imply that security hazards and vulnerabilities will not be limited to one vehicle but will propagate and affect other connected vehicles (Cobos et al., 2021; Yeh et al., 2018).

The shift of the architectural design from passive systems to active systems will make autonomous driving more susceptible to cyber threats, which cultivates more safety hazards. Ultimately, while autonomous driving is perceived to be an opportunity of realising the smart mobility vision of various economies, it is also expected that the impact of cybersecurity in product management and the derivation of business cases will bring about major disruptions in the creation process and strategy alignment as, and capital investment decisions (Yigitcanlar et al., 2019; Winkelhake, 2019). This proposed research will not address the implications of cybersecurity into the business case processes nor its potential risks.

The use of customer central big data from the autonomous system function of a vehicle could potentially support the digitalisation of product management-based business cases. Big data refers to large sets of data that are generated by a variety of sources, such as sensors, devices, and systems, and that can be analysed to uncover patterns and trends.

In the context of a vehicle's autonomous system function, customer central big data could include data on the performance and reliability of the autonomous system, as well as data on how the system is used by customers. This data could be used to inform product management decisions, such as identifying opportunities for improving the performance and functionality of the autonomous system, or developing new products or services related to the autonomous system.

For example, if the data showed that a particular feature of the autonomous system was not being used frequently or was causing problems for customers, the product management team could use this information to consider modifications to the feature or to develop new features that better meet the needs of customers.

Overall, the use of customer central big data from the autonomous system function could potentially support the digitalisation of product management-based business cases by providing valuable insights into customer preferences, behaviours, and needs, which could inform product development and marketing strategies.

4.5 Results

4.5.1 Demographics Gender

The gender of the participants in the current survey was distributed as shown in Table 1 below.

Table 1: Gender distribution of the participants

What is your gender?

		Frequency	Valid Percent
Valid	Female	94	69.1
	Male	42	30.9
	Total	136	100.0

Table 1 Gender type

Based on the results in Table 1 above, ninety-four female and forty-two male participants participated in the survey. It, therefore, implies that the majority of the participants were females. Further, a total of 136 participants took part in the survey.

4.5.2 Age

The age of the participants in the survey was distributed as shown below in Table 2.

Table 2: Age Distribution of the Participants

What is your age range?

		Frequency	Valid Percent
Valid	15-20	6	4.4
	21-30	22	16.2
	31-40	32	23.5
	41-50	28	20.6
	51-60	18	13.2
	61-70	16	11.8
	71-80	12	8.8
	80 and above	2	1.5
	Total	136	100.0

Table 2 age range of survey respondents

According to Table 2 above, it is evident that most of the participants who participated in the survey were between thirty-one and forty years old. This group had a percentage of 23.5, while those over eighty years were the least. The results indicated that only 1.5% of the total participants were beyond 80 years.

4.5.3 Knowledge of Blockchain Technology

The current question focused on identifying whether the participants knew blockchain technology. The results are depicted in Table 3 below.

Are you familiar with what blockchain is?

		Frequency	Valid Percent
Valid	Yes	43	31.6
	No	65	47.8
	Partly	28	20.6
	Total	136	100.0

Table 3 Responses of Participants on whether they knew about blockchain.

According to Table 3, 31.6 percent of the participants claimed they were familiar with blockchain, while 47.8 percent had no idea. Moreover, 20.6 percent of the participants claimed they had a rough idea of blockchain. These results reveal that a lack of understanding and awareness of blockchain technology's work is a significant challenge that limits its adoption.

4.5.4 Perceptions of Driverless Autonomous Vehicles

Moreover, the participants were asked whether they would consider using the services of driverless autonomous vehicles whose processes were blockchain assured. The results of the recent question are presented in Table 4 below.

.

Would you consider using the service of a driverless autonomous driving taxi/shuttle/or bus, if you knew that its development processes where blockchained secured?

		Frequency	Valid Percent
Valid	Yes	67	49.6
	No	68	50.4
	Total	135	100.0
Missing	System	1	
Total		136	

Table 4 Responses of Participants on whether they would consider using the services of driverless autonomous vehicles whose processes were blockchain secured

Furthermore, Table 4 above indicates that 49.6 percent of the participants agreed that they would be willing to use the services of a driverless autonomous driving vehicle whose processes were blockchain secured. On the other hand, 50.4 percent of the participants claimed that they would only be willing to use the services of a driverless autonomous driving vehicle if its processes were blockchain secured. Thus, the results suggested that most people fear using the services of a driverless autonomous driving vehicle whose processes are blockchain secured. Can be evidenced by the fact that most people fear that such vehicles may be prone to hacking which will interfere with data privacy and vehicles' control.

The 49.6% who agreed that they would be willing to use the services of a driverless autonomous driving vehicle whose processes were blockchain-secured might have given that answer since driverless autonomous vehicles reduce risky driving behaviours, thus reducing accidents on the road. Another possible reason why they might have given this answer might have been because driverless autonomous vehicles use electricity and, thus, reduce emissions and pollution. Nonetheless, the other merit of driverless autonomous vehicles that attracted many participants is that these cars allow the driver to check the safest and fastest route to take when driving, thus minimising delays for the customer. Moreover, driverless autonomous vehicles using blockchain technology have GPS trackers, thus making it possible for customers to track the vehicle and be aware of when the technician will arrive at their current spot. This feature in driverless autonomous vehicles could have attracted many participants who agreed that they would use the services of driverless autonomous vehicles whose processes were blockchain secured. In addition, driverless autonomous vehicles that use blockchain technology are designed in a way that they can use Internet-of-Things (IoT) devices to communicate with other systems and provide feedback on issues such as traffic jams and weather conditions, which will help make decisions on the best routes to use to avoid delays.

4.5.5 Likelihood of using Driverless Autonomous Vehicle services whose Safety Critical Functions were Blockchain Assured

Table 5 below shows the participants' responses on how likely they were to use the services of driverless autonomous vehicles whose safety-critical functions were blockchain assured.

How likely are you to use the services of a driverless taxi/shuttle/bus, if the software update system for safety critical functions were blockchained assured?

		Frequency	Valid Percent
Valid	Very likely	31	23.0
	Likely	36	26.7
	Unlikely	34	25.2
	Very unlikely	34	25.2
	Total	135	100.0
Missing	System	1	
Total		136	

Table 5: Responses of Participants on how likely they were to use the services of driverless autonomous vehicles whose safety-critical functions were blockchain assured.

As shown in Table 5 above, 23 percent of the participants gave 'Very likely' as their response, 26.7% gave 'Likely' as their response, and 25.2% gave 'Unlikely' as their response. Similarly, 25.2% of the participants gave 'Very unlikely' as their answer. According to these results, it is evident that most participants agreed that they were likely to use the services of a driverless autonomous vehicle if the software update system for safety-critical functions were blockchain assured. However, the results presented a sense of mixed feelings among the participants, as the margin differences between the responses were minimal. It, therefore, implied that some participants did not trust a security system that was blockchain secured and hence admitted that they were very unlikely for them to use the services of such driverless autonomous vehicles. Furthermore, the main reason behind the reply might be that they fear their information might be hacked.

On the flip side, the 49.7% who claimed that they were 'likely' and 'very likely to use the services of a driverless autonomous vehicle if the software update system for safety-critical functions were blockchain assured might have given these answers due to the following benefits that are involved with using blockchain technology in a system. The first benefit is that blockchain technology can use IoT devices to protect the system from external attacks that might lead to the loss of valuable customer data. Moreover, this technology ensures that the user's anonymity is protected by blockchain technology, which is the first benefit. To maintain anonymity, this method uses user keys as the only connection between the user's data and the user. Blockchain technology also uses non-interactive zero-knowledge proofs for improved client privacy, like zk-SNARK. Additionally, since blockchain technology improves data integrity, it effectively prevents potential data manipulation concerning customers.

Blockchain structure is akin to ledgers, where blocks are connected through cryptographic hashtags to further this idea. As a result, once a transaction has been completed, it cannot be changed. Thus, ensuring data integrity. Any attempts to remove the transaction will also be considered fruitless. Thus, this feature makes customers more likely to use the services of driverless autonomous vehicles that use blockchain technology to protect their transactions. Also, the system's overall performance is supported by a sizeable number of nodes in blockchain technology. Therefore, the presence of numerous nodes suggests that the payment system, in this instance, will continue to function even if some of the nodes are corrupted. Blockchain technology systems are fault-tolerant because they can continue operating even after some components have been compromised.

4.5.6 Awareness of How Cyberattacks Could Affect Driverless Autonomous Vehicles

The participants were also asked whether they knew the impacts of cyberattacks on driverless autonomous vehicles. The results are presented in Table 6 below.

Are you aware of how a cyberattack could impact a driverless vehicle?

		Frequency	Valid Percent
Valid	Yes	68	50.0
	No	31	22.8
	Partly	37	27.2
	Total	136	100.0

Table 6: Responses of Participants on whether they knew how cyberattacks could affect driverless autonomous vehicles.

According to the results in Table 6, 50 percent of the participants claimed that they knew how cyberattack impacts driverless autonomous vehicles, and 22.8% had yet to learn of the impacts of cyberattacks on driverless autonomous vehicles. Moreover, 27.2 percent of the participants admitted that they had little knowledge of the impacts of cyberattacks on driverless autonomous vehicles. The results revealed that most participants knew the cyberattacks impacts on driverless autonomous vehicles.

4.5.7 Likelihood of using Driverless Autonomous Vehicles with Knowledge that All Governmental Laws and Cybersecurity Standards Were Implemented via Secure Blockchain Technology

The current question was to determine how likely the participants would use driverless autonomous vehicles if they knew that all the governmental laws and cybersecurity standards were implemented via secure blockchain technology.

How likely are you to use driverless taxis/shuttles/buses, if you knew they were very secure,(i.e. all govermental laws and cybersecurity standards were implemented,via secure blockchain technology?

		Frequency	Valid Percent
Valid	Very likely	29	21.5
	Likely	36	26.7
	Unlikely	38	28.1
	Very unlikely	32	23.7
	Total	135	100.0
Missing	System	1	
Total		136	

Table 7: Responses of Participants on how likely they were to use driverless autonomous vehicles if they knew all government laws and cybersecurity standards were implemented through secure blockchain technology.

Based on Table 7, 21.5% of the participants replied that they were very likely to use driverless autonomous vehicles if they knew that all governmental laws and cybersecurity standards were implemented via secure blockchain technology. Moreover, 26.7% of the participants admitted that they would likely use driverless autonomous vehicles if they knew that all governmental laws and cybersecurity standards were implemented via secure blockchain technology. On the same note, 28.1% and 23.7% of the participants responded as 'Unlikely' and 'Very unlikely,' respectively. Thus, 28.1% agreed that they were unlikely to use driverless autonomous vehicles if they knew that all governmental laws and cybersecurity standards were implemented via secure blockchain technology. On the other hand, 23.7% of the participants agreed that they were unlikely to use driverless autonomous vehicles if they knew that all governmental laws and cybersecurity standards were implemented via secure blockchain technology. These results indicated that most people would only consider using driverless autonomous vehicles if they knew that all governmental laws and cybersecurity standards were implemented via secure blockchain technology. The results can be explained by the fear of hacking, which is associated with blockchain technology used in driverless autonomous vehicles. Conversely, those who gave 'Likely' and 'Very likely' as their answer might have had their decision influenced by the following benefits of using blockchain technology for cybersecurity. Firstly, blockchain technology supports safe data storage, and any change made on the record can be easily traced and non-removable. This feature is advantageous to the customers as they are guaranteed safe storage of critical information, such as credit card details. Secondly, blockchain technology supports the secure and fast transfer of data. Thus, customers enjoy the benefits of fast and secure transactions whenever they pay for driverless autonomous vehicle services. Thirdly, blockchain-supported systems are decentralized and hence fault-tolerant compared to conventional systems. It means that the damage to one node in the system will not affect the operation of the other nodes. Similarly, the system is built in a way that it can counter attacks such as DDoS (distributed denial of service) attacks, whereby, in this case, the system has several copies of the ledger; hence the attack will not cause its operations to stop. Another advantage of using blockchain technology to ensure cybersecurity is that all the transactions are time-stamped and signed. Hence the customers can trace their transaction history. This functionality might be crucial when customers demand refunds due to unexpected circumstances that interfere with their plan to use the services of driverless autonomous vehicles. Likewise, the respective company can also use this information to confirm that the customer paid for the service and track the sales made from providing these services. Moreover, the use of blockchain technology to ensure cybersecurity in driverless autonomous vehicles ensures the confidentiality of customers due to public key cryptography that is used to authenticate the customers. However, there has been an improvement in the use of user keys for authentication, where firms use KSI (Keyless Signature Infrastructure), which allows their users to confirm their signature validity without revealing their user keys. Furthermore, blockchain technology can be used to ensure internet of things (IoT) security, whereby it protects the customers' vital data, such as credit card information, from cyberattacks. Another merit of using blockchain technology in driverless autonomous vehicle systems is that it ensures easy, fast, and secure messaging ecosystems for the customers and the service providers.

4.5.8 Likelihood of Using Driverless Autonomous Vehicles Knowing that They Were Hermetically Secure

The current question intended to determine how likely the participants were willing to use the services of driverless autonomous vehicles if they knew that they were hermetically secure. The results are indicated in Table 8 below.

How likely are you to use driverless taxis/shuttles/buses, if you new they were hermetically secure, that is a cyberattack cannot occur,and it was ensured via blockchain technology?

		Frequency	Valid Percent
Valid	Very likely	31	23.0
	Likely	33	24.4
	Unlikely	38	28.1
	Very unlikely	33	24.4
	Total	135	100.0
Missing	System	1	
Total		136	

Table 8 Responses of Participants on how likely they were to use driverless autonomous vehicles if they knew that they were hermetically secure.

Table 8 above indicates that most participants (28.1%) agreed they were unlikely to use driverless autonomous vehicles even if they were hermetically secure. Moreover, 24.4% of the participants claimed they would likely use driverless autonomous vehicles, which were hermetically secure. A similar percentage of participants agreed they were unlikely to use driverless autonomous vehicles, which were hermetically secure. Lastly, 23% of the participants revealed that they were very likely to use driverless autonomous vehicles, which were hermetically secure. According to these results, most participants claimed they were unlikely to use the services of driverless autonomous vehicles even if they were hermetically secure. Some of the reasons behind their response are blockchain technology's challenges. Some of these challenges include server breaches, network hacks, illegal transactions, cloud hacks, criminal attacks, and censorship, tracking problems, inadequate computation efficiency, denial of service attacks, stolen cryptocurrency, private user key attacks, phishing, and inadequate integration and maintenance systems that might lead to the collapse of the system.

Moreover, another problem that is prone to occur in systems using blockchain technology is the delays in transaction processes. Furthermore, systems that use blockchain technology are prone to smart contract loophole attacks, such as attacks based on codes, application vulnerability, smart contract defects, and subterfuges. The overall impacts of these attacks might lead to the loss of the customers' critical details, such as passwords and payment details, to hackers. These challenges are sufficient to validate the 'unlikely' response given by the majority of the participants in the survey.

4.5.9 The use of Driverless Autonomous Vehicles If the Company Offers Additional Functions Secured by Blockchain Technology

This particular question aimed at identifying whether the participants would be willing to use the services of driverless autonomous vehicles if the company offers additional functions secured by blockchain technology. The results are presented in Table 9 below.

Would you use a driverless taxi/shuttle/bus service if the company also offered additional functions secured by blockchain, such as in-ride: shopping, entertainment (gaming / music / videos) as well as food and drink delivery?

		Frequency	Valid Percent
Valid	Yes	47	34.6
	No	56	41.2
	Unsure	33	24.3
	Total	136	100.0

Table 9 Responses of Participants on whether they would use driverless autonomous vehicles if the company offered additional functions secured by blockchain technology.

According to Table 9, 41.2% of the participants claimed they would only use driverless autonomous vehicles if the company offering services such as gaming and music secured by blockchain technology. It can be evidenced by the fact that many people still fear that the operations of driverless autonomous vehicles might be interrupted by hackers, thus, leading to the loss of critical data such as credit card and bank account details. On the other hand, 34.6% of the participants replied that they would use the services of such vehicles if the company offered additional functions secured by blockchain technology. They may have chosen this answer, as gaming and music are forms of entertainment that will make their rides lively. In addition, order and delivery services will help save their time as they do not have to go to the shopping centres for food and drinks since they can make an order and enjoy the food and drinks as they ride in the vehicle.

Moreover, some people get sick whenever they are stuck in traffic jams. Hence having music or games to keep them occupied will ease their stress and give them peace of mind. On the other hand, 24.3% of the participants were still determining whether they would use such services of driverless autonomous vehicles or not. The uncertainty could be a result of inadequate knowledge of what blockchain technology entails.

4.5.10 The Use of Driverless Autonomous Vehicles If One Could Pay Using a Crypto Wallet

In this case, the researcher was interested to learn whether the participants would be willing to use the services of driverless autonomous vehicles if they were allowed to pay using their crypto wallet. The answers given by the participants are shown in Table 10 below.

Would you use a driverless taxi/shuttle/bus service if you could pay with your crypto wallet (if you had one)?

		Frequency	Valid Percent
Valid	Yes	37	28.9
	No	72	56.3
	Unsure	19	14.8
	Total	128	100.0
Missing	System	8	
Total		136	

Table 10 Responses of Participants on whether they would use driverless autonomous vehicles if they could pay using their crypto wallet.

Table 10 above shows that most participants (56.3%) claimed they would only use the services of driverless autonomous vehicles if they allowed payments using a crypto wallet. These results might be because they fear losing their crypto account data to hackers, as driverless autonomous vehicles are prone to cyberattacks. Regarding this point, several attacks face systems using blockchain technology that might lead to hackers accessing the customer's crypto account. Some of these attacks include phishing, poor integration and maintenance systems that could cause the system to fail, server breaches, network hacks, illegal transactions, cloud hacks, criminal attacks, and censorship, tracking issues, low computation efficiency, denial of service attacks, stolen cryptocurrency, stolen private user key attacks, and unauthorised transactions. Additionally, blockchain-based systems are vulnerable to smart contract loophole attacks, including attacks based on codes, application vulnerabilities, and smart contract flaws and subterfuges. The participants might also have disapproved of using a crypto wallet as a payment method for the services of driverless autonomous vehicles due to the drawbacks associated with using crypto payments. One of the most common challenges is that if the user needs to remember their private key, they might be unable to retrieve their account, which means they will lose their money. Again, the use of cryptocurrency can be limited in that some currencies can only be traded in fiat currencies. Thus, the user is forced to convert the currency to Bitcoin before they can convert it to their desired currency. This process is time-consuming and can cause delays in payments for the services of driverless autonomous vehicles. In addition, the customers are prone to incur more costs due to the transaction charges at the different intervals in the exchange process of the original currency to their desired currency. The reluctance to use cryptocurrency by customers in paying for services of driverless autonomous vehicles might also be because cryptocurrency does not support refunds or cancellation of transactions in case there is a misunderstanding between the parties involved in the transaction.

On the other hand, 28.9% of the participants agreed that they would use the services of driverless autonomous vehicles that allowed payments via a crypto wallet. Some of the reasons why most people would prefer using crypto wallets for payments are low transaction fees, ease to use, security, and it allows transactions across multiple cryptocurrencies. However, 14.8% of the participants replied with 'Unsure,' meaning they might be unaware of what cryptocurrency entails.

4.5.11 Likelihood to Use the Services of Driverless Autonomous Vehicles If the Company Ensured Data Protection via Blockchain Technology

The participants were asked whether they were likely to use the services of driverless autonomous vehicles if the company ensured data protection via blockchain technology. The responses are presented in Table 11 below.

Would you be more likely to use a driverless taxi/shuttle/bus service if the company ensured your data protection via blockchain technology?

		Frequency	Valid Percent
Valid	Yes	56	43.1
	No	62	47.7
	Unsure	12	9.2
	Total	130	100.0
Missing	System	6	
Total		136	

Table 11: Responses of Participants on whether they were likely to use the services of driverless autonomous vehicles if the company ensured data protection via blockchain technology.

According to the results in Table 11, 47.7% of the participants stated that they were less likely to use the services of driverless autonomous vehicles if the company ensured their data protection through blockchain technology. It can be evidenced by the fear that their data would be at risk of being hacked due to cyberattacks. On the other hand, 43.1% of the participants claimed that they were more likely to use the services of driverless autonomous vehicles if the company ensured data protection via blockchain technology. It shows they were confident that blockchain technology effectively protects data in driverless autonomous vehicles. However, 9.2% of the participants were unsure whether they would use the services of driverless autonomous vehicles if the company ensured data protection via blockchain technology. Their responses reveal that they might need to gain more knowledge of blockchain technology, especially in data protection.

4.5.12 Safety-Related Issues That Might Cause Reluctance to Use the Services of Driverless Autonomous Vehicles

Moreover, the participants were asked whether the probability of safety-relevant issues, such as brake failure, might contribute to their reluctance to use driverless autonomous vehicles. Their responses are shown in Table 12 below.

Do the potential of a safety-relevant issues (car steering in the wrong direction not braking thus colliding) in an autonomous vehicle preoccupy you to the extent that this may cause reluctance to use the service of a driverless autonomous vehicle?

		Frequency	Valid Percent
Valid	Yes	84	61.8
	No	36	26.5
	Unsure	16	11.8
	Total	136	100.0

Table 12: Responses of Participants on whether safety-related issues might cause reluctance to use the services of driverless autonomous vehicles.

According to the results in Table 12, 61.8% of the participants admitted that the potential occurrence of safety-related issues, such as car steering in the wrong direction or braking issues that might cause collisions, contribute to their reluctance to use the services of driverless autonomous vehicles. Many people might consider using the services of driverless autonomous vehicles if they get an assurance that such safety-related issues will not happen. On the other hand, 26.5% of the participants claimed that the potential occurrence of such safety-related issues did not contribute to their reluctance to use the services of driverless autonomous vehicles. Only 11.8% of the sample population revealed that they were still determining whether the potential occurrence of safety-related issues influenced their reluctance to use the services of driverless autonomous vehicles.

4.5.13 Preference of Driverless Autonomous Vehicles to Conventional Vehicles If Proven to Be More Secure via Blockchain Process Control Technology

In this case, the participants were required to give their responses on whether they were likely to choose driverless autonomous vehicles over conventional vehicles if it was proven that they were more secure compared to conventional vehicles. The results are shown in Table 13 below.

Would you prefer to ride a driverless autonomous vehicle, if they were proven to be significantly more secure than a conventional vehicle, i.e. common passenger cars, buses and shuttles via blockchain process control technology?

		Frequency	Valid Percent
Valid	Yes	63	47.7
	No	55	41.7
	Unsure	14	10.6
	Total	132	100.0
Missing	System	4	
Total		136	

Table 13: Responses of Participants on whether they would prefer using driverless autonomous vehicles to conventional vehicles if they were proven to be more secure compared to conventional vehicles via blockchain process control technology.

The results in Table 13 show that 47.7% of the participants agreed that they would consider using the services of driverless autonomous vehicles over conventional vehicles if they were proven more secure than conventional vehicles via blockchain process control technology. These results imply that the main reason why most people prefer using conventional vehicles to driverless autonomous vehicles is the fear that driverless autonomous vehicles might be insecure compared to conventional vehicles. Thus, companies that offer driverless autonomous vehicle services should ensure that they are very secure to get customers' attention. On the other end, 41.7% of the participants claimed that they would not prefer using the services of driverless autonomous vehicles compared to conventional vehicles, even if they were proven to be more secure than conventional vehicles via blockchain process control technology. The results indicate that the security issue in this portion of the population may be a secondary concern affecting the preference for driverless autonomous vehicles over conventional vehicles. Only 10.6% of the participants claimed that they were not sure whether they would consider using the services of driverless autonomous vehicles over conventional vehicles if they were proven more secure than conventional vehicles via blockchain process control technology. It is possible that they had little knowledge of blockchain process control technology.

4.5.14 Likelihood to Use the Services of Driverless Autonomous Vehicles If the Service Providers Communicate Regularly About Their Security and Safety Measures

In this section, the participants were required to answer whether they were more or less likely to use the services of driverless autonomous vehicles if the service provided regular updates on their safety and security measures. The responses are shown in Table 14 below.

Would it make you less or more likely to use the service of a driverless autonomous vehicle, if the service provider communicates regularly their safety and security process measures such as blockchain based: product connection security technology, develo

		Frequency	Valid Percent
Valid	Very likely	24	17.8
	Likely	44	32.6
	Unlikely	44	32.6
	Very unlikely	23	17.0
	Total	135	100.0
Missing	System	1	
Total		136	

Table 14: Responses of Participants on whether they were more or less likely to use the services of driverless autonomous vehicles if the service provided regular updates on their safety and security measures.

According to the results in Table 14, 17.8% of the participants claimed that they were very likely to use the services of driverless autonomous vehicles if the service providers gave regular updates on their safety and security measures, such as blockchain-based product connection security; In comparison, 32.6% claimed they were likely to use the same services o0f driverless autonomous vehicles. On the flip side, 32.6% of the participants claimed that they were unlikely to use the services of driverless autonomous vehicles if the service providers gave regular updates on their safety and security measures, such as blockchain-based product connection security, and 17% claimed that they are very unlikely to use the same services of driverless autonomous vehicles. There was only one participant who did not answer this question. The result reveals mixed feelings as the number of participants who agreed that they were likely to use the services and those who claimed they were unlikely to use the services was the same. Therefore, regular updates on service providers' safety and security measures might not have much influence on the use of driverless autonomous vehicle services.

4.5.15 Likelihood to Use the Services of Driverless Autonomous Vehicles If the Payment Transactions Were Secured Using Blockchain Technology

The use of autonomous-driving electric taxis, also known as self-driving electric taxis, has the potential to offer significant environmental benefits compared to conventional transport methods.

One of the most important environmental benefits of autonomous driving electric taxis is the reduction of greenhouse gas emissions. Electric vehicles do not produce tailpipe gases, meaning they do not contribute to air pollution or greenhouse gas emissions. In contrast, conventional vehicles with combustion engines contribute significantly to air pollution and climate change.

In addition to reducing greenhouse gas emissions, autonomous driving of electric robotaxis can also help reduce traffic congestion and improve fuel efficiency. Autonomous vehicles can be programmed to optimise their routes and driving patterns, resulting in fewer stop-and-go trips and more efficient use of fuel.

In addition, the use of autonomously driving electric robot taxis can help reduce the overall number of vehicles on the road. As autonomous taxis can be used by multiple passengers, they can help reduce the number of private vehicles used for transport. This can help reduce the demand for productive resources, which in turn can reduce the environmental impact of the transport sector.

Overall, the use of autonomously driving electric robotaxis has the potential to offer significant environmental benefits by reducing greenhouse gas emissions, improving fuel efficiency, and reducing the overall number of vehicles on the road.

The participants were also asked to specify whether they were more or less likely to use the services of driverless autonomous vehicles if their payment transactions were secured using blockchain technology. Their responses are shown in Table 15 below.

Would you be more willing to use an autonomous riding service if you knew your payment transaction was secured via blockchain technology

		Frequency	Valid Percent
Valid	Very likely	22	16.4
	Likely	44	32.8
	Unlikely	43	32.1
	Very unlikely	25	18.7
	Total	134	100.0
Missing	System	2	
Total		136	

Table 15: Responses of Participants on whether they were more or less likely to use the services of driverless autonomous vehicles if their payment transactions were secured using blockchain technology.

Based on the results presented in Table 15 above, 16.4% of the participants claimed that they were very likely to use the services of driverless autonomous vehicles if they knew that their payment transactions were secured via blockchain technology. Moreover, 32.8 percent of the participants also replied that they were likely to use the services of driverless autonomous vehicles if they knew that their payment transactions were secured via blockchain technology. These results revealed that to ensure that more people use the services of driverless autonomous vehicles, the service providers should assure them that their payment details are blockchain secured from hackers.

However, the results also revealed that 32.1% of the participants would only be willing to use the services of driverless autonomous vehicles if their payment transactions were secured via blockchain technology. The results show that most people do not trust that blockchain technology effectively protects their payment transactions' details.

Furthermore, 18.7% of the participants claimed that they were very unlikely to use the services of driverless autonomous vehicles if they knew that their payment transactions were secured via blockchain technology. It adds to the lack of trust in the use of blockchain technology to ensure the security of payment transaction details.

On the other hand, those individuals that replied with 'Likely' and 'Very likely' to this question might have been triggered by the following benefits of using blockchain technology in the surety of data. The first advantage is that blockchain technology ensures the user's anonymity is observed. This process involves using user keys as the only link between the user's data and the user to ensure anonymity. Blockchain technology also involves using non-interactive-zero-knowledge-proofs such as zk-SNARK for enhanced customer confidentiality. Secondly, blockchain technology enhances data integrity and is thus effective in preventing any possible corruption of customers' data. To expound on this point, the design of the blockchain is similar to that of ledgers, where cryptographic hashtags are used to link one block to the adjacent one. Therefore, there cannot be any changes that can be made to a transaction once it has been completed.

Furthermore, any attempts to delete the transaction will be deemed futile. This feature contributes to the likelihood of customers using the services of driverless autonomous vehicles that use blockchain technology to secure their transactions. Thirdly, blockchain technology has many nodes used for the system's general performance. Thus, the availability of many nodes implies that the payment system, in this case, will still work even if some of the nodes are compromised. Finally, this feature is related to fault tolerance, which refers to the system's ability to keep working even after some components have been compromised.

4.5.16 Summary of Findings Management Responses

One example of how managers at a Tier-2 automotive company could use blockchain is by implementing a supply chain management system that utilizes blockchain technology. This could involve using smart contracts to automate and streamline the process of ordering and tracking parts and components from suppliers. By using blockchain to create an immutable record of transactions, managers can have a more accurate and transparent view of their supply chain, which can help to reduce the risk of fraud or errors. Additionally, by using blockchain to automate certain processes, managers can save time and resources that can be better used elsewhere in the business. This could lead to improved efficiency and productivity, which can ultimately lead to increased profits for the company.

Technological advancements have made it easier for hackers to compromise systems, such as autonomous vehicles. Cyberattacks have affected thousands of businesses and government agencies in the US, including telecommunications companies and accounting firms. In response, companies have implemented cybersecurity measures, including penetration testing, to prevent intrusions into their systems. Many managers in the automotive industry are familiar with autonomous vehicle services and are willing to use them in their daily operations because they are convenient, affordable, and environmentally friendly. Most of the managers interviewed had a background and understanding of the AV industry, which helped them understand the software and hardware measures in place. The analysis of their responses provided insights on how to address the gap between consumer mobility needs and the services offered by AV providers.

Twenty-one managers in the automotive industry were asked about their perspectives on the communication of cybersecurity measures. Most of these managers had experience with autonomous vehicle services and were familiar with the innovation. They were willing to use AVs in their daily operations because they found them to be convenient, affordable, and environmentally friendly. The responses of these managers in interviews were consistent with those of the general population in the US. The managers had backgrounds in the AV industry, which gave them a strong understanding of the software and hardware measures used in AVs. They held positions with a comprehensive overview of the industry, which made analysis of their responses useful for breaking down technical terms and providing insights. The analysis also helped identify the best approach for addressing the gap between consumer mobility needs and the services offered by AV service providers.

Most of the responses from the interviews (Appendix C) of managers in the automotive industry are consistent with findings from the general population in the United States. Managers' background and experience in the architecture of the autonomous vehicle development industry (see Figure 9) help them understand the software or hardware measures applied within a AV. They hold administrative and managerial positions that come with a comprehensive overview of the industry. Therefore, analysis of interview responses is essential to break down the complicated terminologies and insights. The analysis also paved the way for evaluating the best alternative to bridge the gap between consumer mobility needs and the services offered by autonomous vehicle service providers.

4.6 Presented Blockchain System

4.6.1 System Architecture of a typical Autonomous driving function

Autonomous driving has become a major focus of research and development in the field of robotics and artificial intelligence. The system architecture of an autonomous driving function consists of several components that enable an autonomous vehicle to safely navigate its environment. At the heart of the system is a sensing unit that provides data about the vehicle's environment and helps with decision-making related to navigation, path planning and responses to unexpected events. Sensor technology can include cameras, LiDAR, and RADAR.

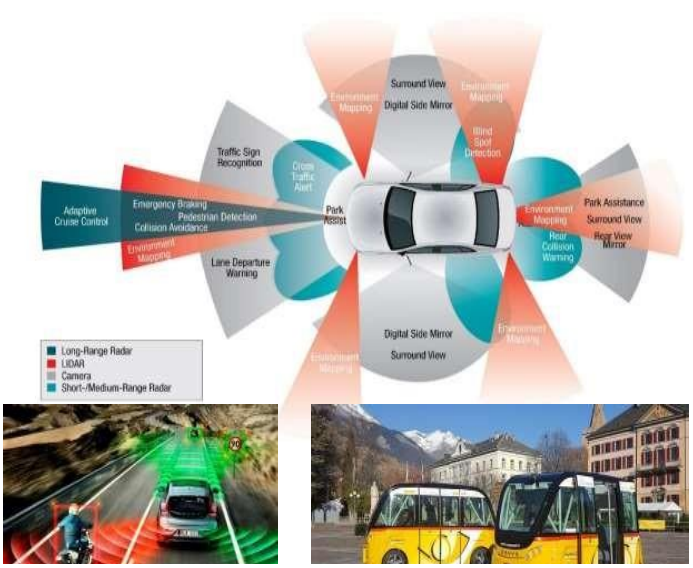


Figure 4 an autonomous vehicle architecture

Autonomous driving features such as adaptive cruise control (ACC) and lane departure warning (LKA) are becoming increasingly common in modern vehicles. The system architecture of a typical autonomous driving function is a complex, interconnected network of sensors, cameras, computers, and other components. At the heart of the system is a central control unit that is responsible for collecting data from the sensors, processing it, and then instructing the other components to respond accordingly. This data is often supplemented by data from cameras and other external sources, allowing the system to operate in a variety of different environments.

Autonomous driving functions are highly dependent on system architecture to be effective. The system architecture of a typical autonomous driving function consists of three main components: Sensing systems, decision-making systems, and control systems. The sensing system is responsible for gathering information about the environment and translating it into a form that can be understood by the decision-making system. The decision-making system is responsible for interpreting the data from the sensing system and developing an appropriate action.

4.6.2 Software Architecture of a typical Autonomous driving function

Autonomous driving functions are software systems that enable cars to navigate safely and autonomously on the roads. To realise this, the architecture of the autonomous driving system must include several high-level components. Typically, an autonomous driving system consists of a perception system, a prediction system, a planning system, and an execution system. The perception system is responsible for recognising and interpreting data from the environment.

The software architecture of a typical autonomous driving function includes a complex set of systems, algorithms, and sensors. This architecture is designed to enable the autonomous vehicle to understand its environment and move safely on the roads. To achieve this goal, the vehicle must be able to collect data from its environment, such as traffic patterns and road conditions, and interpret this data to make decisions about its route and driving behaviour. The main components of the autonomous driving system include a computer vision system, a decision-making algorithm, and a control system. The autonomous driving functions are enabled by a complex system of sensors, processors, and actuators. This system is called an autonomous driving system (ADS) and consists of two different architectures: the hardware architecture and the software architecture. The hardware architecture is responsible for providing the physical components necessary for autonomous driving to function. These include the sensors, processors and actuators that enable the system to perceive its environment and make decisions based on these observations.

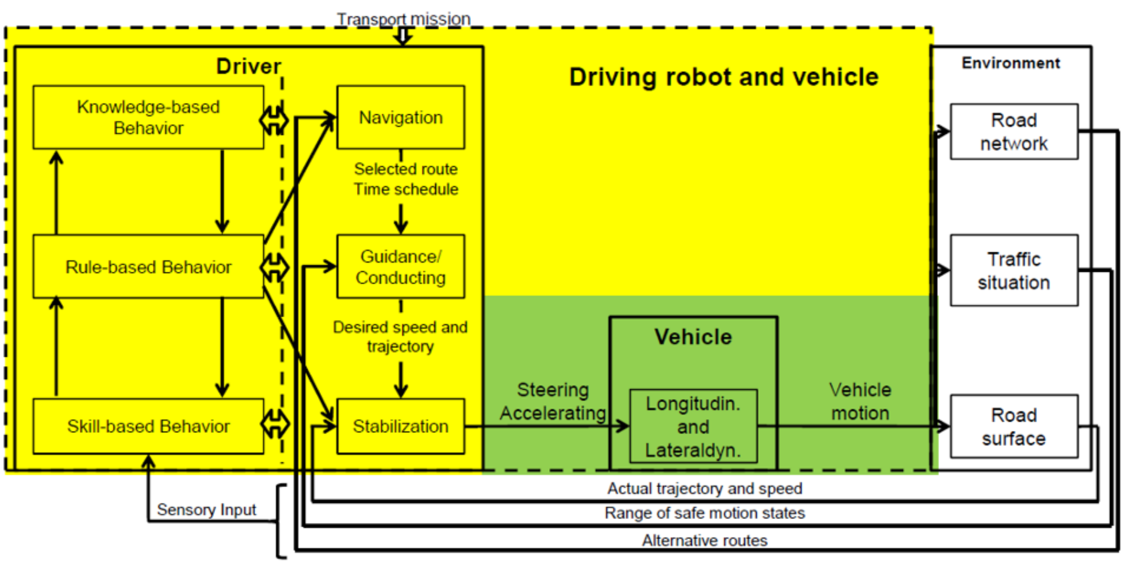


Figure 5 SW architecture of an autonomous riding shuttle

Autonomous driving functions are a set of software systems that are responsible for the safe operation of a self-driving vehicle on public roads. While the architecture of these systems can vary, they generally consist of three core components: an object recognition system, a motion planning system, and a control system. The object detection system is responsible for accurately detecting objects in the driving environment, such as other vehicles, pedestrians, cyclists, and road signs. The motion planning system uses this information to create a safe trajectory that avoids dangerous situations.

Autonomous driving functions require a sophisticated mix of hardware and software to properly manage their operation. This includes the software architecture of a typical autonomous driving function. The software components must work together with the hardware components to ensure safe and efficient operation of the driverless car. The software architecture of a typical autonomous driving function consists of four layers: Detection, Control, Decision Making and User Interaction.

4.6.3 Development processes of a typical Autonomous driving function

The development process of a typical autonomous driving function is very complex and involves several technical disciplines. It starts with the design of the system, which includes the definition of the architecture, the selection of the appropriate hardware and software components and the definition of the system parameters for the different functions. The next step is the implementation of the software, which consists of coding the various components and services that make up the system. This is followed by testing and verification, which is important to ensure that all components work as intended and that the system functions as expected.

The development processes for a typical autonomous driving function require extensive collaboration between software, hardware, and system engineers. To ensure safe operation of the system, the software must be extensively tested in various simulated environments. In addition, the hardware components must also be tested to ensure that they are compatible with the software. In addition, the system must be validated in road tests and in various real-world scenarios such as encounters with pedestrians and other vehicles.

The software development process of a typical autonomous driving function starts with the design and prototyping of the hardware and software components. Once the components are defined, they must be integrated and tested to ensure that they function properly. Once the testing phase is complete, the components are ready to be used in an autonomous driving system. Finally, the system must be tested in a controlled environment to verify that it meets safety and performance requirements.

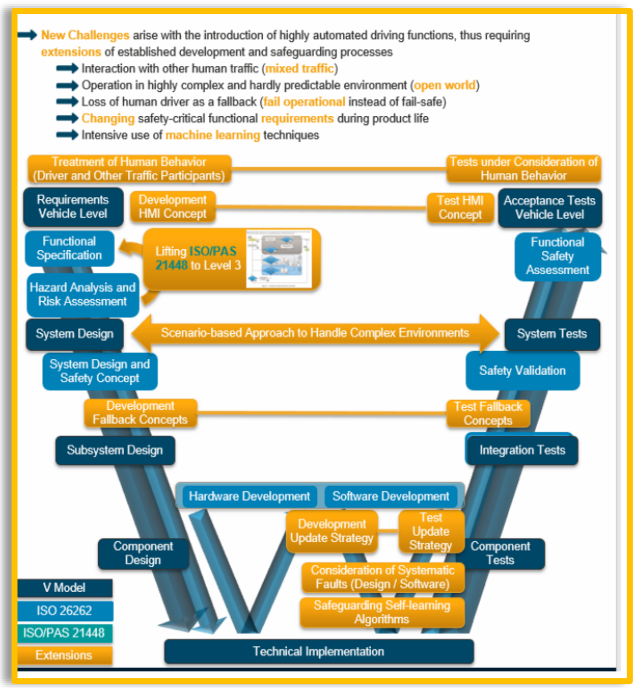


Figure 6 Development process of an autonomous driving vehicle. Source Pegasus project

The development process of a typical autonomous driving function involves the collaboration of several teams. Developers must design, code, and test the software components that power the vehicle, while engineers must ensure that the hardware components are properly configured. Data scientists and machine learning experts must also be involved to ensure that the system is able to accurately recognise objects in the driving environment. Finally, safety and quality assurance teams must ensure that strict standards are met, and that the system operates safely and efficiently.

The development of a self-driving vehicle is a highly complex undertaking. To ensure that the software components work together effectively, a development process must be followed. This includes understanding the requirements and design of the autonomous driving function, designing the architecture, and writing the code. In addition, extensive testing and validation is required to ensure that the system works correctly in all scenarios.

4.6.4 Requirements of an autonomous driving vehicle

In autonomous driving, a technical system completely takes the place of the human driver. This means that the system takes over all driving tasks that were previously the responsibility of humans. The processes it applies in an automated manner are the perception of the environment and vehicle state variables, the cognition of these variables into a world representation, behavioural decisions based on the world representation and behavioural execution. These four components correspond to the four levels of requirements for a human driver described in the previous chapter.


Figure 7 Autonomous driving roboshuttles, source DALL-E

Various sensors are used to perceive the environment more and more efficiently. These sensors include video cameras, radar sensors, laser sensors and others. They are used to try to capture the most detailed 360-degree environment of the vehicle. This detailed image of the environment is then available to the autonomous systems for processing. Quantities that were visually displayed to humans via instruments, such as speed and RPM, could be queried directly digitally via the data path. The instructions of the navigation system are also available, so that the human would be responsible for entering the destination and from then on, the system would decide on the route. In this way, instruments such as speedometers installed in fully autonomous vehicles and navigation systems could be omitted, as they only provide a visualisation for people and do not have to visually present the necessary data to the autonomous system.

Need to be presented. For the cognition and behavioural decision components, it is also necessary to replace human processes. The question arises whether autonomous systems need to learn. There are still many unresolved questions in this area, which also means that there is a lack of knowledge for effective algorithms. But it is clear that adaptation to changing environmental conditions is necessary and thus the implementation of machine learning is obvious. Learning during active driving conditions and the associated adaptation opens up another degree of freedom.

Automation that can be used to optimise autonomous driving. However, for reasons of road safety, these adaptive systems are only used within an optimised framework of conventional systems. Terms of behavioural execution, the primary and secondary activities could be completely taken over by the autonomous system, which in the case of a fully autonomous vehicle, this could also eliminate the pedals and steering wheel, as well as indicator switches and other physical controls. This results from the fact that these Elements have been adapted for humans to operate the vehicle. However, since a technical system is the sole driver of the vehicle, it can directly access the on-board computer or other vehicle components.

The autonomous system always has a mission, which can either be entered by humans or assigned autonomously, for example to drive to the charging station. The mission always includes a transport task in which people, goods or only the vehicle itself are transported. Goods or only the vehicle itself are transported. In addition, it must

Humans must always be able to adapt the mission to allow emergency stops or to drive to intermediate destinations if necessary. Further requirements for autonomous

Driving are, firstly, that the traffic space in public traffic with other human-controlled vehicles, other automated vehicles, and unprotected road users such as pedestrians and animals.

In addition, compliance with locally applicable regulations is required, which is referred in autonomous driving with e.g., by types of traffic signs, also defines the required scope of perceptual performance. Precisely because the traffic space must be shared with other vehicles of different types, interaction with them is not left out. On the one hand, it is a matter of communication between vehicles, which can take place through common signs such as flashing or also C2X2, as well as considering the wishes of other road users as well. In order to ensure that automated and human-controlled vehicles can drive together automated vehicles must be able to use traffic space based on the same visual characteristics as humans. The next chapter discusses traffic scenarios and dynamic elements that should be perceived.

4.6.5 Manual based development processes

An example of a manual-based development process for an autonomous vehicle function could include the following steps:

Define the requirements: The development team would first define the requirements for the autonomous driving function, including performance, safety, and functional specifications.

Design: The team then designs the autonomous driving function, including the algorithms and software the vehicle needs to navigate and make decisions.

Implement: The team would then implement the autonomous driving function by writing the necessary code and integrating it into the vehicle's systems.

Test: The team conducts tests to ensure that the autonomous driving function works as intended and meets the required specifications. This may include manual testing, where a tester checks the function manually, or automated testing, where a tool is used to check the function.

Debugging and fixing problems: If problems are found during testing, the team would debug the code and fix the problems found.

Retest: The team would then repeat the testing and troubleshooting process until the autonomous driving function works correctly and meets the required specifications.

Overall, this manual development process would involve a combination of design, implementation, testing and debugging to ensure that the autonomous driving function is of high quality and works as intended.

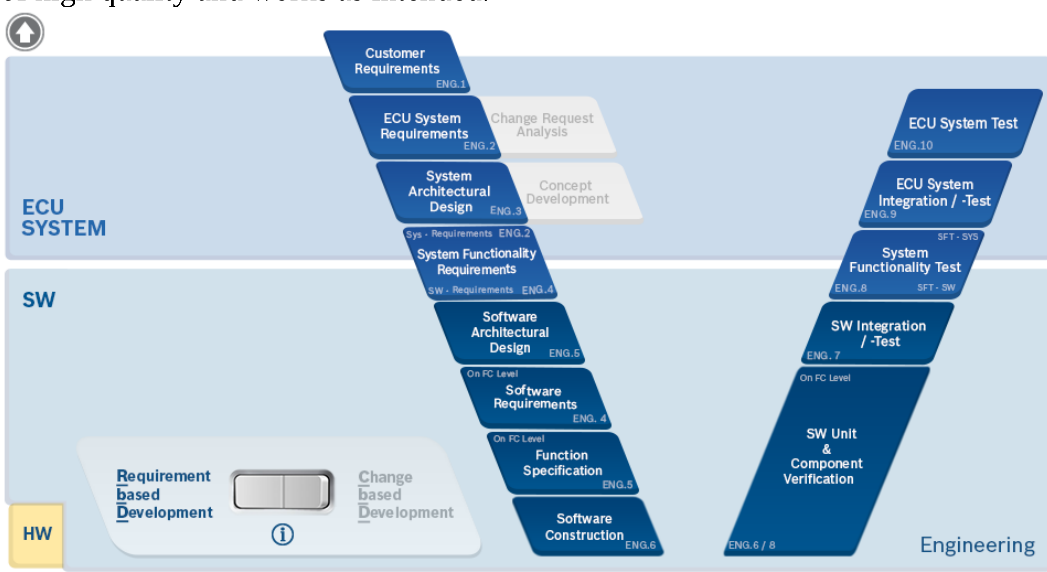


Figure 8 Manual based development process for vehicle systems software- source student

4.6.6 Quality and validation of manually based development processes

Quality and validation are important aspects of any development process, whether it is manual or automated. In a manual development process, quality and validation refer to the steps taken to ensure that the product being developed meets the required specifications and standards and functions as intended.

There are several ways to ensure quality and validate a manually supported development process:

Define clear requirements and specifications: Clearly defined requirements and specifications help ensure that the product being developed meets the desired requirements and standards. This can include functional, performance and design specifications.

Use a systematic approach: A systematic approach helps to ensure that the development process is well organised and follows a logical, step-by-step process. This can include the use of tools such as flowcharts, diagrams, and checklists to guide the development process.

Use peer reviews: Peer review involves asking other team members to review the product being developed to identify any problems or opportunities for improvement. This can be a useful way to identify and address problems early in the development process.

Conduct testing: Testing is an important step in the development process to ensure that the product works as intended. This can be manual testing, where a tester checks the product manually, or automated testing, where a tool is used to check the product.

Use version control: version control helps track changes made to the product during the development process, making it easier to identify and fix problems. This can be done with tools such as Git or Subversion.

Overall, quality and validation in a manual-based development process involve a combination of clear requirements, a systematic approach, peer reviews, testing and version control to ensure that the final product meets the required standards and works as intended.

4.6.7 Automated software development processes via blockchain

An automated software development process using blockchain technology involves using the blockchain to automate various aspects of the software development process. This includes tasks such as tracking changes to the code base, managing dependencies, and coordinating the work of multiple developers.

Figure 9 an autonomous driving car system and blockchain based software architecture, intrepreted by DALL-E

In an automated software development process using blockchain, developers can use smart contracts to automate certain tasks. For example, a smart contract could be used to automatically deploy a new version of the software once it has been tested and approved by the relevant parties.

Another aspect of an automated software development process with blockchain is the use of decentralised version control systems. These systems use blockchain technology to track changes to the code base and ensure that all developers are working on the latest version of the software.

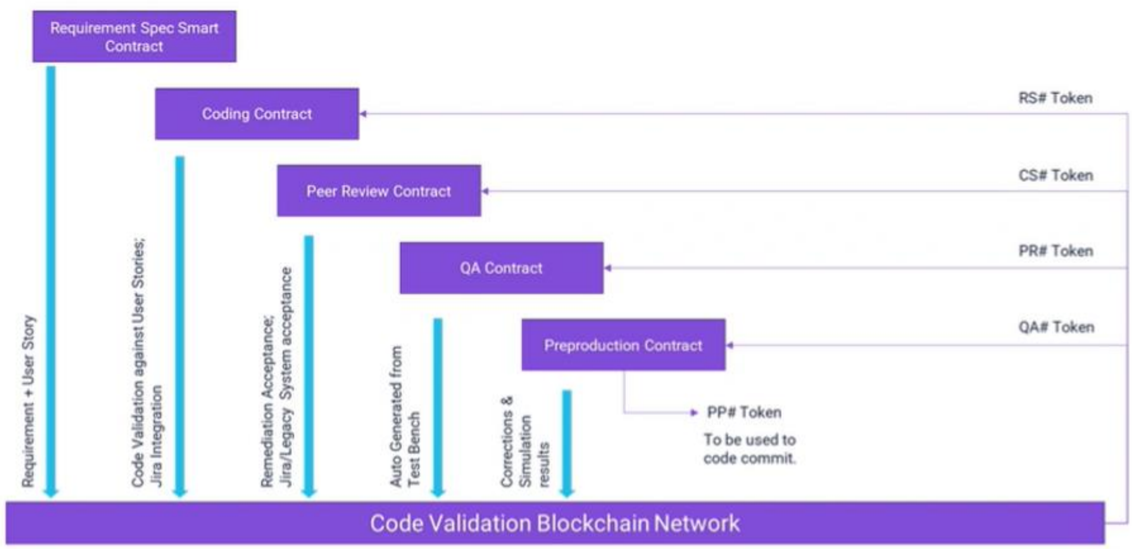


Figure 10 Blockchain based vehicle systems SW development- source student.

Overall, an automated software development process with blockchain can help streamline the development process, improve collaboration between developers and increase the reliability and security of the software developed.

4.7 Presented System to managers for Automated software development processes via blockchain, to gather interview information.

4.7.1 Introduction

Overall, this software architecture would provide a decentralized and automated platform for software development that allows developers to collaborate and streamline the development process.

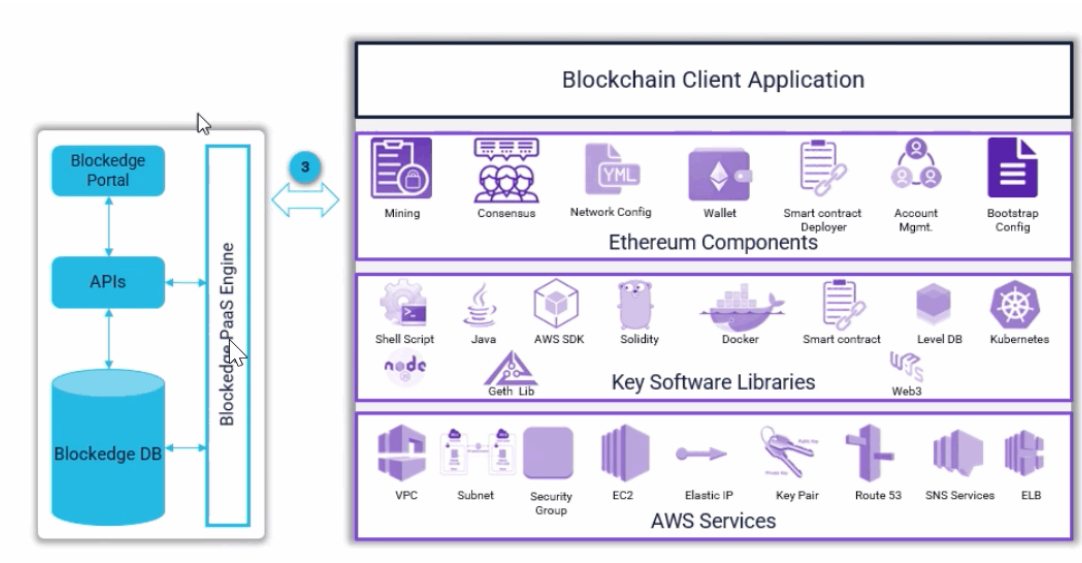


Figure 11 SW architecture of blockchain based system for SW development process QA- source student.

This is literally a "clever contract". "Clever" is understood here in a comparable way to "intelligence" in the term "artificial intelligence": the system IT imitates appropriate human behaviour. In the case of a "smart contract", this means that the programme that ultimately represents the smart contract reacts to certain boundary conditions, facts, and actions of the contracting parties in a defined way - but to such an extent that it appears "intelligent" to the observer. The simplest example of this - according to Gabler's Wirtschaftslexikon - is the vending machine: After a certain input - insertion of the correct amount in the form of coins and selection of the desired product - the system reacts after checking the amount and the presence of the product by handing over the product and, if necessary, the change. A contractual partner has thus been replaced by a machine.

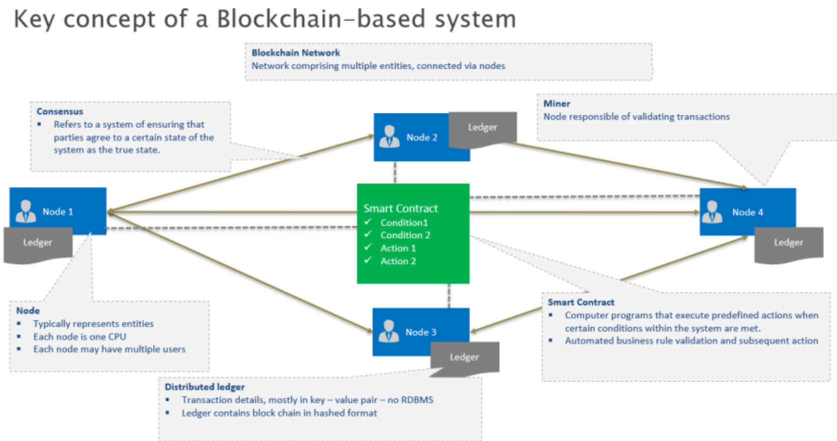


Figure 12 overview of a blockchain system- source student

In the age of digitalisation, more and more functions in business life are being automated, so that the second contractual partner is also increasingly replaced by a system - and, for example, the purchasing company's procurement system "negotiates" with the supplier's ordering system. If one also leave the physical level where the valuables (money and goods) are directly exchanged, the challenges become even more complex: Questions arise such as: What are the goods, what is the means of payment - and above all: Who guarantees the accuracy and reliability of this information in the anonymous network?

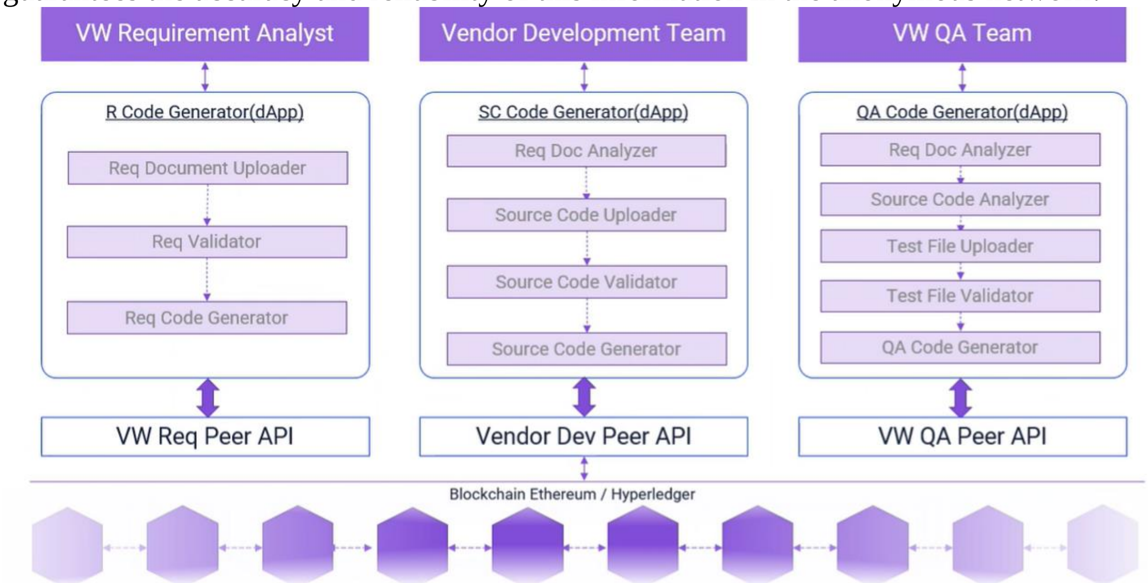


Figure 13 Pseudoanononimisation of the process workproduct results creator within the blockchain system- source student

These are precisely the questions that smart contracts aim to answer through the use of IoT, blockchain and artificial intelligence. Artificial intelligence takes over the control of the processes, the Internet of Things regulates the connection of the physical and virtual processes and the blockchain ensures security by guaranteeing the identity of the participating entities and the authenticity, authenticity, and traceability of the processes. In this way, it provides the necessary trust between the participants, who often do not know each other. The combination of these functions then leads to a decentralised application (dApp) or a decentralised autonomous organisation (DAO) that can enter into business agreements with other DAOs and companies without traditional human control.

Conceivable initial use cases can be found in the insurance environment, e.g. in flight cancellation or travel cancellation insurance, in the automation of supply chains in industry and logistics or in financial transactions. In corporate practise, however, there are hardly any smart contract solutions so far. When driving a car, for example, the vehicle could charge at the traffic lights via the induction coil and then pay independently with the stored credit card. Because the car knows: whenever it is in front of the traffic lights, it should fill up with electricity.

Smart contracts will also play a role in the manufacturing and aftersales sector: Production data can be tracked, irrevocably stored thanks to blockchain and checked for compliance using smart contracts. This can then be used to certify that the product was manufactured with the right materials, process parameters, final dimensions and tolerances and help within the warranty claim process, an example can be found in figure 12 below.

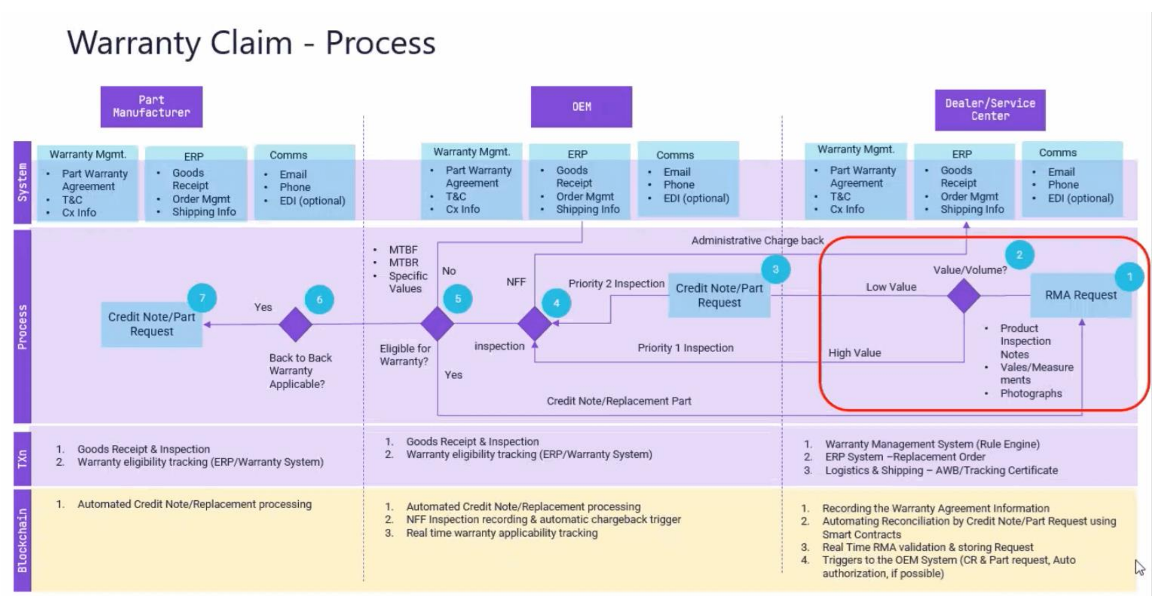


Figure 14 smart contracts within manufacturing of vehicle parts, vehicle assembly and vehicle warranty claims- system architecture source student

The economic advantages of smart contracts are that the processes between the systems involved can run automatically, because "data storage, validation and documentation take place directly in the blockchain. Transactions can also be triggered automatically. This in turn saves time, frees up human resources that were previously used for manual processing and verification, and ultimately also reduces transaction costs".

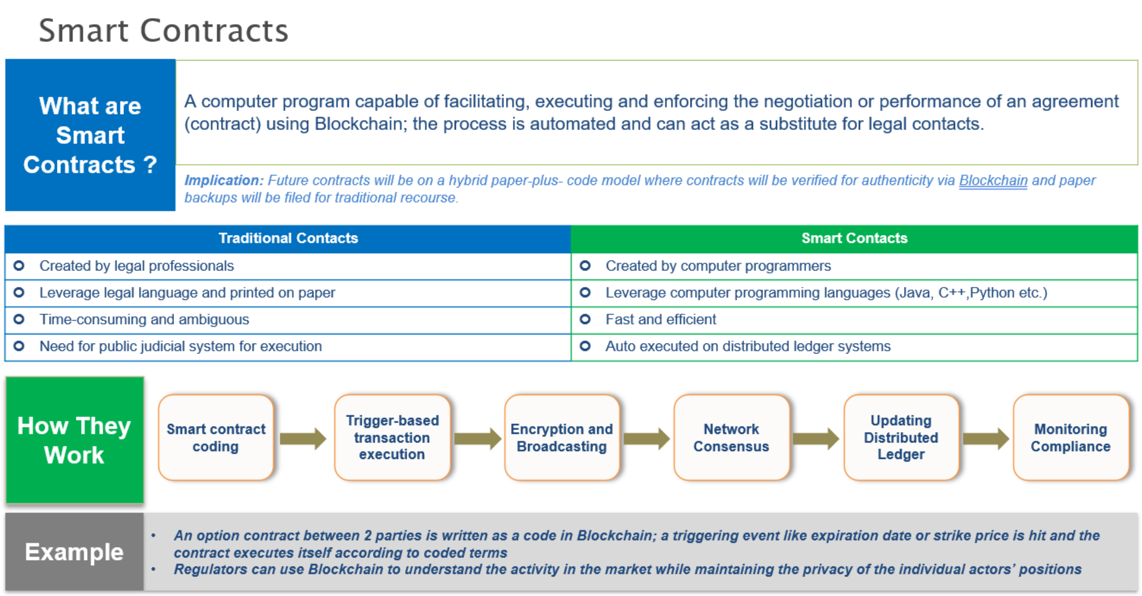


Figure 15 Overview of a smart contract system- source student

Particularly exciting is the long-term potential that may arise from the increasing use of smart contracts. How are governments and regulators shaping the legal framework within which smart contracts or DAOs can operate? Which government or organisation would even be responsible for regulating a virtual system that does not run on its own computer but "somewhere" in the cloud? Is an extended social contract emerging when autonomous digital entities and "smart" machines connected to the network increasingly negotiate and act autonomously, perhaps acquiring a legal and financial significance that today is only attributed to citizens, companies, and administrations? Or will technology overtake politics and society and create facts before national and international bodies can establish binding rules?

4.7.2 Presented Workflow

Tokenisation is the process of representing a physical or digital asset as a unique digital token in a blockchain. In the context of supply chain processes, tokenisation can be used to improve supply chain transparency, efficiency, and security by enabling the tracking and verification of goods and materials in real time as they move through the supply chain.

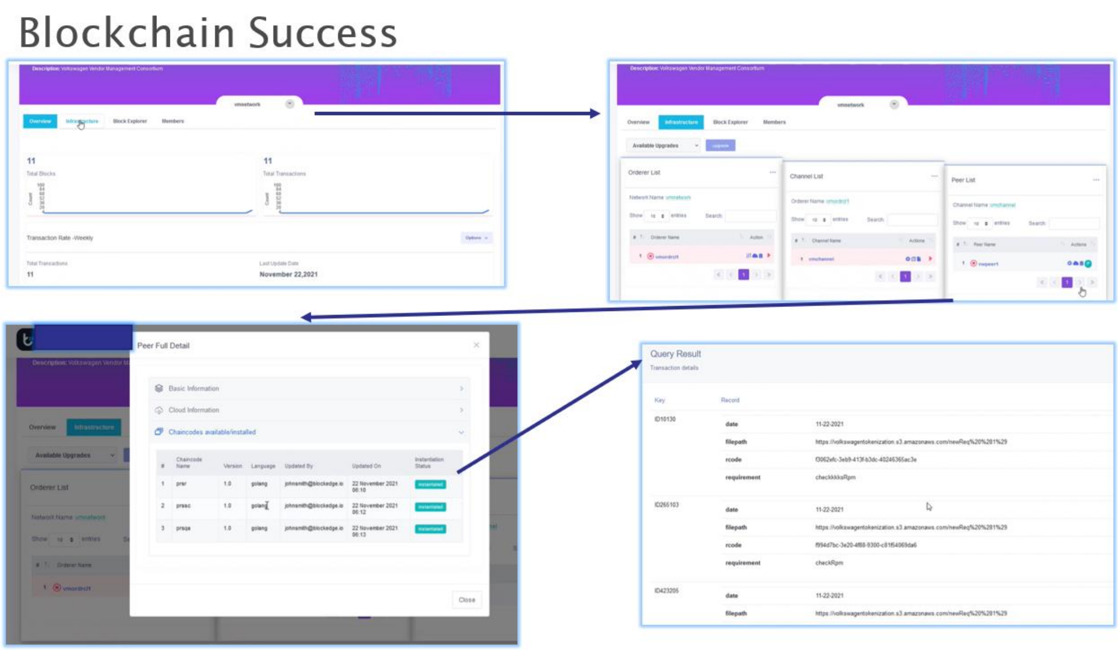


Figure 16 workflow for tokenisation of software and related HW E/E components- system self-programmed by student

Here is an example of how tokenisation could work in a supply chain process using blockchain technology:

A manufacturer produces a batch of goods and assigns a unique token to each item in the batch.

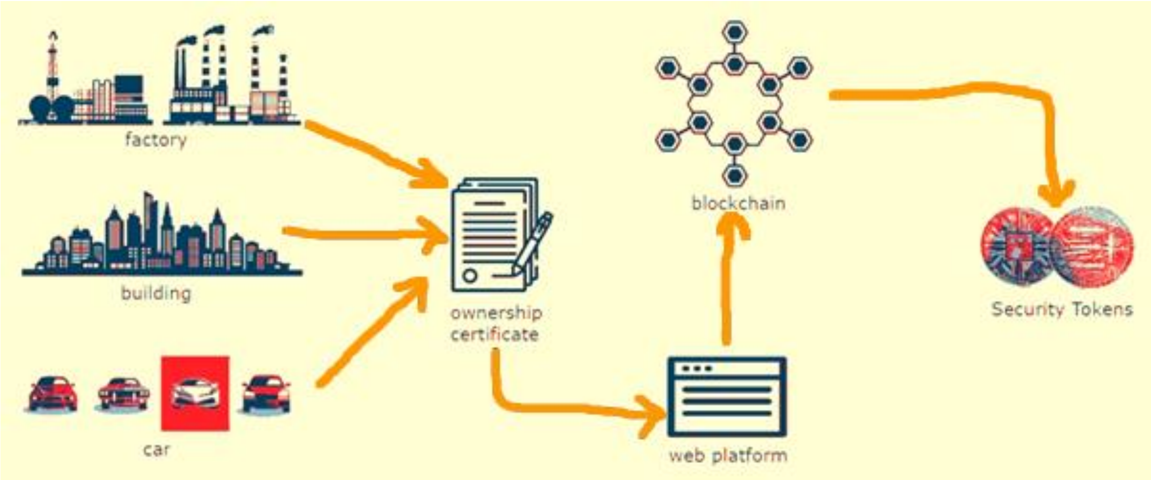


Figure 17 blockchain based automotive supply chain-source student.

The manufacturer then records the issuance of the tokens on the blockchain, along with information about the goods, such as origin, quality, and quantity.

As the goods move through the supply chain, the tokens are transferred from one party to another on the blockchain, enabling real-time tracking and verification of the goods.

At each stage of the supply chain, the parties involved can verify the authenticity of the goods by checking the information about the goods and the tokens stored on the blockchain.

When the goods reach the end consumer, the consumer can verify the authenticity of the goods by checking the information stored in the blockchain about the goods and the tokens.

Overall, tokenisation can help improve the transparency, efficiency, and security of supply chain processes by enabling the tracking and verification of goods and materials in real time using blockchain technology Automated Process quality check across the different processes:

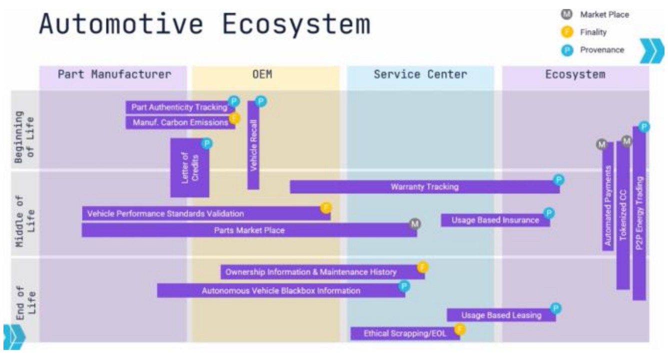


Figure 18 Blockchain based automatic process checker- source student.

This paper aimed at investigating how adopting Blockchain technology could aid in the automation of quality assurance processes. The recurring theme throughout our examination revealed Blockchain's transformative potential, notably the chance to enhance transparency, efficiency, and data integrity within quality assurance systems.

The study found that adopting Blockchain technology for process quality assurance increased transparency significantly. This is due to every action being logged in an unalterable manner, thanks to Blockchain's decentralised nature (Tapscott & Tapscott, 2016). By guaranteeing a traceable and tamper-proof record for qualitative analysis system functioning problems related to accuracy can be eliminated that remains ubiquitous within traditional Quality Assurance systems. Henceforth the investigation indicates a possibility of more accountable and transparent Quality Assurance systems through blockchain adaptation.

The analysis discovered substantial potential through automating processes using smart contracts on the blockchain for improved efficiency. Smart contracts execute agreements autonomously once predetermined conditions are met without third-party intermediaries (Mougayar, 2016). This automated process streamlines Quality Assurance procedures by reducing both time and resources required previously during these operations' performance. Additionally, the investigation detected a considerable time reduction when smart contracts are utilised while reducing manual intervention it may improve output consistency by mitigating the human error risk.
Furthermore, a significant finding of this study relates to blockchain's unmatched data integrity capacity.

Through its design alteration after consensus on majority vote require altering every block proceeding subsequently (Nakamoto, 2008). Therefore, providing unparalleled security and immutability reinforcing trust in qualitative data regarding its reliability within Quality Analysis systems. The importance of data accuracy in Quality Assurance renders Blockchain as a formidable solution while enabling solutions that address traditional deficiencies.

However as with all emerging technologies there remains an implementation hurdle with factors leading up to its drawbacks while employing it into practice regardless its promising applications benefits.

Potential issues have been raised concerning blockchain systems' scalability due to their significant computational demands—particularly public blockchains. This challenge could restrict the management of complex or large-scale quality assurance processes within the industry.
Furthermore, regulations that govern Blockchain technology worldwide remain distinguishably fluid with varying levels of recognition or acceptance that may pose a considerable impediment towards its widespread adoption; mostly impacting modern supply chains.

Adept future studies will have to observe legal and regulatory landscapes effective at controlling its use. Successful implementation requires substantial cultural reorientation within organisations since blockchain technology significantly diverges from traditional quality assurance systems necessitating different individual behavioural changes promoting effective adoption. Nonetheless, our study reveals that potential enhancements such as transparency improvement, enhanced data integrity with resultant efficiency makes a compelling case for applying blockchain technology in process quality assurance.

Future research must be aimed at conducting empirical case studies that assess realistic applicability & scalability of such QA systems while taking cognisance of developing robust adaptive regulations critical to its associated success despite any perceived challenges along the way.

4.7.3 Female Manager Responses

About 60% of female managers are open to autonomous driverless taxis. This population is aware of the benefits of introducing autonomous vehicles in the automotive industry. The effective introduction of autonomous vehicles depends on academic research. The primary contribution of academic research is to disseminate the acquired knowledge to all relevant stakeholders in the automotive industry. Furthermore, academic results pave the way for the further development of key approaches to the implementation of innovations. According to Cavazza et al. (2019), the technology needs to be combined with the establishment of a business model that is consistent with their goal of enabling radical innovation. Proponents of autonomous driving vehicles understand the implications of empirical research for the adoption of driverless vehicle services.

Furthermore, almost all female managers understand cyberattacks and the impact of such attacks on the functionality of autonomous driverless vehicles. Today's automotive companies shop their important information on computers. This information concerns the latest developments in the industry and the functionality of these innovations. The availability of such information in computers makes them vulnerable to cyber-attacks. Consequently, the attacks pose a significant threat to the users of such services. Most female managers are affected by the potential threat of cyber-attacks when using driverless vehicles. However, almost half of the population is still willing to use these services. Therefore, female managers would require service providers to share the cyber security measures they have taken to ensure the safety of their users. The population would also require service providers to outline their compliance with quality assurance measures.

In addition, the cost of using autonomous driverless vehicle services is critical. Most female managers are willing to use autonomous vehicles if they cost less than USD 1 per mile. For example, about 90% of respondents say they would use an autonomous vehicle if it cost 10 cents per mile. However, the numbers shift if providers decide to charge more than 1 USD per mile. A charge of more than USD 1 would classify the service as expensive compared to a conventional taxi in the United States. According to Boesch et al. (2018), the most important determinant of the profitability of autonomous vehicles is the competitiveness of their cost structures. Most customers travelling in urban centres value comfort and value for money. Therefore, autonomous driverless vehicles can only survive in the transport industry if they offer lower prices or catch up with the other vehicles. Most of the female managers therefore also believe that the services should be affordable in order to attract new customers.

Nevertheless, the women managers have different opinions about the proper processes in the production of automotive products and the successful yields of the finished products. According to the responses to the survey, about 6 out of 10 female managers strongly believe that the form and practical functionality of an automotive product are essential compared to the processes followed in the development of the vehicle. The population believes that the excellent functionality of the finished product plays a crucial role in attracting and retaining customers. Similarly, the population believes that companies producing autonomous vehicles will fail if they do not invest heavily in cyber security. The population believes that the current wave of technological advancement requires stringent security measures to protect users and the company. A functioning cybersecurity system ensures that the manufacturing company maintains its reputation and gains the trust of its customers.

4.7.4 Diverse Manager Responses

In addition to interviewing managers of different genders, the study also included interviews with respondents who were not ready to use autonomous vehicle services and did not fully understand the potential consequences of a cybersecurity breach. These respondents were not initially receptive to the innovation due to their lack of information about how it works. They also indicated that they would not use the service if they learned of a recent cyberattack on the system. The introduction of technology in the automotive industry has had both positive and negative impacts (Gruel and Stanford, 2016). One of the challenges that must be addressed is increasing awareness of the potential for cyberattacks. However, the cost of using the service per kilometre did not influence the decision of managers of different genders to use the service. They believe that the future of the automotive industry is being disrupted by autonomous vehicles and that they will play a vital role in driving this change.

4.7.5 Male Manager Responses

Male managers also participated in the interviews. The number of male respondents was similar to the number of female respondents. The population is well acquainted with the introduction of autonomous driverless service vehicles. Their responses show that they are positive about the introduction of this technology in the modern automotive industry. Moreover, their views provide an in-depth perspective on the most appropriate strategies to effectively introduce driverless service vehicles. The analysis is therefore crucial to making an informed decision and gaining the trust of customers as service providers implement stringent cybersecurity measures.

The cost of autonomous vehicle services is an important factor in gaining the trust of most male managers. According to the responses from the interviews, most male demographics are interested in the fees for using driverless services. Thus, most male managers are willing to use autonomous vehicles if they charge less than USD 1 per mile. On the other hand, the population was not willing to use the service if the providers would charge more than 1 USD per mile. According to Andersson and Ivehammar (2019), the benefits and costs of autonomous vehicle services to society are crucial when commercial success depends on the manufacturer. The costs incurred by users of autonomous vehicles play an important role in attracting new customers in the automotive industry.

In addition, most male managers believe that the processes followed in the development of autonomous vehicles are crucial to the outcome of driverless vehicles. Most vehicle manufacturers focus on the form and good functionality of their products. They believe that the final product is the most important step in gaining the trust of their customers and attracting new customers. According to the interview responses, most male managers do not believe that the form and functionality of the final product are more important than the proper manufacturing process of the vehicles. Similarly, male managers do not believe that low investment in cyber security necessarily leads to the failure of such businesses. Therefore, while cybersecurity is essential to the functionality of most autonomous vehicles, it is not critical to the success of the automotive industry.

Finally, most male managers state that it is essential for service providers to communicate their production processes and the security features used in their companies. The main goal for autonomous driverless vehicle innovation is to minimise accidents, energy consumption, pollution and congestion while improving transport accessibility (Bagloee et al., 2016). Achieving the above objectives will contribute immensely to the success of driverless vehicles. Therefore, the response of male managers is a great step for vehicle manufacturers to communicate their production processes. This information is crucial as it is consistent with production policies and promotes a manufacturer's credibility.

Moreover, autonomous vehicles will retain their customers in the event of a cyber-attack on their systems. For example, most males emphasise that they will continue to use autonomous vehicles even if they receive negative publicity for cyberattacks. However, managers want constant assurances from manufacturers about their mitigation strategies.

4.7.6 Conclusion

The increasing prominence of self-driving cars or robotaxis represents a remarkable shift within current transportation systems globally. These futuristic automobiles rely heavily on advanced sensor systems and other sophisticated technologies to navigate roads independently and make crucial decisions without human intervention with ease. However, despite their potential benefits such as bettering road safety standards worldwide while offering passengers more convenience when traveling - there remain significant security hazards that need close consideration- with regards to cybersecurity.

In this regard this research paper delves deeply into specific measures that can be implemented to enhance the security of autonomous vehicles. It aims to examine the potential effectiveness of introducing blockchain technology alongside other security measures in protecting these vehicles from cyber threats. By providing insightful and practical recommendations we hope to contribute significantly towards securing self-driving cars against cybersecurity vulnerabilities.

Cybersecurity risks in robotaxis: Robotaxis are vulnerable to a variety of cybersecurity threats, including malware, hacking, and physical tampering. Hackers could potentially take control of a robotaxi and cause accidents or steal sensitive data from the vehicle. In addition, the complex systems and networks that enable robotaxis to function are also at risk of attack.

The importance of securing robotaxis: The consequences of a cyber-attack on a robotaxi could be severe, including physical harm to passengers and damage to the vehicle itself. In addition, the loss of sensitive data, such as passenger information or proprietary technology, could have serious financial and legal implications for the companies that operate robotaxis.

Ways to improve cybersecurity in robotaxis: There are several measures that can be taken to improve the cybersecurity of robotaxis. One approach is to use blockchain technology to secure data and transactions within the vehicle. Blockchain can provide a decentralised and tamper-proof record of data, making it more difficult for hackers to access or alter sensitive information. Other measures include implementing robust security protocols, such as encryption and authentication, and regularly updating software to address vulnerabilities. Physical security measures, such as protecting against tampering with hardware and sensors, can also be important in protecting against cyber-attacks.

Robotaxis are an exciting and innovative technology that has the potential to revolutionize transportation. However, the cybersecurity of these vehicles must be given careful consideration to ensure the safety of passengers and the integrity of the systems and networks that enable them to operate. By implementing measures such as blockchain technology and robust security protocols, companies can help to mitigate the risks of cyber-attacks on robotaxis and ensure their continued safe operation.

CHAPTER V: DISCUSSION

5.1 Discussion of Results

5.1.1 Introduction

This study aims to present and discuss the perspectives of managers in the automotive industry regarding the implementation of blockchain technology in supply chain management and the communication of cybersecurity measures in autonomous vehicle services. Through in-depth interviews, this research provides valuable insights into the perceptions and attitudes of managers, shedding light on the potential benefits and challenges associated with these areas. This discussion chapter will delve into the findings, considering the viewpoints of both female and male managers, while also accounting for variations in familiarity and understanding of the autonomous vehicle industry.

5.1.2 Utilising Blockchain in Supply Chain Management

The exploration of blockchain technology in the context of supply chain management has garnered attention, and managers in the automotive industry perceive it as a promising solution. By leveraging features such as smart contracts and an immutable record of transactions, blockchain can streamline and automate various aspects of supply chain operations, particularly the ordering and tracking of parts and components. This implementation holds the potential to enhance accuracy, transparency, and resource utilisation, thereby mitigating the risks of fraud or errors. The positive reception of managers towards blockchain aligns with existing literature, emphasising its potential for revolutionising supply chain management practices in diverse industries (Meng et al., 2018; Shen et al., 2019). Consequently, the findings of this study reinforce the notion that blockchain technology can significantly improve the efficiency and effectiveness of supply chain management in the automotive sector.

5.1.3 Cybersecurity Measures in Autonomous Vehicle Services

The insights gleaned from managers' responses about cybersecurity measures in autonomous vehicle services reveal a heterogeneous perception of the associated risks and the necessity of protective measures. Managers who possess substantial experience and knowledge within the autonomous vehicle industry exhibit a heightened awareness of cybersecurity and its significance in ensuring the safety and functionality of driverless vehicles. These managers recognise the vulnerabilities of computer systems to cyberattacks, acknowledging the potential threats they pose to users of autonomous vehicle services. Consequently, they emphasise the imperative for service providers to transparently communicate their cybersecurity measures and adhere to quality assurance standards to instil trust among customers.

However, it is noteworthy that managers who possess limited familiarity with autonomous vehicle services exhibit a lesser understanding of the potential consequences stemming from cybersecurity breaches. Consequently, their initial hesitancy towards embracing this innovation is primarily influenced by their perception of the system's vulnerability to cyberattacks. This underscores the importance of raising awareness and providing education regarding cybersecurity within the context of autonomous vehicles. Service providers should effectively communicate the measures they have implemented to ensure user safety, thereby addressing concerns pertaining to cybersecurity breaches.

Moreover, the findings underscore the significance of trust in the acceptance and adoption of autonomous vehicle services. Managers emphasise the need for continuous reassurances from service providers, particularly in terms of their mitigation strategies in the event of a cyberattack. These findings align with prior research, highlighting the criticality of establishing trust among users of autonomous vehicles through transparent communication and a clear demonstration of cybersecurity measures (Guo et al., 2020; Mladenovic et al., 2021). Establishing trust serves as a pivotal factor in facilitating the successful adoption of autonomous vehicle services, as it assuages concerns and engenders confidence among potential users.

5.1.4 Gender Differences in Perspectives

The examination of gender differences in managers' perspectives on autonomous vehicle services reveals intriguing insights. Female managers, in particular, demonstrate a notable openness towards the concept of autonomous driverless taxis. They recognise and appreciate the benefits associated with the integration of autonomous vehicles, encompassing aspects of convenience, affordability, and environmental friendliness.

Furthermore, female managers exhibit a greater inclination to utilise autonomous vehicles when the cost per mile falls below the USD 1 threshold. This aligns with prior research, underscoring the significance of competitive pricing in attracting customers to autonomous vehicle services (Boesch et al., 2018). Notably, female managers also emphasise the necessity for service providers to effectively communicate their cybersecurity measures, to affirm trust in algorithms derived from artificial intelligence demands a multifaceted evaluation spanning multiple areas: quality of training data used in developing algorithms, intricate details behind an algorithm's design and deployment process as well as its functional performance within real-world scenarios.

Ensuring quality and reliability begins with meticulous curation efforts followed by careful diversity checks to ensure satisfactory representation across the sampled dataset range employed for rule formulation. Efforts must be made explicitly towards identifying prevalent biases that could skew results obtained from the analysis so apt measures can then address them appropriately before iteration repeats culminating in expected transparency levels all through.

For greater efficiency within supply chain management processes related directly or indirectly to manufacturing braking systems in passenger cars, blockchain technology stands out as a top-pick solution.

By leveraging the innate transparency provided by a blockchain, it is possible to track the movements and details of components and materials used in manufacturing braking systems. Monitoring supply chains for any anomalies that could compromise the integrity or quality of input raw materials through production processes when using blockchain technology is seamless and efficient.

Similarly, recording crucial data associated with the extensive testing that characterises braking system products' QC norms as well as outlining compliance needs vis-à-vis relevant regulatory frameworks should be stored on blockchain solutions platforms. That way, stakeholders who ever want to assess an entire recall process can do so with certainty regarding authenticity levels of salvageable parts besides making determinations towards reusing some parts following repairs.

Lastly, the ability to track warranty information serves as an invaluable tool during complex repairs scheduling alongside efficiently managing correspondence around maintenance scheduled activities thanks to data recorded on blockchains. By leveraging blockchain technology in the development of passenger cars' braking systems decentralised immutable ledgers can offer increased transparency and traceability while also improving production efficiency testing protocols and simplifying maintenance procedures.

Furthermore - conceivably with regards to cybersecurity - secure decentralised systems for storing operating & maintenance-related information could be explored using this technology. Crypto techniques such as hashing & digital signatures would ensure that information alterations are increasingly challenging for hackers without raising red flags up masking their activities steeping up protection measures.

In addition to tighter security measures having been taken in this context; a blockchain-based system is capable of keeping track of conclusive records affording greater security with irrefutable proof.

In doing so provides benefits like verifying past repairs and correct ownership securing accurate insurance coverage by making records easily accessible through its distributed ledger structure thereby offering protection from abuse.

5.1.5 Female Manager Responses

In analysing responses from female managers surveyed about their attitudes towards embracing autonomous driverless taxis, around 60% appeared very open-minded about it all - signifying positive attitudes toward self-driving technology having potential benefits for automating processes within the auto industry itself. However, integrating fully functional autonomous vehicles into our lives requires solid groundwork via academic research which can facilitate disseminating invaluable knowledge and insights to relevant stakeholders. At the same time, findings from such epidemiological studies inform further innovation that enables refining of current approaches adopted for driverless cab services as well. Crucially, Cavazza et al. (2019) also suggest that businesses must strike an intricate balance between technology and business objectives while also enabling radical change whenever possible.

Proponents of adopting self-driving technologies acknowledge how research work is key in easing the transition towards driverless services. For female managers though, this newfound urgency comes with significant concerns considering potential cyber threats & vulnerabilities associated with these vehicles as automobile companies store much more sensitive data than ever via computer systems concerning industry updates and technological functionalities alike.

Despite the inherent risks then, almost half of the surveyed women still expressed strong willingness to utilise such offerings provided they receive adequate information detailing cybersecurity measures taken by service providers to ensure user safety at all times - a sentiment that was stretched further as females also expect such businesses to lay out clear compliance measures regarding quality assurance standards in place so users feel secure & trustful about their dealings in this specialised area.

Speaking of trust and security though, cost-effectiveness is something that's emerged as a major consideration within female managers' decision-making process before availing autonomous taxis or cars themselves - with most supposing only costs below $1 per mile would drive them towards this new innovative movement captured via driverless tech solutions plus approx. 90% indicating a strong inclination towards trying out such options only if costs dipped even lower: below 10 cents per mile preferably perhaps! The preference for autonomous vehicles changes and people tend not to prefer them when providers charge more than $1 per mile as they become expensive compared to regular taxis in the US; affordability emerges as a crucial consideration. Boesch et al.'s (2018) study place significance on autonomous vehicle cost structures determining profitability. Customers value comfort and value for money when travelling around cities; therefore, competitive pricing is necessary or matching alternative transportation options' prices is essential.

Female managers consider affordable pricing key to attracting new customers; thus, affordability is one of their primary considerations regarding these services' viability.

However, they have differed opinions regarding automotive product development processes' significance and ultimate success; six out of ten female managers suggest practical functionality outweighs specific development processes' importance. Excellent functionality results from finished products that ensure customer attraction and retention.

In addition, female managers advocate heavily investing in cybersecurity while facing increasing security challenges posed by technological advancements, ensuring strict security measures protect users. A robust cybersecurity system helps manufacturing companies maintain their customers' trust and overall credibility.

5.1.6 Diverse Manager Responses

In addition to examining the perspectives of female managers, this study also sought to capture the viewpoints of managers who exhibited diverse responses and those who were initially hesitant to adopt autonomous vehicle services. The inclusion of these diverse perspectives adds depth and nuance to the overall findings, shedding light on the challenges associated with raising awareness and addressing concerns related to cybersecurity.

The findings indicate that some managers expressed reservations about embracing autonomous vehicle services due to their limited knowledge and understanding of how the technology works. This lack of information contributed to their initial reluctance to adopt these services. Moreover, managers in this category indicated that they would be deterred from using autonomous vehicle services if they became aware of recent cyberattacks on the system. This underscores the importance of increasing awareness about the potential for cyberattacks and the measures in place to mitigate such risks. As the automotive industry continues to integrate advanced technologies, it becomes crucial to educate and inform stakeholders about the benefits and safeguards associated with autonomous vehicle services.

The introduction of technology, including autonomous vehicles, in the automotive industry has brought both positive and negative impacts. While autonomous vehicles hold the potential to revolutionize transportation, challenges such as cybersecurity risks must be addressed. These challenges are not unique to autonomous vehicles but rather represent a broader issue faced by various industries as they adopt digital technologies (Gruel & Stanford, 2016). As such, it is crucial to increase awareness of the potential risks associated with cyberattacks in autonomous vehicles and emphasize the measures being implemented to mitigate these risks.

Interestingly, the cost of utilising autonomous vehicle services did not emerge as a significant influencing factor in the decision-making process for managers with diverse responses. This finding suggests that managers' perceptions regarding the adoption of autonomous vehicle services are driven by factors beyond cost considerations. Rather, their focus lies primarily on the disruptive nature of autonomous vehicles and their anticipated role in transforming the automotive industry. This aligns with the growing recognition that autonomous vehicles represent a paradigm shift in transportation, with the potential to redefine mobility and reshape urban environments (Hensher et al., 2017).

Overall, managers with diverse responses indicate an acknowledgement of the transformative potential of autonomous vehicles and the role they are poised to play in driving change within the automotive industry. Despite initial reservations, these managers recognise the inevitability of technological advancements and the need to adapt to emerging trends. As the adoption of autonomous vehicle services becomes more widespread, it is essential to address concerns, raise awareness, and promote understanding among managers to foster a smoother transition and successful integration of these technologies.

5.1.7 Male Manager Responses

In this study, interviews were also conducted with male managers, yielding insights that complement the perspectives of female managers. The responses from male managers provide an in-depth perspective on the introduction and implementation of autonomous driverless service vehicles, shedding light on their positive attitudes and highlighting strategies to effectively introduce these vehicles.

The findings indicate that male managers in the automotive industry are well acquainted with the introduction of autonomous driverless vehicles and exhibit a positive outlook regarding this technological innovation. Their perspectives offer valuable insights into the most appropriate strategies to facilitate the successful integration of driverless service vehicles. Consequently, a thorough analysis of these responses is critical for making informed decisions and gaining the trust of customers, especially as service providers implement stringent cybersecurity measures.

The cost of autonomous vehicle services emerges as a key factor influencing the trust and acceptance of male managers. According to the interview responses, most male managers express a keen interest in the fees associated with utilising driverless services. Consequently, the cost per mile becomes a pivotal consideration for male managers when deciding whether to adopt autonomous vehicles. These findings align with the research by Andersson and Ivehammar (2019), who emphasise the significance of considering the societal benefits and costs of autonomous vehicle services, particularly when their commercial success is contingent upon manufacturers.

5.2 How Do Autonomous Vehicles Work

Autonomous Vehicles (AVs) represent a transformative juncture in the automotive industry, propelled by a synergy of sophisticated technologies including sensors, software, radar, Global Positioning Systems (GPS), Lidar, and cameras, all meticulously orchestrated to monitor road conditions and direct AV navigation (Schoettle & Sivak, 2014). These technologies allow AVs to operate independently, leveraging computer systems, electronics, and sensors to deliver advanced automotive safety.

The operation of AVs is structured according to the SAE International's classification system, which delineates six levels of autonomy. This hierarchy begins at Level 0 where humans bear all driving responsibility and ascends through various stages of Driver Assistance Technology to culminate at Level 5 - denoting full autonomy where no human intervention is required (National Highway Traffic Safety Administration, n.d.).

In shaping the landscape of AV technology, companies such as AutoX, GM Cruise, Nvidia, Uber, Waymo, and Nuro have been instrumental, alongside valuable contributions from academic and governmental research institutes like the University of Michigan's Transportation Research Institute and the Congressional Research Service (CRS, 2017).

Waymo, a subsidiary of Alphabet Inc., has been at the forefront of this evolution, having logged in excess of 20 million miles in on-road testing complemented by exhaustive simulations (Waymo, n.d.). The technology underpinning Waymo's Level 4 autonomy hinges on advanced object detection, interpretation, and adaptive behavioural modification. These processes rely on trained machine learning models that have been nurtured on extensive datasets drawn from myriad driving scenarios (The Washington Post, 2020). It is imperative to distinguish these comprehensive autonomous systems from more rudimentary driver-assistance technologies such as lane-keeping systems, which necessitate continuous driver supervision.

A cornerstone of AV technology is the ability to harness sensor data, enabling the rapid execution of Artificial Intelligence (AI) algorithms and thereby facilitating prompt vehicle responses to environmental changes. Waymo's high-resolution camera system, for instance, can identify traffic lights, construction zones, school buses, and emergency vehicle lights, augmenting its situational awareness (Waymo, n.d.). The fusion of diverse sensor data into a coherent whole allows AVs to navigate their surroundings in real-time, employing techniques akin to human visual perception.

Moreover, the use of multiple sensor modalities, such as cameras and Lidar, not only enhances object detection but also predicts potential movements of detected objects, thereby allowing AVs to adapt their behaviour in response to real-time circumstances (The Washington Post, 2020). Ultimately, the evolution of autonomous vehicles relies heavily on the seamless integration of sensors, cameras, and AI-based algorithms, all aimed at maximising road navigation efficiency and safety.

5.2.1 Robotaxi Services as a business case

With the rise of autonomous technology comes the possibility of implementing a robotaxi service wherein self-driving vehicles are used for ferrying customers from one place to another. The concept holds much promise concerning its potential benefits such as increased efficiency, availability at any time and enhanced safety while offering an immersive travel experience that is tailored specifically towards individual needs.

One salient advantage of a Robotaxi system lies in its ability to provide practical solutions at a more economical rate compared with traditional taxi services thereby offering reduced fares to customers.

The latest innovative progression in transportation is the concept of a robotaxi service that provides specialised features such as personalised temperature control, on-demand entertainment options and unique route selections catered to individual needs. These qualities can heighten customer satisfaction rates, which may lead to increased loyalty towards the service provider. With cost savings potential while improving efficiency and safety records, the success of the robotaxi service looks promising in urban areas that have demanding needs for economical mobility solutions. Even so, bureaucratic hurdles towards gaining regulatory approval alongside ensuring technological maturity pose challenges to its general acceptance by society. As such this field requires ongoing research & development.


Figure 19 A robotaxi concept as seen by DALL-E*

5.2.2 The importance of cybersecurity measures as part of the business case of an autonomous riding shuttle

Emergent technologies such as the Internet of Things (IoT), big data analytics, blockchain technology, Machine Learning (ML), and Artificial Intelligence (AI) are rapidly transforming our current epoch towards increased automation and connectivity. As an academic in Vehicle Engineering, I witness assorted opportunities that come with technological advancements but also significant challenges that come with changing work environments at individual levels.

IoT facilitates seamless intercommunication between interconnected devices capable of autonomous operations such as self-parking or self-diagnosing malfunctioning systems in smart vehicles while collecting real-time performance-related metrics that enhance vehicular safety efficiency. Big Data Analytics provides important insights derived from complex datasets to optimise vehicular designs through surveys done over multiple vehicles increasing efficiency and enabling the development of more efficient future vehicles.

Blockchain presents an impenetrable decentralised method for recording transactions enhancing supply chain transparency or managing usage records creating possibilities for irrefutable vehicle histories when combined with IoT. Lastly, machine learning and artificial intelligence characterised by their pattern recognition abilities have an immense capacity for automating vehicles and enhancing their connectivity potential across various systems achieving optimised performance levels during vehicular use. Advanced driver-assistance systems (ADAS), predictive maintenance technologies, and traffic management tools along with developments related to increasing autonomy in vehicular travel have enabled operationally excellent procedures contributing towards safer modes of transport for users everywhere.

While innovative roadways forward necessitate a boost in technological adoption - mainly when it comes to successful intelligent transportation system development - this acceleration towards achieving digitalisation has come across its own set of challenges related to security.

The vast volume and complexity of secondary generation data pose significant cybersecurity reforms; simultaneously posing new dangers which often require protection against escalating numbers within the realm of vehicular travel. Cybersecurity now proves to be the paramount concern to address while we are amidst a time of rapidly evolving digitalisation and automation.

The cybersecurity challenges associated with vehicle engineering primarily arise from increasing connectivity and autonomy, culminating in a necessity for stringent measures that need to be taken against threats such as remote hijacking, data breaches, privacy invasion, and unauthorised access. If left unaddressed, these risks could have catastrophic outcomes which threaten users' safety across all domains.

The challenge in achieving safety goals grows exponentially by the fact that at present attackers possess easy access to various publicly available hacking tools coupled with specialised expertise exploiting third-party computers as bots.
Therefore, additional measures must be implemented consisting of robust cybersecurity protocols considered essential for succeeding within the burgeoning threat landscape of autonomous vehicles.
Thus, it is evident that continued technological development supported by comprehensive cybersecurity measures remains critically essential in maximising digital advancement's potential benefits while limiting or mitigating associated risks.

Such results require expert practitioners and academia to implement individual responsibility towards successfully navigating driving technologies towards excellence within safer more efficient domains maximised by sustainable solutions.

5.2.3 New security through AI

The rapid growth of cyber threats necessitates a fresh perspective involving comprehensive threat detection alongside an in-depth understanding of their behaviour within cyberspace. Valuable insights accrued here power development cycles that focus on delivering robust IT systems fused with effective protective measures –hence institutions such as Fraunhofer Institute for Applied & Integrated Security (AISEC) commit to this pioneering approach by utilising intelligent cognitive security technologies. AISEC concentrates on applying AI to strengthen IT systems in both hardware and software.

This strategy incorporates cutting-edge algorithms that capture even the smallest details of potential cyber threats, with AI-driven neural networks and machine learning techniques standing out as powerful components– they allow cybersecurity systems to learn dynamically from operational data.

AI also streamlines large-scale, high-complexity tasks enabling swift identification of patterns as red flags for cyber-attacks, sifting through considerable amounts of information for probable dangers, and spotting latent anomalies that could otherwise go unrecognised. By doing this automatically, personnel can channel more time and resources into creating overall robust systems enhancing cybersecurity across the board.

In designing scaled-up security solutions for internet-borne attack activities swiftly assessed within cyberspace, Fraunhofer AISEC's machine learning applied endeavours feature direct solutions with novel protective mechanisms alongside worthy best-practice applications reflecting current trends within its adaptive nature.

AI-based cybersecurity technology evolves based on real-time operationally dynamic scenarios. This requires regular input from experts continuously updating processes keeping them equipped with industry-leading knowledge regarding emerging threat trends —collaboration is key! To ensure constant improvement in AI-based security technologies', Fraunhofer AISEC holds regular discussions with distinguished experts from the community. The knowledge gained from these interactions helps in designing customised solutions tailored explicitly for individual customers' unique challenges.

Since we are advancing further into the digital era, developing innovative security technologies has become more critical than ever before. Promising solutions lie within AI and its related techniques that can provide strong, flexible, effective protection against various threats. Institutions like Fraunhofer AISEC set a perfect example by devoting significant time towards pioneering research activities concerning future cybersecurity issues through advanced AI.

However, collaboration among experts within the industry will remain essential as we navigate the road ahead while making technological advancements along with appropriate regulatory measures- ensuring trustworthy network connectivity worldwide. As one invested academically in this field of inquiry, contributing through research initiatives while grooming potential vehicle engineering professionals represents my primary objective.

5.3 How the digital transformation of autonomous driving functions helps facilitate and simplify the processes involved in creating the related business cases.

Digital transformation refers to the use of digital technologies to fundamentally change the way an organisation operates and delivers value to its customers. In the context of autonomous driving, digital transformation could help facilitate and simplify the process of creating business cases in several ways:

Data-driven decision-making: Digital technologies such as big data analytics and artificial intelligence (AI) can be used to analyse vast amounts of data related to autonomous driving, including data on customer demand, traffic patterns, and market trends. This can help organisations to make more informed decisions about the viability of different autonomous driving business cases, and to identify areas of opportunity or potential risk.

Enhanced collaboration: Digital tools such as cloud-based project management software and virtual collaboration platforms can make it easier for teams working on autonomous driving business cases to share information and collaborate in real-time, regardless of their location. This can help to speed up the process of developing business cases, as well as improve the quality of the final product.

Increased efficiency: Digital technologies can also help to streamline various processes involved in creating business cases, such as data collection, analysis, and reporting. For example, automation tools can be used to process and analyse data more quickly, freeing up time for other tasks.

Overall, the digital transformation of autonomous driving functions can help to facilitate and simplify the process of creating business cases by enabling data-driven decision-making, enhanced collaboration, and increased efficiency.

5.3.1 AI in automotive technology Driver assistance systems

The landscape of vehicular transportation has been dramatically reshaped by the advent of intelligent systems, many of which have seamlessly integrated into the standard functionalities of modern vehicles. Such technologies, originally perceived as elements of Artificial Intelligence, have become commonplace, rendering them almost unnoticeable. Common systems include parking assistance, cruise control, and various camera perspectives for enhanced visibility.

Advanced technological systems have also emerged, providing enhanced assistance to drivers, and promoting road safety. Notable among these systems are Turn Assist, which monitors oncoming lanes once the indicator is activated, Lane Change Assist, which warns of objects in the blind spot during lane changes, Adaptive Cruise Control, aiding in maintaining a safe distance from vehicles ahead, and Lane Departure Warning, cautioning against unintentional lane departures. These systems are usually available as optional add-ons.

More recent developments include systems such as Night Vision Assist for improved visibility in low-light conditions, Distance Control with Stop & Go function for maintaining distance in slow-moving traffic, PreSense for collision risk detection and preventative action initiation, and Traffic Sign Recognition for driver information. These systems are often offered as add-ons for luxury models, further demonstrating the progression of intelligent system integration in vehicular technology.

Notwithstanding these advancements, the grand vision lies in achieving autonomous driving – a feat that could revolutionise transportation. Autonomous driving leverages AI for real-time object recognition within the vehicle's environment. The German industry leads in this domain, holding 52% of all patents for autonomous driving, with Audi, Bosch, and Continental spearheading the efforts. Projections, however, suggest that fully autonomous door-to-door vehicles may not be realised until 2040.

The advantages of autonomous driving are manifold. It fosters societal integration for the elderly and disabled, enables productive or recreational use of travel time, promotes environmental sustainability through efficient engine operations, and promises safer road conditions by reducing human-error accidents, which account for 90% of all road incidents.

The journey towards autonomous driving is generally classified into five levels: Assisted driving, partially automated driving, Highly automated driving, Fully automated driving, and Autonomous driving. As of now, most manufacturers have achieved the second level, "partially automated driving," wherein vehicles can independently perform certain driving tasks under constant human supervision.

At level three, "highly automated driving," the vehicle assumes various functions in specific situations, such as navigating long stretches of highways autonomously. Nevertheless, the driver must be ready to resume control when prompted by the vehicle.

The Audi A8, with its "traffic jam pilot" feature, is recognised as the first production vehicle capable of level-3 driving. This feature enables the vehicle to navigate traffic autonomously up to 60 km/h on multilane highways, thereby allowing the driver to engage in other activities in certain situations as dictated by the manufacturer and national regulations.

The forecast anticipates the production of up to 48 million partially and fully automated vehicles by 2035, marking a significant milestone on the path to fully autonomous vehicles.

5.3.2 Networking of vehicles Car-to-X communication

Car-to-X communication is a rapidly burgeoning area within the realm of vehicular and transport technology. This term encompasses two distinct types of communication: Car to Car (C2C) and Vehicle to Infrastructure (V2I). With the aid of wireless networks or mobile radio technology, this form of communication facilitates the real-time exchange of information between vehicles as well as between vehicles and their surrounding infrastructure.

As it gains traction it holds great promise for revolutionising transportation safety optimising driving behaviour reducing pollution levels and enhancing overall roadway efficiency. In the case of C2C communication vehicles can share vital information about traffic conditions, accidents, or other potential risks in advance. This is particularly useful for circumstances a driver might not see right away.

Through C2C communication capabilities these vehicles can provide advanced warnings about hazards such as wrong-way drivers on the roadways or dangerous weather conditions. In so doing, C2C communications augment safety on the roadways by enabling drivers or autonomous systems to anticipate circumstances ahead and respond accordingly.

At the same time that C2C communications provide information for safety purposes they also minimise environmental impact by making vehicular operations more efficient. Vehicular operations become more eco-friendly through real-time adjustments based on traffic patterns ahead as well as weather forecasts that signal which routes are best suited to a car's technological infrastructure.

In contrast to C2C communications that deal with vehicle-to-vehicle interactions, only V2I communications enhance how cars interact with infrastructure components like traffic signals or construction sites offering an even greater benefit potentiality. Automotive industry leaders such as Mercedes Benz have already implemented pioneering C2C comm standards in their range; they are prepared to employ V2I vehicles in due time. Some governing bodies like Hesse State in Germany have begun installing Car to X communicative tech along permanent roadwork areas keeping drivers safe while safeguarding worksites' makers simultaneously. With advancements in technology, it is even possible for vehicles to interact with traffic signals receiving updates on forthcoming light phases and therefore optimising their travel time and reducing energy usage during transit.

Extensive research shows that Car to X communication is capable of benefiting roadway safety through the averting of accidents while simultaneously aiding the environment by making transport more cost-effective. These features can contribute towards saving billions of euros annually. Future versions of the technology may also include in-built alternate route proposals and parking space location aids - all these systems improve overall driving experiences.

Car-to-X communication is an innovative area growing in vehicular transport tech which facilitates the real-time exchange of information between vehicles via wireless networks or mobile radio. This new mode, which comprises two types namely, Car to Car (C2C) and Vehicle to Infrastructure (V2I) promises to revolutionise transportation safety optimise driving behaviour reduce pollution levels and enhance roadway efficiency significantly. Additionally, C2C communication methods aid driver situational awareness by sharing a vehicle’s information about direct accidents or potential risks ahead. This early warning system provides critical extra seconds for drivers' decision-making process about potential hazards like wrong ways drivers or dangerous weather conditions on the roadways - and thereby augmenting travelling safety contingencies positively.

In contrast, V2I communications enable cars to interact with infrastructure components such as traffic signals or construction sites tactically adding extra environmental beneficence.

The automotive industry has integrated pioneering C2C comm standards like Daimler into their products while still purposing newer V2I services eventually. Meanwhile, state governments such as Hesse have already installed Car to X transmission qualities along permanent roadwork areas causing less disruption to the operation, but they are preparing for even more advanced technologies interactions across many different industries in various sectors. Efforts aimed at determining benefits accruable from Car to X communication indicate that it can significantly reduce environmental burdens and enhance safety measures on the roadways. Leading brands in vehicular manufacture like Mercedes Benz have spurred its advancement and they are researching into making alternate route suggestions and creating parking location aids - utilising their innovation to provide a much-improved driving experience.

Car-to-X communication is an innovative area growing in vehicular transport tech which facilitates the real-time exchange of information between vehicles via wireless networks or mobile radio. This new mode, which comprises two types namely, Car to Car (C2C) and Vehicle to Infrastructure (V2I) promises to revolutionise transportation safety optimise driving behaviour reduce pollution levels and enhance roadway efficiency significantly. In contrast, V2I communications enable cars to interact with infrastructure components such as traffic signals or construction sites tactically adding extra environmental beneficence. The automotive industry has integrated pioneering C2C comm standards like Daimler into their production while still purposing newer V2I services eventually. Meanwhile, state governments such as Hesse have already installed Car to X transmission qualities along permanent roadwork areas causing less disruption to the operation, but they are preparing for even more advanced technologies interactions across many different industries in various sectors. Additionally, C2C communication methods aid driver situational awareness by sharing a vehicle's information about direct accidents or potential risks ahead. This early warning system provides critical extra seconds for drivers' decision-making process about potential hazards like wrong ways drivers or dangerous weather conditions on the roadways - thereby augmenting travelling safety contingencies positively.

Efforts aimed at determining benefits accruable from Car to X communication indicate that it can significantly reduce environmental burdens and enhance safety measures on the roadways. Leading brands in vehicular manufacture such as Mercedes Benz have spurred its advancement. R&D conducted by both private organisations like those mentioned above could make way for propositions regarding alternate route suggestions which improve time-saving journey alternatives while simultaneously offering parking location aids.

Vehicle communication actuated through wireless networks and mobile radio earns the title of Car to X communication. It comprises two forms: Car to Car (C2C) and Vehicle to Infrastructure (V2I) and it maximises transportation safety while reducing pollution. Besides being a paradigm shift C2C applications raise driver situational awareness by supplying information about direct accidents or potential hazards ahead of time. Similarly, V2I applications increase eco-friendly efficiency by inspecting a vehicle's complete routing system. Leading automotive manufacturers like Mercedes Benz are pioneers in implementing C2C communication - which is starting to retool their V2I service fleet. If we take one example a state like Hesse starts utilising permanent roadwork areas with Car-to-X communicative technologies to keep drivers and worksites protected from potential harm. On the other hand, technology-driven adjustments such as interaction with traffic signals can optimise energy management and roads are much less congested. Ultimately research shows that adopting this strategy creates significant environmental solutions while saving billions of euros annually courtesy of companies like Daimler. Also, in future versions alternate route proposals and parking space location aids may make way for a much more improved driving experience.

Wireless network-supported communication systems derive their name from vehicle-oriented groupings known as Car-to-X communication. A well-known phrase represents these groups -namely: -Car to Car (C2C) and Vehicle to Infrastructure (V21). Not only does it revamp transportation general security issues in an astonishing way it also mitigates pollution. Unlike its V21 complement the C2C applications improve overall driver awareness via early warning mechanisms. They relay information regarding access hazards like wrong-directional driving or perils on the road such as inclement weather. Therefore, enabling travel safer for motorists who ply various channels reduces the likelihood of side-swipe accidents. Major automotive concerns like Mercedes Benz are front runners in adopting C2C communication into their entire range of vehicles. V2I applications are starting to be newly included in their range of services. Moreover, state-level administrations like Hesse are leading the way by installing Car to X communication during road construction - thereby safeguarding both drivers and construction workers while on the job site.

Technology-driven adjustments such as interaction with traffic signals increase energy management and reduce congestion levels with efficient mobility thus making environmental reductions possible. Through technological advancements, C2C communication can enable alternate routing options as well as help identify on-street parking. (Daimler considers C2C communication capable of significantly enhancing road safety resulting in billions of euros saved yearly in reduced accidents). Beyond such improvements, these alterations may lead to an incredible driving experience. Car-to-X communication is an exciting technology because it has great transformative potential within the transportation sector. Furthermore, artificial intelligence (AI) shows promise as a means of optimising traffic flow. By processing data from traffic cameras effectively with machine learning algorithms such as AI's ability to estimate things like traffic density accurately. As a result of this capability, it can help regulate signal timing dynamically based on real-time fluctuations in density easing road congestion and increasing travel times enhancing urban life through decreasing air & noise pollution.

Furthermore, modern parking management solutions that guide vehicles directly to open spots have the potential of contributing considerably towards curbing heavy urban traffic induced by drivers looking out for vacant lots; about 40% of city-based commute results given this problem area's relevance, to demonstrate better parking solutions innovatively Daimler and Bosch conducted a trial run with sensor-laden vehicles scanning roadsides where open spots were found and then anonymously shared using cloud infrastructure. Car-to-X communication incorporation backed up with AI integration brings about significant opportunities for enhancing roadway safety, efficacy, and sustainability. Obligatory research investment will adequately harness these potential benefits and enable us to overcome any hurdles we face in terms of regulation or technology.

5.4 How digital transformation barriers and vulnerabilities compromise autonomous driving functions business cases and general productivity within the transport industry.

Blockchain technology's remarkable potential as a game-changer has captured attention worldwide, and it has an excellent capacity to transform many industries, including supply chain management. Its unique features provide secure, immutable, and transparent transactional records that can alter traditional paradigms dramatically.

Blockchain technology's applications in supply chain management and cybersecurity contexts to identify its benefits of existing implementations and prospects.
Blockchain offers several advantages, including enhanced traceability when integrated into the supply chain mechanism adequately. The distributed ledger can document product journeys from their origin to the final point of sale impeccably. Precise documentation is especially essential in sectors like agriculture or food production where regulations govern quality control compliance while tracking product provenance, and trajectory, to investigate problems when recalls emerge across periods.

Additionally, blockchain adds significant value by substantially bolstering security measures utilised within the traditional supply chain system. The cryptographic hashing methods coupled with decentralised consensus mechanisms provide tamper-proof transactional records effectively reducing risks associated with fraudulence or illicit activities from taking advantage of various lapses that obstruct continuous real-time surveillance.

Overwhelmingly accommodating improved operational efficiency from automating processes using unique functions such as smart contracts streamline operations like record-keeping asset tracking orderly payment processing methods overall reducing operation costs considerably leading towards profitability.
As participants have equal access to accurate up-to-date information based on shared data on each phase involved in product manufacturing from source materials to sales transactions can enhance collaboration while building trust within an ecosystem thanks to

blockchain's characteristic transparency feature fostering equitable efficient facilitation led by adhering rightful principles.

Lastly, capitalising beyond exclusively being used for managing supply chains alone, could utilise this advanced Cybersecurity technique serving identity & Access Management secure decentralised systems over wide-ranging domains successfully ensuring regulatory compliance and enhancing operational efficiency. Blockchain technology introduces an irrefutable source of truth for user identities which complicates unauthorised impersonation attempts from malevolent actors.

Blockchain is also excellent in fostering secure communications between different parties an example is its ability to create tamper-proof messaging systems where sensitive information can safely be transmitted without worry about interception by outsiders because of the recorded ledger trail available for auditing purposes. Furthermore, organisations can securely store important files using decentralised file storage provided by the same ledger effectively eliminating concerns about malicious individuals tampering with or gaining undue access without authorisation to sensitive data.

In addition, deploying this technology secures supply chains further by maintaining indisputable transaction records which only authorised personnel are allowed to peruse leading to better governance aimed at curbing illegal actions designed to infiltrate supply chains.

To summarise, blockchain's capabilities in offering decentralised, secure, and verifiable storage serve multiple applications within the security sector and supply chain management where it continues revolutionising these industries as innovation increasingly gains acceptance.

5.4.1 How does software development process automation through digitalisation improve their business case?

The prospect brought about by digitalisation ushers in new possibilities that benefit robotaxi service providers through automating software development processes-translating into transforming possibilities; a scenario marked by heightened productivity, improved accuracy levels, reduced costs, and improved scalability measures. This essay delves into how these factors offer benefits that enhance robotaxis profitability and competition in a constantly evolving transport industry. Efficiency is one of the major benefits provided by automation in software development.

The pressure from time constraints and labour-burdens associated with manual completion can be effectively mitigated through automating repetitive tasks, directly resulting in a quicker turnaround period which implies robotaxi service providers can handle a larger workload volume while delivering enhanced productivity coupled with heightened efficiency measures leading to direct profitability growth among their wide range of customers.

Furthermore, automating software development processes provides another key benefit -- reducing the risk of human errors while increasing software quality with fewer defects. In developing autonomous vehicles via software, there are multiple complex procedures, which have human error potential—since automation steps up this mechanical process in manufacturing—there's an increased potential for delivering higher reliability and more robust services that factor customer satisfaction into every product.

Robotaxi service providers will get to reduce costs significantly while also cutting down on labour requirements needed – by obviating certain roles or reducing manual intervention for certain components associated with product development etc -- all culminating towards lower overhead expenses contributing directly to marked profit growth, maintaining a level playing field within the sector instances where significant investments go towards setting up a robotaxi service; achieving these cost savings become crucial considerations towards achieving long-term financial feasibility of such services.

Finally, automation facilitates scaling up business operations efficiently–a crucial outcome stemming from streamlined processes that require minimal expansion personnel ultimately leading to optimal functionality with little resource expansion —assured operational efficiency at low cost; thus, making Robotaxis more innovative, and competitive while delivery high standards at relatively low costs across various niches within the vast locale. Nimble expansion is necessary for a successful robotaxi service thriving in dense urban areas due to rapidly increasing demands from ridership growth. The solution lies within automation technology that paces with market dynamics while keeping operational costs low proportionally. Digitalising certain software development tasks offers great advantages such as efficient operations, lower costs along with quick implementation of scalability plans which enhance performance leading towards greater competitiveness & profitability within this evolving autonomous transport sector.

5.4.2 An example of a digitalization strategy for software development processes at a Tier-2 company.

The growth in the digital transformation of business processes is an excellent cause for companies to transform their operations and adopt automation in business processes. The necessity of driving digital transformation initiatives and improving the customer experience has evolved and moved the BPM market toward digital process automation. Business users are now in a position to own and maintain the process automation that is critical for improving the customer experience and enabling digital transformation.

Automation helps customers receive the things they want more quickly, and it shifts the focus of operations from repetitive tasks to more challenging tasks that deliver business value. When businesses shift from simply digitising to automating, particularly in manual, repetitive tasks, it gives employees more time to focus on the company's customers. When combined with digitalisation (which relies on using digital technologies within processes), automation enhances workflows, resulting in substantial time savings, often translating to better sales.

Business automation uses digital technologies to make routine processes/repetitive tasks more efficient, eliminating human interaction. With the help of a process automation solution that has proper integration capabilities, it is possible to automate the workflows across different functions, such as marketing, customer relationship management, sales, support, and finance. Process automation software provides an intelligent approach to reducing and controlling costs, allowing businesses to expand and improve services to customers, minimising costs.

In addition to offering traditional BPM features such as compliance, cost reduction, and smooth process management, digital process automation supports a wide range of enterprise-driven applications, which put a premium on the customer's outcomes. This means that BPM can be applied to manual, repetitive tasks across the entire organisation to increase efficiency, and in the meantime, link applications and optimise processes across departments, from employee onboarding in HR to purchasing in finance. It is safe to say that, whereas business process digitisation is focused heavily on moving basic business processes online, Business Process Automation is focused heavily on improving productivity, reliability, and reducing costs.

Companies that have digitalised their operations may take advantage of emerging technologies such as AI to uncover new ways of optimising and customising automated processes, which could provide opportunities for extra revenue streams or increased customer loyalty. By adopting software solutions that incorporate key digital technologies such as AI, advanced data analytics, and Robotic Process Automation (RBA), these companies are reaping immediate benefits, setting the stage for the larger gains in strategic value that will follow the wider adoption of their digital transformation initiatives. There are many benefits to adopting RPA within one company, ranging from releasing human staffing to streamlining processes, and collectively, they make automation a great win for any organisation.

Leveraging automation should help provide an end-to-end customer experience through simple processes, as well as allow one to integrate separate enterprise operations across one enterprise into one unified process aligned to customers' needs. To indicate what is possible, automated admin processes could dramatically accelerate the pace at which digital products are developed, and artificial intelligence and machine learning could accelerate the detection and validation of users. One can also simplify oner developers' lives with a workflow automation solution that takes a visual, low-code approach, which allows one to deliver enterprise-grade features into Web applications, and to distribute this development among multiple people - citizen developers within one organisation.

5.5 An example of a digitalization strategy for software development processes for automotive functions: Discussion of Research Question One: How could the digital transformation of a Tier-2 company Enterprise architecture based, could thrive the product management process-based business cases

Digital transformation carries substantial implications for product management within Tier-2 companies. The potential benefits are numerous, leading to improved operational efficiency, an enhanced customer experience, increased agility, and data-driven decision-making.

Technologies that enable automation and streamlining of product management tasks promise enhanced productivity, freeing up resources for more strategic endeavours. In the realm of customer experience, digital tools provide unprecedented insights into customer needs and preferences, enabling more personalised, targeted offerings. Furthermore, the agility imparted by digital technologies allows quick adaptation to shifting market conditions and customer needs, thereby maintaining competitiveness. Finally, the influx of data available through digital tools can inform and refine product development and marketing strategies.

Successful digital transformation necessitates careful planning, execution, and collaboration among relevant stakeholders. A robust infrastructure must be established to support the implementation and use of digital tools and technologies. Constant monitoring and evaluation are crucial to measure the impact of digital transformation on product management processes and make necessary adjustments.

Given the escalating integration of sophisticated technology in automotive systems, efficient development processes are of paramount importance. An effective approach includes the incorporation of digital tools aimed at streamlining processes while ensuring high-quality output. The interplay of automation and human skill can achieve these goals, leading to a transformative digitalisation strategy for software development in the automotive industry.

To implement digitalisation effectively in the automotive sector, specifically in software development processes, several key steps must be taken. Firstly, process analysis and mapping are necessary to identify areas of improvement within the existing software development process. Next, Agile methodologies must be integrated into the process for their efficacy in managing iterative and collaborative software development, ensuring shorter development cycles and increased flexibility.

The incorporation of DevOps practices is an essential step in improving workflow by combining the functions of Development and Operations, reducing time-to-market, and ensuring quality results. Furthermore, Model-Based Development (MBD) focuses on using graphical models and simulations to design shorter developmental cycles and efficient code generation. Cloud computing, with its virtualisation technologies, provides scalability and flexibility at an economical cost, significantly enhancing productivity and the quality of code development.

In addition, AI technologies, such as machine learning algorithms, can be utilised to review codes and identify defects, enabling performance enhancements and facilitating continuous improvement of software quality based on user feedback and vehicle sensor data.

Implementing these digitalisation strategies results in several benefits, including improved efficiency through streamlined processes, enhanced collaboration among stakeholders, and optimised resource usage. The integration of these strategies improves the overall reliability and safety of automotive functions, reduces error rates, and facilitates a reduced need for physical infrastructure.

By futureproofing against emerging technologies like autonomous driving systems or advanced driver-assisted systems, this digitalisation strategy enables seamless integration with existing teams and work streams. Embracing this digital transformation strategy is key to meeting the demands of a competitive market landscape, producing reliable, efficient, cost-effective automotive products without compromising functionality.

5.6 Discussion of Research Question Two: Does the use of customer-central Big Data in a vehicle's autonomous system function support the digitalization thriving of product management-based business cases?

The use of customer-central big data can potentially support the digitalisation thriving of product management-based business cases for an autonomous vehicle system. Big data can provide companies with a wealth of information about their customers' needs, preferences, and behaviours, which can be used to inform product development and marketing decisions. For example, customer-central big data can be used to identify trends in customer demand for certain features or functionality, which can help companies prioritise their product development efforts.

In addition, Big data can be used to improve the customer experience by providing personalised and targeted products and services based on individual customer preferences. For example, an autonomous vehicle system could use customer data to tailor the driving experience to an individual's preferred style or to provide recommendations for routes and destinations based on past behaviour.

Overall, the use of customer-central big data can help companies better understand their customers and make more informed and strategic product development and marketing decisions, which can support the digitalisation thriving of product management-based business cases. However, it is important to ensure that the use of customer data is ethical and compliant with relevant laws and regulations, such as those related to data privacy.

5.7 Discussion of Research Question Three: Does the use of Big Data for the support of enterprise architecture-based product management-based business cases may aid as a framework for the successful digital transformation of a Tier-2 company?

The use of big data can potentially aid as a framework for the successful digital transformation of a Tier-2 company's enterprise architecture and product management processes. Big data can provide companies with a wealth of information about their customers, markets, and operations, which can be used to inform decision-making and drive strategic initiatives. For example, big data can be used to identify trends and patterns in customer behaviour, which can help companies tailor their products and services to better meet customer needs and preferences. It can also be used to optimise business processes and improve efficiency, by providing insights into areas where improvements can be made. In addition, big data can be used to support the development of new products and services, by providing a deeper understanding of customer needs and preferences and identifying opportunities for innovation. It can also be used to inform marketing and sales efforts, by providing insights into the most effective channels and tactics for reaching and engaging customers.

Overall, the use of big data can provide valuable insights and support the digital transformation of a Tier-2 company's enterprise architecture and product management processes. However, it is important to have the necessary infrastructure and processes in place to effectively collect, store, and analyse big data, and to ensure that the use of data is ethical and compliant with relevant laws and regulations.

Big data refers to extremely large datasets that are collected and analysed to extract insights and make informed decisions. Here is an example of how big data could be used to improve a robotaxi riding service:

Collecting data: The robotaxi service could collect data on various aspects of its operation, including the location and destination of each trip, the duration of each trip, the traffic conditions encountered along the route, and any issues or problems that arose during the trip. This data could be collected using sensors, GPS, and other technologies installed on the robotaxis.

Analysing data: The robotaxi service could then use big data analytics tools to analyse this data and extract insights. For example, the service could identify patterns in the data that indicate which routes are most popular, which times of day are busiest, and which areas have the most traffic congestion.

Improving service: Based on the insights gained from the data analysis, the robotaxi service could make various improvements to its operation. For example, it could route robotaxis along the most popular routes during peak times to improve efficiency and reduce wait times for passengers. It could also use data on traffic congestion to route robotaxis along alternative routes to avoid congested areas.

Overall, the use of big data can help the robotaxi service to optimise its operations and improve the overall experience for its customers.

5.8 Measures that may need to be implemented to enhance the productivity of autonomous driving functions business case creation, especially in dynamic environments. Discussion of Hypothesis 1

Hypothesis 1: Digital transformation in Tier-2 companies facilitates improved operational efficiency, customer experience, agility, and data-driven decision-making in product management, and can streamline software development processes in the automotive industry, enhancing collaboration, optimizing resources, improving reliability and safety, and enabling futureproofing against emerging technologies.

Several measures may need to be implemented to enhance the productivity of autonomous driving functions in business case creation, especially in dynamic environments:

To promote productivity in the creation of business cases relevant to autonomous driving functions, multiple processes can be put in place; particularly when functioning under dynamic conditions.

Agile project management process: Utilising Scrum models ensures adaptability through constant iteration despite environmental changes thereby leading to higher performance levels throughout.

Collaboration platforms: Virtual communication tools employing cloud-based project management services promote collaboration amongst team members enhancing work speed even across different locations and hence allowing for quicker resolution affecting productivity positively.

Data-driven decision-making process via AI Analytics helps identify weak areas along with high reward opportunities within autonomous driving structures leading to informed decisions made holistically in an efficient way.

Constant Learning via training programs enhances staff with technical expertise essential towards high-performance growth within any new-age software design platform resulting in optimising overall work efficiency.

Being flexible and adaptive when faced with changing circumstances ensures the embracement of new technological advancements promoting productivity at all times even in challenging environments.

Blockchain-based cybersecurity software development processes include robust security protocols such as encryption as well as up-to-date authenticated access control processes thereby limiting potential cyber threats posed on autonomous driving structures during development projects especially when undergoing patching or updates regularly. To safely distribute updates between relevant stakeholders, implementing a blockchain-based digital development process is key. Companies must stay ahead of cyber threats using pre-emptive measures such as threat intelligence tools and services, especially at the Tier-2 level. Using an all-encompassing testing framework allows for transparent monitoring via blockchain technology while guaranteeing functionality in autonomous driving capabilities. In addition to this technical approach, promoting employee education on cybersecurity best practices sets an important precedent for building a secure work culture.

5.9 Discussion of Hypothesis 2

Hypothesis 2: Leveraging customer-centric big data in autonomous vehicle systems can significantly bolster the digitalisation of product management-based business cases by offering rich insights into customer needs, preferences, and behaviours, thus guiding product development and marketing strategies. However, while this data-driven approach can enable personalisation of services and the ability to anticipate market trends, it necessitates ethical usage and strict compliance with data privacy laws and regulations to ensure customer trust and legal integrity.

5.9.1 Introduction:

Robotaxis, also known as autonomous vehicles or self-driving cars, are becoming an increasingly popular topic in the automotive industry. These vehicles are equipped with advanced sensors, cameras, and other technologies that enable them to navigate roads and make decisions without the need for a human driver. While the potential benefits of robotaxis are significant, there are also many challenges and uncertainties surrounding this new technology. In this research paper, we will explore the views of managers at automotive companies on robotaxis and the challenges and opportunities they present.

5.9.2 Central Ideas and Opinions from interviewed Managers :the emerging Potential and Implications of Robotaxis in the Automotive Industry

The advent of robotaxis signifies a landmark shift in the landscape of transportation, one that is perceived as revolutionary by numerous managers within the automotive industry. Robotaxis, or self-driving taxis, present a myriad of potential benefits, from safety and efficiency enhancements to congestion reduction and improved accessibility. Despite the promises this technology holds, the implementation of robotaxis also entails several challenges. The concerns revolve around the significant developmental and deployment costs, intricate regulatory landscapes, reliability, security, and potential socioeconomic impacts. In navigating these complexities, the role of government regulation is deemed essential. While the future of robotaxis is enveloped in a degree of uncertainty, the consensus among many industry managers is an optimistic outlook, anticipating the widespread presence of these vehicles in the global transport system.

5.9.3 Beneficial Prospects of Robotaxis

Managers within automotive companies recognise several key advantages that robotaxis could bring to the transportation sector. A crucial benefit lies in the area of safety. Human error is a significant contributor to traffic accidents worldwide. Robotaxis, designed with advanced sensors and artificial intelligence, possess the capability to minimise these human-induced mishaps by detecting and responding to potential hazards with accuracy and speed beyond human capabilities. They can adhere strictly to traffic regulations, thus mitigating the risks associated with distracted or impaired driving.

Efficiency is another promising aspect of robotaxis. Automated vehicles can potentially optimise travel routes and speed, yielding significant fuel and time savings. By incorporating data from various sources, including real-time traffic updates, weather conditions, and roadworks, robotaxis could select the most efficient routes and maintain optimal speeds, thus reducing travel time and enhancing passenger convenience.

Congestion is a pervasive problem in urban centres globally, leading to substantial time wastage and contributing to air pollution. Robotaxis could alleviate these issues by optimising road usage and facilitating a shift from individual car ownership to shared mobility. This transition could result in fewer vehicles on the roads, thereby reducing traffic congestion and the associated environmental impact.

Another salient advantage of robotaxis is their potential to improve transportation accessibility. For individuals unable to drive due to age, disability, or other factors, robotaxis could provide a reliable, independent mode of transport, enhancing their mobility and social inclusion.

5.9.4 Challenges in the Implementation of Robotaxis

While the benefits of robotaxis are significant, so too are the challenges associated with their development and deployment. Many managers in the automotive industry express concerns about the costs associated with the research, development, testing, and production of self-driving taxis. The technology required, such as sensors, LiDAR systems, and AI software, is complex and expensive, making the production of robotaxis a costly venture.

Regulatory complexities also pose considerable challenges. Each country has its own set of rules and standards governing vehicle safety and emissions. The introduction of autonomous vehicles adds a new layer of complexity, requiring new regulations to ensure safety and reliability. Furthermore, in many jurisdictions, current laws do not adequately account for vehicles without a human driver, creating uncertainties for companies involved in the development of robotaxis.

Reliability and security of robotaxis are also significant concerns. While autonomous vehicles are designed to operate safely under various conditions, unexpected scenarios such as unpredictable weather conditions, non-standard traffic situations, or malicious cyberattacks pose significant challenges. It is imperative for developers to ensure that these vehicles can operate reliably and securely in diverse and challenging environments.

Another critical issue is the potential socioeconomic impact. The shift towards autonomous vehicles could potentially disrupt employment within the transportation sector, with drivers being the most directly affected. Although new jobs could be created in areas such as robotaxi fleet management and maintenance, the transition might be challenging for those whose livelihoods are tied to traditional driving jobs.

5.9.5 The Promises and Challenges of Robotaxis and the Potential Advantages of Robotaxis

Automotive industry leaders envision robotaxis as a transformative technology capable of fundamentally altering the transportation landscape. The potential benefits of robotaxis are manifold, encompassing enhanced safety and efficiency, alleviation of traffic congestion, and increased mobility for individuals restricted by age or disability.

5.9.6 Enhanced Safety and Efficiency

One of the most compelling benefits of robotaxis is the potential for increased safety. As these vehicles are governed by algorithms and AI, the human errors responsible for a significant proportion of road accidents are drastically reduced. In addition, automated vehicles could be programmed to adhere strictly to traffic rules, potentially leading to fewer accidents. From an efficiency standpoint, robotaxis could optimize routes, reduce travel times, and offer a consistent level of service, leading to a more predictable and seamless commuting experience.

5.9.7 Reduced Traffic Congestion

Robotaxis could also have a profound impact on traffic congestion. Automated routing and advanced AI capabilities could result in more efficient use of road space, reducing gridlock, and improving overall traffic flow. This could have subsequent knock-on effects, including reduced commuting times, lower levels of vehicle emissions, and improved urban air quality.

5.9.8 Improved Accessibility

Robotaxis may play a pivotal role in making transportation more accessible for those who cannot drive due to age, disability, or other factors. By offering a safe and reliable means of transport, these vehicles could enable more individuals to access services, social opportunities, and employment, enhancing quality of life and societal inclusion.

5.9.9 The Challenges of Implementing Robotaxis

Despite the potential benefits, implementing robotaxis also presents a multitude of challenges, encompassing high development and deployment costs, a complex regulatory environment, reliability and security concerns, and potential economic implications.

5.9.10 Development and Deployment Costs

The development and deployment of robotaxis represent a significant financial undertaking. Designing these vehicles requires high-tech components and advanced software, driving up costs. Furthermore, launching a fleet of robotaxis necessitates considerable infrastructure development, including charging stations, maintenance facilities, and control centres. These financial hurdles could pose challenges for companies, particularly smaller enterprises with limited capital.

5.9.11 Regulatory Environment

The robotaxi industry is surrounded by a complex regulatory environment, presenting another significant challenge. Clear, consistent regulations are crucial to ensure the safe operation of these vehicles. However, differing laws and standards across regions could potentially hinder global market entry and expansion.

5.9.12 Reliability and Security Concerns

Reliability and security are also significant concerns. Breakdowns and technical glitches could undermine trust in robotaxis, leading to consumer reluctance. Moreover, as these vehicles rely heavily on software, they are susceptible to cyber-attacks. Hence, robust security measures are essential to safeguard against potential threats.

5.9.13 Economic Impact

Another key consideration is the potential impact of robotaxis on jobs and the economy. While robotaxis may create new jobs related to their operation and maintenance, there are concerns they could also displace many traditional driving jobs, such as taxi drivers and delivery drivers. This could have significant economic and societal implications that require careful consideration.

5.9.14 The Role of Government and Regulation

Government and regulatory bodies play a pivotal role in the development and deployment of robotaxis. Clear and consistent regulation is needed to ensure these vehicles operate safely and reliably. Furthermore, a level regulatory playing field would facilitate healthy competition within the industry, fostering innovation and technological advancements.

Regulatory frameworks should also address the ethical and societal concerns raised by robotaxis. For instance, regulations could guide the industry on how to handle liability in the event of accidents, how to safeguard consumer data, and how to manage the transition period where both OEMs and suppliers have the time to adapt their SW development processes for a systems-engineering based SW development approach, and best use automation in their process quality.

5.9.15 Insights from Industry Leaders, their vision for the Future

Despite the numerous challenges highlighted, managers from several automotive companies remain hopeful for the future of robotaxis. These professionals share a common vision - that robotaxis will one day become a typical feature on roads worldwide. This belief is driven by a clear recognition of the substantial benefits these autonomous vehicles could bring, as well as the technological advancements made in recent years.

5.9.16 Active Engagement in Development

Moreover, these industry managers are not mere observers in the development and deployment of robotaxis. Many of their companies are investing substantial resources into research and development (R&D) for these vehicles, affirming their belief in the potential of this innovative technology. This active involvement in R&D demonstrates a commitment to overcoming existing challenges and making robotaxis a reality.

5.9.17 Advocacy for Governmental Support

Automotive managers also emphasise the crucial role of governments and regulatory bodies in the evolution of robotaxis. They call for transparent, comprehensive, and consistent regulations that would provide an equitable operating environment for all industry players. Furthermore, they urge the government to aid in infrastructure development to accelerate the adoption of robotaxis.

5.9.18 Addressing Societal Concerns

Industry leaders are cognisant of the societal concerns surrounding robotaxis, particularly in terms of job displacement. While acknowledging these valid concerns, they advocate for a balanced approach. They highlight the creation of new job opportunities in the maintenance and control of robotaxis, as well as in related industries such as data analytics and cybersecurity. Simultaneously, they stress the need for proactive societal measures, such as retraining and upskilling programs for individuals who may be affected by this shift towards automation.

5.10 Discussion on Hypothesis 3

Hypothesis 3: Utilizing big data and implementing measures such as blockchain-based cybersecurity can enhance the productivity of autonomous driving functions business case creation, optimise robotaxi services, and support the digital transformation of a Tier-2 company's enterprise architecture and product management processes."

The study's findings underscore the potential of big data in transforming autonomous driving business cases. The vast amount of data generated by autonomous vehicles, when analysed and interpreted correctly, can provide valuable insights into optimizing driving functions and creating robust business cases. This aligns with the broader trend of digital transformation, where data-driven decision-making is becoming increasingly crucial in shaping business strategies and operations.

The role of blockchain technology in enhancing cybersecurity measures within this context is also noteworthy. The decentralized nature of blockchain technology offers heightened security, making it a promising solution for protecting the vast amounts of data generated by autonomous vehicles. This is particularly relevant given the increasing concerns about cybersecurity in the era of digital transformation.

Moreover, the potential of blockchain technology in optimizing robotaxi services was explored. The study found that blockchain could streamline transactions, increase transparency, and potentially enable the development of innovative services, such as decentralized platforms for matching riders with drivers and the use of smart contracts.

The research also highlighted the potential of these technologies in supporting the digital transformation of Tier-2 companies' enterprise architecture and product management processes. The integration of big data analytics and blockchain technology could lead to more efficient and secure processes, thereby enhancing productivity and competitiveness.

However, the study also pointed out the challenges and considerations in implementing these technologies. These include ethical implications related to privacy and data ownership, the need for regulatory frameworks and skilled personnel, and the issue of interoperability between blockchain systems and existing non-blockchain systems.

In conclusion, while the utilization of big data and the implementation of blockchain-based cybersecurity measures hold significant potential in enhancing the productivity of autonomous driving functions business case creation, optimizing robotaxi services, and supporting the digital transformation of a Tier-2 company's enterprise architecture and product management processes, careful consideration must be given to the associated challenges and implications. Future research should continue to explore these areas, with a particular focus on addressing the identified challenges and considerations.

5.11 Conclusion: Prospects and Directions

In conclusion, while robotaxis hold enormous potential for enhancing safety, efficiency, and accessibility, their widespread implementation is hindered by substantial challenges. Key among these are financial hurdles, regulatory complexities, reliability and security issues, and societal implications. However, industry managers remain optimistic, buoyed by the progress made in autonomous vehicle technology and the transformative impact robotaxis could have on transportation. They urge governments to play a proactive role, emphasizing the need for a supportive regulatory framework and the provision of necessary infrastructure.

To fully harness the potential of robotaxis, a multifaceted approach is required, combining technological innovation, regulatory support, financial investment, and societal measures. While this road may be fraught with challenges, the destination—a world where safe, efficient, and accessible robotaxis are the norm—promises significant benefits for all members of society. As industry leaders continue to innovate and drive progress in this field, we may inch closer to this vision, marking a new era in transportation and mobility.

5.12 Conclusion on how managers viewed the system's usability:

Overall, managers at automotive companies see robotaxis as a promising technology with the potential to revolutionise transportation. While there are many challenges and uncertainties surrounding these vehicles, they also see many opportunities for improving safety, efficiency, and accessibility. To realise these benefits, however, it will be important for the industry to address the various challenges associated with implementing robotaxis, and for governments to provide clear and consistent regulations that support the safe and reliable deployment of these vehicles.

5.13 Overall Conclusion

Trusting AI algorithms requires a well-designed combination approach comprised of intentional data curation continuum and ongoing monitoring processes alongside transparent algorithm use significantly in TIER 2 enterprises' ecosystem leveraging Blockchain technology potential features readjustments within their system engineering framework. The fact that Blockchain can enable a firm's regulatory reporting standards implementation via its decentralisation distribution governance makes it indispensable in maintaining utmost operational security hence reducing fraudulent activities or human errors making core business transaction reporting more transparent simultaneously improving reliability levels across departments enabling different stakeholders consummate information access held on a secure database platform smart contract inclusion also facilitates automation allowing fluidity amid complex processes reducing the requirement for intermediaries ultimately driving efficiency. For instance, by using smart contracts, it will automate payment procedures during invoicing and tracking resulting in reduced workloads for administrators. Furthermore, through blockchain systems engineering development, tier 2 companies can construct progressively decentralised project management platforms enhancing real-time visibility into completed projects allowing parties involved to alter their input towards a common goal such as project timelines with specific task allocation automating resource allocation seamlessly once more boosting efficiency levels, and broadening scope on blockchain technology immense digital representation potential underpinning tier 2 industry digital migration stirring robust pace of innovation possibilities.

CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

Blockchain technology has the potential to revolutionise the way we think about and use digital systems in a variety of industries, including systems engineering. In particular, it has the potential to support the digitalisation of a Tier-2 company's systems engineering architecture in several keyways.

First and foremost, one major benefit of using blockchain to support the digitalisation of a Tier-2 company's systems engineering architecture is increased security and transparency. With traditional digital systems, it can be difficult to track and verify the authenticity of transactions and data. This can lead to issues such as fraud and errors in record-keeping. However, by using a decentralised, distributed ledger, blockchain technology allows for a secure and transparent record of all transactions and data related to the company's systems engineering processes. This can help to reduce the risk of fraud and errors and increase confidence in the accuracy and reliability of the information being recorded.

Another advantage of using blockchain to support the digitalisation of a Tier-2 company's systems engineering architecture is improved efficiency. Traditional digital systems can be complex and time-consuming to manage, as they often require multiple intermediaries to facilitate transactions. By using blockchain, the company can streamline its systems engineering processes and reduce the need for intermediaries, leading to faster and more efficient processes.

In addition, blockchain technology has the potential to facilitate the development of new and innovative systems engineering solutions. For example, it could be used to create a decentralized platform for tracking and verifying the authenticity of parts and components used in the company's systems. It could also be used to enable the use of smart contracts, which could automatically facilitate transactions and payments based on predetermined conditions related to the company's systems engineering processes.

Overall, the use of blockchain technology has the potential to greatly enhance the digitalisation of a Tier-2 company's systems engineering architecture, by increasing security and transparency, improving efficiency, and enabling the development of new and innovative solutions. As such, it is an exciting area for further exploration and development.

6.2 Implications

Embracing blockchain technology as a support for the digitalisation of Tier-2 companies carries with it an array of implications worth exploring. Here are some examples:

One significant benefit is heightened transparency alongside strengthened security through decentralisation that negates the chances of fraud or mishaps as data is securely recorded on the distributed ledger system.

Moreover, opting for such disruptive tech enhances operational efficiency thanks to its capacity to simplify complex processes without requiring intermediaries while allowing robust customisation options into stand-out services.

Another win would come in bolstered control over private data that decentralisation provides for secure storage thus stemming cases of unauthorised access dreaded under traditional digital systems while potentially saving much-needed cost from reduced reliance on intermediaries.

It is essential though that decision-makers comprehensively weigh both benefits against anticipated cost implications before settling on implementing these type-casting systems.

Moving forward with research endeavours may perhaps begin at identifying possible problem areas within current Tier-2 companies' digital systems, with an aim to disentangle processes via blockchain-powered automation and elimination of intermediaries. To determine if it would be feasible, implementing a blockchain-based digital system for our company requires a thorough evaluation.

Conducting an analysis of the costs versus benefits would indicate if investing could yield high returns, but challenges that may come with its adoption must still be considered effectively to avoid setbacks. Searching through various platforms and technologies available for many options can lead us closer to what fits best into our business model while providing scalability, security, and interoperability with other systems simultaneously.

With better understanding comes room for innovation which is where we explore use cases that Blockchain technology might have within our organisation that we have not yet tapped into, identifying new directions we can take towards growth by finding ways it could address underlying issues when working collaboratively amongst our stakeholders responsible for different departments.

Conducting pilot studies by creating prototypes and then testing them out first must go hand-in-hand to evaluate both effectiveness data metrics while gathering qualitative feedback from engaged stakeholders. With Blockchain technology's numerous advantages, it will undoubtedly be useful in supporting our Tier-2 company's systems engineering architecture through versatility and transformation in many innovative ways. Firstly, blockchain can be used to enhance the security of digital systems within the company. Because it uses a decentralised ledger system, blockchain can provide a secure, tamper-proof record of transactions and data. This can be particularly useful in the field of cybersecurity, where the protection of sensitive data is of the utmost importance.

Secondly, blockchain can be used to streamline and automate various processes within the company. For example, the use of smart contracts can allow for the automatic execution of certain tasks or agreements when certain conditions are met. This can save time and reduce the risk of errors in manual processes.

Thirdly, blockchain can enable the creation of a more transparent and accountable system for the management of resources within the company. For example, it can be used to track the flow of materials or assets within the supply chain or to verify the authenticity of certifications or qualifications.

To enhance the productivity of autonomous driving functions business case creation, especially in dynamic environments, several measures may need to be implemented using a blockchain-based digitalised development process for cybersecurity software.

It may be necessary to establish clear protocols for the exchange of data between autonomous vehicles and other systems. This can ensure that relevant data is consistently and accurately captured, and that data privacy is protected. As well as to implement robust cybersecurity measures to protect against cyber threats and vulnerabilities. This can include the use of secure communication protocols, encryption, and regular automated checks.

6.3 Final Research Conclusion

The study used a combination of qualitative research methods, including semi-structured interviews and questionnaires, to gather data from employees of an acquired company. The interviews served as the primary source of information, while the questionnaires were used to supplement any potential missing information. Detailed steps and procedures for data collection and analysis were outlined, including the use of specific coding techniques from the work of Zueva-Owens et al. (2012) to interpret the interview transcripts, and resulting findings. The limitations and delimitations of the study were also discussed, and trustworthiness was ensured through the use of triangulation for data validation.

This research focused on the digital transformation of autonomous driving business cases. It was guided by three research questions and objectives, which seek to investigate various issues concerning the study, such as how autonomous driving influences peoples' mobility and car purchase decisions as a business case example. In addition, this study seeks to recommend how the transport industry could be optimised by using digital transformation to overcome issues such as disruptions in business cases, such as ridesharing. The objectives of this research were met by using case studies to determine the most relevant information regarding the problem statement, as well as interviews with managers at Tier-2s and potential customers. While the results of this study expected that digital transformation of autonomous driving business cases may improve general transport productivity in terms of traffic and personalised user services, it is also expected that cybersecurity issues would affect the realisation of the set objectives. In this regard, user safety, security, and general perception of autonomous technology may be key to determining the level of automation within the transport industry. This study was conducted within 14 months. Through the literature review, the proposal has explored how different trends have come up in the automotive industry at OEMs and Tier-1s to increase customer experience. While embracing technological developments increases companies' competitiveness, such advancements change operating models and businesses, making them reliable, effective, and more agile. The proposal has established that digital technologies are the current drivers of the automotive industry, and this is also crucial for Tier-2s. Some of them play a great relevance in the industry and have been able to support the introduction of autonomous systems. With such development, the industry is headed, for now, that architecture keeps on evolving each day. For such reasons, it is necessary to research how new technologies may help flourish and support or thrive their digitalisation.

Blockchain technology has the potential to revolutionise the way we think about and use share-riding services. One keyway that it can do this is by supporting the digitalisation of these services.

Blockchain is proving increasingly valuable in the digitalisation process surrounding share riding services for several reasons. Primarily, security is heightened with this approach due to its effective ability to track every transaction made with complete accuracy regardless of how complex or varied they are. This achieves a far more transparent landscape than in traditional digital systems where it is common for authenticity to become unclear often leading to errors in record-keeping or even fraud as hackers may exploit loopholes generated via intermediary parties involved in managing transactions. Blockchain's decentralised distribution ledger prevents this from happening by securing all data closely related within each distinct service record creating an indelible footprint that substantially increases confidence in its legitimacy.
Secondly, blockchain streamlines the transaction process within sharing services thereby boosting productivity & reducing expenses otherwise incurred under less effective traditional systems featuring numerous intermediaries coexisting under various

regulations & liabilities for enforcing said regulations. In addition, blockchain technology has the potential to facilitate the development of new and innovative share-riding services. For example, it could be used to create a decentralised platform for matching riders with drivers, allowing for greater flexibility and customisation of services. It could also be used to enable the use of smart contracts, which could automatically facilitate transactions and payments based on predetermined conditions.

The implementation of blockchain technology has the potential to revolutionise the quality assurance field.

However, it is important to consider the ethical implications that come hand in hand-with this technology. While blockchain could improve transparency and efficiency it may also lead to concerns related to privacy and data ownership. Data stored on a blockchain is immutable meaning once it has been recorded it cannot be changed or removed. This lack of flexibility can create problems in situations where data removal or alteration becomes necessary for legal or ethical reasons. As such a thoughtful approach towards the ethical implications of blockchain-based quality assurance systems is required.

Future research should explore these ethical and privacy considerations further.

Realizing the potential benefits of blockchain technology will require not only appropriate infrastructure but also regulatory frameworks, skilled personnel, and supportive end users. For instance, initiatives aimed at educating professionals about blockchain technology are likely to play a critical role in fostering its adoption. In addition, economic implications must be fully understood before deciding whether such systems are viable for small to medium-sized enterprises.

Lastly, interoperability between blockchain systems and existing non-blockchain systems requires further exploration. Investigating how different organisations could use blockchains with their various existing technologies will ultimately increase their flexibility while providing enhanced efficiency and security benefits. To ensure smooth operational flow across organisations using different blockchain platforms; their ability to communicate with one another is of utmost importance.

Beyond this challenge lies the need for integrating non-blockchain systems since not all existing systems will be replaced by this disruptive technology (Clack et al., 2016). Blockchain isn't just another addition but holds enormous potential towards transforming our process quality assurance landscape. However, having a critical eye when assessing implementation barriers including ethical considerations is necessary alongside interoperability issues that may arise. Blockchain evolution must be adequately followed by both research and businesses, so they'd gain an advantage without being hindered by any arising problem(s). While recognising that it doesn't cover every quality assurance challenges, well-harnessed blockchain will bring significant improvement.

Overall, the use of blockchain technology has the potential to greatly enhance the digitalisation of share riding services, by increasing security and transparency, improving efficiency, and enabling the development of new and innovative services. As such, it is an exciting area for further exploration and development.

6.4 Suggested Future Research

This research focused on the digital transformation of autonomous driving business cases. It was guided by three research questions and objectives, which seek to investigate various issues concerning the study, such as how autonomous driving influences peoples' mobility and car purchase decisions as a business case example. In addition, this study seeks to recommend how the transport industry could be optimised by using digital transformation to overcome issues such as disruptions in business cases, such as ridesharing. The objectives of this research were met by using case studies to determine the most relevant information regarding the problem statement, as well as interviews with managers at Tier-2s and potential customers. While the results of this study expected that digital transformation of autonomous driving business cases may improve general transport productivity in terms of traffic and personalised user services, it is also expected that cybersecurity issues would affect the realisation of the set objectives. In this regard, user safety, security, and general perception of autonomous technology may be key to determining the level of automation within the transport industry.

This study was conducted within 14 months. Through the literature review, the proposal has explored how different trends have come up in the automotive industry at OEMs and Tier-1s to increase customer experience. While embracing technological developments increases companies' competitiveness, such advancements change operating models and businesses, making them reliable, effective, and more agile. The proposal has established that digital technologies are the current drivers of the automotive industry, and this is also crucial for Tier-2s. Some of them play a great relevance in the industry and have been able to support the introduction of autonomous systems. With such development, the industry is headed, for now, that architecture keeps on evolving each day. For such reasons, it is necessary to research how new technologies may help flourish and support or thrive their digitalisation.

Blockchain technology has the potential to revolutionise the way we think about and use share-riding services. One keyway that it can do this is by supporting the digitalisation of these services.

Blockchain is proving increasingly valuable in the digitalisation process surrounding share riding services for several reasons. Primarily, security is heightened with this approach due to its effective ability to track every transaction made with complete accuracy regardless of how complex or varied they are. This achieves a far more transparent landscape than in traditional digital systems where it is common for authenticity to become unclear often leading to errors in record-keeping or even fraud as hackers may exploit loopholes generated via intermediary parties involved in managing transactions. Blockchain's decentralised distribution ledger prevents this from happening by securing all data closely related within each distinct service record creating an indelible footprint that substantially increases confidence in its legitimacy.
Secondly, blockchain streamlines the transaction process within sharing services thereby boosting productivity & reducing expenses otherwise incurred under less effective traditional systems featuring numerous intermediaries coexisting under various regulations & liabilities for enforcing said regulations. In addition, blockchain technology has the potential to facilitate the development of new and innovative share-riding services. For example, it could be used to create a decentralised platform for matching riders with drivers, allowing for greater flexibility and customisation of services. It could also be used to enable the use of smart contracts, which could automatically facilitate transactions and payments based on predetermined conditions.
The implementation of blockchain technology has the potential to revolutionise the quality assurance field.

However, it is important to consider the ethical implications that come hand in hand with this technology. While blockchain could improve transparency and efficiency it may also lead to concerns related to privacy and data ownership. Data stored on a blockchain is immutable meaning once it has been recorded it cannot be changed or removed. This lack of flexibility can create problems in situations where data removal or alteration becomes necessary for legal or ethical reasons. As such a thoughtful approach towards the ethical implications of blockchain-based quality assurance systems is required.

Future research should explore these ethical and privacy considerations further.

Realizing the potential benefits of blockchain technology will require not only appropriate infrastructure but also regulatory frameworks, skilled personnel, and supportive end users. For instance, initiatives aimed at educating professionals about blockchain technology are likely to play a critical role in fostering its adoption. In addition, economic implications must be fully understood before deciding whether such systems are viable for small to medium-sized enterprises.

Lastly, interoperability between blockchain systems and existing non-blockchain systems requires further exploration. Investigating how different organisations could use blockchains with their various existing technologies will ultimately increase their flexibility while providing enhanced efficiency and security benefits. To ensure smooth operational flow across organisations using different blockchain platforms; their ability to communicate with one another is of utmost importance.

Beyond this challenge lies the need for integrating non-blockchain systems since not all existing systems will be replaced by this disruptive technology (Clack et al., 2016). Blockchain isn't just another addition but holds enormous potential towards transforming our process quality assurance landscape. However, having a critical eye when assessing implementation barriers including ethical considerations is necessary alongside interoperability issues that may arise. Blockchain evolution must be adequately followed by both research and businesses, so they'd gain an advantage without being hindered by any arising problem(s). While recognising that it doesn't cover every quality assurance challenge, well-harnessed blockchain will bring significant improvement.

Overall, the use of blockchain technology has the potential to greatly enhance the digitalisation of share riding services, by increasing security and transparency, improving efficiency, and enabling the development of new and innovative services. As such, it is an exciting area for further exploration and development.

REFERENCES

Abraham, H., Seppelt, B., Mehler, B., & Reimer, B. (2017, September). What's in a name: Vehicle technology branding & consumer expectations for automation. In Proceedings of the 9th international conference on automotive user interfaces and interactive vehicular applications (pp. 226-234).

Arndt, W. H., Drews, F., Hertel, M., Langer, V., & Wiedenhöft, E. (2019). Integration of shared mobility approaches in Sustainable Urban Mobility Planning. Topic guide.

Arseven, I. (2018). The use of qualitative case studies as an experiential teaching method in the training of pre-service teachers. International Journal of Higher Education, 7(1), 111-125.

Al Najada, H., & Mahgoub, I. (2016). Autonomous vehicle's safe-optimal trajectory selection based on big data analysis and predefined user preferences. In (Eds.) 2016 IEEE 7th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) (pp. 1-6). IEEE.

Almeaibed, S., Al-Rubaye, S., Tsourdos, A., & Avdelidis, N. P. (2021). Digital twin analysis to promote safety and security in autonomous vehicles. IEEE Communications Standards Magazine, 5(1), 40-46.

Alvarez-Coello, D., Wilms, D., Bekan, A., & Gómez, J. M. (2021). Towards a data-centric architecture in the automotive industry. Procedia Computer Science, 181, 658-663.

Amini, S., Gerostathopoulos, I., & Prehofer, C. (2017). Big data analytics architecture for real-time traffic control. In 2017 5th IEEE international conference on models and technologies for intelligent transportation systems (MT-ITS) (pp. 710-715). IEEE.

Analytics, M. (2016). The age of analytics: Competing in a data-driven world. Technical report. McKinsey & Company.

Alauthaman, M., Aslam, N., Zhang, L., Alasem, R., & Hossain, M. A. (2018). A P2P botnet detection scheme based on decision tree and adaptive multilayer neural networks. Neural Computing. Appl., 29, 991–1004.

Alcaraz, C., Rubio, J. E., & Lopez, J. (2020). Blockchain-assisted access for federated Smart Grid domains: coupling and features. J. Parallel Distr. Computing, 144, 124-135.

Aliata, V. L., Ojera, P. B., & Mise, J. K. (2016). Relationship between Service Quality and Customer Satisfaction of Commercial Bank Customers, Nairobi Kenya. IJARS International Journal of Management and Corporate Affairs, 2(5). https://doi.org/10.20908/ijarsijmca.v2i5.6715

Alladi, T., Chamola, V., Parizi, R., & Choo, K. R. (2019). Blockchain Applications for Industry 4.0 and Industrial IoT: A Review. IEEE Access. PP. 1-1. 10.1109/ACCESS.2019.2956748.

Anjum, H. F., Rasid, S. Z. A., Khalid, H., Alam, M. M., Daud, S.M., Abas, H., Yusof, M. F. (2020). Mapping research trends of blockchain technology in healthcare. IEEE Access, 8, pp. 174244-174254

Anjum, H.F., Rasid, S.Z., Khalid, H., Alam, M.M., Daud, S.M., Abas, H., Sam, S.M., & Yusof, M.F. (2020). Mapping research trends of blockchain technology in healthcare. IEEE Access, 8, 174244-174254.

Androulaki, E., Barger, A., Bortnikov, V., Cachin, C., Christidis, K., De Caro, A., Enyeart, D., Ferris, C., Laventman, G., Manevich, Y., Muralidharan, S., Murthy, C., Nguyen, B., Sethi, M., Singh, G., Smith, K., Sorniotti, A., Stathakopoulou, C., Vukolic, M., Cocco, S. W., & Yellick, J. (2018). Hyperledger fabric: a distributed operating system for permissioned blockchains. In Proceedings of the Thirteenth EuroSys Conference, p. 30.

Babar, Z. and Yu, E., 2015, June. Enterprise architecture in the age of digital transformation. In: International conference on advanced information systems engineering. Springer, Cham, pp. 438-443.

Baldini, G., Barboni, M., Bono, F., Delipetrev, B., Duch Brown, N., Fernandez Macias, E., & Nepelski, D. (2019). Digital transformation in transport, construction, energy, government, and public administration. Technical Report. Joint Research Centre (Seville site).

Banks, V. A., & Stanton, N. A. (2019). Analysis of driver roles: Modelling the changing role of the driver in automated driving systems using EAST. Theoretical Issues in Ergonomics Science, 20(3), 284-300.

Becker, F., & Axhausen, K. W. (2017). Literature review on surveys investigating the acceptance of automated vehicles. Transportation, 44(6), 1293-1306.

Behrendt, F. (2016). Why cycling matters for smart cities. Internet of bicycles for intelligent transport. Journal of Transport Geography, 56, 157-164.

Bissell, D., Birtchnell, T., Elliott, A., & Hsu, E. L. (2020). Autonomous automobilities: The social impacts of driverless vehicles. Current Sociology, 68(1), 116-134.

Bilgeri, D., Wortmann, F. and Fleisch, E., 2017. How digital transformation affects large manufacturing companies' organization. International Conference on Information Systems.

Ben-Sasson, E., Chiesa, A., Garman, C., Green, M., Miers, I., Tromer, E., & Virza, M. 2014. Proceedings – IEEE Symposium on Security and Privacy. Zerocash: Decentralized Anonymous Payments from Bitcoin (IEEESan Jose, 2014), pp. 459–474.

Boucher, P. (2017). How blockchain technology could change our lives. European Parliamentary Research Service, (EPRS).

Boukis, A. (2019). Exploring the implications of blockchain technology for brand-consumer relationships: A future research agenda. Journal of Product & Brand Management. 10.1108/JPBM-03-2018-1780.

Çağlıyangil, M., Erdem, S., & Özdağoğlu, G. (2020). A blockchain based framework for blood distribution Digital Business Strategies in Blockchain Ecosystems. Springer, Cham, 63-82.

Casino, F., Dasaklis, T. K., & Patsakis, C. (2018). A systematic literature review of blockchain-based applications: current status, classification, and open issues. Telemat. Informatics. 36, 55–81.

Carlan, V., Sys, C., Vanelslander, T., & Roumboutsos, A. (2017). Digital innovation in the port sector: Barriers and facilitators. Competition and Regulation in Network Industries, 18(1-2), 71-93.

Chanias, S., & Hess, T. (2016). Understanding digital transformation strategy formation: insights from Europe's automotive industry. PACIS, 296.

Chinoracký, R., & Čorejová, T. (2019). Impact of digital technologies on labor market and the transport sector. Transportation Research Procedia, 40, 994-1001.

Clements, L. M., & Kockelman, K. M. (2017). Economic effects of automated vehicles. Transportation Research Record, 2606(1), 106-114.

Cobos, L.P., Ruddle, A.R. and Sabaliauskaite, G., 2021. Requirements for a cybersecurity case approach for the assurance of future connected and automated vehicles. In VEHITS (pp. 626-633).

Cohen, T., & Cavoli, C. (2019). Automated vehicles: Exploring possible consequences of government (non) intervention for congestion and accessibility. Transport Reviews, 39(1), 129-151.

Congressional Research Service. (2017). Issues in Autonomous Vehicle Testing and Deployment.

National Highway Traffic Safety Administration. (n.d.). Automated Vehicles for Safety.

Cunneen, M., Mullins, M., & Murphy, F. (2019). Autonomous vehicles and embedded artificial intelligence: The challenges of framing machine driving decisions. Applied Artificial Intelligence, 33(8), 706-731.

Candelo, E., 2019. Innovation and digital transformation in the automotive industry. In: Marketing innovations in the automotive industry. Springer, Cham, pp. 155-173.

Chanias, S. and Hess, T., 2016. Understanding digital transformation strategy formation: insights from Europe's automotive industry. PACIS, 296.

de Freitas, I.C.H., Loures, E.D.F.R., Deschamps, F. and Cestari, J.M.A.P., 2019, July. Enterprise architecture requirements for digital transformation projects in an automotive industry. In: International joint conference on industrial engineering and operations management. Springer, Cham, pp. 293-301.

Candelo, E. (2019). Innovation and digital transformation in the automotive industry. In E. Candelo (Eds.) Marketing innovations in the automotive industry (pp. 155-173). Springer.

Chanias, S., & Hess, T. (2016). Understanding digital transformation strategy formation: Insights from Europe's automotive industry. In (Eds.) Proceeding for PACIS.

Chen, B., Yang, Z., Huang, S., Du, X., Cui, Z., Bhimani, J., Xie, X., & Mi, N.. (2017). Cyber-physical system enabled nearby traffic flow modelling for autonomous vehicles.

In 2017 IEEE 36th International Performance Computing and Communications Conference (IPCCC) (pp. 1-6). IEEE.

Corcoran, P., & Datta, S. K. (2016). Mobile-edge computing and the internet of things for consumers: Extending cloud computing and services to the edge of the network. IEEE Consumer Electronics Magazine, 5(4), 73-74.

Correani, A., De Massis, A., Frattini, F., Petruzzelli, A. M., & Natalicchio, A. (2020). Implementing a digital strategy: Learning from the experience of three digital transformation projects. California Management Review, 62(4), 37-56.

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond Bitcoin. Applied Innovation, 2(71), 1-10.

Chartier-Rueg, T. C., and Zweifel, T. D. (2017). Blockchain, leadership and management: business as usual or radical disruption. EUREKA Soc. Humanit. 4, 76–110. doi: 10.21303/2504-5571.2017.00370

Christodoulou, P., Christodoulou, K., & Andreou, A. (2018). A decentralised application for logistics: using blockchain in real-world applications. Cyprus Rev., 30(2), 181-193.

Clohessy, T., Acton, T., & Rogers, N. (2019). Blockchain adoption: technological, organisational, and environmental considerations. In Business Transformation through Blockchain, Vol. I, eds H. Treiblmaier and R. Beck (Cham: Springer International Publishing), 47–76. doi: 10.1007/978-3-319-98911-2_2

Croman, K., Decker, C., Eyal, I., Gencer, A. E., Juels, A., Kosba, A., Miller, A., Saxena, P., Shi, E., Gün Sirer, E., Song, D., & Wattenhofer, R. (2016); in International Conference on Financial Cryptography and Data Security. On Scaling Decentralized Blockchains (Springer Christ Church, 2016), 106–125

Devarajan, Y. (2018). A study of robotic process automation use cases today for tomorrow's business. International Journal of Computer Techniques, 5(6), 12-18.

Ghose, A. (2018). What blockchain could mean for marketing. Harv. Bus. Rev. 2–5.

Glaser, F. (2017). Pervasive decentralization of digital infrastructures: a framework for blockchain enabled system and use case analysis. In Bui, T. (ed.) Proceedings of the 50th Hawaii International Conference on System Sciences.

Dremel, C., Wulf, J., Herterich, M.M., Waizmann, J.C. and Brenner, W., 2017. How AUDI AG established big data analytics in its digital transformation. MIS Quarterly Executive, 16(2).

Daniel, A., Subburathinam, K., Paul, A., Rajkumar, N., & Rho, S. (2017). Big autonomous vehicular data classifications: Towards procuring intelligence in ITS. Vehicular Communications, 9, 306-312.

Darwish, T. S., & Bakar, K. A. (2018). Fog based intelligent transportation big data analytics in the internet of vehicles environment: Motivations, architecture, challenges, and critical issues. IEEE Access, 6, 15679-15701.

Dixit, V. V., Chand, S., & Nair, D. J. (2016). Autonomous vehicles: Disengagements, accidents, and reaction times. PLoS One, 11(12), 1-14.

Digiconomist. (2021). Bitcoin energy consumption index. https://digiconomist.net/bitcoin-energy-consumption

Ebert, C., & Duarte, C. H. C. (2018). Digital transformation. IEEE Software, 35(4), 16-21.

Ertemel, A. V. (2018). Implications of blockchain technology on marketing. J. Int. Trade Logist. Law 4, 35–44. http://jital.org/index.php/jital/article/view/98/pdf_61

Eyal, I., & Sirer, E. G. (2014). Financial Cryptography and Data Security, 18th International Conference, FC 2014, Christ Church, Barbados, March 3-7, 2014, Revised Selected Papers, ed. by N. Christin, R. Safavi-Naini. Majority Is Not Enough: Bitcoin Mining Is Vulnerable (SpringerBerlin Heidelberg, 2014), 436–454.

Faisal, A., Kamruzzaman, M., Yigitcanlar, T., & Currie, G. (2019). Understanding autonomous vehicles. Journal of Transport and Land Use, 12(1), 45-72.

Fatah, S., & Ali, B. (2018). The impact of Marketing Strategy on Customer Satisfaction for E-learning: A Marketing strategies Model Approach. International Journal of Computer Science and Information Security, 16(10), 95-102.

Felix, R. (2017). Service Quality and Customer Satisfaction in Selected Banks in Rwanda. Journal of Business & Financial Affairs, Economics and Management, 1(2), 9-15.

Fosso Wamba, S., Kamdjoug, J. R. K., Bawack, R. E., and Keogh, J. G. (2020). Bitcoin, blockchain and fintech: a systematic review and case studies in the supply chain. Prod. Plan. Control, 31, 115–142.

Friedlmaier, M., Tumasjan, A., & Welpe, I. M. (2018). Disrupting industries with blockchain: the industry, venture capital funding, and regional distribution of blockchain ventures. In Proceedings of the 51st Hawaii International Conference on System Sciences.

Genzorova, T., Corejova, T., & Stalmasekova, N. (2019). How digital transformation can influence business model, Case study for transport industry. Transportation Research Procedia, 40, 1053-1058.

Gold, C., Körber, M., Lechner, D., & Bengler, K. (2016). Taking over control from highly automated vehicles in complex traffic situations: the role of traffic density. Human Factors, 58(4), 642-652.

Gunasekaran, A., Yusuf, Y. Y., Adeleye, E. O., & Papadopoulos, T. (2018). Agile manufacturing practices: The role of big data and business analytics with multiple case studies. International Journal of Production Research, 56(1-2), 385-397.

Gupta, S. (2018). Driving digital strategy: A guide to reimagining oner business. Harvard Business Press.

Gurbaxani, V., & Dunkle, D. (2019). Gearing up for successful digital transformation. MIS Quarterly Executive, 18(3).

Gurumurthy, K. M., Kockelman, K. M., & Simoni, M. D. (2019). Benefits and costs of ride-sharing in shared automated vehicles across Austin, Texas: Opportunities for congestion pricing. Transportation Research Record, 2673(6), 548-556.

Graham, G., Burns, L. and Hennelly, P., 2019. Digital transformation in the automotive supply chain. https://doi.org/10.17863/CAM.45895.

Grieger, M. and Ludwig, A., 2019. On the move towards customer-centric business models in the automotive industry-a conceptual reference framework of shared automotive service systems. Electronic Markets, 29(3), pp. 473-500.

Grieger, M., & Ludwig, A. (2019). On the move towards customer-centric business models in the automotive industry-A conceptual reference framework of shared automotive service systems. Electronic Markets, 29(3), 473-500.

Gružauskas, V., Baskutis, S., & Navickas, V. (2018). Minimizing the trade-off between sustainability and cost effective performance by using autonomous vehicles. Journal of Cleaner Production, 184, 709-717.

Guerra, E. (2016). Planning for cars that drive themselves: Metropolitan planning organizations, regional transportation plans, and autonomous vehicles. Journal of Planning Education and Research, 36(2), 210-224.

Hanelt, A., Piccinini, E., Gregory, R. W., Hildebrandt, B., & Kolbe, L. M. (2015, March). Digital transformation of primarily physical industries-exploring the impact of digital trends on business models of automobile manufacturers. In Wirtschaftsinformatik (pp. 1313-1327).

Heilig, L., Schwarze, S., & Voß, S. (2017). An analysis of digital transformation in the history and future of modern ports. https://aisel.aisnet.org/hicss-50/da/decision_support_for_scm/2/

Hensher, D. A. (2017). Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: Are they likely to change? Transportation Research Part A: Policy and Practice, 98, 86-96.

Hanelt, A., Piccinini, E., Gregory, R.W., Hildebrandt, B., and Kolbe, L.M., 2015, March. Digital transformation of primarily physical industries-exploring the impact of digital trends on business models of automobile manufacturers. Wirtschaftsinformatik, pp. 1313-1327.

Hars, A., 2015. Self-driving cars: the digital transformation of mobility. In: Marktplätze im Umbruch. Springer Vieweg, Berlin, Heidelberg, pp. 539-549.

Haq, IN. (2018). Determination of price and customer satisfaction. Journal of Economicate Studies, 1, 97-108.

Hartmann, S., & Thomas, S. (2020). Applying blockchain to the Australian carbon market Economic paper. A Journal of Applied Economics and Policy, 39(2), 133-151.

Harvey, C. R., Moorman, C., & Toledo, M. (2018). How blockchain can help marketers build better relationships with their customers. Harvard Business Review.

https://hbr.org/2018/10/how-blockchain-can-help-marketers-build-better-relationships-with-their-customers

Huang, J., Kong, L., Chen, G., Wu, M.-Y., Liu, X., & Zeng, P. (2019). Towards secure industrial IoT: Blockchain system with credit-based consensus mechanism. IEEE Trans. Ind. Informatics., 15(6), 3680–3689.

Ilieska, K. (2013). Customer satisfaction index–as a base for strategic marketing management. TEM Journal, 2(4), 327-331.

Jović, M. A. R. I. J. A. (2019). Digital transformation of Croatian seaports. In in 32nd Bled eConference: Humanizing Technology for a Sustainable Society Conference Proceedings/Doctoral Consortium (pp. 1147-1164).

Jameel, F., Chang, Z., Huang, J., & Ristaniemi, T. (2019). Internet of autonomous vehicles: Architecture, features, and socio-technological challenges. IEEE Wireless Communications, 26(4), 21-29.

Jha, S., Banerjee, S. S., Cyriac, J., Kalbarczyk, Z. T., & Iyer, R. K. (2018). Avfi: Fault injection for autonomous vehicles. In (Eds.) 2018 48th annual IEEE/IFIP international conference on dependable systems and networks workshops (DSN-W) (pp. 55-56). IEEE.

Jung, Y., & Agulto, R. (2021). Virtual IP-based secure gatekeeper system for internet of things. Sensors, 21(1), 1-26.

Jahan, F., Sun, W., Niyaz, Q., & Alam, M. (2019). Security modeling of autonomous systems: A survey. ACM Comput. Surv, 52(5), 1–34.

Jain, M., Marasini, B., Jha, A. K., & Jasbir, P. (2019). Autonomous vehicle using various machine learning algorithms. International Journal of Scientific Research in Computer Science, Engineering, and Information Technology, 5(2), 754-760.

Jain, S., J.Ahuja, N., Pulipeti, S., Bhadane, K., Nagaiah, B., Kumar, A., & Konstantinou, C. (2021). Blockchain and Autonomous Vehicles: Recent advances and future directions. IEEE Access. Early Access, 9, 1-65.

Javaid, M., Haleem, A., Singh, R. P., Khan, S., & Suman, R. (2021). Blockchain technology applications for Industry 4.0: A literature-based review. Blockchain: Research and Applications, 4(2), 1-11.

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. Diabetes & Metabolic Syndrome, 14(4), 419–422. https://doi.org/10.1016/j.dsx.2020.04.032

Juniper Research. (2017). Ad fraud to cost advertisers $19 billion in 2018. https://www.juniperresearch.com/press/press−releases/ad−fraud−to−cost−advertisers−19-billion-in-2018

Kang, J., Lin, D., Bertino, E., & Tonguz, O. (2019). From autonomous vehicles to vehicular clouds: Challenges of management, security, and dependability. In (Eds.) 2019 IEEE 39th International Conference on Distributed Computing Systems (ICDCS) (pp. 1730-1741). IEEE.

Kashlev, A., Lu, S., & Mohan, A. (2017). Big data workflows: A reference architecture and the dataview system. Services Transactions on Big Data (STBD), 4(1), 1-19.

Knieps, G. (2019). Internet of Things, big data, and the economics of networked vehicles. Telecommunications Policy, 43(2), 171-181.

Kocić, J., Jovičić, N., & Drndarević, V. (2018). Sensors and sensor fusion in autonomous vehicles. In (Eds.) 2018 26th Telecommunications Forum (TELFOR) (pp. 420-425). IEEE.

Kumar, S., & Goel, E. (2018). Changing the world of autonomous vehicles using cloud and big data. In (Eds.) 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 368-376). IEEE.

Kroll, H., Horvat, D., & Jäger, A. (2018). Effects of automatisation and digitalisation on manufacturing companies' production efficiency and innovation performance (No. 58). Fraunhofer ISI Discussion Papers-Innovation Systems and Policy Analysis.

Krusenvik, L. (2016). Using case studies as a scientific method: Advantages and disadvantages. Halmstad University.

Kessler, T. and Buck, C., 2017. How digitization affects mobility and the business models of automotive OEMs. In: Phantom ex Machina. Springer, Cham, pp. 107-118.

Kasten, J. E. (2020). Engineering and manufacturing on the blockchain: a systematic review. IEEE Eng. Management Review, 48(1), pp. 31-47.

Khoshavi, N., Tristani, G., & Sardolzaei, A. (2021). Blockchain applications to improve operation and security of transportation systems: A survey. Electronics, 10(629), 1-44.

Knirsch, F., Unterweger, A. & Engel, D. (2019). Implementing a blockchain from scratch: Why, how, and what we learned. EURASIP J. on Info. Security 2019.

Kotler, P., & Armstrong, G. (2010). Principles of Marketing. 13th ed. Pearson Education Inc. New Jersey.

Kshetri, N. (2019). Blockchain and the Economics of Customer Satisfaction. IT Professional, 21(1), 93-97.

Lee, J., Chang, H., & Park, Y. I. (2018, August). Influencing factors on social acceptance of autonomous vehicles and policy implications. In 2018 Portland International

Conference on Management of Engineering and Technology (PICMET) (pp. 1-6). IEEE.

Llopis-Albert, C., Rubio, F. and Valero, F., 2021. Impact of digital transformation on the automotive industry. Technological Forecasting and Social Change, 162, p.120343.

Labrado, J. D., Erol, B. A., Ortiz, J., Benavidez, P., Jamshidi, M., & Champion, B. (2016). Proposed testbed for the modeling and control of a system of autonomous vehicles. In (Eds.) 2016 11th System of Systems Engineering Conference (SoSE) (pp. 1-6). IEEE.

Li, C., Luo, Q., Mao, G., Sheng, M., & Li, J. (2019). Vehicle-mounted base station for connected and autonomous vehicles: Opportunities and challenges. IEEE Wireless Communications, 26(4), 30-36.

Llopis-Albert, C., Rubio, F., & Valero, F. (2021). Impact of digital transformation on the automotive industry. Technological Forecasting and Social Change, 162, 1-10.

Marusin, A., Marusin, A., & Ablyazov, T. (2019, September). Transport infrastructure safety improvement based on digital technology implementation. In International Conference on Digital Technologies in Logistics and Infrastructure (ICDTLI 2019) (pp. 348-352). Atlantis Press.

Mavromatis, I., Tassi, A., Piechocki, R. J., & Sooriyabandara, M. (2020, May). On urban traffic flow benefits of connected and automated vehicles. In 2020 IEEE 91st Vehicular Technology Conference (VTC2020-Spring) (pp. 1-7). IEEE.

Moschko, L., Blazevic, V., & Piller, F. T. (2020). Managing digital transformation: comprehending digitalization tensions for driving disruptive change. In Academy of

Management Proceedings (Vol. 2020, No. 1, p. 17397). Briarcliff Manor, NY 10510: Academy of Management.

Manfreda, A., Ljubi, K. and Groznik, A., 2019. Autonomous vehicles in the smart city era: an empirical study of adoption factors important for millennials. International Journal of Information Management, p.102050.

Manfreda, A., Ljubi, K., & Groznik, A. (2019). Autonomous vehicles in the smart city era: An empirical study of adoption factors important for millennials. International Journal of Information Management, 58(1), 1-10.

Martínez-Díaz, M., & Soriguera, F. (2018). Autonomous vehicles: Theoretical and practical challenges. Transportation Research Procedia, 33, 275-282.

Mikalef, P., Krogstie, J., Pappas, I.O. and Pavlou, P., 2020. Exploring the relationship between big data analytics capability and competitive performance: the mediating roles of dynamic and operational capabilities. Information & Management, 57(2), p.103169.

Müller, E. and Hopf, H., 2017. Competence center for the digital transformation in small and medium-sized enterprises. Procedia Manufacturing, 11, pp.1495-1500.

Mondragon, A. E. C. Mondragon, C. E. C., & Coronado, E.S. (2018). Exploring the Applicability of Blockchain Technology to Enhance Manufacturing Supply Chains in the Composite Materials Industry. 2018 IEEE International Conference on Applied System Invention (ICASI) IEEE (2018, April), 1300-1303.

Munari, L., Ielasi, F., & Bajetta, L. (2013). Customer Satisfaction Management in Italian Banks. Qualitative Research in Financial Markets, 5(2), 139- 160.

Münsing, E., Mather, J., & Moura, S. (2017). Blockchains for decentralized optimization of energy resources in microgrid networks," in 2017 IEEE Conference on Control Technology and Applications (CCTA) (Mauna Lani, HI: IEEE), 2164–2171.

Nandico, O.F., 2016. A Framework to support digital transformation. In: Emerging trends in the evolution of service-oriented and enterprise architectures. Springer, Cham, pp. 113-138.

National Highway Traffic Safety Administration. (2017). Automated vehicle safety. From https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

Naujoks, F., Wiedemann, K., & Schömig, N. (2017, September). The importance of interruption management for usefulness and acceptance of automated driving. In Proceedings of the 9th international conference on automotive user interfaces and interactive vehicular applications (pp. 254-263).

Noble, A. M., Klauer, S. G., Doerzaph, Z. R., & Manser, M. P. (2019, November). Driver training for automated vehicle technology–knowledge, behaviors, and perceived familiarity. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 63, No. 1, pp. 2110-2114). SAGE Publications.

Nathali Silva, B., Khan, M., & Han, K. (2017). Big data analytics embedded smart city architecture for performance enhancement through real-time data processing and decision-making. Wireless Communications and Mobile Computing, 2017(1), 1-13.

Normann, O. S. (2018). Importance of human influence in systems engineering-implications for autonomous vehicles (Master's thesis, NTNU).

Narteh, B., & Kuada, J. (2014). Customer Satisfaction with Retail Banking Services in Ghana. Thunderbird International Business Review, 56(4), 353-371.

Nguyen, X., Tran, H., Phan, H., & Phan, T. (2020). Factors influencing customer satisfaction: The case of Facebook Chabot Vietnam. International Journal of Data and Network Science. 4(2), 167-178.

Nieves, J., & Diaz-Meneses, G. (2016). Antecedents and outcomes of marketing innovation: an empirical analysis in the hotel industry. Int. J. Contemp. Hosp. Management, 28, 1554–1576.

Orsato, R.J. and Wells, P., 2007. U-turn: the rise and demise of the automobile industry. Journal of Cleaner Production, 15(11-12), pp. 994-1006.

Osipova, O. (2019, September). Digital transformation of personnel management services. In International Conference on Digital Technologies in Logistics and Infrastructure (ICDTLI 2019) (pp. 317-322). Atlantis Press.

Ovchynnikova, V., Kuzmenko, A., Yusupova, T., Toropova, V., & Gontar, N. (2019). Digital transformation of innovative business processes on railway ransport. In SHS Web of Conferences (Vol. 67, p. 01009). EDP Sciences

Papa, E., & Ferreira, A. (2018). Sustainable accessibility and the implementation of automated vehicles: Identifying critical decisions. Urban Science, 2(1), 5.

Piccinini, E., Hanelt, A., Gregory, R. and Kolbe, L., 2015. Transforming industrial business: the impact of digital transformation on automotive organizations. International Conference on Information Systems.

Piccinini, E., Flores, C. K., Vieira, D., & Kolbe, L. M. (2016). The future of personal urban mobility–towards digital transformation. Wirtschaftsinformatik (MKWI), 1(1), 55-66.

Polzin, S. E. (2016). Implications to public transportation of emerging technologies. National Center for Transit Research.

Pütz, F., Murphy, F., Mullins, M., & O'Malley, L. (2019). Connected automated vehicles and insurance: Analysing future market-structure from a business ecosystem perspective. Technology in Society, 59, 101182.

Papadopoulos, G. (2015). Blockchain and digital payments: an institutionalist analysis of Cryptocurrencies," in Handbook of Digital Currency, Bitcoin, Innovation, Financial Instruments, and Big Data, ed D. L. K. Chuen (Boston, MA: Elsevier), 153–172.

Patel, K. (2021). The internet's next step: The era of digital credentials. https://www.ibm.com/blogs/blockchain/2021/12/the-internets-next-step-the-era-of-digital-credentials/

Pokhrel, S. R., & Choi, J. (2020). Federated learning with blockchain for autonomous vehicles: Analysis and design challenges. IEEE Trans. Commun., 68(8), 4734–4746.

Prasetyo, Y., Tanto, H., Mariyanto, M., Hanjaya, C., Oneng, M., Persada, S., Miraja, B., Redi, A. P. N. (2021). Factors affecting customer satisfaction & loyalty in online food delivery service during COVID-19 pandemic: It's relation with open innovation.

Roblek, V., Stok, Z. M., & Mesko, M. (2016). Complexity of a sharing economy for tourism and hospitality. In Faculty of Tourism and Hospitality Management in Opatija. Biennial International Congress. Tourism & Hospitality Industry (p. 374). University of Rijeka, Faculty of Tourism & Hospitality Management.

Riasanow, T., Galic, G. and Böhm, M., 2017. Digital transformation in the automotive industry: towards a generic value network. European Conference on Information Systems.

Riasanow, T., Jäntgen, L., Hermes, S., Böhm, M. and Krcmar, H., 2020. Core, intertwined, and ecosystem-specific clusters in platform ecosystems: analyzing similarities in the digital transformation of the automotive, blockchain, financial, insurance and IIoT industry. Electronic Markets, pp.1-16.

Roubaud, J., 2017. Why automation won't replace data scientists yet. [Online] Available at: https://cloudcomputing-news.net/news/2017/mar/28/why-automation-wont-replace-data-scientists-yet/ [Accessed 23/5/2021].

Roland Berger Strategy Consultants, 2015. The digital transformation of industry. [Online] Available at: www.rolandberger.com/publications/publication_pdf/roland_berger_digital_transformation_of _industry_20150315.pdf [Accessed 23/5/2021].

Reddig, K., Dikunow, B., & Krzykowska, K. (2018). Proposal of big data route selection methods for autonomous vehicles. Internet Technology Letters, 1(5), 1-6.

Riasanow, T., Galic, G., & Böhm, M. (2017). Digital transformation in the automotive industry: Towards a generic value network. In (Eds.) Proceedings of the 25th European Conference on Information Systems (ECIS) (pp. 3191-3201).

Russo, M., 2019. Digital transformation in the automotive supply chain: a comparative perspective. In Economic policy, crisis, and innovation. Routledge, pp. 233-249.

Rathee, G., Sharma, A., Iqbal, R., Aloqaily, M., Jaglan, N., & Kumar, R. (2019). A blockchain framework for securing connected and autonomous vehicles. Sensors, 19(14), 3165.

Rejeb, A., Keogh, G. J., & Treiblmaier, H. (2020). How Blockchain Technology Can Benefit Marketing: Six Pending Research Areas. Frontier in Blockchain, 1-13.

Rejeb, A., Keogh, J. G., and Treiblmaier, H. (2019). Leveraging the internet of things and blockchain technology in supply chain management. Future Internet 11:161. doi: 10.3390/fi11070161

Roland Berger. (2018). The blockchain bandwagon: Is it time for automotive companies to start investing seriously in blockchain?

Sen, B., Kucukvar, M., Onat, N. C., & Tatari, O. (2020). Life cycle sustainability assessment of autonomous heavy-duty trucks. Journal of Industrial Ecology, 24(1), 149-164.

Shah, S., Logiotatopouloh, I., & Menon, S. (2019). Industry 4.0 and autonomous transportation: The impacts on supply chain management. International Journal of Transportation Systems, 4.

Smetsers, E. (2016). Automated vehicles: Navigating towards a smarter future in a network of expectations (Master's thesis).

Soe, R. M., & Müür, J. (2020). Mobility acceptance factors of an automated shuttle bus last-mile service. Sustainability, 12(13), 5469.

Stalmašeková, N., Genzorová, T., Čorejová, T., & Gašperová, L. (2017). The impact of using the digital environment in transport. Procedia Engineering, 192, 231-236.

Stocker, A., & Shaheen, S. (2017). Shared automated vehicles: Review of business models. International Transport Forum Discussion Paper.

Sandengen, O.C., Estensen, L.A., Rødseth, H. and Schjølberg, P., 2016, November. High performance manufacturing: an innovative contribution towards industry 4.0. In: 6th international workshop of advanced manufacturing and automation. Atlantis Press, pp. 14-20.

Salas, E., Tannenbaum, S.I., Kraiger, K. and Smith-Jentsch, K.A., 2012. The science of training and development in organizations: what matters in practice. Psychological Science in the Public Interest, 13(2), pp. 74-101.

Siebel, T.M., 2017. Why digital transformation is now on the CEO's shoulders. McKinsey Quarterly, 4(3), pp. 1-7.

Sabah, S., Mahdi, N., & Majeed, I. (2019). The road to the blockchain technology: Concept and types. Periodicals of Engineering and Natural Sciences (PEN), 7(4), 1821-1832. 10.21533/pen.v7i4.935.

Sharma, K. T., 2020. Public vs. Private Blockchain: A comprehensive comparison. https://www.blockchain-council.org/blockchain/public-vs-private-blockchain-a-comprehensive-comparison/

Shivers, R., Rahman, M. A., & Shahriar, H. (2019). Toward a secure and decentralized blockchain-based ride-hailing platform for autonomous vehicles, 68(8), 4734–4746. [Online]. Available at: http://arxiv.org/abs/1910.00715

Schoettle, B., & Sivak, M. (2014). A survey of public opinion about autonomous and self-driving vehicles in the US, the UK, and Australia. University of Michigan Transportation Research Institute.

The Washington Post. (2020). What Self-Driving Cars Work, and When They'll Get Real.

Waymo. (n.d.). Waymo Safety Report.

Tolkachev, S. A., Morkovkin, D. E., Shcherbachenko, P. S., Gibadullin, A. A., & Bykov, A. A. (2020, December). Formation of a digital transformation system for the transport complex. In IOP Conference Series: Materials Science and Engineering (Vol. 941, No. 1, p. 012074). IOP Publishing.

Tomičić Furjan, M., Tomičić-Pupek, K., & Pihir, I. (2020). Understanding digital transformation initiatives: Case studies analysis. Business Systems Research: International Journal of the Society for Advancing Innovation and Research in Economy, 11(1), 125-141.

Trček, D. (2019). APIs and emerging economy-driving digital transformation through e-government. In SHS Web of Conferences (Vol. 65, p. 04009). EDP Sciences.

Tsakalidis, A., Gkoumas, K., & Pekár, F. (2020). Digital transformation supporting transport decarbonisation: Technological developments in EU-funded research and innovation. Sustainability, 12(9), 3762.

Tokody, D., Albini, A., Ady, L., Rajnai, Z., & Pongrácz, F. (2018). Safety and security through the design of autonomous intelligent vehicle systems and intelligent infrastructure in the smart city. Interdisciplinary Description of Complex Systems: INDECS, 16(3-A), 384-396.

Traub, M., Maier, A., & Barbehön, K. L. (2017). Future automotive architecture and the impact of IT trends. IEEE Software, 34(3), 27-32.

Tien, N. (2021). Factors affecting customer satisfaction on service quality at joint stock commercial banks in Vietnam. Journal of Critical Reviews, 8.

Treiblmaier, H. (2019a). Combining blockchain technology and the physical internet to achieve triple bottom line sustainability: A comprehensive research agenda for modern logistics and supply chain management. Logistics 3, 1–13. doi: 10.3390/logistics3010010

Tschorsch, F., & and B. Scheuermann, B. (2016). Bitcoin and beyond: A technical survey on decentralized digital currencies. IEEE Communications Surveys & Tutorials, 18, 2084-2123.

Ubex. (2019). Artificial Intelligence in Advertising. https://www.ubex.com

Unterweger, A., Knirsch, F., Leixnering, C., & Engel, D. (2018). The 9th IFIP International Conference on New Technologies, Mobility and Security (NTMS). Lessons Learned from Implementing a Privacy-Preserving Smart Contract in Ethereum (IEEEParis, 2018).

Van Ark, B., Erumban, A., Corrado, C., & Levanon, G. (2016, October). Navigating the new digital economy: driving digital growth and productivity from installation to deployment. Conference Board, Incorporated.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118-144.

Viriyasitavat, W., & Hoonsopon, D. (2019). Blockchain characteristics and consensus in modern business processes. Journal of Industrial Information Integration, 13, 32-39.

Vuksanović Herceg, I., Kuč, V., Mijušković, V. M., & Herceg, T. (2020). Challenges and driving forces for industry 4.0 implementation. Sustainability, 12(10), 4208.

Vukolić, M. (2017). Rethinking permissioned blockchains. In Proceedings of the ACM Workshop on Blockchain, Cryptocurrencies and Contracts, pp. 3-7.

Wadud, Z. (2017). Fully automated vehicles: A cost of ownership analysis to inform early adoption. Transportation Research Part A: Policy and Practice, 101, 163-176.

Watson, R., Lind, M., & Haraldson, S. (2017, January). Physical and digital innovation in shipping: Seeding, standardizing, and sequencing. In Proceedings of the 50th Hawaii International Conference on System Sciences.

Winkelhake, U. (2019). Challenges in the digital transformation of the automotive industry. ATZ worldwide, 121(7), 36-43.

Wintersberger, P., von Sawitzky, T., Frison, A. K., & Riener, A. (2017, September). Traffic augmentation as a means to increase trust in automated driving systems. In Proceedings of the 12th biannual conference on Italian sigchi chapter (pp. 1-7).

Wintersberger, S., Azmat, M., & Kummer, S. (2019). Are we ready to ride autonomous vehicles? A Pilot Study on Austrian Consumers' Perspective. Logistics, 3(4), 20.

Winkelhake, U. (2019). Challenges in the digital transformation of the automotive industry. ATZ Worldwide, 121(7), 36-43.

Wang, J., Yang, Y., Wang, T., Sherratt, R.S. and Zhang, J., 2020. Big data service architecture: a survey. Journal of Internet Technology, 21(2), pp. 393-405.

Wang, H. and Zhang, J., 2016, May. Research on the relationship between customer characteristics and categories in personal automotive business. In: 2016 Chinese control and decision conference (CCDC). IEEE, pp. 1003-1008.

Wells, P. and Nieuwenhuis, P., 2012. Transition failure: understanding continuity in the automotive industry. Technological Forecasting and Social Change, 79(9), pp. 1681-1692.

Wiatr, R., Lyutenko, V., Demczuk, M., Slota, R., & Kitowski, J. (2020). Click-fraud detection for online advertising.

Winkelhake, U. 2018. Digital transformation of the automotive industry. New York, NY: Springer International Publishing AG.

Wiggers. K. (2020). Waymo's driverless cars were involved in 18 accidents over 20 months. https://venturebeat.com/2020/10/30/waymos-driverless-cars-wereinvolved-in-18-accidents-over-20-month/

Wood, G. (2017). Ethereum: A Secure Decentralised Generalised Transaction Ledger. Technical report, Ethereum. https://ethereum.github.io/yellowpaper/paper.pdf.

Xu, X., Weber, I., Staples, M., Zhu, L., Bosch, J., Bass, J., Pautosso, C., & Rimba, P. (2017). A taxonomy of blockchain-based systems for architecture design. In 2017 IEEE International Conference on Software Architecture (ICSA), 243-252.

Yanik, S., and Kiliç, A. S. (2018). A framework for the performance evaluation of an energy blockchain," in Energy Management—Collective and Computational Intelligence with Theory and Applications, eds C. Kahraman and G. Kayakutlu (Cham: Springer), 521–543. doi: 10.1007/978-3-319-75690-5_23

Yigitcanlar, T., Wilson, M., & Kamruzzaman, M. (2019). Disruptive impacts of automated driving systems on the built environment and land use: An urban planner's perspective. Journal of Open Innovation: Technology, Market, and Complexity, 5(2), 24.

Zaki, M. (2019). Digital transformation: harnessing digital technologies for the next generation of services. Journal of Services Marketing, 33(4), 429-435.

Zhang, W., Zhang, Z., & Chao, H. C. (2017). Cooperative fog computing for dealing with big data in the internet of vehicles: Architecture and hierarchical resource management. IEEE Communications Magazine, 55(12), 60-67.

Clack, C.D., Bakshi, V.A. and Braine, L. (2016) 'Smart Contract Templates: foundations, design landscape and research directions', arXiv preprint arXiv:1608.00771.

Mougayar, W. (2016) 'The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology', Wiley.

Nakamoto, S. (2008) 'Bitcoin: A Peer-to-Peer Electronic Cash System'. [online] Available at: https://bitcoin.org/bitcoin.pdf (Accessed: 27 May 2023).

Risius, M. and Spohrer, K. (2017) 'A Blockchain Research Framework: What We (don't) Know, Where We Go from Here, and How We Will Get There', Business & Information Systems Engineering, 59(6), pp. 385-409.

Tapscott, D. and Tapscott, A. (2016) 'Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World', Penguin.

Zwitter, A. and Boisse-Despiaux, M. (2018) 'Blockchain for humanitarian action and development aid', Journal of International Humanitarian Action, 3(1), p.16.

Appendix A: Survey Questions

Q1: What is your gender?

Q2: What is your age range?

Q3: Are you familiar with what blockchain is? Blockchain is a record-keeping technology designed to make it impossible to hack the system or forge the data stored on it, thereby making it secure and immutable. It is a type of distributed ledger technology (DLT), a digital system for recording transactions and related data in multiple places at the same time.

Q4: Would you consider using the service of a driverless autonomous driving taxi/shuttle/or bus, if you knew that its development processes where blockchained secured?

Q5: How likely are you to use the services of a driverless taxi/shuttle/bus, if the software update system for safety critical functions were blockchained assured?

Q6: A cyberattack is any offensive maneuver that targets computer information systems, computer networks, infrastructures, or personal computer devices with the purpose to affect their proper function. Are you aware of how a cyberattack could impact a driverless vehicle?

Q7: How likely are you to use driverless taxis/shuttles/buses, if you knew they were very secure,(i.e., all govermental laws and cybersecurity standards were implemented,via secure blockchain technology?

Q8: How likely are you to use driverless taxis/shuttles/buses, if you knew they were hermetically secure, that is a cyberattack cannot occur,and it was ensured via blockchain technology?

Q9: Would you use a driverless taxi/shuttle/bus service if the company also offered additional functions secured by blockchain, such as in-ride: shopping, entertainment (gaming / music / videos) as well as food and drink delivery?

Q10: Would you use a driverless taxi/shuttle/bus service if you could pay with your crypto wallet (if you had one)?

Q11: Blockchain is another emerging technology with various applications anddomains for improved security, privacy, and trust, considering the peculiarfeature that makes it robust and unhackable.)e privacy and security issues ofthe IoT network can be handled using the Blockchain.Would you be more likely to use a driverless taxi/shuttle/bus service if the company ensured your data protection via blockchain technology?

Q12: Do the potential of a safety-relevant issues (car steering in the wrong direction not braking thus colliding) in an autonomous vehicle preoccupy you to the extent that this may cause reluctance to use the service of a driverless autonomous vehicle?

Q13: Would you prefer to ride a driverless autonomous vehicle, if they were proven to be significantly more secure than a conventional vehicle, i.e., common passenger cars, buses, and shuttles via blockchain process control technology?

Q14: Would it make you less or more likely to use the service of a driverless autonomous vehicle, if the service provider regularly communicates their safety and security process measures such as blockchain based: product connection security technology, development processes to ensure software security, as well as the status of their quality assurance?

Q15: A Blockchain wallet is similar to a bank account. It allows us toreceive bitcoins, store them, and then send them to others.)ere are many Blockchain features, for example, security,instantaneous transaction, currency conversion, and accessibility.)Ere are various types of Blockchain wallets. Would you be more willing to use an autonomous riding service if you knew your payment transaction was secured via blockchain technology?

Q16: Immutable means something whichcannot be changed. It is an essential feature of Blockchainin which blocks cannot be altered. Immutability is achievedby the concept of proof of work. Proof of work is achievedby mining, and the work of miners is to change the nonce. Anonce is a varied value to create a unique Hash address ofthe block, which is less than the target hash value. Are you comfortable with blockchain technology tracking every single transaction you made whilst using the autonomous riding service, even though this is in a centralized private system?

Q17: V2V is a wireless protocol similar to WIFI calleddedicated short-range communications. When DSRC iscombined with GPS, low-cost technology is formed. V2V communication system provides a 360-degree view ofsimilarly equipped vehicles within the communicationrange. Transmitted messages common to all vehicles includecurrent GPS position, vehicle speed acceleration, headings,and vehicle control information such as the transmissionstate brake status and steering wheel angle, and the vehicle'spath history and the path prediction. Would you feel more secure whilst riding an autonomous vehicle if the vehicle to vehicle (V2V) communication was protected by blockchain technology?

Q19: Household Income

Q20: Region within the USA by State

APPENDIX B: Informed Consent Form

SSBM Swiss School of Business and Management

INFORMED CONSENT FOR INTERVIEW

JOB SATISFACTION: THE APPLICATION OF THE LEADERSHIP MINDSET FOR SMALL BUSINESSES PERFORMANCE

I, ... agree to be interviewed for the research which will be conducted by ....a doctorate students at the Swiss School of Business and Management, Geneva, Switzerland.

I certify that I have been told of the confidentiality of information collected for this research and the anonymity of my participation; that I have been given satisfactory answers to my inquiries concerning research procedures and other matters; and that I have been advised that I am free to withdraw my consent and to discontinue participation in the research or activity at any time without prejudice.

I agree to participate in one or more **electronically recorded** interviews for this research. I understand that such interviews and related materials will be kept completely anonymous and that the results of this study may be published in any form that may serve its best.

I agree that any information obtained from this research may be used in any way thought best for this study.

....

Signature of Interviewee **Date**

APPENDIX C: Interview Questions

Management interview questionnaire used to gather data on the use of blockchain in the development of autonomous driving software functions:

1) How familiar are one with blockchain technology and its potential applications in the development of autonomous driving software functions?
2) In oner opinion, what are the main benefits of using blockchain in the development of autonomous driving software functions?
3) What challenges do one see in implementing blockchain in the development process for autonomous driving software functions?
4) In oner experience, what are the main considerations for implementing blockchain in the development of autonomous driving software functions?
5) How do one envision the use of blockchain impacting the development and deployment of autonomous driving software functions in the future?
6) Are there any specific examples or case studies of the use of blockchain in the development of autonomous driving software functions that one can share with us?
7) Do one have any additional thoughts or insights on the use of blockchain in the development of autonomous driving software functions that one would like to share?
8) What is oner opinion on the use of a blockchain technology automated software development system, do one think it would help support the robotaxi business case by ensuring software quality for cybersecurity software?

APPENDIX E: Interview Protocol

This interview is about strategies to improve small business performance and job satisfaction. Before we begin, I want to thank one for taking the time to participate and assure one that all information shared will be treated as confidential. The recording device has been turned on and the participant's identification code and the date of the interview have been announced. The interview will last approximately 30 minutes and will include both predetermined questions and follow-up questions. We will also discuss the concept and plan for member authentication through contracts. Once the interview is complete, the responses were transcribed, and the participant will have the opportunity to review and verify the accuracy of the collected data. If any changes need to be made, please let me know as soon as possible. Finally, I want to express my sincere gratitude for oner participation in this study.

Q1. "I am familiar with blockchain technology and its potential applications in the development of autonomous driving software functions. I have researched the topic and have a good understanding of how blockchain can be used to improve the reliability, security, and efficiency of autonomous driving systems. For example, blockchain can be used to track changes to the software and ensure that all developers are working on the most up-to-date version, and smart contracts can be used to automate certain tasks in the development process. I believe that blockchain has the potential to significantly improve the development of autonomous driving software functions and I am eager to explore its potential further."

Q2. "In my opinion, the main benefits of using blockchain in the development of autonomous driving software functions are improved security, reliability, and efficiency. Blockchain technology provides a secure and decentralized platform for tracking and verifying changes to the software, which helps to ensure that the software is of high quality and functions as intended. Additionally, blockchain can be used to automate certain tasks in the development process, which can help to streamline the development process and improve efficiency. Overall, I believe that the use of blockchain in the development of autonomous driving software functions has the potential to significantly improve the reliability and security of these systems while also improving the efficiency of the development process."

Q3. "There are several challenges that I see in implementing blockchain in the development process for autonomous driving software functions. One challenge is the learning curve associated with using blockchain technology. It can be difficult for developers who are not familiar with blockchain to get up to speed on the technology and understand how to use it effectively in the development process. Another challenge is the potential for scalability issues. As the use of blockchain in the development process grows, it may be necessary to scale the system to handle the increased volume of transactions and data. This can be a complex and time-consuming process. Additionally, there may be regulatory challenges to consider when using blockchain in the development process. It is important to ensure that the use of blockchain complies with any relevant laws and regulations. Overall, these are some of the main challenges that I see in implementing blockchain in the development process for autonomous driving software functions."

Q4. "In my experience, the main considerations for implementing blockchain in the development of autonomous driving software functions are:

Ensuring that the team has the necessary skills and knowledge to effectively use blockchain technology in the development process. This may involve training or hiring developers with experience in blockchain development.

Evaluating the scalability of the blockchain platform to ensure that it can handle the volume of transactions and data that will be generated during the development process.

Ensuring that the use of blockchain complies with any relevant laws and regulations.

Ensuring that the development process is well-organized and follows a logical, step-by-step process to ensure that the software being developed is of high quality and functions as intended.

Ensuring that appropriate security measures are in place to protect the software being developed and the blockchain platform.

Overall, these are some of the main considerations that I believe are important when implementing blockchain in the development of autonomous driving software functions."

Q5. "I envision the use of blockchain having a significant impact on the development and deployment of autonomous driving software functions in the future. By providing a secure and decentralized platform for tracking and verifying changes to the software, blockchain has the potential to improve the reliability and security of autonomous driving systems. Additionally, the use of smart contracts and other blockchain-based tools can help to automate certain tasks in the development process, improving the efficiency of the development process and enabling the deployment of autonomous driving systems more quickly.

I also believe that the use of blockchain in the development and deployment of autonomous driving software functions will enable greater collaboration and transparency among developers, as all changes to the software will be recorded and easily verifiable on the blockchain.

Overall, I see the use of blockchain having a transformative impact on the development and deployment of autonomous driving software functions in the future, enabling the deployment of more reliable and secure systems more efficiently and transparently."

Q6. "There are several examples and case studies of the use of blockchain in the development of autonomous driving software functions that I can share with one. One example is the Waymo autonomous vehicle company, which is using blockchain technology to track and verify changes to the software that powers its self-driving vehicles. This helps to ensure that the software is of high quality and functions as intended, improving the reliability and safety of Waymo's autonomous vehicles.

Another example is the MOBI (Mobility Open Blockchain Initiative) consortium, which is a group of companies working together to explore the use of blockchain in the development of autonomous driving software functions. MOBI is conducting research and pilot projects to determine how blockchain can be used to improve the reliability, security, and efficiency of autonomous driving systems.

Overall, these are just a few examples of the use of blockchain in the development of autonomous driving software functions. I believe that we will see many more examples and case studies in the future as the use of blockchain in this field continues to grow and evolve."

Q7. "I believe that the use of blockchain in the development of autonomous driving software functions has the potential to revolutionize the field. By providing a secure and decentralized platform for tracking and verifying changes to the software, blockchain can help to improve the reliability and security of autonomous driving systems. Additionally, the use of smart contracts and other blockchain-based tools can help to automate certain tasks in the development process, improving the efficiency of the development process and enabling the deployment of autonomous driving systems more quickly.

However, it is important to note that the use of blockchain in the development of autonomous driving software functions is still in its early stages, and some many challenges and considerations need to be addressed. For example, there is a learning curve associated with using blockchain technology, and it may be necessary to invest in training and development to ensure that the team has the necessary skills and knowledge to effectively use blockchain. Additionally, there are scalability, regulatory, and security considerations that need to be considered.

Overall, I believe that the use of blockchain in the development of autonomous driving software functions has the potential to significantly improve the reliability, security, and efficiency of these systems, and I am excited to see how this technology will continue to evolve and be used in the future."

Q.8 "In my opinion, the use of a blockchain technology automated software development system has the potential to significantly improve the quality and security of software for the robotaxi business. This type of system uses blockchain technology to create a secure, decentralized platform for managing and tracking software development, which can help ensure that all changes to the software are thoroughly tested and reviewed before being implemented. Additionally, the decentralized nature of a blockchain system makes it more resistant to tampering and hacking, which can be critical for ensuring the security of cybersecurity software. Overall, I believe that the use of a blockchain technology automated software development system could be a valuable tool for supporting the robotaxi business case by helping to ensure the quality and security of the software used in this industry."

APPENDIX F   Survey Results Data

The data can be provided upon request, data can be found in the following GitHub repository: https://github.com/kt16abq/DefenseData