INNOVATION AND TECHNOLOGY: THE ERA OF AUTONOMOUS CARS AND THEIR OUTCOMES IN LAW ENFORCEMENT

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List of Abbreviations

Autonomous Vehicles (AVs)

Criminal Justice System (CJS)

Artificial Intelligence (AI)

CHAPTER ONE: INTRODUCTION

Overview

The purpose of this research study is to explore the cybersecurity of Autonomous Vehicles (AVs), including the technological challenges, barriers, and impacts on society. This research study provides a framework for law enforcement agencies to understand the scope of security of AVs and develop relevant policies and strategies to enhance the security of these vehicles. AVs are a relatively nascent concept in the automotive industry, and thus, there is limited knowledge about cybersecurity. In the upcoming years, there will probably be a considerable increase in the number of semi-autonomous vehicles on many US and European roads. Some experts even predict that fully autonomous vehicles might be on the road within the next ten years. There are problems that arise with respect to criminal and civil liability, the obligations of manufacturers and insurers, and the future regulation of road traffic as a result of these developments. This research study aims to explore and address the knowledge gaps related to cybersecurity, law enforcement policies and regulations, and the impact of AVs on society. The methods used to conduct research on AV procedures for analyzing data and the names of the interviewees will also be listed.

Background

Historical Context

Advancement in technology has provided a platform for innovators to think beyond the current settings and develop new systems that revolutionize the world. Autonomous vehicles were regarded as future science inventions but have now become a reality. Today, autonomous vehicles have been developed and continue to be improved. The ability of autonomous vehicles to connect wirelessly to systems around makes them vulnerable to malicious attacks. Concerns

have been raised about cybersecurity dangers, like whether cybercriminals may "remotely take an AV's electronics with the purpose of triggering a crash," allowing them to hack self-driving automobiles (Sifakis, 2018).

Due to their high level of connectedness, AVs are prime targets for cybercriminals who may "try to obtain financial information from the motorists or execute high-level terrorist operations by converting AVs into weapons." Self-driving automobiles are vulnerable because of AI technologies (Sifakis, 2018). These AI systems "identify traffic signs and signage, recognize vehicles, evaluate their speed, and plot the course ahead" constantly. Campisi et al. (2021) point out that in addition to accidental dangers such as abrupt AI system defects, purposeful attacks target AI systems' safety-critical operations. Two examples are road paintings that confuse the navigation system or stickers placed on stop signs to obstruct them from being noticed. The changes above may cause AI systems to incorrectly identify objects, causing the self-driving vehicle to behave dangerously.

Many research articles have recently been published that demonstrate hacking against machine learning systems. Gambi et al. (2019) reiterate that a cyber-hacker could meddle in an AV and bring problems by affecting the vehicle's driving qualities. As technology advances, so do the systems employed inside AVs and their weaknesses. Hackers will tend to look for new ways to break into AVs, which might lead to new and previously unknown vulnerabilities that are harder to identify and guard against.

Social Context

The urban environment continues to increasingly engage in artificial intelligence with the focus on automation changing towards urban processes (Dia, 2017). Technological innovations, including the use of autonomous vehicles, have created a shift in social dimensions as

technology and AI take a human face. There is a disconnect in labor as the AVs have no driver, thereby creating a shift in the workforce. Privacy is also a key issue in the development of AVs, as passengers have to engage with technology and relay information that could otherwise fall into the hands of malicious hackers (Dia, 2017).

It is undeniable that writing software without defects is extremely tough, notably when the software is highly sophisticated. Abraham and Rabin (2019) note that bugs can frequently be leveraged as security weaknesses. More advanced systems, such as AVs, could have security flaws that hackers could exploit or depend on sensors to make decisions that hackers could alter. A traffic sign that seems human as a stop sign can be changed to resemble something else.

Theoretical Context

This study adopts the systems theory in understanding cybersecurity issues in autonomous vehicles and outcomes in law enforcement. Systems theory depicts an interdisciplinary study of systems within cohesive groups of interdependent and interrelated components. Systems have causal boundaries defined by structure, influenced by context, role and function, and through relations with other systems. The systems theory provides a holistic approach to cybersecurity and AV from the context of information technology, business, and social perspectives. The theory will consider the interrelationships of different stakeholders existing at the managerial, strategic, and operational levels of autonomous vehicles. Systems theory will facilitate an understanding of how manufacturers and operators of AV align with laws and policies to ensure law enforcement agencies are able to deliver on their mandate of law and order in the transport sector.

Situation to Self

This research study will use epistemological assumptions to bring the research and the

paradigm. Based on the assumption mentioned above, the study entails researchers attempting to get as near to the participants as possible. The study will be supported by socio-technical systems and political systems theories.

Problem Statement

The problem to be addressed in this research study is the proliferation of AVs by cyber criminals. Autonomous vehicles are an emerging trend in technology. These vehicles use artificial intelligence to simulate the environment, which enables their self-driving capabilities. As with any technology, proliferation by cybercriminals into this technology is likely to happen. Autonomous vehicles are expected to connect or even be merged with personal phones. Hacking and loss of confidential information are likely to increase. Campisi et al. (2021) note that when criminals manage to penetrate the artificial intelligence of these automobiles, law enforcement officers might find it challenging to combat. Officers will be overwhelmed since they are not adequately prepared to introduce autonomous vehicles. Dealing with cybercrime means the police or traffic officers need to know about cybersecurity to understand the different cybercrimes and what to do in case of any cybercrime associated with AVs. Therefore, it is necessary to enact new laws that will aid in curbing new crimes related to vehicles since they are not regular vehicles but rather AVs.

Qualitative data can be collected using qualitative focus group design and semi-structured interviews. This study shall adopt a focus group design and semi-structured interviews because the methodologies contained in the two are most helpful in determining the meaning of an experience and the nature of an occurrence or phenomenon (Busetto et al., 2020). Additionally, qualitative research methods are flexible, responsive, and not complex compared to quantitative research methods. The study population shall include police officers of varying levels of

government. The study population will include local, state, and federal law enforcement. The population of this study is based on the validity of their output based on their knowledge relating to autonomous vehicles and the legal ramifications surrounding the topic. For example, criminal gangs could use autonomous vehicles for massive destruction of property and loss of lives.

This research study aims to address the knowledge gap related to the absence of policy regulating autonomous vehicles and how law enforcement officers can regulate their activities. For instance, Giuffrida (2019) asserts that criminal law isn't made to deal with nonhuman actors' behavior when it comes to completely autonomous vehicles or semi-autonomous vehicles running under the correct supervision of an automated driving system (ADS). This could result in a "responsibility gap," wherein the vehicle's human occupant, or "user-in-charge," even if they aren't really driving, is exempt from liability for crimes committed while the car is functioning in accordance with the rules and specifications set forth by the manufacturer (Giuffrida, 2019). In situations where there is no reasonable way to hold a person accountable, this may call for the use of new methods for determining criminal responsibility or other methods altogether. There are no existing laws. There is no current or specific legal definition of a "self-driving" or autonomous vehicle. There is no current legislation defining the level of awareness a driver must have when operating an autonomous vehicle (Li et al., 2021).

There is a grey area for those who violate the law while utilizing autopilot or autonomous software during traffic stops. There has been confusion on citations and charges to file for those pulled over in self-driving vehicles while sleeping, under the influence of alcohol, texting, and driving, and other instances of not fully operating the vehicle. Sinha et al. (2021) assert that there are no laws regarding accidents caused by autonomous vehicles, including who to blame in case of an accident, whether the vehicle's owner or the manufacturer, and how accident victims are

compensated. There are no stated rules on dealing with possible cybercrimes associated with autonomous vehicles, and the officers may be challenged in their line of duty, especially if they lack cyber security knowledge.

Policymakers and governments need to start making legislation, monitoring, regulating, and balancing the use of these automobiles. If policymakers leave this technology unchecked, autonomous vehicles will penetrate the market to the extent that they overwhelm the authorities that manage them. The researcher will pinpoint the repercussions of this technology and make relevant recommendations to policymakers. Li et al. (2021) note that AVs would be more popular and enhanced if experts came up with a mechanism that has customizable driving style choices to fit the needs of consumers.

Autonomous vehicles continue to make headlines. The rumors about the adoption of fully autonomous vehicles are becoming a reality, especially with manufacturing companies adopting and testing semi-autonomous vehicles and the features of autonomous vehicles. AVs will change the approach toward driving as they will operate automatically without human intervention (Nastjuk et al., 2020). The federal and state governments are largely unprepared for this transition. Previous research has shown the unpreparedness by studying the lack of available regulations. The research on autonomous vehicles has mainly been technological, with relatively lesser research on the probable effects of regulatory unpreparedness on law enforcement agencies and society (Hayward & Maas, 2021). The research on the societal impacts of autonomous vehicles is limited. Most states have few (or incomprehensive) policies and regulations governing the manufacture and use of autonomous vehicles (Abraham & Rabin, 2019). This research will add to the growing body of research on the impacts of autonomous

vehicles on society. The research will build on previous studies that have surveyed the theoretical effects of autonomous vehicles on society.

The introduction of autonomous vehicles in society needs regulation. Yet, many, even those in law enforcement who recognize the potential impact of AVs, acknowledge that little has been done in preparation for this milestone (Freemark et al., 2019). With the benefits potentially associated with AVs, such as developing smart cities, reducing road accidents, and bridging the gap for non-drivers, the potential adverse effects are also a factor to consider (Campisi et al., 2021). The success or failure of AVs impacts the CJS in multiple ways, including new cybercrimes such as hacking of AVs, new traffic rules and approaches, and the possibility of using AVs to fight crime. Sinha et al. (2021) argues that studying the repercussions of having unregulated or no policies governing the industry or usage of autonomous vehicles to the population will provide additional data to state and federal policymakers on the possible direction to formulate policies. The research will also inform manufacturers' practices to respond to potential legal changes and public perspectives.

Purpose Statement

This research study aims to understand the effects of automated vehicles on society and culture on a larger scale. It explores the implications of fully automated vehicles. The implications include an increase in cybersecurity issues in the automotive sector. The research will contain qualitative analyses of police officers in the DC and Virginia areas. The DC metro area provides a promising research ground for this study because it is one of the United States with no regulations for autonomous vehicles. Yet, their testing and manufacture are underway (Feng et al., 2021). The DC and northern VA area is also one of the riches areas in the country and has one of the highest amount of AV vehicles. The study results will contribute to current

theoretical frameworks on proposed policies and regulations for manufacturers and users (the public) and different law enforcement officers in the CJS.

Significance of the Study

Empirical Significance

It is predicted that fully autonomous vehicles on the roads will be standard practice within the next decade. Classen et al. (2022) contend that complex changes need to be addressed for the change to be effective by 2030. The research will investigate industry collaboration and policy matters. Most IT specialists believe that cybercrimes increase with digital technologies' rapid adoption and advancement. Similar to the changes during the industrialization phase that necessitated changes in labor laws and the introduction of the first auto motors that also forced the law enforcement agencies to change the rules in line with the times, the introduction of autonomous vehicles necessitates law enforcement agencies to change the practices. Empirical research will be adopted through a set of research questions that will guide the investigation. The research questions will be geared towards realization of the research objectives and align with the significance of the study.

Practical Significance

The research will also investigate the impact of autonomous vehicles on society. The research will analyze how the average citizen perceives autonomous vehicles and what moral, ethical environment, and legal obligation they have in society. The framework for self-driving vehicle technology will be dependent on developments of the regulations, which will lead to the use of autonomous vehicles in the next decade (Sinha et al., 2021). Eventually, fully autonomous vehicles will overtake the use of conventional vehicles (Nastjuk et al., 2020). The potential benefits discussed show that their uptake will increase with societal acceptance and adequate

safety measures for AVs (Campisi et al., 2021). This research will investigate the potential impact of AVs on the CJS and, thus, society as a whole.

Theoretical Significance

Systems theory consider cybersecurity from an information technology, social, and business perspective (Sony & Naik, 2020). These entities work together within multiple stakeholders to ensure innovations do not pose risks to users. Systems theory will be significant in this study in understanding the role of different stakeholders involved in operation of autonomous vehicles and the responsibility of ensuring security of the systems. In addition, systems theory facilitates an understanding of the interrelation among the stakeholders especially law enforcement in managing AV. Legislators as key policy developers will be crucial stakeholders in ensuring necessary legal standards are put in place to safeguard against cyber threats.

Research Questions

By 2035, autonomous vehicles will gradually gain traction in the market. AVs will have far-reaching impacts on society beyond the novelty of driverless rides. The research questions are formulated to gather qualitative information on the possible implications of AVs' regulation (or lack thereof) from different groups directly involved in AVs' operation when they are released on the roads.

Q1. Will images taken by self-driving cars be used by the police to solve a crime?

Q2. Does transforming conventional vehicles into fully autonomous vehicles contribute to cybercrime?

Q3. Can autonomous vehicles be used as witnesses in cybercrimes?

Q4. Are there safety measures in place to safeguard against data breaches that may jeopardize AV operations?

Q5. Are there areas of cyber security that are essential in the development of AV?

Q6. Can law enforcement agencies be integrated into the development and operations of AV?

Q7. Does the development of AVs contribute to the proliferation of cybercrimes?

Q8. Are there policies and regulations governing AVs' use and manufacture regarding their safety and security?

Q9. Does transforming conventional vehicles into fully autonomous vehicles affect the sustainability of the automobile industry in terms of employment and workforce?

The research questions provide a framework to explore the participants' experiences, knowledge, and beliefs about AVs. The researcher can employ semi-structured questions to learn more about the perceptions, beliefs, and experiences if the participants respond "yes". The researcher intends to create an open-ended dialogue where the limited confines of their research will only limit the respondent. This approach allows for exploring new ideas or themes concerning the topic not initially identified by the researcher.

Definitions

1. *Autonomous Vehicle* - An AV can sense its surroundings and operate without human intervention. A human passenger is not necessary to control the vehicle at any point or be located in the vehicle (Zhao et al., 2021).
2. *Criminal Justice System* - The CJS is a network of government and commercial institutions tasked with managing criminals who have been charged and convicted. Corrections, academics, law enforcement, forensics, and the judiciary are among the interconnected pillars of the CJS.

Summary

Cybercriminals are likely to take advantage of AV technology, as they are with any other. Self-driving vehicles are anticipated to link to or possibly merge with cellphones. As a result, the number of hacking incidents and data breaches is expected to rise. The primary goal of this study will be to examine the consequences of having an uncontrolled industry and no policies overseeing AV use by the general public. On a bigger scale, this qualitative study tries to comprehend the effects of AVs on society. With the improvement in technology, the cyber criminals have methods for perpetrating crime. Therefore, the study will analyze how the technology will ensure that the autonomous vehicles will not be used by cybercriminals. The findings will add to existing theoretical frameworks on recommended regulations for manufacturers, users (the general public), and various law enforcement officials in the CJS.

CHAPTER TWO: LITERATURE REVIEW

Overview

This chapter will examine literature covering topics on the relationship between law enforcement and Autonomous Vehicles (AVs), focusing on the role of law enforcement in regulation and control. This chapter will also cover AVs' positive and negative impacts on the greater society, covering aspects of environmental, political, ethical, and moral issues., among other disruptions. This section will evaluate different theories and models in support of the claims in the study. These theories include socio-technical systems and political systems theories. This section will examine scholarly articles retrieved from Google Scholar and other reputable sources of similar journals like PsychINFO. The choice of the articles is based on the validity of their output based on their knowledge asymmetry, particularly on issues relating to (autonomous vehicles) and legal background inefficiencies facing the same. The articles are limited to those published in the last five years (2017-2021). The researcher critically examined bibliographies of significant peer-reviewed studies on the few additional review articles about AVs.

Theoretical Framework

Systems Theory

Systems theory depicts an interdisciplinary study of systems relating to one another in complex and larger systems (Sony & Naik, 2020). Systems theory is based on the assertion that the whole is greater as compared to the sum of its parts. Smaller systems are integrated to affect a greater complex system. This means that the characteristics of the entire complex system cannot be rationalized by examining a single element of the system. Systems theory explains and develops the hypotheses based on characteristics that develop within the complex systems that

cannot be understood by examining one component of the parts.

The development and implementation of autonomous vehicles involves different stakeholders and units' right from design, manufacturing, testing, infrastructure development, and user experience. The element of cybersecurity thus requires an integration of different units and people involved to ensure cyber threats are managed and that the law enforcement agencies are able to manage transport sector based on law and order. The development of laws and policies is also crucial and the involvement of diverse stakeholders ensures that the legal standards set are meant to safeguard against cyber threats. Systems theory facilitates an understanding of different stakeholders involved, bringing together their roles and ensuring the laws and policies set can be enforced by law enforcement.

Policies and Regulations

Much less different than the shift of policies and regulations experienced during the changes of regulations after increased industrialization in the workplace, the introduction of Automated Vehicles (AVs) marks a significant need to negotiate or change the current legislation for more comprehensive laws (Menon & Alexander, 2020). The introduction of AVs is rife and will continue to increase throughout the country. The laws and regulations must consider various factors such as laws that govern the manufacture, public usage, individual liability, and how the CJS responds. Li et al. (2021). The effects of AVs on humanly-controlled traffic and how manufacturers' reports on accident control and police reports on the same either differ or agree. Currently, the available literature on AVs indicates multiple gaps in the manufacture, use, and regulation of AVs, seeing as it is an ongoing and relatively new field of technology. Abraham and Rabin (2019, p.2,4) explain that the transition will be long and financially demanding since the shift to AVs will happen at different levels. The integration of

AVs will not automatically rule out Conventional Vehicles (CVs). Therefore, the existing rules will work together with the new laws enacted to guarantee the smooth running of the transport system.

Policies and Regulations in The Manufacture

Abraham and Rabin (2019, p.3) explain that the policies and regulations for AVs will require increased accountability of the manufacturers, especially for the highly automated vehicles. The increased responsibility for the manufacturers will be needed because the vehicles will have less influence from human drivers. Thus, if an accident occurs, it is due to the vehicle and not human error (Menon & Alexander, 2020). The authors propose a system that will impose substantial but appropriate financial compensatory responsibility on manufacturers to the victims of AVs accidents. Abraham and Rabin (2019, p. 6) propose that when the proportion of AVs to CVs reaches 25%, the need for what the authors refer to as the "Manufacture Enterprise Responsibility" (MER) will be necessary. MER is the system where the responsibility for all injuries occurring due to AVs lies with the manufacturer. In the meantime, monitoring semi-autonomous Vehicles should be a priority, as proposed by Pearl (2018, p.3), since their success may hinder or boost the adoption of AVs.

Bakioglu and Atahan (2021) add that manufacturers are under no obligation to design 100% safe motor vehicles. They act under the doctrine of strict liability. Strict liability is a standard of liability where a manufacturer is held legally responsible for the consequences of faulty products, even in cases without criminal liability (Wendehorst, 2020). Strict liability would minimize the losses suffered by the public while still dressing the safety concerns of the AVs. Giuffrida (2019) argues that several tests have been developed to ascertain the level of liability under product defects or design defects that cause damage to consumers. These tests are

critical in the AVs industry as they help in mitigating the consequences of defects and, at the same time, act as deterrence against the production of defective products like AVs. These tests are as follows: consumer expectation test. Sama (2019) reveals that customers anticipate that the goods they use or consume will meet minimal safety requirements. Kuokkanen and Sun (2020) found that the consumer will anticipate that the AV will operate safely in autonomous mode, and it is anticipated that the manufacturer will take precautions to make sure the AV is secure. Kuokkanen and Sun (2020) say that what a rational person would anticipate from a product will eventually be decided by the court under the consumer expectation doctrine. However, the consumer can file claims using the consumer expectation test when an accident occurs contrary to their expectations. For instance, a consumer may pursue a design flaw claim if an AV travels in an unexpected direction and thereby causes an accident; the consumer has a right to file a claim against the manufacturer on the basis of the design flow. In this case, the claimants expect the court to grant relief on the basis of the consumer expectation doctrine. However, some courts have different perspectives about design flaws and may never grant relief for design flaws.

Risk utility test: the test states that the consumers have the option to illustrate to the court the alternative method or design, which, when used, could have minimized the risk. Hasfar et al. (2020) add that under this test, consumers can argue that the safety cost outweighs the cost of altering the design. However, this will also depend on the court because some courts will view safety concerns as design defects and therefore fall under the consumer expectations test.

Failure to warn test. Under this, if the manufacturer did not warn the consumers about a certain aspect of the design and how to respond to different warnings. Wang et al. (2020) claim that manufacturers are expected to inform consumers of the potential dangers of their products while offering necessary precautions. Jha et al. (2019) observe that failure by the manufacturer to

notify consumers of the dangers and precautions of the product gives the consumers the right to bring the claim before the court. In all these tests, the court will have to require expert evidence on the performance of the AVs and the reasonable degree of operation placed on the manufacturers (Jha et al., 2019). The court will also require the services of an expert in deciding on remedial measures. The move is likely to increase the cost of the cases due to the complexity level of technology. Therefore, it will be difficult to hold the manufacturer legally liable for the defect under these tests. According to Jha et al. (2019), new rules and regulations are needed to regulate the AV industry so that the manufacturer is held liable for any defect which, if ascertained, can cause grave dangers to the public. The industry, when well regulated, will be a game changer in the transportation industry.

If the test and simulation of autonomous vehicles negatively impact society and people, AVs will probably receive negative comments and not be adopted into the transport system. The responsibility of AVs in case of issues is primarily left to the manufacturing companies because consumers have little or no control over their use. Gopalswamy and Rathinam (2018) argue that a distributed accountability approach is better and will accelerate the incorporation of AVs into the market. Perhaps similar to Pearl's (2018) argument on control of semi-autonomous vehicles, the division of responsibility places greater accountability on all involved parties and requires collaboration, which gives a more holistic approach to AVs. This approach differs from the proposed MER system discussed above. Another important point is that connectivity between technology-based devices will extend beyond just vehicle-to-vehicle with the increased IoT. The capacity for remotely controlling devices may extend beyond the manufacturers' control, irrespective of security measures (Hayward & Maas 2021). Ulybyshev et al. (2018) also echo the findings that increased vehicle-to-vehicle connectivity warrants more excellent encryption for

protection against malicious use of data. Suppose individuals experience loss of confidential information due to cybercrime. In that case, they will not accept autonomous vehicles in the market since no one would want their data stolen and possibly used by cybercriminals. Manufacturers should ensure they install appropriate and protective software. Having focused on the regulations and policies squarely focused on manufacturers may prove an inadequate approach to AVs' regulation and safety.

Policies and Regulations for Public Usage

The most significant percentage of road accidents is driver-focused since drivers' errors are the leading cause of road accidents. New policies and regulations for user accountability will inevitably emerge. Abraham and Rabin (2019, p.3) postulate that new regulations will be necessary regarding accidents caused by automated vehicles since no laws exist to judge vehicles causing an accident. If any accident occurs in the absence of laws to consider what is acceptable or wrong in an accident, compensating victims affected by accidents will not be possible. The current laws will continue to be in place, especially since semi-automated vehicles will mark the transition (Abraham & Rabin, 2019, p.8). In agreement with this observation, Pearl (2018) indicates that while the increasing use of semi-autonomous vehicles indicates positive progress towards fully autonomous vehicles, the federal and state regulations focus more on AVs than semi-AVs. With the ignorance of the legal system in developing laws that monitor and hold drivers accountable for the accidents and faults of semi-automated vehicles, the adverse outcomes before the final shift have fatal consequences. The oversight of semi-autonomous vehicles may hinder the uptake of AVs as automation may be viewed as potentially more dangerous, even though full automation may pose significantly less danger. However, with a

faultless transition, fully-automated vehicles will mean that the shift will require new laws to govern emerging problems associated with autonomous vehicles.

Contrary to Abraham and Rabin's (2019, p.6) proposal of the MER, Pearl (2018) proposes a no-fault compensation system that is primarily controlled and implemented by the National Highway Traffic Safety Administration (NHTSA). According to the author, this system would be financed by the tax levied on the sale of AVs and would highly protect the manufacturers while still compensating the victims. Pearl (2018) explores the government's role in controlling economic-driven aspects of AVs. The current regulations largely favor minimal government interruption and an economically-driven system. As seen in the past economic literature, the "laissez-faire" approach may not produce the best outcomes, which is the argument presented supporting a more government-regulated approach.

Although the continued support for government regulation, Freemark et al. (2019) find that few governments have been preparing for the arrival of AVs on a municipality and local level, even though, ironically, they express their worries and support a more regulated approach to AVs. Most importantly, since the government has different levels with defined responsibilities, such as planners and transport officials in municipal classes, their differing opinions on AVs and their respective responsibilities may affect AV legislation and consequent use. Different states continue to develop laws and regulations for the usage of AVs. It is also important to remember that changes may be necessary over time since this is a growing industry.

Implications of Autonomous Vehicles on the Criminal Justice System (CJS)

Autonomous vehicles are inherently different from manual and partially autonomous vehicles, making applying the same rules difficult (Pearl, 2019). The author explains the need to introduce new legal requirements and regulations to govern their operations on the road. Pearl's

(2019) concern on the inadequacy of the legal system is not isolated, as multiple authors and researchers echo her remarks. Pearl (2018) proposes a compensation system that is potentially beneficial to the manufacturers as it offers them protection, gives compensation to the victims of AVs accidents, and at the same time reduces the burden on the CJS. Although states are currently adopting laws that allow and regulate AVs, the CJS is not entirely well-equipped to deal with complaints against AV-related issues (Pearl, 2018). The response of the CJS towards AVs will determine whether the manufacturers can bear the risk and cost of manufacturing or whether the viability of the market will be affected by the CJS to the extent that a manufacturer is no longer a viable option (Pearl, 2018; Abraham & Rabin, 2019). Echoing these remarks, Pearl (2019) proposes a "no-fault quasi-judicial victim compensation scheme." The advantages of this system are that it would ensure that victims of harm caused by AVs are quickly compensated, the manufacturers are adequately protected, and the judicial system has time to adapt to the new provisions and challenges posed by AVs.

Atkinson (2020, p. 1) goes beyond the legal responsibility of AV manufacturers to explore the legal obligation of other parties in the industry, including software companies, mapping agencies, and suppliers. The author's findings align with Pearl's (2018) prediction of a more complex legal system, both in transition and application, since autonomous vehicles are associated with more complex problems than ordinary vehicles. For instance, when an accident occurs when there is no driver in the autonomous vehicle, who will be questioned, is it the Vehicle manufacturer or the owner?

A contentious matter in the CJS (and social) setting is the possibility of granting legal status to AVs (Bikeev et al., 2019). Legal status would grant the justice system the responsibility to charge AVs with a crime. Additionally, just like any other legal procedure, giving legal status

to AVs will need a prolonged process from definition, levels of AVs and their capacities, procedures for acquiring the use, reporting procedures, and most importantly, the manufacturer's guarantee of the safety of AVs (Bikeev et al., 2019). The manufacturer would hold greater responsibility for the failures and dangers resulting from AVs.

Criminal Liability of Operators, Drivers and Passenger of AV

Operators, drivers, and passengers are involved in the development and implementation of AV. The level of automation of AV directly affects the criminal risks of drivers, operators, and passengers. The passenger in this case may not be liable for any criminal conduct as they have no legal duty of surveillance on the vehicle itself. In addition, passengers do not have the technical capacity to interfere with the software conducts and choices. The general principles of CJS affirm that the passenger cannot be liable as they are considered as third person in the scenario. However, the duty of surveillance can be defined based on the role of the passenger in the vehicle. The ordinary discipline will thus be affirmed based on culpability principle doctrine which states that there has to be a negligent unlawful behavior for the person to be liable for serious harm that may occur (Fell, 2020). The passenger can be regarded as an operator of the vehicle and breach of duty of precaution and care while performing surveillance task may prove criminal liability. This can only be applicable incase the passenger is guided on their surveillance task while onboard and the offence of negligence is provided for within the legal system.

The control dilemma and surveillance duty can thus rest with the human passenger of the AV. Technological development facilitates the operator not to be custodian of control and surveillance tasks. However, the law prescribes them to be in control of the vehicle to support surveillance and help avoid harmful event that may occur. The duty of care as prescribed on the person on board the AV should also take into consideration the specific condition of the AV as

well as the realistic mandate of control in case of emergency. The vehicle-accident negligence standard may not be firm in the case of AV raising the need for elaborate new liability standards and requirements (Feng, et.al. 2021). This is based on the fact that the surveillance task of the person on board may be limited in case they do not know how to operate the vehicle. In addition, AV are expected to be also used by people with disabilities or those who are advanced in age. The issue of surveillance and control based on the passenger triggers the need for elaborate liability metrics.

Criminal liability of Programmers and Producers of AV

The criminal risk of programmers of AV is distinguished between diverse possible scenarios. The first scenario is that the damage is as a result of malfunction of the car based on the sensors being erroneously displayed or the software failing to align with the programme (Yeong, et.al 2021). The programmer may also fail to predict possible interactions that may occur in real world thus triggering harmful conduct by the AV which could be avoided. These cases trigger the general discipline of criminal liability based on negligence. The programmer may be criminally liable in case they made an unavoidable mistake of error in their work of programming the vehicle and the error caused the accident.

In addition, the damage caused by the AV may be as a consequence of the choice of action that may not be the direct action of the original programming of the AV but the outcome of self-learning mandate of the system (Leuzzi et al., 2018). This means that the conduct of the programmer and subsequent action of the robot means that there is a wider area that is not controlled by humans but rather machines. What is developed through artificial intelligence especially on choice of action and the ability to learn from experience may be unforeseeable by the producer and programmer (Wiseman, 2018). The connectivity, autonomy, and capacity of

artificial intelligence systems makes it difficult or impossible in practice to trace back particular harmful actions of AI operations to particular human decision or input in the design (Yokoi & Nakayachi, 2021).

To prove criminal liability, an important question must be answered: can AV deliberately commit a crime? If they can, who should be held liable for that crime? Kirpichnikov et al. (2020) expound that this automatically points fingers at the programmers and producers of AVs. This is in the case of a crime that can be attributed to the malfunctioning of the AVs, like the 2016 London scenario where a person was killed when a car he was travelling in hit a car in front of it. The accident was attributed to the malfunctioning of the brakes light of the front car. The manufacturer was aware that the brake lights were faulty but didn't take action to correct the situation. Kirpichnikov et al. (2020) assert that it is very difficult to attribute criminal liability in these scenarios using the current criminal laws. Therefore, to address this situation, there is a need for distinct and new criminal laws that will handle different criminal liabilities attributable to AVs.

Liability of Infrastructure Managing Entity

Abraham and Rabin (2019) affirm that the technological transitions towards AV mandate the development of infrastructure that supports such vehicles. The infrastructure should align with smooth control and operations of AV in order to ensure safety. Traffic related damages linked to failure to provide necessary infrastructural conditions to support safety and operations can be a source of liability (Bikeev et.al. 2019). Infrastructural development should be supported by digital backbone where connection instruments and sensors are connected and dialog with AV. AV heavily relies on the information that originates from digital network retrieved from other vehicles and sensors and instruments installed in the road infrastructure (Ulybyshev, et.al.

2018). An accident resulting from malfunction of the sensors and instruments triggers the case of liability of road managing entity as the infrastructure failed to align with operational requirements and safety set in the law.

The complexity of digital network supporting operations of AV makes it difficult to understand if eventual damage was triggered by malfunction of vehicle software of infrastructural support (Bikeev, et.al. 2019). The development of policies and laws governing liability of road infrastructure should thus take into consideration the different perspectives of technology deployed, alignment with road infrastructure, and the human element in the entire operation. In this case, data will be important in identifying whether there were any loopholes in the development or implementation phase of road infrastructure and its alignment with operations of the AV.

Effects of Autonomous Vehicles on Police Control of Traffic

Leuzzi et al. (2017) explain that several issues must be resolved for police to manage traffic control, including understanding the latest technological models on vehicles and having the correct response in case of fatal (or non-fatal) accidents. Mainly focused on crime prevention and anticipation of potential accidents and crimes on highways, police traffic needs machine learning, and data mining approaches cannot be overemphasized, especially in the era of AVs (Leuzzi et al., 2018). Due to developments in sensors and mechanisms to sense barriers, AVs are a technology that can potentially impact the future of travel and movement (Yeong et al., 2021). Sensors guarantee that AVs see their settings correctly, and sensor integration and efficacy might affect AV viability.

Menon and Alexander (2020) argue that autonomous vehicles are ideal for reducing traffic as they ensure a buffer between the cars in front and the AVs; hence it ensures that they

only brake when necessary. AVs ensure that fewer police officers will be needed on the road to control and enforce traffic. Uncontrolled use of AVs, or what Pearl (2018) refers to as the laissez-faire approach of governments, would counter the predicted benefits of traffic control and reduced congestion. Similarly, Atkinson (2020) finds that without proper regulatory systems, the full benefits of AVs may not be enjoyed and that the outcomes may be more problematic than beneficial. Correspondingly, Dia (2017) concludes that the endless possibilities of full AV adoption are only possible through regulations. Freemark et al. (2019) found contradictory views on the effect of AVs on traffic as divergent views projecting both an adverse outcome in terms of the increased number of vehicles on the road and sprawl and positive results primarily focused on safety, reduced congestion, and reduced pollution. Priby and Lom (2019) found that depending on which outcome dominates the uptake of AVs, either positive or negative, the effect on traffic control will be different. AVs will increase the number of miles traveled per vehicle, increasing the number of vehicles on the road at each moment in time and increasing traffic congestion without proper response measures (Priby & Lom, 2019). Theoretical frameworks tend to differ in their findings and studies on whether the benefits outweigh the challenges of AVs or not.

Coupled with the general effect of whether or not AVs increase or decrease traffic is the concern of possible security issues that may interfere with human-controlled traffic or even standard traffic lights. For instance, in analyzing the use of Artificial Intelligence in crime, Hayward and Maas (2021) find it possible to hack an AV or manipulate its surrounding environment. AVs do not respond to traffic prompts such as speed controls and traffic stop signs. Considering that AVs are intended to be fully automated and safe to the point that even non-drivers like children will use them, this is a valid concern for traffic control and safety.

Accident Simulations

While AVs are intended to reduce the number of accidents on the roads, some authors have associated AVs with higher rates of accidents (Gambi et al., 2019a; Gambi et al., 2019b; Gambi et al., 2019c). For instance, the autonomous vehicle may not have the suitable algorithms to know when to stop and allow people to cross—for example, a case of a child who crosses the road abruptly. In the case of a human driver, the driver will make sure they avoid hitting the child by all means; however, an autonomous vehicle will crash the child. Thus, aside from accidents, pedestrians will be involved in accidents and lose their lives at an increasing rate due to autonomous vehicles. Pearl (2019) contributes to the discussion on the safety of AVs by arguing that despite the perception that AVs will cause fewer road accidents, the opposite is true. Geary and Danks (2019) argue that the current data on accidents is projected in terms of percentages and is "per mile" traveled. The actual numbers would significantly increase these numbers to the point of very little or no reduction. Boggs et al. (2020) contend that simulation of autonomous vehicles is far much safer, efficient, and cheaper than live testing. Changes in autonomous vehicles are required to meet a certain level required for operation in order to be put to a live test. Implementing a stimulator to these vehicles is ideal as it helps to test the vehicles. These authors call for more accident simulation testing to develop better effective methods of testing accidents and to reflect actual police reports on accidents on the ground. Since testing in substantial traffic is dangerous and expensive, the authors suggest using police reports on accidents to simulate AC accidents in a controlled environment. Bogges et al. (2020) also calls for the study of the specifications required for a realistic simulator to conduct an analysis of autonomous driving and semi-assisted driving. Studying the simple road network is also crucial as it is useful in traffic simulation tests.

While doing simulation, it is important to avoid considering accidents caused by alcohol or speeding that the use of other technologies can avoid. Hallevy (2019) reiterates that although self-driving vehicles may avoid accidents caused by human error, that does not mean they cannot cause accidents. He illustrates that machines are capable of making mistakes that otherwise would not be made by humans. Machines may make mistakes like failing to stop when animals, pets, and even children abruptly choose to cross the road. Failure to stop occurred when a Tesla autopilot tried to drive under the trailer, causing a fatal accident. Hallevy (2019) contends that a human driver cannot sometimes make this mistake. Therefore, machines are also capable of causing accidents, even after avoiding all human-made ones. To mitigate these scenarios, the manufacturers need to devise a way to enable human drivers to intervene in case of a machine mistake. Such interventions would prevent most of the accidents caused by machine failure.

Despite many machine mistakes, AVs have the ability to operate for 24 hours without the need to take a break. Unlike human drivers, who might fall asleep, AVs cannot fall asleep. Wu et al. (2019) argue that AVs cannot be drowsy, unlike human drivers, who can experience drowsiness due to several factors surrounding them, including overworking. He stresses that the response of AVs in case of impending collision during an accident is higher compared to that of a human being. These factors are key in accident prevention because AVs rely on advanced sensors and cameras to gather information about the road and surrounding environment and sophisticated algorithms to make driving decisions. These devices are a critical factor in accident simulation. Do et al. (2019) argue that although simulations are important in AV safety, many simulations have been done based on the parties responsible. Therefore, there is a need for a collective accident simulation among manufacturers and researchers to improve the safety of AVs and public acceptability.

Crime Prevention

The limitless capabilities in technological advancements ring with them a hoard of new avenues for crime as well. As Hayward and Maas (2021) explain, technological innovators have been so fascinated with these limitless possibilities and exciting innovations that they have paid little attention to the other side of technology crime. While technology is made with good intentions, such as helping the police in crime prevention, the same technology is used to engage in persistent crimes. Criminals will exploit autonomous vehicles for their illegal activities as there will be a connection between the vehicles and mobile phones, and a lot of hacking is expected to occur (Sinha et al., 2021). To help mitigate the criminal activities, the author proposes three risk levels be accounted for. For example, critical hardware and software components of the autonomous vehicles that receive wireless updates are supposed to have supply chains that should be protected. Sinha et al. (2021) state that securing the interface of the operating system and equipping it to be able to handle threats and employing heavy security on the vehicle operating centers. There has been little coordination between the technology field and other social fields in trying to counter the adverse effects of technology (Hayward & Maas, 2021). With the growing aspects of the internet and the increased connectivity between devices, excitement about smart cities, and the anticipation of fully automated vehicles, criminologists have to consider the effects of this introduction into their line of work (Li et al., 2021). The results include how and whether they are prepared for the incoming challenges, the consequences of un-regulation of artificial intelligence for crime fights, and, most importantly, how they can employ artificial intelligence to fight and prevent crime, including AVs. Bikeev et al. (2019) propose granting legal status to artificial intelligence, which would mean punishing the artificial intelligence for crimes committed, including the labeling as a criminal, which works as a

warning to potential artificial intelligence crimes by re-programming or destruction of the artificial intelligence. Law enforcement must meet the pace at which technology is advancing if they intend to compete in a world that is becoming technologically dependent.

In addition, police officers can make use of AVs in predictive policing programs in preventing and solving crime. The predictive policing technology gathers crime data, analyzes it and provides information that can be used to enhance police officer allocation (Abraham & Rabin, 2019). The capacity of self-driving vehicles means that police units can upload predictive policing information into officers patrol vehicles in their shifts. This gives the patrol car the capacity to know where and when to drive thus providing visible presence to prevent crime. Currently police units have to source for this information, memorize it or write it down. The development of AVs supports the work of police officers through downloading data in each shift thus providing better insights in reducing crime.

The nature of the work of police officers makes them prone to being distracted. The introduction of self-driving vehicle allows officers to multitask while continuing to drive safely. This gives them adequate space to focus attention on other areas in an effort to collect information and deter criminal activity. According to Nastjuk et al. (2020), AV technology will also help in reduction of number of police officers killed or injured in traffic collisions. Automated related accidents take significant toll of law enforcement officers. The safety features of AV linked to GPS-enabled mapping identifies traffic congestion and current technology of traffic light preemption devices (Boggs et al., 2020). This helps to improve on response time while at the same time ensuring officers arrive safely. AV allows deconfliction at intersections as such police vehicles know when other law enforcement cars are nearing similar intersection

while driving with sirens and lights. Police pursuit will also become safer thus preventing police from over driving.

Reducing the need to investigate and report on traffic collisions creates fiscal advantage. The development of necessary smart infrastructure to support autonomous vehicles paves way for increased adoption of the technology on the roads. AV rely less of the human factor in preventing collisions. Majority of cases involving AV have been identified as caused by human error (Gambi, Huynh, & Fraser, 2019). Increased adoption of AVs will facilitate reduction in time and personnel required to investigate the collisions and save on funds that can be redirected to other areas of law enforcement.

Effect of Autonomous Vehicles on Drug-Related Accidents

Fully autonomous vehicles are expected to reduce the number of drug and alcohol-related accidents. No drivers control the vehicles who drive vehicles reckelessly under drugs, causing accidents. One of the significant arguments for AVs by multiple authors is the removal of functional barriers that are imposed by conventional vehicles, with particular focus on children, senior citizens, disabled persons, people who are unable to drive, and drunk drivers (Abraham and Rabin 2018; Shariff et al., 2017; Priby & Lom, 2019 p. 2). With current policies on drug law enforcement proving inefficient, especially in minority areas, there is a need for new policies that use a harm reduction approach. Kammersgaard (2019) finds out that even with different policies that are ideally meant to decriminalize drug possession partly as an approach to harm reduction, the researcher argues that this is simply a failed attempt while hiding behind the ideation of public health and wellbeing. Finding new policies would require a deep understanding of the current scene on drug law enforcement. Fell (2020) examines the potential outcome of AVs on alcohol-induced accidents, suggesting that although more research in the field is needed, the

possible effects indicate reduced crashes and fatal accidents as AVs do not depend on driver sobriety for performance. Moreover, with ride-sharing observed as a potential benefit of AVs, the studies from rideshare companies such as Uber and Lyft in New York City indicated a decrease in drunk-induced accidents.

The autonomous vehicles are programmed to avoid human errors, such as drunk driving, which causes accidents. However, the AVs are also capable of making mistakes that cannot be made by human drivers, like failing to avoid an oncoming vehicle driven by a drunk driver. RB Voas states that there are different features that should be addressed so as to address the mistake made by the AVs in the situation where drunk pedestrians and children are involved. He cites ease of operation and safety features as considerations when dealing with the VA's response to drugs (Voas, 2020).

Data Encryption/Hackers

Bansal and Kockelman (2018) found that hacking or information security was one of the major global concerns regarding its safety. With the proposed connectivity, such as vehicle-to-vehicle connectivity, the possibility of connecting AVs to other devices such as phones, and most importantly, the ability to control the AV remotely, the fears associated with informational safety are valid. Hayward and Maas (2021) cite that these hacking threats exist even beyond the hacking of internal systems. Previous researchers have indicated that using stockers on traffic lights can cause AVs to ignore speed restrictions and drive full-on into oncoming traffic. Bikeev et al. (2019) also contribute to the data on artificial intelligence for crime prevention and combatting crime. The authors warn that even self-learning artificial intelligence is an independent threat. With robotics able to learn faster and adopt the learned information faster than human beings, threats are inevitable. Joh (2019) focuses on how AVs can be used in crime

reduction. For instance, stolen vehicles are more easily traceable, and encouraging the public to report carelessly driven AVs will discourage driver recklessness.

Holstein et al. (2018) emphasize the need for software engineers to be adequately prepared and create solutions for AVs. According to the authors, software technical issues have solutions and should be solved similarly. Autonomous vehicles are easy to hack. For example, the Tesla S model three introduced to the market in 2019 was hacked within a few minutes. Attacks such as Malware attacks, Denial of Service attacks, and ransomware attacks are possible attacks that can be done on autonomous vehicles (Sinha et al., 2021). Technology constantly evolves; therefore, autonomous vehicle companies should regularly check through the vehicles to ensure that there is no possible gap vulnerable to attack. Hackers will continue to look for new possible ways to hack autonomous vehicles, which will lead to new vulnerabilities. Therefore, companies should look into ways that will make their vehicles more secure.

Autonomous vehicles rely on complex of systems to source, interpret, and transmit data to enable safe operations. According to Bikeev et al. (2019), AV introduces new security risks to sensitive information as well as public safety. Managing risk effectively within the evolving hybrid-threat space requires consistent and close collaboration between physical security and cybersecurity professionals. The main benefits pursued through AV include improvements in overall driving and safety, higher reliability with tech devices fitted onboard, better integration of human-machine set-up, and operational improvements such as reduction in traffic congestion, improved mobility, and optimized freight flow (Ulybyshev, et.al. 2018). The area of safety is of great concern especially as technological innovation face critical cyber threat.

In 2014, Jim Farley Vice president of Ford, told the participants of the motor show that they had a GPS in the auto and hence they had an access to their personal information. This

revelation contributed to public outburst against him forcing him to withdraw the remarks. This brings the concerns about the encryption, data safety and privacy of the consumers. Jinbo Xiong argues that there is a need to implement strong encryption systems to the AVs. This is to ensure that the data is not vulnerable. He proposes that the manufacturers must input a strong data sharing framework like edge-assisted privacy-preserving raw data sharing framework (Xiong et al., 2020).

According to Wiseman (2022), threats and vulnerabilities emerge with advanced adoption of AV. Traditional cyber-attacks compounded with emerging risks affect operations of AV. New form of attacks involve ransomware and IoT attacks. AVs are connected in nature meaning that there are security risks to networks that are connected to the system. These may include roadside sensor networks, traffic control features, or electricity infrastructure. The traditional approach for development of software activities focused on securing product safety and quality and less emphasis on cyber security. This represents high risk that requires procedural and cultural change. Development of software as a new set-up for AV emphasizes on securing product quality and passengers safety. Yeong, et.al. (2021) asserts that the set-up of AVs where they are dependent on array of sensors, electronics, and computer systems puts the vehicle in great risk in terms of cyber security. Strong cyber security ensures such systems work as planned and built to prevent safety risks. Research by Sifakis (2018) emphasized on the need for comprehensive cyber security environment that incorporates multi-layered approach which leverages on the existing cybersecurity frameworks and supports adoption of best practices that enhance security posture of AVs. Scalas and Giacinto (2019) emphasizes in the need for multi-faceted approach focuses on vehicles entry point, wired and wireless, that could create vulnerability towards cyber-attack.

Effects on the Average Citizen

Studies on the effect of AVs on an average citizen continue to explore the divergent views of citizens on the use of AVs. Interestingly, one survey found that emerging markets trust fully automated AVs more than developed markets (Priby & Lom, 2019, p.2). Nastjuk et al. (2020) found that relative to research informing on potential government policies meant to enhance the uptake of AVs in society, there was limited data on how ordinary citizens feel about the use and acceptance of AVs. The average citizen in America views AVs in a positive way as they view them as being able to save lives and reduce motor vehicles death by close to 85%. Menon and Alexander (2020) state that autonomous vehicles are perceived positively by society for having the capability to reduce traffic drastically hence reducing the travel time. Additionally, people who eat in the autonomous vehicle can be productive throughout the journey while riding a much safer vehicle. The average citizen who works as a driver in fields like health care insurance and travel perceives these vehicles as a threat as they will lose their position in these companies; hence their view towards these vehicles is negative.

The researchers evaluated various factors that would influence the acceptance of AVs for normal people, such as their level of knowledge and the perceived benefits of using AVs. The effects on the average citizen inform the potential impact of its introduction and whether or not AVs will be accepted and embraced in society, defining the market. Bansal and Kockelman (2018) conclude that technological evolution causes people to evolve and grow. The inconveniences and uncertainties that come with the changes may influence people's attitudes towards technology, their willingness to embrace them, and ultimately, whether the new technology becomes a success. Geary and Danks (2019) explore the expected benefits of introducing AVs from a more skeptical point of view. Like Pearl (2019), the authors challenge

the seemingly excess positivity portrayed by multiple authors, expecting that the AVs will result in better outcomes.

The Case for AVs

Abraham and Rabin (2019, p.2) cite that an advantage of AVs is bridging the gap for disabled persons since fully automated vehicles do not impose functional barriers to disabled persons since they are self-driven. Additionally, non-drivers, including people without driving licenses or people who may not be confident in driving, such as the elderly, benefit from its introduction. Nastjuk et al. (2020) also found similar data suggesting that people were more likely to judge how they would utilize the AVs. The aspect of being beneficial to society in enhancing the independence of non-drivers and the subsequent opportunities that the AVs opened up for them, such as ease of school attendance, was a significant factor (Nastjuk et al., 2021). Interestingly, while manually driven vehicles have been judged to bring the most satisfaction while driving them, there is an interesting contradictory finding that some people would derive satisfaction riding in an AV (Nastjuk et al., 2021). This finding is important because the satisfaction a person derives from driving determines their interest and acceptance level of the particular vehicle.

While the dangers and challenges of introducing AVs are present, some authors argue that they are no less than challenges faced by any other disruptive technology or exposure to change. For instance, Shariff et al. (2017) argue that AVs are technically safe, but the factors such as overreaction to accidents caused by AVs are barriers to their introduction. The authors also point out that the only way AVs come into play is to fulfill specific needs of people, meaning that their success is dependent on people. Nastjuk et al. (2020) also found that most cases against the adoption of AVs have less to do with technical issues and more to do with

psychological issues. Stilgoe (2018) makes corresponding claims that self-driving solves needs, economic opportunities, and problems presented in society and that their uptake is dependent on social learning and technical acceptability.

For instance, Pribyl and Lom (2019) found that most people who favored the uptake of AVs would use the extra time for task fulfillment, including work, reading, or relaxing. In AVs, a faultless, artificially intelligent motorist substitute for an error-prone motorist. Tennant and Stilgoe (2021) assert that increased productivity when the driving task is no longer a problem is an added advantage of AVs. The effects on the average citizen inform the potential impact of AVs introduction and whether or not AVs will be accepted and embraced in society, defining the market (Pribyl & Lom, 2019). While the dangers and challenges of introducing AVs are present, some authors argue that they are no less than challenges faced by any other disruptive technology or exposure to change (Stilgoe, 2018). AVs contribute to the larger scale of sustainable, intelligent cities that incorporate other technical aspects such as e-mobility and smart parking (Campinsi et al., 2021). Since AVs are not implemented in a vacuum, the authors identify other disruptive technological advancements that, combined with AV, offer undeniably beneficial status after implementation. Ribeiro et al. (2022) found that because of developments in connectivity and sensor technology and the successful application of obstacle detection algorithms, AVs have become an innovation that can potentially change transport direction.

The exciting finding of AVs is that senior citizens are less likely to use them even though they are a category that would highly benefit from AVs (Pribyl & Lom, 2019). These findings are consistent with Bansal and Kockelman (2018). In a survey of Texans' willingness to use AVs, older people associate automation with lesser value and are less likely to use them. Despite supporting AVs, the authors also found that most respondents would not send their children to

the AVs. The impact of AVs on whether or not people shift where they live due to the efficiency and accessibility of cities indicates that most are unwilling to shift, indicating that there may be more factors at play than accessibility on choices of where to live. The issue of information security has been cited as a significant concern in the uptake of AVs. Bansal and Kockelman (2018) found that it was the primary concern. Cases of hacking were most cited as a concern globally. The indication that social acceptability is plausible and that AVs will be allowed to cause accidents now and then.

Campisi et al. (2021) explore the advantages of smart cities and the various decisions that lead to the development of smart cities with autonomous mobility solutions. AVs contribute to the larger scale of sustainable, intelligent cities that incorporate other technical aspects such as e-mobility and smart parking (Campisi et al., 2021). Since AVs are not implemented in a vacuum, the authors identify other disruptive technological advancements that, combined with AV, offer undeniably beneficial status after implementation.

Effects of AVs on Society (Ethics, etc.)

Ethical, Moral-Political

Cohen and Clémence (2018) explore the role (or no role) that the government plays in regulating AVs in the present and future, including developing rules and regulations that will guide traffic police. The moral, ethical, and political impacts and questions raised by the continuously evolving dystopian technology, inclusive of AVs, are significant determinants of how society, governments, and even manufacturers respond to the inevitable technological advancements. Alijauskaitė (2020) explores the various societal effects of morality, ethics, politics, and the environments that the implementation of AVs will have on society. According to the author, one crucial factor of consideration is the claim that AV's involvement in numerous

accidents, contrary to popular opinion, will reduce the number of accidents. AVs are hoped to reduce the number of accidents since they do not rely on humans. There will be reduced rates of careless driving or drug-related accidents. The author also explores the multiple campaigns that have been held against robot introduction in society, including AVs. Holstein et al. (2018) suggest using software engineering to solve ethical and moral issues, even though the authors warn that ethical and moral issues are not as direct as malfunctions and possible security breaches.

Bikeev et al. (2019) cite a case of an AV forced into a situation where it has to choose whose life to save in a case where an accident is inevitable. The authors examine a case study termed the "Moral Machine" (Ethics for a Vehicle), concluding that millions of people consider moral and immoral. For instance, most people were more likely to save people's lives than animals and save the younger people by sacrificing the older. Mercedes Benz showed that their vehicles would save the passengers' lives while ignoring road users who may be more than the vehicles' passengers. Even though they seem perfect, AVs cannot act according to laws or societal morals since they cannot differentiate between good and evil. While these responses are considerable, the authors also noted significant differences in gender and religious beliefs on what was considered moral and immoral (Bikeev et al., 2019). The outcome is that neither of the simulations would be illegal, holding the manufacturer responsible.

The question of responsibility when an AV is involved in an accident or any other situation that potentially poses a danger, for instance, to human beings, is a question of ongoing debate evidenced by the diverse opinions on legal ramifications on different partners (Abraham and Rabin 2019; Gopalswamy & Rathinam 2018; Pearl 2018). Bikeev et al. (2019) explore the possibility of holding an artificial intelligence responsible for the dangers it poses by granting it a

legal status, which extends beyond a legal issue to an issue of morality, ethics, and highly politicized matters. Karnouskos (2018) also explored the ethical problems arising from AV implementation, such as when involved in a fatal accident. Although the author finds limited beliefs associated with ethical limitations for the use of AVs, the author also sees the need for a comprehensive ethical framework that also fills identified and unidentified gaps that may limit the adoption of AVs in society. Yokoi and Nakayachi (2021) contribute to the ethical dilemma by suggesting that technological advancement induces change, but the belief of people in these changes and their moral views and trust (or lack thereof) influence uptake or market failure for these changes.

Environmental and Sustainability

Freemark et al. (2019) found that although AVs are intended to reduce congestion in cities, most officials were worried about the potential environmental effects such as congestion with increased prevalence of AVs. Due to their features, the use of AVs may increase vehicle use, increasing congestion. Klaver (n.d) argues that millions of people will be more willing and ready to use a vehicle, including the young, old, and disabled, because AVs provide new mobility options. In addition, the use of AVs could lead to reduced cost of traveling, thus encouraging many people to travel, increasing the usage of vehicles, and increasing congestion. Similarly, Cohen and Cavoli (2019) conclude that having a laissez-faire approach with minimal government regulation on introducing AVs may increase uptake. Still, the effects will be more devastating to the average citizen. For instance, AVs may lead to increased pollution leading to increased gas emissions in the environment and congestion. Loss of jobs is another factor that the average citizen may experience. For example, the loss of drivers' jobs since the AVs are self-driven. Cohen and Cavoli (2019) expound on this explanation in that AVs uptake will favor the

rich and cause a sprawl, increasing pollution and limiting the accessibility and flexibility of other transport options for ordinary citizens who use other means of transportation bicycles. Zhao et al. (2021) remark that an intelligent driving strategy might urge AVs to interact correctly while leveraging limited safety resources; yet, a poor driving strategy could result in an undesirable rush or jam that could have been avoided.

The author suggests a four-centered approach, where policies and regulations focus on planning, policies and regulations, service provision, and economic instruments. Planning solves the problems of sprawling and promotes the development of space-efficient transportation. Policies and regulations regulate the use of AVs, such as prohibiting empty AVs or regulating parking use for privately owned AVs and other environmentally friendly restrictions. Service providers focus on enhancing efficient public transportation, especially in poorly accessible areas. Economic instruments would influence mode choices through road pricing, limiting private means in favor of general standards. Duarte and Ratti (2018) propose the synergy between AVs and public transport. They argue that replacing public transport (case in point, subways) with AVs is almost unrealistic and causes a more considerable burden. Therefore, the authors propose combining the two where AVs may be used as feeder modes to (Transport Oriented Development) TOD stations and corridors is a more conceivable idea. Nastjuk et al. (2020) suggest that policymakers and operators could introduce incentives for vehicle-sharing for AVs to increase acceptance of AVs in society. In terms of public transport, AVs solve the first and last mile problem, the connection between transport modes such as the beginning of the ride and the final destination. Therefore, the use of AVs increases the viability of sustainable transportation modes. Wiseman (2018) explores the shift and preferences of rail and road after introducing vehicles, concluding that while roads are preferable, phasing out rails was not an

easy option, particularly since they were associated with lesser accidents. These findings correspond to Duarte and Ratti (2018) proposing the synergy approach.

Sustainability is a crucial component of the growing technological industries and virtually every aspect of society. Dia (2017) examines the potential for having low carbon mobility in the future and emphasizes that a holistic well-planned approach is the way to go. The author purports that AVs can achieve the urban plans for zero road injuries and low Carbon living, particularly when combined with other technological trends. The argument towards reduced vehicles on the road primarily achieved with ride-sharing options may have the impact of reduced traffic and drastically minimizing the number of vehicles on the road (Duarte & Ratti, 2018). Complete and successful adoption is dependent on overcoming regulatory, technological, and societal obstacles (Dia, 2017). Seuwou et al. (2020) also find that autonomous vehicles are a valuable and sustainable addition to the attainment of intelligent cities, which is a goal that most governments on different levels are working towards achieving.

Marletto (2019) argues that AVs' impact on urban mobility is positive due to the strict regulations of AVs and also due to their energy efficiency and sustainability. Kopelias et al. (2020) argue that AVs are game changers in greenhouse conservation. They state that AVs have the potential to reduce carbon emission at a great length. Environmental noise pollution has also been an issue that has been associated with road traffic. They argue that AVs can greatly reduce noise pollution because, they optimize driving patterns, reduce fuel consumption and improve traffic flow, lower noise pollution, and decrease CO2 emissions from vehicles. Additionally, AVs are likely to make more efficient use of existing road networks and reduce the need for personal car ownership, which could lead to reduced traffic and therefore reduce emissions from vehicles.

Summary

In summary of this chapter, the review has highlighted the non-technologically focused research on the uptake of AVs. These findings include the policies and regulations developed (or need to be developed) in the regulation of AVs and as a point of reference for future legal processes after the total uptake of AVs. The continued debate on acceptability, ethical perspectives, and social and environmental changes associated with the introduction of AVs contribute to the critical discussion on regulation and the disruptive effects. Whether or not they support automated vehicles, most researchers, authors, and responders conclude that the rolling out of AVs in society is simply a matter of time. There has been little preparation by the legislation to introduce AVs in society. There is a need to investigate the repercussions of having unregulated or no policies governing the manufacture and usage of AVs, the impacts of AVs concerning current legal jurisprudence, and potential changes and the effects of AVs on the greater society (Li et al., 2021). With minimal research outside of the technological aspects of autonomous vehicles, this piece shall contribute to the available literature concerning the named topics above and a particular focus on criminal justice.

Crime and Crime Prevention

Hayward and Maas (2021) explain that technological innovators have been so fascinated with these limitless possibilities and exciting innovations that they have paid little attention to the other side of technology crime. Ignoring the technological advancements or leaving the possible effects on crime increase to the experts is not an option. Law enforcement officers on different levels need to be aware of how to react. Joh (2019), Shariff et al. (2017), and Pribyl and Lom (2019) explore the possibility of AVs reducing crimes and alcohol and drug-related accidents. While AVs, just like other types of Artificial Intelligence, are associated with new avenues for

crimes, the same avenues can be used to prevent and counter crimes, as proposed by Holstein et al. (2018). AVs pose a tremendous cyber security risk, making it possible for cybercriminals to hijack an autonomous vehicle and remotely cause a crash. The vehicles use artificial intelligence, which employs machine learning techniques that enable them to collect data and analyze and make transfers to enable descion making. In other vehicles, these descions are made by human beings (Menon & Alexander, 2020). Artificial intelligence is ideal in the autonomous vehicle as it recognizes traffic lights and markings on the road. AI also detects the vehicle's speed and plans the path ahead of the vehicle. There could also be other forms of crimes despite the cyber security, such as painting the rad to confuse the navigation system of the autonomous vehicle or putting stickers or signs which prevent the vehicle from being recognized. Such alteration can cause Artificial intelligence to classify the objects wrongly, making the autonomous vehicle behave in a way that could seem dangerous (Menon & Alexander, 2020). The most common ways that could cause a vulnerability to the autonomous vehicle include remotely accessing the vehicle via Bluetooth or the internet planting a device into the vehicle and messing with the vehicle's sensory (Menon & Alexander, 2020). This can be prevented by ensuring that as the technology evolves, the systems designing the vehicle are evolving, and hackers will devise ways to expose the system's vulnerabilities.

Effects of AVs on Society (Ethics, etc.)

Different authors have explored the issues of morality, ethics, politics, and environmental and sustainability impacts of AVs on society. Alijauskaitė (2020) and Bikeev et al. (2019) explore the probable adverse societal effects of AVs, while Holstein et al. (2018) discuss the possible solutions for these effects. The results are conflicting, with some suggesting there are no plausible societal effects that may warrant the lack of acceptance of AVs. In contrast, others

argue that the ethical effects may counter the acceptability. Wiseman (2022) asserts that AVs can assist disabled persons, and military AVs can lessen war fatalities. With the preparation that governments on different levels have made to welcome AVs into the society, there is a need to investigate the repercussions of having unregulated or no policies governing the manufacture and usage of AVs, the impacts of AVs on the CJS concerning current legal jurisprudence and potential changes and the effects of AVs on the greater society. Autonomous vehicles have potential benefits to society as they can be beneficial in lowering the carbon emitted to the environment, which gives way for sustainable forms of living in society. Autonomous vehicles can transform society in more positive ways as it has benefits like increased mobility for the people and providing efficiency and convenience (Classen et al., 2022). AVs positively influence society as they reduce the number of accidents that could happen on the road while at the same time preventing them. Sinha (2021) explains that crashes that happen on the road are 80% caused by errors made by human beings, such as driving while texting. Sinha (2021) notes that one ethical issue that could be a result of autonomous vehicles is the ability of machines to make moral decisions. Although autonomous vehicles may reduce road accidents based on past events, the authors state that it is crucial to consider past events. For example, the Waymo and cruise operating in San Francisco resulted in 53 collisions (Sinha et al., 2021). In a situation where a crash occurs, ethical decisions have to be made. The moral decision brings about a moral dilemma based on the Massachusetts Institute of Technology research.

(Zhu et al., 2021) observes that AVs have caused difficulties in bioethical and accident liability ownership. They state that not a single country has a perfect solution for this ethical dilemma. To solve the dilemma, they state that the development of the AVs should go hand in hand with improvement of human well-being, with timely review of relevant laws and technical

regulations. This will ensure that the ethical issues identified are promptly addressed. (Ryan, 2020) argue that AVs are far from ethically being accepted. He state that the debate surrounding AVs' decision making capabilities on a crash situation is far from over. The argue that the guidelines developed by AVs to offer assistance to the programmers to come up with a ethically compliant crash algorithms is too vague, and ineffective at addressing the pressing ethical concerns. This concerns are too valid, given that there have been great concerns about the inability of the AVs in detecting pedestrians/animals crossing the road. (Cuthbertson, 2019) claims that there is an algorithmic bias that prevents the AVs from detecting black skin color. He states that there is a higher probability of a black person being hit by the AVs than a white person due to this algorithmic bias. It therefore means that there is a greater need for a review of the algorithm to prevent cases of bias. The ethical issue surrounding the capability of the AVs' decision-making is a vital one that requires a cautious approach to avoid future bias and build public trust on AVs.

(Evans et al., 2020) proposes a model of the AVs decision making mitigation. They state that the model of AVs' decision making as a claim abatement. They argue that the damage done or injury inflicted by AVs' actions and any uncertainty associated with them, when evaluated and addressed should bring about ethical implementation reflecting the real situation on the ground. They state that the flexibility of this approach provides a simulation that addresses several ethical and moral issues relating to ethical demand and the expectations of road users. This approach is key to addressing several ethical concerns and evaluating the AV's decision-making algorithm. This provides a means of public acceptance of AVs' decision-making and therefore solves an ethical dilemma.

Policies and Regulations

Abraham and Rabin (2019, p. 3) explain that the policies and regulations for AVs will require increased accountability of the manufacturers, especially for the highly automated vehicles. A distributed accountability approach is better and will accelerate the incorporation of AVs in the market. The division of responsibility places greater accountability on all involved parties and requires collaboration, giving AVs a more holistic approach. Cohen and Cavoli (2018) explore the role of government in the control of economic-driven aspects of ACs. In most liberal governments, the regulations largely favor minimal government interruption and more of an economically driven system which Cohen and Cavoli (2018) foresee as a potential disaster with AV introduction in the market. Leuzzi et al. (2017) explore what AVs would mean for traffic control and explain that several issues have to be resolved for police to manage traffic control. For instance, the police should understand the latest technologies on vehicles and have the proper response in case of fatal (or non-fatal) accidents. Government regulations remain largely unprepared for the change with continued studies on proposed legal systems, compensatory strategies, and accountability responsibilities.

The federal autonomous vehicle policy does not state new rules and regulations for autonomous vehicles, although, according to the author, after the widespread (Etzioni et al., 2020). During the deployment of autonomous vehicles, the states need to accomplish much or adjust their rules and regulations in areas that deal with insurance, registration, licensing, and enforcement of traffic. AVs possess the ability to transport systems and how people move across the states. Therefore, as technology continues to develop, the local government and the federal state continue to explore and address the challenges and benefits of the revolution in traffic. Eleven states already have legislation regarding autonomous vehicles, Florida being the top on

the list. Michigan has also eased the restrictions given to manufacturers regarding testing the vehicles on the roads (Etzioni et al., 2020). The policy and regulations regarding autonomous vehicles have begun to take shape around the National Highway Traffic Safety Administration's Federal Motor Vehicle Safety Standards, which means that adopting autonomous vehicles by 2030 is close to reality.

Theoretical Framework

This section outlines the theories and models that support this study's research findings and claims. This research employs epistemological assumptions. Similarly, numerous theories support the views and perceptions of most people regarding autonomous vehicles, their impacts on society, and their cybersecurity realm. This section will evaluate socio-technical systems and political systems theories.

Socio-technical Theory

Erick Trist initially developed the theory in the 1960s (Lawlor & Sher, 2021). Trist wanted to evaluate the benefits of integrating different components to build an entire system. As a result, he contributed to simplifying complex organizational systems by advocating for integrating social and technological systems to manage different operations. This theory is used to explain the organizational systems in the contemporary world. Social and technical systems work together to produce tangible results (Lawlor & Sher, 2021). The social component of these systems consists of aspects related to people, behaviors, culture, and how people interact with various components of an organization.

On the other hand, the technical component of these organizations deals with tasks, processes, infrastructure, and technology used in the organization. These components are interdependent and affect each other (Lawlor & Sher, 2021). For instance, humans depend on

digital technologies like AI to handle various organizational processes like business analytics. Given this interdependence, organizations should focus more on optimizing the social and technological dimensions of the organization to improve productivity (Lawlor & Sher, 2021). In practice, this theory is applicable in developing autonomous vehicles. It also evaluates the relationship between people and technologies like AI. One of the applications of the theory is cybersecurity. The cybersecurity of the systems used in autonomous vehicles can be described using this theory. While IT professionals design these systems from a technical perspective, they should also consider human needs, behaviors, and how this technology will affect them. Therefore, the theory stresses the essence of considering human and technical dimensions when managing a system.

Political Systems Theory

This theory was developed by David Easton (Dupont et al., 2019). The theory evaluates how political systems work in regard to policy making. It also evaluates how the policies developed to affect the community at large. Therefore, it analyzes the relationship between society's cultural, political, social, and economic aspects during policy formulation and implantation (Dupont et al., 2019). Policy makers make laws and regulations in response to the demands of the society. These policies are formulated, processed, and implemented. However, the theory does not stop at the policies. It also evaluates the impacts of these policies on society. According to David, there exist other systems outside political paradigms. These systems include environmental, physical, social, psychological, and biological. These systems are directly impacted by the decisions made in the political systems.

The theory also encompasses the logical stages in policy making. These stages include problem identification, problem definition, agenda setting, policy formulation, implementation,

evaluation, and policy change (Dupont et al., 2019). These stages represent the rationale behind the interaction between political systems and other systems. In this study, the author will evaluate how law enforcement uses AVs, their policies, their effects, and their sustainability. The study also acknowledges the growing need for policy change due to the rapid adoption of digital technologies in the automobile industry. These policies will help control and solve the issues related to fully automated vehicles. These issues include reliability and cybersecurity.

Related Literature

Abraham and Rabin examine the need for new law regimes due to the transformation in the transport industry (2019). There will be changes in the types of vehicles, where manual vehicles will be replaced by automatic vehicles. There will be new forms of accidents caused by vehicles and not the actual drivers themselves. It will be necessary to have new laws to guide individuals in dealing with the new accident cases. The newly developed laws are the Virginia laws and are most influential to students. Alijauskaitė examines how technology and the introduction of robots affect different aspects of society, like ethics, morals, politics, the environment, and society (2020). Robots have caused many accidents, deaths, and problems in society, and campaigns have been held to discourage the introduction of robots in society. This article helps policymakers identify the level of impacts of using robotics, artificial intelligence, AVs and how to deal with the problems to ensure a safe society.

Atkinson examines the obstacles that will affect the introduction of automated vehicles, including the laws and regulations in Wales and England (2020). The author also discusses the need to review the laws to match the changes associated with automated vehicles and advanced technology. There will be new laws for vehicle owners and vehicle manufacturers regarding automated vehicles, making the legislation process complex for both parties. Bansal and

Kockelman examine whether the public is ready for automated vehicles because the success of the vehicles or adopting the use of automated vehicles depends on the people (2018). Even though technology causes people to evolve and grow, the uncertainties and inconveniences influence people's opinions and interests, which affect their willingness to adopt AVs. Individuals were willing to try automated vehicles from different simulations and studies if they owned technological devices or devices in their families.

The authors explain the negative implication of using artificial intelligence. For example, artificial intelligence leads to a rise in ethical problems and raises legal issues, motivating individuals to develop interventions to mitigate the issues and concerns (Fell, 2020). Artificial intelligence possesses characteristics that can help identify criminological risks, classify criminological risks, and the legal regulation against the criminological risks identified.

Artificial intelligence brings justice to individuals because, by using self-learning, individuals who commit a crime can be identified, and the causes to commit a crime are also identified. The authors describe how qualitative research methods are used in healthcare setup. According to the authors, several methods are used for data collection in qualitative research, including semi-structured questionnaires, focused groups, and non-participant observations (Fell, 2020). Based on the authors' description, data analysis in qualitative research includes the transcription of audio files, field notes, and coding of the data using qualitative data management software. According to the author, using qualitative research methods enhances solving research problems. The quality of the research can be further improved by using co-coding, piloting, reflexivity, stakeholder involvement, and sampling strategies, among others.

The authors describe the development of smart cities, including the overview plan for establishing intelligent cities, which involves embracing technology in almost all aspects of a

city, including transportation, infrastructure, and environmental factors. Several interventions will be adopted to ensure the effective use of technology to develop efficient smart cities. The interventions implemented in smart cities include building human capital and solving problems encountered in the development of smart cities. Cohen and Clémence examine the transition of vehicles to automated ones using advancements in technology (2019). The authors discuss the absence or reluctance of governments to adopt technology to enable the transition of AVs. The authors believe that the government should ensure effective transition in automated vehicles because they greatly influence technology adoption. Governments should have well-planned interventions because a "laissez-faire" government would likely fail in a large intake of automated vehicles.

Dia examines the challenge policymakers and city leaders face when determining effective transport that is also environmentally friendly (2017). Environmental stability is not easy given that urban populations are rising and thus leading to increased demand for transportation services. The author provides necessary policies to enable policymakers and city leaders to reduce the existing infrastructure and transportation systems to develop smart cities. Duarte and Ratti state that continued transport, social, and legal issues will be continued, provided continued technological challenges associated with automated vehicles (2018). The author examines the impact of automated vehicles on the cities; for example if the automated vehicles will reduce traffic if the vehicles operate without drivers if the number of vehicles will be few in cities. The author also examines whether automated vehicles will increase urban sprawl or cause people to relocate out of the cities because they are fast and can easily access cities.

The author discusses the policies and interventions that have been taken into consideration to deal with highway accidents, especially those involving drunk drivers (Fell, 2020). Accidents caused by alcohol-impaired drivers have been in existence since the introduction of automobiles, thus the need to develop interventions to reduce accidents associated with them. The author states that the interventions are meant to reduce alcohol use among drivers and have been effective.

Feng et al. (2021) focus their article on examining the efficiency of safety tests for autonomous vehicles. AVs are a progressive and highly technological innovation. With the world moving towards fully adopting ACs as part of everyday transport reality, these researchers examine the viability of an intelligent driving test for ACs as a substitute to available methods. To demonstrate the safety of vehicles would need extensive testing over miles upon miles of distance, yet the inefficiency, both in safety-critical environments and the time, are limiting factors for this approach (Fell, 2020). The researchers' proposal of simulating naturalistic environments would solve both inefficiencies.

Moreover, the training of background vehicles would ensure non-bias and accuracy in the tests. Moreover, using technology to train, the background vehicles can simulate multiple encounters, similar to real-life situations. Even though human driving is quite different from automatic driving and less predictable, this method can still imitate human driving from readily available data on traffic flow. The researchers' proposal is highly sophisticated but easily applicable when given the different variables to consider. While a margin of error is proposed, the viability may be considered in this highly technological advancement.

Freemark et al. (2019) discuss and examine how government policies can affect the adoption or introduction of autonomous vehicles. The authors examine how different

governments like the municipality levels are preparing to adopt autonomous vehicles. The authors discuss existing plans by various cities in the USA and their analysis. Cities or municipalities with larger populations are likely to implement autonomous vehicles. The authors share concerns about the willingness of governments and individuals to implement autonomous vehicles because there are disparities based on different ideologies and preferences.

The authors, Gambi et al. (2019a), examine whether autonomous vehicles led to reduced accidents associated with the statement of few accidents. The use of automated vehicles has led to high accident rates instead of the automation reducing accident rates. The authors state that it is necessary to use simulations using police reports on actual accidents to test the effectiveness of self-driving vehicles' software before letting self-driving automated vehicles on the roads.

The authors Gambi et al. (2019b) state that there has been an increased number of accidents associated with automated vehicles compared to the promise that automated vehicles will reduce the number of accidents on the roads. It is necessary to single out a test to identify the increased number of accidents and provide solutions to increase the efficiency of automated vehicles on the roads. The author states that it is necessary to test the self-drive software's reconstructing accidents using police reports to find out the problem leading to these accidents and ensure the automated vehicles hitting the road will fulfill its notion of reducing accidents.

Gambi (2019c) examines the need to test self-driving software in automatic vehicles. Testing the self-driving software should be done using simulations because using real traffic is dangerous and expensive. The author states that police reports on accidents or automated vehicles should be used to inform the testing of self-driving using simulations, although it is difficult. Geary and Danks (2019) react to the excessive positivism associated with the uptake of AVs in society. They challenge the expectation that AVs will have benefits such as reduced

fatalities, increased access, particularly for individuals with mobility challenges, being more environmentally friendly by reducing carbon emissions, and increased productivity, such as freeing drivers to use that time for other things such as work. Geary and Danks (2019) call for a more realistic approach that balances out the expected benefits and potential challenges. For instance, while the prediction is that fatalities will be reduced per mile traveled, the potential increased uptake of AVs by the society will reduce the percentage margins. Instead, the authors suggest utilizing a more comprehensive approach where numbers are considered more than percentages concerning these predictions, particularly since the drive fully integrates AVs in the transport system.

The authors Gopalswamy and Rathinam examine the impact of leaving the tasks of introducing automated vehicles to manufacturers and how this has slowed the process of implementing automated vehicles (2018). Manufacturers have led to the irregular impacts experienced by automated vehicles in society's economic, social, and environmental issues. Therefore, based on the authors, it is necessary to adopt an "enabled infrastructure economy" to ensure manufacturers and other third players are involved in implementing automated vehicles in society.

The authors Hayward, Keith J., and Matthijs M. Maas discuss the application of Artificial Intelligence (AI) in criminology (2018). Artificial intelligence includes deep learning, machine learning, and reinforcement learning and has benefited criminals and criminal investigators. The authors state that criminals have advanced their illegal activities using artificial intelligence, increasing crime rates. The authors also discussed the application of artificial intelligence in solving crime, including using the different artificial intelligence paradigms to predict and prevent crime.

Holstein et al. (2018) examine the importance of using software to deal with automated vehicles and self-driving software problems. Self-driving causes software engineering problems that can be solved. Also, self-driving causes social and ethical issues that cannot be solved quickly. The authors propose using software engineering to love ethical and social problems associated with automated vehicles.

The authors discuss Automatic Crash Constructor from Crash Report (AC3R) to help solve accident cases associated with automatic vehicles. Thorough testing is necessary for self-driving automated vehicles because there are many accidents associated with them as opposed to its purpose of reducing accidents. The AC3R uses police reports in a simulated environment to help identify the causes of accidents and provide solutions to ensure the efficiency of automatic vehicles.

The authors discuss the importance of self-driving vehicles and how the vehicles can be tracked and stopped if needed. Individuals who miss their vehicles in parking lots can call the police department, and their vehicles can be traced and returned to them. If individuals identify or observe reckless drivers, they can call the police, and the vehicles will be stopped immediately, thus compelling the drivers to report themselves to the police.

The primary focus of this paper was on drug law policies and how the police respond to drug offenders. With a particular focus on marginalized communities who are often affected by drug-related crime activities, including use and possession, Kammersgaard et al. (2019) examine the effectiveness of the current policies on drug use to the victims. Marginalized communities tend to suffer more, and the authors insist on the need for change. Understanding the current situation is fundamental to grasping the role AVs play in drug and alcohol-related crimes and accidents.

The author Karnouskos (2018) examines the ethical frameworks that regulate or guide the use of self-driving vehicles. Self-driving vehicles are independent of human interaction since the use of technology and can be associated with many unethical choices like causing fatal accidents. It is crucial to build ethical frameworks and fill up the knowledge gaps to ensure there is no hindrance to the adoption of self-driving vehicles. There are no consumer beliefs that have been found to hinder the adoption of self-driving vehicles.

The author states that fully automatic vehicles have a significant impact on society. For instance, it will enable people who are not physically fit to drive and any other person who fears driving to get a chance to drive themselves. According to Fell (2020), many people have associated autonomous vehicles with reduced congestion, reduced accidents, and reduced pollution. However, autonomous vehicles will also negatively impact society, leading to the loss of jobs; thus, AVs positively and negatively impact society. The article illustrates the impact and costs incurred by society and governments concerning the introduction of AVs.

Leuzzi et al. examine police needs and any other road events that affect traffic flow, using data traffic mining, vehicle forensics, and understanding patterns (2018). The authors believe that traffic flow is meant to make trips faster and more comfortable and thus should be addressed effectively to improve road networks. Understanding police needs and events that contribute to traffic flow will aid in developing interventions to help promote safety and security on the roads.

Li et al. (2021) offer a new algorithm for decision-making for AVs to avert collisions in many situations. To estimate the risk level of traffic users, a probabilistic-model-oriented scenario evaluation module leveraging conditional random fields was presented. A way of avoiding collisions with preferred driving styles (such as assertive) was developed to suit the

expectations of diverse passengers predicated on the evaluated risk from the scenario assessment module. Finally, the authors used Carla (an AV) to test the algorithm for averting collisions in various circumstances. The findings reveal that the created strategy was adequate for AVs to avert crashes in various scenarios, including various driving styles. The popularity of AVs would be enhanced if experts devised a mechanism with customizable driving style choices to fit the needs of consumers.

The researchers sought to understand how social influences individual factors and system characteristics influence the acceptance of autonomous driving. Although there has been relatively extensive research on proposed government strategies to enhance the acceptance of autonomous vehicles in society, the research on ordinary individual users is limited hence the objective. The researchers examine a couple of factors and their relationship to how much people are willing (or unwilling) to accept, utilize and integrate AVs into their lives. Nastjuk et al. (2020) employ a comprehensive list of literature review sources to guide their research objectives and compare the research outcomes. By performing a mixed qualitative and quantitative research analysis on 316 participants, the researchers base the essence of their research on the wide-stated belief that the most significant barrier to the adoption of AVs is more psychological than technical. Their findings illuminate what influences the perception and acceptance of AVs in ordinary people. For instance, the study found that inexperienced individuals were more likely to trust the opinions of others, and hence their acceptance was dependent on third parties. Additionally, trust in AVs was more likely to be associated with openness and transparency. When the users understood more about the operation of AVs, they were more likely to accept the operation of AVs.

Pearl (2018) examines the need for restrictions on semi-autonomous vehicles. The judicial system has been ignored as it concerns the fully autonomous vehicles produced after the semi-autonomous vehicles. It is wrong to ignore semi-autonomous vehicles because they are more dangerous than fully autonomous vehicles. For example, the drivers can get distracted and cause accidents. The authors believe they should install software to warn drivers when they seem preoccupied and ensure the semi-autonomous drivers are trained to minimize danger.

Pearl (2019) explored the ability of the judicial system to offer fair judgments in accidents associated with autonomous vehicles. Autonomous vehicles were anticipated to reduce road accident cases but have numerous accidents. The existence of accidents due to autonomous vehicles necessitates introducing new litigation measures because accidents will be unique, and no laws exist to judge them. The author states that the choices of the judicial system will affect the ability of manufacturers to continue producing autonomous vehicles and the willingness of consumers to adopt the technology.

Pribyl and Lom (2019) examine the introduction of autonomous vehicles in the city infrastructures and analyze the importance of autonomous vehicles in the mobility of smart cities. Based on the author's analysis, autonomous vehicles can positively or negatively impact cities depending on existing policies. The effectiveness of autonomous vehicles can be achieved through testing or simulations to overcome limitations and gain more market penetration.

Ribeiro et al. (2022) analyzed the potential and performance specifications of sensors typically used in AVs, emphasizing a wide range of radar and LiDAR sensors, vision cameras, and the different settings where they may happen in reality. The authors introduced the main types of sensor calibration and discussed available open-source multi-sensor calibration tools and their interoperability with a range of sensors available on the market. The authors also discussed

current state multi-sensor fusion approaches and algorithms for object recognition in AVs and described the three primary solutions to sensor fusion (Fell, 2020). As a result, the study gave a comprehensive overview of the software and hardware methodologies needed for sensor fusion object detection. Automated driving has become an innovation that can shape the future of travel and mobility, owing to advancements in communication and sensor innovation and the effective use of obstacle detection algorithms. Sensors are critical to an AV's view of its settings. The utilization and operation of many integrated sensors can substantially hamper the viability of AVs. Sensor calibration is the cornerstone of every AV and the sensors that make it, and it must be handled right before obstacle detection, and sensor fusion occurs. Finally, the authors discussed obstacles in sensor fusion and research avenues for AVs.

Seuwou et al. (2020) provide an overview of the future smart city characterized by connected and autonomous electric vehicles (CAEVs), microgrids, and renewable energy generation resources. The authors credit the advancement in technology with contributing to intelligent cities because technology will help dependency on fossil fuels in power generation. The authors also discuss the importance of solar panels in control schemes other than environmental benefits. The authors state that smart cities are the best strategies to help cities solve or deal with problems like pollution, traffic, waste treatment, and energy consumption. Introducing technology and adopting connected and autonomous vehicles (CAVs) is the best way to build smart cities. Based on the authors' analysis, adopting technology will result in urban development, solutions to economic, social, and environmental problems, and ensure transportation sustainability to ease mobility.

Shariff et al. (2017) analyze three aspects of the adoption of technology and autonomous vehicles, including overreaction to accidents, ethical dilemmas, and the creation of solutions to

problems resulting from autonomous vehicles. Based on the authors' analysis, the use of autonomous vehicles has made people feel safe and happy because of the efficiency of the vehicles. Autonomous vehicles are technically safe, and it's only the people's psychological needs that need to be addressed to ensure widespread adoption of vehicles and self-driving because it is the future of smart cities.

Sifakis (2018) examines the use of IoT to change the notion of computing to the development of autonomous system designs. There will be the need for new inventions or innovations to help deal with complexities in the economic and social environment. The author proposes using knowledge-based designs to generate new foundations to ensure control paradigms are in place for cities to meet the autonomous challenge.

Strilgoe (2018) discusses self-driving and whether autonomous vehicles were "born smart" or advancing as technology advances. Technology has social learning and machine learning, contributing to self-driving. However, some crashes have been reported due to social learning. Therefore, making it necessary to improve social learning using machine language. It is also important to note that just like any other technology, self-driving is influenced by people's needs, economic opportunities, and problems that can be solved by self-driving.

Tan, Xiaoqi, and Alberto Leon-Garcia (2018) examine the opportunities and challenges associated with shared mobility, distributed energy resources, autonomous driving, and transport electrification. Also, to successfully manage autonomous mobility in smart cities in the future, it is essential to develop a structure that allows the convergence of autonomous mobility and energy resources. Also, the energy services built on existing infrastructure and autonomous mobility should be flexible on-demand to increase autonomous mobility on demand and ensure sustainable smart cities.

Tennant and Stilgoe (2021) note that a flawless, artificially intelligent driver replaces an error-prone driver in AVs. The autonomy discourse offers freedom from the drawbacks of automobility, even if it means relinquishing authority to independent, free-moving persons. The authors delve deeper into this story to learn about the ties that AVs are expected to form with the rest of the world. After interviewing AV developers, academicians, and numerous players, the authors examine the technological ties that parties see within the AV, on the highway, and worldwide. The ties include everything from software and technology to road users' actions to the economic, social, and physical framework that enables driving and self-driving (Tennant & Stilgoe, 2021). The authors divide innovators' understanding of, engagement with, and break free from these attachments into the following classes: 'brute force,' which views connections as concerns to be rectified with extra data; 'tackle the planet one location each moment,' which views attachments as constraints on the innovation's sphere of influence; and 'avert the ambiguity of the space,' that views attachments as the answer to issues faced by developers. Recognizing attachments is a potent tool for anticipating various technological configurations.

Ulybyshev et al. (2018) examine the Vehicle-to-Everything (V2X) communication systems, how vehicles and infrastructural devices can communicate using V2X, and how this can be applied in the transportation systems. Based on the authors’ analysis, to ensure the efficiency of V2X, there is a need to protect the data exchange between vehicles and infrastructural devices by encrypting the data to prevent the data from being used in places not intended. Data encryption is necessary because it provides security against hackers and thus ensuring the safety of vehicles and the transport system.

Wiseman (2018) examines how the introduction of autonomous vehicles changed the entire transport system and made rail transport obsolete. Several factors associated with the use

of autonomous vehicles like reduced accidents thus, safe, autonomous vehicles being fast, and reduced environmental pollution led to the preference for road use rather than rail. Based on the author's analysis, even though people preferred roads to rails due to the introduction of autonomous vehicles, there have been more vehicle accidents than rail accidents. Additionally, rails have been adopted to reduce congestion on roads, and vehicles can be put on trains to reduce air pollution.

Wiseman (2022) notes that Siegfried Marcus designed the first vehicle in 1870. The vehicle had no brakes or steering wheel. The driver's legs instead operated the vehicle. It took more than one step to transform traditional automobiles into autonomous vehicles. The initial step was taken in 1898, just 28 years after creating automobiles. The idea behind this stage was to move a vehicle using a remote controller. Many functionalities of current automobiles have been modified to be automatic without the need for even remote control following this first stage, as computers have become more powerful and smart.

Further research is required until an automobile can securely transport individuals to where they are going without causing an accident or requiring people to drive or be present. SAE International (Society of Automotive Engineers) has listed six tiers of AVs in vehicles. In the AV sector, this scale is entirely satisfactory.

AVs are a technology that can shape the future of travel and movement, owing to advancements in sensors and ways to detect obstacles and computations. Sensors ensure AVs view their settings correctly, and the integration and efficiency of sensors can influence the viability of AVs. Sensor calibration is the cornerstone of every AV and the sensors that make it up, and it must be done right before sensor fusion and obstacle detection can occur. The authors assess the potential and performance specifications of sensors typically used in AVs, focusing on

a wide range of vision cameras, LiDAR and radar sensors and the many settings they may work. Yeong et al. (2021) introduces the main types of sensor calibration and discuss available open-source multi-sensor calibration tools and their interoperability with a variety of sensors.

Yokoi and Nakayachi (2021) examine the factors determining whether people will trust Autonomous Vehicles (AVs). AVs are meant to promote change in the transport systems. Still, some factors determine their trust, like moral beliefs, reasons for adopting AVs, and the challenges Artificial Intelligence faces since they are similar. The authors state that moral beliefs, especially utilitarian beliefs, greatly influence the adoption of AVs.

Zhao et al. (2021) have defined the phrase driving approach as "comprehensible and informative driving processes established by AVs premised on gathered traffic and environmental attendee data with the goal of steering ego to make contact and ascertain next activity to verify efficiency." A good driving approach can encourage AVs to engage appropriately, utilizing restricted safety resources; nevertheless, a failing driving approach could cause an unnecessary rush or gridlock that could have been averted. The most significant distinction between defensive and competitive driving is the latter’s more idealistic premise that the nearby vehicles will drive logically and steadily. AVs are risky to embrace this premise without more usage to validate it. According to the analysis, this could trigger AVs to lose attentiveness in unforeseen situations and cause dangerous tendencies due to recklessness in the behavior model. Furthermore, this option will cause the AV to seek selfish self-driving objectives, resulting in a loss in overall efficiency.

Cybersecurity Concerns on Autonomous Vehicles

Digital migration is very prevalent and rapid in the modern world. Many businesses, cities, and sectors are increasingly integrating digital technologies into their infrastructure. Smart

mobility is an essential integration in this smart world (Kim et al., 2021). According to the author, autonomous cars are integral to this intelligent mobility. However, like other computer systems, autonomous vehicles are vulnerable to cyberattacks. These vulnerabilities cause serious concerns since they can affect the quality of life and human safety (Kim et al., 2021). Cybercriminals target various components of autonomous cars. These include autonomous driving systems, autonomous control systems, and vehicle-to-everything communications (Kim et al., 2021). Attacks on autonomous driving systems may lead to the malfunctioning of the components of these parts. These components include light detection and ranging (LIDAR) sensors, video camera radio detection and range (RADAR) sensors, Global Positioning System (GPS), Global Navigation Satellite Systems (GNSS), ultrasonic sensors, and central computer systems (Kim et al., 2021; Stocco et al., 2020). These components help the car navigate through different locations and obstacles on the highway. Malfunctions may misinterpret these obstacles and locations, leading to fatal accidents.

Automotive control systems are made up of in-vehicle networks connecting the main hardware component to other devices (Kim et al., 2021; Raiyn, 2018). These systems are made up of units and networks. These units include electronic control units (ECU) controlling the automatic transmission systems in these cars. They control the sensors installed in the vehicles. These sensors control the functioning of essential modules and the power train. These modules include doors, power locks, seats, airbags, light controls, and air condition systems. Attacks on this system could compromise these modules and lead to malfunctions and accidents (Kim et al., 2021). Raiyn (2018) explains that cybercriminals can hijack and infiltrate vehicle communication systems. These systems can be classified into vehicle-to-vehicle (V2V), Vehicle-to-infrastructure

(V2I), an external terminal (V2X), and vehicle ad hoc networks (VANETs) (Kim et al., 2021). Attackers infiltrate the wireless communication channels used in these systems, causing them to transmit inaccurate data and information. The automobile industry should consider these issues when manufacturing AVs (Kim et al., 2021; Liknov et al., 2019). This approach is essential in establishing defense systems and responses to address the cybersecurity concerns in these vehicles.

Taeihagh & Lim (2019) reviewed the safety, liability, and privacy concerns related to the cybersecurity risks of AV. The authors acknowledged the benefits of these vehicles and unintended consequences. The unintended consequences result from various technological risks. The rapid development of AVs comes with an increased level of risks. These vehicles present a wide range of technical risks related to cybersecurity (Taeihagh & Lim, 2019). These risks pose a serious concern to the safety and privacy of passengers since these vehicles are designed to make decisions even in the event of uncertainties. For instance, an attack on the remote system could lock a passenger in the vehicle or prevent the doors from locking (Linkov et al., 2019). AVs use artificial intelligence (AI), big data, and sensors to assess information and make decisions regarding changing and complex situations on behalf of human beings (Taeihagh & Lim, 2019). These components help the AVs perform basic vehicle operations like parking, lane-changing, braking, and collision avoidance.

A mistake in this decision-making process could compromise the safety and privacy of these passengers (Taeihagh & Lim, 2019). AVs are perceived to be superior to human beings since they can handle multiple vehicle operations more effectively and efficiently than humans. However, cyberattacks compromise the functionality of these vehicles leading to errors and unintended negative consequences. Companies racing to grab considerable market shares in the

AVs industry must invest in cybersecurity systems to improve the security and privacy of these vehicles. The government initially linient on these companies to promote the adoption of AVs (Taeihagh & Lim, 2019). AVs are eco-friendly and reduce the carbon blueprint due to their reliance on electricity instead of fossil fuels (Liu et al., 2020). However, there is a growing need to implement stricter laws to improve these vehicles' cybersecurity.

According to Linkov et al. (2019), AVs are an important emerging area of interest in the automobile industry. The authors identified the increasing contribution of AVs to traffic safety. AVs are vulnerable to cyberattacks. However, these vulnerabilities are caused by human failures (Linkov et al., 2019). The human factor is the heart of all AV cyberattacks (Khan et al., 2022). Human beings are the weakest point in the fight against cyberattacks in AVs. For instance, AVs might be infected by malware infections resulting from human mistakes and failed fixes (Khan et al., 2022). Therefore, AV manufacturers must eliminate human-induced errors to enhance these vehicles' cybersecurity. Cyberattacks often target autonomous vehicle system software and hardware components (Linkov et al., 2019). The human factor plays an essential role in enhancing cybersecurity issues in AVs. These factors are evident in the behavior and mistakes made by humans. For instance, risky cybersecurity behavior is attributed to over-trusting automated technologies. This behavior limits car owners from effectively assessing the hardware and software components of the vehicle simply because they trust the digital technologies used in the cars (Linkov et al., 2019). For this reason, car manufacturers must evaluate these factors and increase cybersecurity awareness among human beings. This approach will increase the knowledge required to enhance the cybersecurity of AVs.

Stocco et al. (2020) describe the essence of Deep Neural Networks (DNNs) in modern AVs. AVs are embedded with autonomous driving systems that control various car components

and modules. DNNs are responsible for controlling the driving process. The DNN inputs are camera images. The DNN systems process the images and determine the steering wheel angles to control the car's direction (Stocco et al., 2020). Cyberattacks on AVs target these systems, compromising their efficiency and effectiveness in determining the accuracy of the car's direction. These attacks could lead to misbehaviors in predicting safety-critical situations and responding to unexpected execution situations (Stocco et al., 2020). As a result, cars could cause accidents. Companies must establish self-assessment protocols to detect anomaly situations in the system. This approach would help prevent further damage resulting from cyberattacks.

Developing connected and autonomous vehicles (CAVs) has been expanding rapidly in recent years. He et al. (2020) approximate that by 2035, most cars on the roads will be either partially or fully autonomous. However, this development is accompanied by multiple issues like cybersecurity concerns. These concerns have been predominant in the existing CAVs contributing to the complications in deploying these vehicles (He et al., 2020). One factor contributing to these complications is the absence of universal standards or frameworks governing the cybersecurity aspect of CAVs. Different countries have different standards. The situation worsens in countries that don't manufacture these cars since most lack standards for using them (He et al., 2020). The authors advocate for universal frameworks and standards to control the cybersecurity of these cars.

Fully automated driving must consider the limitations in their functionalities and machine perceptions used to process and make decisions. This is because humans are not used as a backup in fully autonomous vehicles (Pisarov & Mester, 2022). AVs must perceive their environments, interpret them correctly, and execute appropriate decisions. The limitations in functionality and machine perceptions form the basis of cybersecurity concerns in these vehicles.

The technologies and machine learning methods used in AVs should enhance the efficiency of the car's performance (Pisarov & Mester, 2022). This performance should be beyond human capabilities to justify the lack of human backups.

Digital transformation in the automotive industry has led to the developing of a new paradigm known as Mobility-as-a-Service (MaaS) (Scalas & Giacinto, 2018). This paradigm has also enabled companies to develop driverless cars to suit the needs of passengers needing to move around congested and busy cities. From a cybersecurity approach, these manufacturers produce next-gen cars embedded with complex cyber-physical systems to meet the demand for intelligent services in MaaS (Scalas & Giacinto, 2018). Cyber-physical systems are monitored and controlled by computer-based algorithms. The infrastructure of modern AVs includes a connected network, an improvement from the old automotive infrastructure that used a single closed network. A single closed network did not allow external communication. Modern AVs integrate external communication, which is a loophole for cybersecurity issues. This issue sets the basis for developing the Secure-by-design (SBD) paradigm to address cybersecurity concerns (Scalas & Giacinto, 2018). SBD is a security initiative used to enhance various infrastructures' security and surroundings. This paradigm will help improve the security of all components in the connected network of AVs.

Connected and autonomous vehicles integrate complex machine-led dynamics, mimicking and replicating human-oriented decision-making in driving processes (Liu et al., 2020). These dynamics are prone to exploitation and manipulation by cyber criminals. Cyberattacks constitute numerous traffic safety and moral problems in the automotive industry. CAVs are susceptible to unethical hacking and data exploitation (Liu et al., 2020). The higher the connectivity and computational functionality in CAVs, the higher the risk of exploitation through

cyberattacks. Cybersecurity concerns pave the way for data and information mismanagement in CAVs. For instance, criminals could get the exact location of high-profile individuals by hacking the GPS systems of CAVs (Liu et al., 2020). They can use this information to kidnap and attack these individuals. These concerns necessitate timely and meaningful interventions to address privacy and cyber security issues in CAVs (Khan et al., 2022). These measures mainly target the failed fixes that improve cyber criminals' capabilities. Policy frameworks to govern the cybersecurity realm of these cars are also essential points of consideration.

It’s critical to recognize and come up with clear framework to understand and deal with cyber security issues of the automated vehicles. According to Hussein, thorough understanding of the cyber security and privacy concern is only way that can be used to come up with strong solution (Hussain et al, 2022). This is important for the automotive industry and relevant authorities to prioritize cyber security in the design, development, and operation of autonomous vehicles to ensure their safety and protection against cyber threats. Cohen and Cavoli argues that the way to regulate this cybersecurity in this technology remains under-researched. They recommend for anticipatory governance to deal with cyber security issues (Cohen and Cavoli, 2018). This would lessen the risk of cyber attacks on the AVs. Cyber security is an area of great concern requiring regular oversight to create safe AVs to guarantee the public trust in future. Luis Pendro states that to address cyber security issue, we must use case based approach. This will systematically address the concerns while ensuring the safety of AVs and at the same time building the public confidence on AVs (Cobos et al., 2018).

Summary

This research will address gaps in existing literature since the authors cited in this research offer three crucial characteristics to evaluate driving practices: preferred objective, risk

appetite, and collaborative way. The paper also examines various concepts surrounding the cybersecurity realm of AVs. Existing literature considers the cybersecurity issues in AV, their causes, and their impacts. This analysis provides an understanding of the cybersecurity aspect of AVs. Such knowledge is essential for creating policies and prevention measures to enhance the cybersecurity of AVs. Different literature cites various cybersecurity aspects to consider when manufacturing AVs. These factors include the human factor, full autonomy, and the security of the hardware and software components of the cars. Cybersecurity issues mainly erupt from the interaction between human and technical factors. The impacts of cyberattacks on AVs are safety issues, the quality of life of passengers, damages, and economic constraints from these damages.

The paper divides contemporary AVs driving techniques into four categories based on these three aspects: cooperative driving, competitive driving, defensive driving, and negotiated driving approaches. The paper offers a new comparison of these four tactics and identifies potential improvements to high-level driving strategy design. AVs will have an impact on the global transportation business. AVs will boost our standard of living while also boosting road safety, lessening the number of traffic accidents. Vehicle markers and policymakers in particular need to come up with an agreement on what to prioritize and what they can compromise on; these include taking into account factors that involve security matters and the different forms of social change attributed to autonomous vehicles. Furthermore, autonomous vehicles can assist with parking concerns, for instance, the capability to park in a remote place. These AVs will be more fuel-efficient and affordable to insure. The innovation can help those with disabilities, and military AVs can dramatically decrease fatalities in conflict (Fell, 2020). The artificial intelligence in autonomous vehicles has made them a reality as they allow AVs to self-drive and optimize and also to revolutionize safety standards.

CHAPTER THREE: RESEARCH METHODOLOGY

Overview

The researcher conducted qualitative data analysis because it is more flexible, open, and responsive, and the data collection and analysis methods are related, unlike in a quantitative research method. Qualitative data is used mainly when a researcher intends to understand concepts, thoughts, and experiences. This type of data collection allows the researcher to understand their research topic, especially one poorly understood. The amount of multi-disciplinary research concerning autonomous vehicles has been minimal beyond technological advancement (Hayward & Maas, 2021). Qualitative data allows the researcher to develop informed conclusions on AV regulation from different perspectives.

The section on research methodology is essential when conducting a research study because it provides the researcher with the methods and procedures to employ in completing the study. Therefore, the researcher should select the appropriate methodology depending on the study to ensure credible data for presentation and conclusions about the impacts of having unregulated autonomous vehicles and the lack of policies governing the autonomous vehicles industry and their usage in society. Adequate selection of the research methodology is regarded as a prerequisite to the successful study of the impact autonomous vehicles can bring to society, given the proliferation of technology and the growth of the internet of things that can cause a data security risk. Therefore, this section looked at how the researcher intended to conduct the research, how the research planned to tackle data collection, participant selection, and other plans to ensure a successful research study. Walliman (2017) defines the research method as a formula that shows how the researcher will put the study into practice. Therefore, the research method is

considered a systematic way in which the researcher intended to solve the research problem identified in the introduction. This section is thus divided into several sections as follows.

Research Philosophy

Research philosophy refers to the set of beliefs the researcher has about the nature of the study. Walliman (2017) observes that researchers think about research philosophy in two primary contexts: ontology and epistemology. Creswell and Creswell (2017) point out that epistemology includes a philosophical stance that deals with what should be regarded as reality about a phenomenon and how one can gain it. It includes various perspectives, including positivism, interpretivism, and realism. Creswell and Creswell (2017) found that interpretivism is a philosophical approach that emphasizes qualitative research analysis over the statistical approach to the study, unlike positivism, which focuses on gaining knowledge about reality through statistical analysis. The interpretivism approach was chosen for this study because it allowed the researcher to collect and analyze qualitative data about the implications of having unrestricted and no policies guiding the sector and the use of autonomous automobiles by the general public. This method suited this study since it permitted the researcher to incorporate subjective opinions about adopting autonomous vehicles and their social impact. Thus, this philosophical approach allowed the researcher to recognize the differences in people's interpretations of the use of AVs since it includes human interests and beliefs in research.

Design

An influential research design was developed to seek to know the impacts of having unregulated autonomous vehicles on society. Creswell and Creswell (2017) assert that research design is a step-wise process the researcher employs when researching a particular phenomenon. It entails various protocols and methods the researcher employs to successfully answer the

research question about using autonomous vehicles in an unregulated aerial environment. Although many research designs exist, including experimental, descriptive, and explanatory research designs, the researcher employed a descriptive research design. The latter involved describing the phenomenon under study using the data collected without digging deeper into the phenomenon to gain knowledge about autonomous vehicles and the threats they can cause to the users. Creswell and Creswell (2017) highlight that descriptive research design is typically used because it has the slightest margin of error. The advantage of this design is that it does not require internal validity since validity depends entirely on the sampling techniques employed.

Research Methods

Research methods refer to the strategy the researcher employs in conducting the study. Bresler and Stake (2017) insist that three main research methods exist: mixed, qualitative, and quantitative. The mixed research method combines qualitative and quantitative research methods whereby the researcher uses both methods to support the other since they have advantages and limitations. Bresler and Stake (2017) imply that the qualitative research method entails collecting non-numerical or raw data from the participants and analyzing the data using qualitative methods. On the other hand, quantitative research methods involve collecting data through qualitative methods but analyzing the data quantitatively using statistical data analysis methods. The researcher thus employed a qualitative method in this study about AVs and their impact on users and society. The researcher used qualitative methods in this study because they are flexible and help gather data based on the researcher's judgments. Kumar (2019) underscores that the method helps researchers understand AVs' concepts, thoughts, and experiences. The qualitative research method helped the researcher gain in-depth data about the research questions, which entailed understanding the repercussions of using autonomous vehicles in an unregulated aerial

environment. According to Kirsch (2020), little research has been conducted reagrding autonomous vehicles beyond technological advancement. Thus, qualitative data allowed the researcher to gain a deeper understanding of the phenomenon and make informed conclusions on regulations of autonomous vehicles from various perspectives.

This research utilized qualitative data analysis. Qualitative data is used mainly when a researcher intends to understand concepts, thoughts, and experiences. This type of data collection allows the researcher to understand their research topic, especially one poorly understood. The amount of multi-disciplinary research concerning AVs has been minimal beyond technological advancement (Hayward & Maas, 2021). Qualitative data allows the researcher to develop informed conclusions on AV regulation from different perspectives. The researcher collected data by offering semi-structured interviews. Semi-structured interviews provide a general direction of how the interviewer seeks to discover and provide the open-endedness that the respondents need to formulate unbiased self-directed responses (Saldaña, 2021). The researcher then applied data-driven coding. Although this type of coding is more time-consuming, it has lower bias levels and gives a complete look at the themes developed in the data (Busetto et al., 2020). With minimal research in AVs, open coding allowed the researcher to explore possibly unexplored themes and provide a broader outlook on the social effects of unregulated AVs.

Data Collection Tools

Selecting data collection tools is essential in understanding the research questions and collecting reliable data for analysis. The researcher adopted in-depth interview techniques in this study to gather data from the target population (Kumar, 2019). The interview questions were issued to police officers in society to collect and hear their opinions regarding autonomous vehicles. For this reason, the researcher employed semi-structured interviews to collect

qualitative data about AVs and regulations regarding the topic. Semi-structured interviews provided good data because they gave a general direction of how the researcher intended to seek data regarding autonomous vehicles amid technological advancement. The technique also offered the open-mindedness that the participants needed to provide impartial, self-guided responses. In addition, an in-depth interview technique was selected because it is considered less costly and less time-consuming than other data collection methods, such as questionnaires and ethnography (Bresler & Stake, 2017). The interview method was also accurate in capturing the interviewers' reactions and helps in accurate screening. Structured interview questions were also employed since they introduced more objectivity and created a standardized list of questions and assessments to give to the participants. Afterward, the interviewer analyzed the data provided (Bresler & Stake, 2017). The data gathered was then transcribed and stored for analysis.

Research Material

The researcher used semi-structured email interviews with open-ended questions that allowed for written or typed answers. The interviews aimed to reveal opinions, experiences, narratives, or accounts. The interviews included quantitative questions such as age and ethnicity. The interviewer then analyzed the information gathered from the different states that have passed laws regarding autonomous vehicles.

Semi-Structured Interviews

When further research was needed, interviews were conducted via email to find out participants' experiences, understandings, and opinions. The length of a discussion took no longer than 15 minutes for the participant to complete. A set list of questions needed to be asked to increase the reliability and credibility of the data but decrease responsiveness to the participants. Semi-structured interviews are flexible and quick to add data, and most participants

are familiar with the format (Saldaña, 2021). Semi-structured interviews are limited in that not all participants are equally articulate and receptive to the interview. The transcription of the interviews is time and labor-intensive. These semi-structured interviews must also be worded precisely to prevent response bias.

Sampling Design

This section highlights information about the study's sample design and the selection of participants. Busetto et al. assert that sampling is the foundation of a research project (2020). As a result, defining the sampling design is critical in the research process. It allows the researcher to identify and describe the appropriate sampling method. This way, the researcher can design a best-fitting sampling method for their research work (Busetto et al., 2020). The sampling design integrates information about the sampling frame, sampling, sampling units, probabilities of selection, and sample sizes. The researcher must outline the processes involved in sample selection when conducting the research (Busetto et al., 2020). Researchers must select between probability and non-probability sampling designs.

Sampling Technique

Non-probability sampling techniques were the most appropriate for selecting the participants of this study. According to Busetto et al. (2020), non-probability sampling techniques are widely used in qualitative studies due to their convenience and ease of use. This design allows the researcher to use non-random criteria to select participants. Busetto et al. state that not all individuals have an equal chance of selection (2020). The researcher used purposive sampling, a method of non-probability sampling where the researcher selects appropriate individuals from a larger population to interview because the population has experience and knowledge about the study phenomenon (Busetto et al., 2020). The researcher then focused on

individuals who know AVs and their use in data collection. Purposive sampling was used because the study is specific about the legislation that needs to be adopted to regulate the use of AVs.

Target Population, Sampling Frame, and Units

Defining the target population helps the researcher select participants that fully represent and cover the population of interest. The target population for this study consists of individuals with relevant knowledge and experience with the security and safety of AVs. They include police officers. Police officers were interviewed because of their insider knowledge about the future problems of non-regulation from the perspective of law enforcement regarding probable accidents or malfunctions. Criminals could use AVs to cause massive destruction of property and data (Hayward & Matthijs, 2020).

The sampling frame highlights the list from which the researcher obtains the sample. Busetto et al. (2020) assert that the researcher must maintain the quality of the sampling frame since it affects the quality of the sample. Sampling units represent the building blocks of research data (Busetto et al., 2020). They integrate individual population members from which research data is selected during sampling. The sampling frame for this study incorporated a list of individuals with relevant information regarding the safety and security of AVs. They include police officers, users, and manufacturers in various regions like DC, Virginia, and Maryland. These groups formed the basis for this study's sampling units.

Sample Size

In particular, the researcher selected 25 individuals from the abovementioned population for interviews. The population was selected from the DC, Maryland, and Virginia regions. The region was chosen for this study because it is one of the regions in the U.S. with no regulations

regarding the manufacture and use of autonomous vehicles, although testing is underway. Thus, the police officers were selected from this region for interviews. Twenty-five individuals are considered a good number when conducting qualitative studies since saturation levels of qualitative data lie around 20 to 30 research participants.

Data Analysis Procedures

The researcher employed the thematic analysis technique to analyze the data gathered. Busetto et al. (2020) emphasize that thematic analysis is used in qualitative research studies because it organizes the collected data into themes. The themes are then categorized and coded for analysis and making conclusions. Through this procedure, the researcher thoroughly examined the collected data and identified the initial themes and patterns using data-driven coding. Data-driven coding involves the researcher analyzing the data as it was gathered without prior conceptions or predictions about the patterns (Busetto et al., 2020). This method of data-driven coding was used because it has lower bias levels than concept-driven coding. The researcher used NVivo to code qualitative data. NVivo helps analyze and organize qualitative data from surveys and interviews (Jackson & Bazeley, 2019). It helps the researcher organize and code qualitative data from multiple sources into a single project file. The researcher can assign attributes to the data for comparative analysis. The author should then add notes and interpretations (Jackson & Bazeley, 2019). Searching and querying research data helps the researcher present reliable and credible evidence. The software allows the researcher to visualize the information in an easily understandable format. Hence, data-driven coding provides a holistic view of the themes developed in the data (Saldaña, 2021). Thus, with minimum research about AVs and regulation, the data-driven coding allowed the researcher to explore other themes, thus giving a more comprehensive perspective on the impacts of unregulated access.

Ethical Considerations

Ethics are essential when researching since they ensure the credibility of the research. Hence, the researcher ensured the confidentiality of the respondents by keeping their names anonymous. In addition, before participating in the study, the respondents were given informed consent seven days before conducting the study to ensure that participation in the study was voluntary. Finally, the researcher presented the results truthfully by reading the respondent's interview transcripts and making informed decisions about the data without bias.

Data Analysis Procedures

The researcher employed the thematic analysis technique to analyze the data gathered. Busetto et al. (2020) emphasize that thematic analysis is used in qualitative research studies because it organizes data into themes. The themes are then categorized and coded for analysis, and conclusions are made using NVivo. Therefore, the researcher thoroughly examined the collected data and identified the initial themes and patterns using data-driven coding. Data-driven coding involves the researcher analyzing the data gathered without prior conceptions or predictions about the patterns (Busetto et al., 2020). The method of data-driven coding, specifically NVivo, was used because it has lower bias levels than concept-driven coding. Hence, data-driven coding provides a holistic view of the themes developed in the data (Saldaña, 2021). Thus, with minimum research about AVs and regulation, the data-driven coding allowed the researcher to explore other themes, thus giving a more comprehensive perspective on the impacts of unregulated access.

Methodology

Various police officers from departments across the DC metro area were interviewed. These officers described their experiences pulling over people who drive autonomous vehicles.

Most of the interviewed officers were concerned about crashes involving AVs. Police officers were interviewed on drivers who take videos using their phones, hang out of their windows, or honk while speeding and performing dangerous stunts. For instance, we interviewed the police in VA looking for a driver who vanished after wrecking his Tesla in a "risky stunt." By interviewing such police officers, we were able to obtain reliable data. An AV agency in VA was also interviewed for accident information and policy sights for AVS. AV owners were also interviewed for this study.

Interview Subjects

Officers from the Prince William County Police, Fairfax County Police, Loudoun County Police, and VA State Police were interviewed on complaints concerning AVs complaints & accidents concerning AVs. They were interviewed about their experiences in their divisions with AVs. They were interviewed through a legal lens on cases of AV malfunctioning and legal issues concerning AV performance and efficiency. Federal agents from the Department of Homeland Security located in Sterling, VA, and DC were interviewed regarding cybersecurity concerns with increased autonomous vehicles. Questions regarding legal approaches to AVs were included.

Research Questions

Autonomous vehicles have a wide-reaching effect on society beyond changes to advancements in technology. Therefore, the researcher delved into the steps to implement autonomous vehicles properly and how these vehicles can be used in crime prevention (Abraham & Rabin, 2019).” The research questions that this study sought to answer included the following:

Q1. Will the police use images taken by self-driving cars to solve a crime? This question was vital in the study as autonomous vehicles are still being researched to see how they can be implemented in society (Abraham & Rabin, 2019).

Q2. Does transforming conventional vehicles into fully autonomous vehicles contribute to cybercrime? The lack of understanding could increase incidents of accidents due to improper usage. The lack of regulations and understanding may lead to new forms of criminal activity, such as cybercrime.

Q3. Can autonomous vehicles be used as witnesses in cybercrimes? Autonomous vehicles can facilitate timely information access, especially when fitted with GPS-enabled systems. The nature of AV ensures they can capture data that can be relied upon in different circumstances, including in law enforcement. This question helped me understand AV's capacity to access and safeguard data to mitigate cybercrime.

Q4. Are safety measures in place to safeguard against data breaches that may jeopardize AV operations? This question helped to address any gaps that may trigger the involvement of law enforcement agencies, especially in data breaches. It outlines the safety measures that can be applied across the different stakeholders to help mitigate adverse data breaches.

Q5. Are there areas of cyber security that are essential in the development of AV? This question is essential because many laws must be changed to accommodate these new machines when implemented in society (Cohen & Cavoli, 2019). Law enforcement must understand how to handle the vehicles in case of an accident, decreasing police corruption due to bribes. It would also help prevent deaths and injuries by drunk driving and other means and lower the cost of health due to AV.

Q6. Can law enforcement agencies be integrated into the development and operations of AV? This question was crucial because it details the AV industry and its impact on law enforcement agencies' roles. For example, police officers directly manage transport activities, including traffic and law and order. Adoption of AV requires the active involvement of law enforcement agencies in understanding the transforming nature of their work in streamlining transport roles.

Q7. Does the development of AVs contribute to the proliferation of cybercrimes? This question provided a framework for analyzing the impacts of AVs on cybercrime. Given the continuous development and innovation in AV industries, it also helped the researcher explore the extent and frequency of these impacts.

Q8. Are there policies and regulations governing the use and manufacture of AVs regarding their safety and security? This question helped the researcher assess the causes of security concerns regarding AVs. Some states lack policies and regulations regarding the use and manufacture of AVs.

Q9. Does transforming conventional vehicles into fully autonomous vehicles affect the sustainability of the automobile industry in terms of employment and workforce? This question helped the researcher explore the social impacts of AVs in society. Ideally, digital transformation leads to the corrosion of human skills and talents, especially when artificial intelligence takes over the tasks previously performed by humans.

The study results helped the researcher conclude the areas mentioned above. The researcher used the results presented here to conduct a study that explains autonomous technology vehicles, comprising some basics regarding their usage throughout society, ways to improve society, potential outcomes of their use, and possible impacts on crime (Fell, 2020).

This research investigates the potential impact of Level Four and Level Five vehicles as described by the National Highway Traffic Safety Administration (NHTSA) (Abraham & Rabin, 2019). The researcher describes scenarios in which automated vehicles operate without human intervention. Automated vehicles, also referred to as driverless vehicles or self-driving vehicles, can perform all driving functions free of the intervention of a human driver. According to the NHTSA, there are five levels of automated vehicles, from those that only have a few computerized options and require driver's intervention to vehicles that do not (Abraham & Rabin, 2019). The impact of AVs extends beyond just the technological aspect and will impact many aspects of personal lives, the industry, and the CJS.

Need for the Study

It is predicted that fully autonomous vehicles on the roads will be standard practice within the next decade. Eventually, fully autonomous vehicles will overtake the use of conventional vehicles (Nastjuk et al., 2020). The potential benefits discussed show that their uptake will increase with societal acceptance and adequate safety measures for AVs (Campisi et al., 2021). Autonomous vehicles have become very popular and will soon be used in the next decade. Therefore, the study is crucial as it evaluates whether the public can replace conventional vehicles with autonomous vehicles (Bresler & Stake, 2017). The study evaluated the cybersecurity risks associated with using the vehicles as they will be connected to the technology, and the hackers will look for vulnerabilities in the system. The study is essential as it also evaluates the impact of autonomous vehicles on society, which will be the most affected by the use of the vehicles (Nastjuk et al., 2020). People's attitudes towards autonomous vehicles and the ethical implications of autonomous vehicles. This research investigated the potential impact of AVs on the CJS and, thus, society as a whole. Similar to the changes during the

industrialization phase that necessitated changes in labor laws and the introduction of the first automobiles that also forced law enforcement agencies to change rules in line with the times, the introduction of AVs necessitated law enforcement agencies to change the rules.

Purpose Statement

This qualitative research aimed to understand the effects of AVs on society, the CSJ, and culture on a larger scale. The research contains qualitative studies of police officers in the DC, Maryland, and Virginia areas. The DC, Maryland, and Virginia areas provided a promising research ground for this study because it is one part of the United States with no regulations for AVs. Yet, their testing and manufacture are underway (Feng et al., 2021). The study results provide input to current theoretical frameworks on proposed policies and regulations for manufacturers and users (the public) and different law enforcement officers in the CJS.

Setting

The setting was virtual since mail surveys were used.

Participants

The participants interviewed included local, state, and federal law enforcement officials. Probability sampling was used to avoid bias so that all police officers nearby had an equal chance of being interviewed. Stratified sampling was the procedure used to select interviewees. Gender and age were not criteria for interview selection.

Procedures

Only senior police officers who can be authorized to speak were interviewed. Elicitation is pulling out or drawing feelings, truths, or viewpoints. When locating elicitation in qualitative interviewing, people focus on strategies that cause or arouse replies, recollections, or tales from participants. Elicitation has its origins in anthropology, and picture elicitation is popular. Object

elicitation is another method for eliciting information (Busetto et al., 2020). An interviewee is given or brings an item to an interview and is prompted to contemplate the object's relevance to a particular encounter, incident, or phenomenon or to question the object's material qualities.

Additional elicitation techniques may require the interviewee to participate in a particular act in the interview. Timelining is a powerful elicitation tool when encouraging participants to contemplate a timeline of events (Busetto et al., 2020)—for instance, personal history, milestone encounters, or evolving shifting concepts of identity over time. Timelining can take on many forms. A researcher may ask a participant to sketch a timeline in text format with a broad range of dates. An investigator could urge an interviewee to include photos–perhaps by drawing a timeline or cutting and pasting photographs into one. As far as elicitation goes, there are numerous techniques for timelining.

Good questionnaires should not be too lengthy. The questionnaire should be long enough to collect the information needed but not so long that respondents find it challenging to answer. The questions should also be organized in order of difficulty, from simplest to most complex. The completed forms will be collected, and the information will be tallied.

The Researcher's Role

The research interviewer asked questions, documented responses, and conducted follow-up questions to collect precise and usable data. After performing an interview, the researcher gathered data and provided reports. In qualitative research, the researcher aims to assess study participants' thoughts and emotions (Busetto et al., 2020). The latter is a complex undertaking since it entails persuading people to discuss topics that may be highly sensitive to them. The researcher aimed to remove biases while collecting and documenting interview data.

Data Collection

Interviews

Open-ended Questions

Standardized Open-Ended Interview Questions

Questions for the Autonomous Vehicle Survey

1. Does the police force understand the rules and regulations on cyber security issues for autonomous vehicles?
2. Do you know about the cybersecurity of AVs?
3. Would possible changes in cyber security rules and regulations for autonomous vehicles affect your field?
4. Are there indicators for police officers to identify an autonomous vehicle violating cyber security rules?
5. Are there positive or negative effects you would presume autonomous vehicles would have regarding cyber security issues in society?
6. Do you think autonomous vehicles have effects on cybercrime?
7. Do you know the kinds of new cybercrimes? If yes, do you know anything likely to come up due to the increased use of autonomous vehicles?
8. Are there some things that are likely to shift in cybercrimes due to internet connectivity and the use of IoT with autonomous vehicles?
9. Can autonomous vehicles be used in cybercrime prevention?
10. Do you think the Criminal Justice System is prepared enough to deal with complaints filed against autonomous vehicle-related issues?

11. Does an autonomous vehicle provide more strategies for cyber attackers to enhance cybercrime? Why or why not?

Data Collection and Interpretation

This research investigated the potential impact of Level Four and Level Five vehicles as described by the National Highway Traffic Safety Administration (NHTSA) (Abraham & Rabin, 2019). The researcher describes scenarios in which automated vehicles operate without human intervention. Among other states and the federal government, Virginia has no comprehensive regulations for manufacturing or using automated vehicles, including liability for accidents (Feng et al., 2021). The lack of policies and regulations indicates a legal state of unpreparedness, even as technological research continuously points towards a future of fully automated vehicles. The methodology employed in this research aimed to gain comprehensive qualitative data from the police, AV companies, programmers, and Tesla dealerships as different players in the field of AV that are affected by the (non) regulation of AVs.

Manner, Feasibility of Data Collection, Population(s), and Data Set(s)

Data collection, which involves gathering information from the targeted population or variables of interest, enables the researcher to get information that will answer the research problem and help make informed choices regarding the problem (Li et al. 2021). In this case, the researcher collected data by offering email questionnaires or interviews with the variables of interest to the researcher. Semi-structured interviews offer a general direction in which the interviewer seeks to discover information and provide the open-endedness that the respondents need to formulate unbiased self-directed responses (Saldaña, 2021). The researcher's work was informed by previous research on AVs, which formed the basis of the study and pointed toward

unexplored areas that needed clarification. The respondents were asked to respond to earlier reports, such as accident simulation research for AVs. This study is founded on the postulation that respondents understand the concept of AVs. To ensure the feasibility of data collection and adequate data examination, the researcher took field notes and audio recordings written down into protocols, and transcripts and coding was done using data-management software (Busetto et al., 2020). The researcher also conducted a study outline.

Various fields are affected by autonomous vehicles and the effects of their (non-) regulation. To gain holistic and qualitative data that focuses on these different fields, the researcher identified respondents in the police force. The aim of interviewing the police was to have an insider's perspective of the probable impact of non-regulation in law enforcement, the preparation (or non-preparation), especially for traffic police, on how to respond to AVs on the road, and their perspective on who should be held responsible in cases of accidents or malfunctions. The contribution of the police to fighting cyber crimes associated with AVs was examined. Programmers and Tesla dealerships helped further explore the technical details and their views on accountability concerning various proposed legal changes and approaches. AV companies create their policies concerning the different variables. In the case of automobiles, the current system focuses more on the drivers since driver error is the leading cause of accidents. However, with the introduction of Automated vehicles, the liability shift is likely to fall more on manufacturers, and programmers may have to shift the development of their products, factoring in these variables and possibly offering packages for manufacturers. Manufacturers and dealers also need to consider these legal changes and liability burdens.

The researcher focused this research on the DC, Maryland, and Virginia areas. The DC, Maryland, and Virginia areas provided an excellent research ground for this study since it is one

of the United States with no regulations for autonomous vehicles. Yet, their testing and manufacture are underway (Feng et al., 2021). Tesla is one of the pioneering manufacturers in the AV industry and has already been involved with the legal system due to accidents occurring when some of their vehicles were on autopilot.

Coding of Data

Qualitative research coding categorizes data in a qualitative study to identify themes, patterns, and the relationship between the identified themes. In addition, coding in qualitative research entails how individuals define the data they are analyzing to create and assign codes to the different data sets by categorizing similar data together. Data coding can either be deductive or inductive in qualitative research, involving two stages. The initial stage is initial coding, which entails getting an overview of the data being analyzed by reading and understanding the concepts while developing initial data codes per the data set. The other stage is the line-by-line stage, which involves developing codes by reorganizing the initial codes set in the first stage and creating new codes where necessary, primarily if one uses the inductive coding method. Whether concept-driven or data-driven (open coding), the researcher must thoroughly examine the collected data and identify initial themes and patterns (Busetto et al., 2020). Concept-driven coding is when the researcher approaches the data with a developed system of codes.

In contrast, data-driven coding requires the researcher to go through the data without unprecedented code, allowing it to "speak for itself" (Busetto et al., 2020). The researcher applied data-driven coding. Although this type of coding is more time-consuming, it has lower bias levels and gives a complete look at the themes developed in the data. With minimal research in AVs, open coding allowed the researcher to explore possibly unexplored themes and provide a broader outlook on the social effects of unregulated AVs.

Conclusion

The methodology used in this work attempted to collect qualitative data from the police. Qualitative data enabled the researcher to draw well-informed conclusions about the regulation of AVs from many angles. The researcher gathered information using semi-structured interviews and questionnaires. Semi-structured interviews provide rough guidance for what the interviewer seeks while allowing respondents to create unbiased, self-directed responses. The technique of categorizing data in a qualitative study to find themes and patterns is known as qualitative coding. The researcher must thoroughly sift through the acquired data and identify first themes and designs, either concept-driven or data-driven (open coding). This chapter presents the researcher's methods in conducting the research. It has highlighted the research design, method, sample size, data collection methods, and data analysis techniques the researcher employed in conducting the study. The following section will provide data presentation, analysis, and interpretation. This research aims to investigate the repercussions of having no policies or regulations governing the manufacture and usage of automated vehicles. The uptake of AVs is projected to increase; hence, the impact of AVs on the average citizen is also explored in this research. Through a qualitative study, the researcher explored themes related to automated vehicles, their regulation, and their impact on society.

Surveys/Questionnaires

All surveys and questionnaires must elicit qualitative, not quantitative, data. If using a published survey or questionnaire, be sure to gain permission to use it and explain here how the survey was developed and how validity and reliability were established. If generating your own, you need to address face and content validity and describe piloting procedures.

Document Analysis

Document analysis may be applied to various sources, including but not limited to legal documents, records, meeting minutes, letters, diaries, etc. Every effort should be made to incorporate primary as opposed to secondary sources. Identify and describe the specific documents collected. Provide a specific rationale for why each type of document was selected.

Focus Groups

Focus groups provide an opportunity for the researcher to interact with multiple participants simultaneously. Focus groups are beneficial for exploring complex, multi-layered concepts from the participants' perspectives. Focus group questions must be developed and reported using the same format as interview questions (see interview section above).

Observations

If conducting observations, develop and include your observation protocol in the appendices (examples are provided in most qualitative research texts). Be sure to address both descriptive and reflective field notes. Discuss whether observations will be scheduled or unscheduled and whether you will be a participant or non-participant observer. Identify the frequency and duration of observations.

Data Analysis

In this section, data obtained from the questionnaires are cross-tabulated. Subgroups are compared depending on the respondent’s career. The data also compares and contrasts with data obtained in previous years. The data is also analyzed and interpreted in Microsoft Excel. The data is prepared and organized, and discourse analysis is used to analyze the written text.

Trustworthiness

Credibility

The degree to which the conclusions correctly reflect reality is referred to as credibility (Campisi et al., 2021). Credibility is based on the depth of the data acquired and the researcher's analytical ability. To determine the credibility of the research, the researcher answers questions like why the study was undertaken, who conducted it, and how data was collected. The research should also contain data that is secondary to supporting claims made. Credibility is an essential aspect of trustworthiness in research.

Dependability and Confirmability

Reliability and confirmability in quantitative research deal with continuity, which is tackled by giving comprehensive information about the study's setting. Dependability in research is portrayed by giving a detailed description of the methods used for research. *Confirmability* is a research process that is easy to establish as it looks out for an explanation of the decisions made in the research process (Sinha et al., 2021). The details are vital as they provide the readers with insights about information derived from the data collected.

Transferability

Another facet of qualitative research that needs to be considered is transferability, which alludes to the potential for what was discovered in one setting to apply to other contexts, situations, times, and populations (Menon & Alexander, 2020). The magnitude to which a study discovery can be used in various contexts and investigations is referred to as its transferability. Thus, it is the same as or a substitute for generalizability and external validity concepts.

Ethical Considerations

Ethical considerations in research are important as they guide the research practice and design (Freemark et al., 2019). The ethical principles in research include voluntary participation of the people being interviewed or providing data and anonymity. Informed consent,

confidentiality, results of the communication, and adhering to the ethical concerns in research are essential as they promote the research's aim and help avoid errors that could occur. Pseudonyms were used to discuss those who participated in the study to ensure anonymity. Institutions will also be protected using pseudonyms. The researcher will be careful to keep any future encroachment on the autonomy of interviewees to a minimum. Informed consent from the interviewees was obtained. The researchers need to articulate which data will be obtained and how they will be employed beforehand (Freemark et al., 2019). Researchers must protect interviewees from any possible adverse repercussions that may emerge.

Summary

The researcher's procedures for performing the study are described in this chapter. This chapter underlined the study's research design, research method, sample size, data gathering methods, and data analysis methodologies that the researcher used in presenting, analyzing, and interpreting data. This chapter looked into the consequences of having no guidelines or legislation overseeing the development and use of AVs. Since AV use is expected to rise, the influence of AVs on the typical citizen was also examined in this chapter. Through a qualitative study, the researcher investigated themes connected to AVs, supervision, and social impact. The researcher's procedures for performing the study are described in this chapter. The chapter detailed the study's research design, research method, sample size, data gathering methods, and data analysis methodologies that the researcher used. They also presented, analyzed, and interpreted data.

CHAPTER FOUR: FINDINGS

Overview

This chapter will begin by describing the participants, overall sample, and results from the research. In contrast to quantitative research, the scholar will do qualitative data analysis since it is more dynamic, accessible, and adaptable, and the data gathering and analysis procedures are linked. Qualitative data is used when a researcher wants to comprehend concepts, beliefs, or memories. This kind of data gathering assists the researcher in having a better understanding of their research topic, mainly if it is not well known. When performing a research study, the section on research methodology is critical since it gives the researcher the activities and procedures to single out this study. As a result, the researcher will determine the proper technique for the study to provide factual evidence for presentation and conclusions about the consequences of having uncontrolled AVs and the lack of rules supervising the AV sector and its use in society.

This chapter also contains the results of the descriptive research conducted to answer the following research questions:

Q1. Will images taken by self-driving cars be used by the police to solve a crime?

Q2. Does transforming conventional vehicles into fully autonomous vehicles contribute to cybercrime?

Q3. Can autonomous vehicles be used as witnesses in cybercrimes?

Q4. Are there safety measures in place to safeguard against data breaches that may jeopardize AV operations?

Q5. Are there areas of cyber security that are essential in the development of AV?

Q6. Can law enforcement agencies be integrated into the development and operations of AV?

Q7. Does the development of AVs contribute to the proliferation of cybercrimes?

Q8. Are there policies and regulations governing AVs' use and manufacture regarding their safety and security?

Q9. Does transforming conventional vehicles into fully autonomous vehicles affect the sustainability of the automobile industry in terms of employment and workforce?

This chapter includes a discussion of the data analysis process and results, which is consistent with the data collection procedures and methods pertinent to the selected research design. Additionally, the researcher provides a discussion of the demographics, presented using tables. The researcher used thematic data analysis to analyze the responses from 24 participants. This chapter includes tables representing the results, discussions of the tables, and detailed codes and themes from the participant responses.

Participants

The research participants for this study were mainly members of law enforcement agencies, particularly police officers. The researcher was interested in understanding the scope of cybersecurity issues surrounding AVs. The law enforcement agencies play a vital role in enhancing the security of the society. Therefore, police officers provide a great framework for assessing the policies, laws, and regulations set in place to govern the development and use of AVs.

Demographics

Gender

Table 4.0: The Gender of the participants

Gender	Number
Male	17

Female	3
Unspecified	4
Total	24

The researcher ensured all genders participated in the study. The researcher interviewed 17 males and 3 females. The remaining 4 participants did not provide their names and gender information. There is some element of gender balance in the responses obtained from the survey.

Familiarity with AVs

Table 4.1: Respondents' familiarity with AVs

Categories	Number
Familiar	1
Very familiar	1
Slightly familiar	13
Not familiar	6
Did not respond	3
Total	24

The table above shows the classifications of the respondents regarding their familiarity with AVs. From the table above, it is evident that most participants, law enforcement officers, are not very familiar with AVs. The majority of the respondents cite that they have heard the concept from various sources, including the news. However, they have little or no information about how these AVs function, security features, structure, or societal impacts. Therefore, this

information reveals the need for more training and awareness among law enforcement officers about emerging technologies.

Response Rate

Table 4.2: Respondents' response rate

Response Rate	Number
Responded to all questions	21
Responded to some questions	2
Did not respond at all	1
Total	24

The table above provides a visual representation of the response rate of the respondents. The survey integrated 24 participants. Out of the 24 participants, one participant did not answer any of the questions in the survey. 2 participants answered some questions, while the remaining 21 thoroughly answered the survey questions. The high number of respondents who responded to all the questions provides sufficient information for drawing inferences regarding the research problem.

Results

Research Question Responses

The researcher will employ thematic analysis to analyze the data obtained from the surveys. Thematic analysis allows the researcher to identify, analyze, and interpret repetitive patterns in qualitative data (Braun & Clarke, 2019). Open coding will enable the researcher to investigate potentially uncharted subjects and offer a larger perspective on the social implications of uncontrolled AVs with little AV inquiry. Open coding is one of the most critical steps and stages in qualitative data analysis. It provides a framework for qualitative researchers to break

down and analyze data to identify concepts, themes, and categories (Cascio et al., 2019). Open coding can be achieved by developing codes or classifying the phenomena that are under consideration. Data in open code is put into segments to create meaningful expressions.

Qualitative Analysis of the Surveys

The introduction of Autonomous Vehicle (AV) technology has brought several complexities to the transport and law enforcement department. The law enforcement department, which plays an essential role in the enforcement of traffic regulations, is at the center stage of this development. There is a need to get insights into the perspectives and understanding of law enforcement personnel on AVs and the challenges and possibilities they bring. The findings of the survey below, which was conducted on 24 officials with 23 officials responding, provide essential insights into the police perspectives and comprehension of the complexities brought by AVs.

Q. 1. Consent

Table 4.3: Participants' informed consent

Informed Consent	Number
Consented	23
Did not consent	1
Total	24

All but one participant (23/24) agreed to participate in the survey, indicating a high interest in the subject. Of the 23 who responded with affirmative, 3 did not complete the survey. However, 21 participants responded to all survey questions, demonstrating the participation of over 80% of the officials interviewed. The high rate of consent provides a solid foundation for the survey's subsequent questions. It implies that participants are more likely to make meaningful

and candid comments, which can result in significant qualitative data for understanding law enforcement viewpoints on AVs.

Q. 2. Names

Table 4.4: Participants' names

Response Rate	Number
Provided their names	21
Did not provide their names	3
Total	24

The majority of participants (21/24) gave their names and email addresses. This demonstrated their willingness to engage further in the topic and offer more information. This also shows that the majority of the participants were confident with the researchers' measures to enhance and maintain their confidentiality and anonymity, which are major ethical considerations in qualitative research. The researcher assured the participants that they would keep their personal information safe, including contact details and names. Some of the measures include storing the survey questionnaires safely, limiting access to the research team members, and securing computer folders with password encryptions.

Q. 3. Familiarity

Table 4.1 provides a snapshot of the respondent's familiarity with the research subject matter, which is AVs. This question was designed to assess participants' familiarity with AVs. Out of the 24 participants, only 2 were knowledgeable about AVs and the security issues surrounding them. The majority (13/24) of the participants stated they were slightly familiar with and only knew AVs from the news and social media posts. The response indicates the need for

training and awareness among law enforcement officers about emerging technologies. It is worth noting that the majority of participants learned about AVs from the media, emphasizing the importance of information transmission in molding their understanding. There is also a need for regular training among law enforcement officers on emerging technologies to seal the knowledge gap among them.

Q. 4. Preparing Law Enforcement

Table 4.5: Preparing for Law Enforcement Responses

Proposal	Number
More public and police training	5
EMP training	2
Use of laser tools	1
Introducing a kill switch/shut button	2
Campaigning for stronger regulations	8
Harsh punishments for traffic rule violations	1
Unsure	4

Participants presented a variety of proposals on how law enforcement may prepare for the expected presence of autonomous cars. More public and police training (5), EMP training (2), the use of laser tools (1), introducing a kill switch or shut button (2), and campaigning for stronger regulations (8) were among the responses. Some participants (4) were unsure about the next actions. One participant contended that there would be a need for harsh punishment against traffic rule violations by AVs. These responses represent the various techniques officers believe could effectively respond to this technological transformation. These techniques and varied

responses demonstrate a significant knowledge gap in the specific technique to tackle the challenges and possibilities brought by AVs in the law enforcement department. Therefore, the law enforcement department is not adequately prepared to address concerns brought about by AVs

Q. 5. Impact of Changes in Rules and Regulations

Table 4.6: Impacts of changes in rules and regulations

Impacts	**Number**
Unsure	4
No impact	1
Legal issues leading to crashes and traffic offenses	1
Complicated police work	2

Table 4.7: Steps

Steps	Number
Emergency buttons	2
Fail safes and auto braking	1
Educating the public	4
Software updates	3
Inspections	2

The responses to this question revealed an inconsistent depiction of how changes in legislation for self-driving cars would affect law enforcement. Some individuals (4) were unsure,

while others thought there would be no impact (1) or that changes would be beneficial (1). Concerns included the possibility of legal issues leading to more crashes and traffic offenses (1) and complicating police work (2). Installing emergency buttons (2), adding fail-safes and auto-braking systems (1), and educating the public and law enforcement on the new rules were all suggested as ways to assure compliance. Software updates should be mandatory, while inspections should be done more frequently. These responses emphasize the importance of clear communication and training in order to address potential challenges.

Q. 6. Responding to Autonomous Vehicles Violating Traffic Rules

Most participants (13) indicated they would stop the car, hold the driver accountable, and issue tickets or summons per routine operating procedures. A couple of individuals (2) advised contacting the car company/manufacturer, while two others suggested disabling the vehicle. One participant underlined the need to adhere to department standards and use emergency shut-off keys provided by technology companies, illustrating the requirement for a planned response protocol.

Q. 7. Anticipated Positive and Negative Effects of AVs

Table 4.8: Anticipated positive effects of AVs

Anticipated positive effects	Number
Greater road safety	3
Cost-effective transportation	2
Reduced demand for personal driving	1
Improved traffic flow	2
Reduced police workload	1

Table 4.9: Anticipated negative effects of AVs

Anticipated negative effects	Number
Risk of hacking	2
Tougher traffic laws	1
Increased road accidents	2
Over-reliance on AVs	1
High insurance rates	1
Legal loopholes	1

Participants had divergent opinions regarding the potential societal impacts of AVs. The participants' responses encompassing positive impacts of AVs included greater road safety (3), cost-effective transportation (2), reduced demand for personal driving (1), improved traffic flow (2), and reduced police workload (1). The respondents who observed adverse effects of AVs included the risk of hacking (2), tougher traffic laws (1), increase in road accidents (2), over-reliance on AVs (1), high insurance rates (1), and legal loopholes for evading traffic infractions (1). These replies emphasize the issue's complexities and the need for law enforcement to assess the benefits and the obstacles. The responses also indicate the knowledge gap regarding the impacts of AVs on society and the need for training and civic education on the impacts of emerging technologies such as AV in society.

The participants' perspectives on AVs' positive and negative effects illustrate the emergent technology's complexity and diverse character. While optimism about the possible benefits, such as greater safety and convenience, there are concerns about cybersecurity, regulatory issues, and societal adaption. As AVs continue to evolve and integrate into our

transportation systems, the findings highlight the significance of careful planning, regulatory frameworks, and public awareness.

Q. 8. Impact on Crime

The influence of AVs on crime has elicited a variety of responses. Some participants projected decreased crime rates (5), while others saw no influence (4) or predicted rising crime rates (4). One speaker pointed out the significance of law enforcement officers in dealing with AVs and technological change. 90% of the respondents failed to respond on the specific methods the law enforcement department should employ to address the complexities brought by AVs. The responses demonstrate a significant knowledge gap on the intricacies surrounding the development and operation of AVs in the law enforcement department.

Q. 9. New Forms of Crimes

As AVs become more common, participants anticipated new types of crime. Cybercrime responses included hacking (6) and typical crimes such as illegal vehicle usage, theft, and trafficking (5). Some were skeptical (3), while others felt no new crimes would be committed (4). One participant proposed using self-driving cars as decoys in pursuits for other offenses. The response indicates that all the participants did not recognize any new form of crime that the AVs might bring about.

Q. 10. Preparing for New Forms of Crimes

Participants proposed a variety of strategies to prepare for potentially new types of crimes, including increased training of law enforcement personnel and public awareness (6), the use of EMP technology (2), increased vigilance (1), the enactment of new laws (3), and reallocating resources from traffic police to address other crimes (1). One participant strongly argued for the complete ban on AVs. The responses posit that training and civic education is the

best strategy to prepare and address the knowledge gap. Legislation of new laws centered on addressing emerging issues brought by AV was also among the key recommendations.

Q. 11. New cybercrimes and strategies to deal with the crime

Respondents mentioned hacking (9) and other cybercrimes as key concerns with AVs. Traditional offenses were also highlighted by others (4). However, none gave specific law enforcement strategies for dealing with such threats, highlighting the need for further research and planning.

Q. 12. Use of Autonomous Vehicles in Crime Prevention and Investigation

Participants explored the advantages and disadvantages of using AVs in crime prevention and investigation. Benefits identified by the respondents included utilizing them as bait for criminals (1), collecting evidence (2), having kill switches (1), and making it easier to identify traffic violators (1). None of the respondents identified any anticipated single risk of using AVs. These observations indicate that using AVs efficiently could be valuable assets for law enforcement.

Q. 13. Comfort with Driving Autonomous Vehicles

Only two participants said they were comfortable driving AVs while on patrol. Concerns about technology and software limitations, potential accidents, hacking, and a desire to control the car were among the reasons for the mistrust. This suggests that law enforcement officials' trust and confidence in autonomous technology is very low and must be improved.

Q. 14. Training in Handling Cybersecurity Incidents

Only two respondents indicated receiving mandatory departmental training on handling cybersecurity incidents involving AVs. This shows that cybersecurity training is not generally accessible among law enforcement officers, meaning a potential gap in preparedness. Therefore,

it was noted that there is a high need for establishing mechanisms and programs to enable law enforcement departments to carry out training on the intricacies of cyber security in the wake of AV technologies.

Q. 15. Strategies for Boosting Safety

Participants proposed multiple approaches to improve physical and cybersecurity safety in AVs, including software updates and validation (3), more law enforcement training (2), mandatory identification before boarding (1), and banning AVs (1). Thirteen participants were unsure or did not identify particular strategies, indicating the need for additional research in this area.

Theme Development

The researcher employed thematic analysis to develop the themes. Thematic analysis is a versatile data analysis approach that can be used in more deductive and exploratory research studies. This data analysis technique is the most appropriate for this study since it allows the researcher to identify the main themes and repeated patterns related to the subject matter of the research. The researcher employed the following steps in the data analysis process:

Familiarization

This is the first stage in the thematic data analysis process. In this stage, the researcher immerses themselves into the data to gain a deeper and broader understanding of the data, including main concepts and ideas. The researcher read through the surveys repeatedly to understand the nature of the data. This stage was essential in determining what to code, thus setting the foundation for open coding.

Coding and looking for Themes

The researcher employed open coding to identify the main codes within the data set. The researcher identified distinct concepts and repeated patterns in the data set for categorization. The subject matter and research problem set the foundation for developing the codes and concepts for this research. The researcher identified significant concepts, including law enforcement, legislation, the effects of AVs, crime, cybersecurity, and training. These codes were obtained from the participants' responses. For instance, one of the respondents stated, "Companies who decide to engage in the technology of autonomous vehicles should make law enforcement safety their #1 priority, and the resources available should be shared with their agencies for proper safety protocols." From this statement, the researcher can deduce a code related to law enforcement and cybersecurity. These codes laid a strong foundation for developing solid themes for the research.

Reviewing the Themes

This stage involves reviewing the identified themes to confirm their authenticity and conformability with the research questions and problem. Two respondents noted that "many motorists using AVs have increased over two years. Thematic analysis is employed in qualitative research studies, according to Freemark et al. (2019), since it classifies the data obtained into themes. The themes are then classified and coded in preparation for analysis and conclusion. Another respondent noted that "AI has increased the efficiency of AVs."As a result, the researcher will meticulously study the obtained data and use data-driven coding to find the data's early themes and patterns (Alijauskait, 2020). Another respondent notes that "more regulations should be put in place to improve the safety of AVs." Data-driven coding entails the researcher examining the data as it is collected without making any assumptions or expectations about the

trends. The data-driven coding method will be employed since it is less biased than concept-driven coding.

As a result, data-driven coding delivers a comprehensive perspective of the data topics (Saldaa, 2021). One participant claimed that "with technological advancements for making sensors, AVs can only get better. “Thus, with only a basic understanding of AVs and control, data-driven coding will enable the researcher to delve further into other topics, providing a more holistic picture of the effects of unfettered access. Another respondent asserts that "AVs will change the transport sector." The researcher must extensively study the acquired data and find initial themes and patterns, either concept-driven or data-driven (open coding) (Joh, 2019). When a scholar uses an established system of codes to approach data, this is known as concept-driven coding.

Finalizing the Themes

In this stage, the researcher develops a final list of themes related to the research problem and questions. These themes should provide sufficient answers to the identified research questions. The researcher identified various themes, including the need for training, legislative changes, cybersecurity enhancement, public and police training and education, and crime prevention. These themes relate to the impact of AVs and the measures to address these impacts.

Discussion of the Findings

After developing a list of the final themes, writing a report outlining the study's findings is essential. This study explored the nature and scope of AVs. It helped the researcher understand the effects of AVs on society, the CSJ, and culture on a larger scale. The results indicate that AVs will spearhead various changes, including legislation and regulations. These changes stem from the negative impacts of AVs, such as cybercrime and other forms of crime. Therefore,

policymakers and stakeholders must implement various changes, including laws, requirements like training, cybersecurity features and strategies, and crime prevention measures to enhance the safety of AVs.

The survey's findings shed insight into the challenging environment law enforcement personnel confront as AVs increase. While most of the surveyed officers are aware of this technology, it is evident that many still don't fully grasp its unique characteristics. The requirement for continued education and training programs to equip law enforcement for the challenges presented by AVs is emphasized by this knowledge gap.

Participants' perspectives on the potential implications of AVs on society and law enforcement were diverse. While some officers anticipated positive impacts like increased road safety, others were concerned about potential negative implications like hacking and legal complexities. These various points of view highlight the significance of early planning and policy development in dealing with the complications associated with AVs. The survey also highlights law enforcement personnel's division over AVs' influence on crime rates. While some predicted a decline in some sorts of crimes, others predicted new challenges. This disparity demonstrates that law enforcement departments should monitor and respond to evolving criminal dynamics in the age of AVs. Additionally, law enforcement agencies should prioritize tackling cybersecurity vulnerabilities linked with AVs. One of the most serious concerns expressed in the survey was the possibility of the emergence of cybercrime connected to AVs. Participants highlighted hacking as a significant risk, highlighting the importance of better training and cybersecurity measures to protect both technology and public safety.

Therefore, the survey findings provide an essential insight into law enforcement personnel's perspectives and concerns about AVs. The findings demonstrate that law

enforcement institutions must adjust their strategies, processes, and training protocols as AVs evolve to successfully manage this disruptive technology's unique challenges and opportunities. Law enforcement agencies must partner with relevant stakeholders like other government agencies, technology companies, AVs' and other digital experts to develop cohesive strategies that prioritize public safety and ensure the effective integration of AVs into our transportation ecosystem. Law enforcement can play a critical role in designing a

Summary

The data was gathered using semi-structured interviews and questionnaires. Semi-structured interviews give participants a vague estimation of what the interviewer seeks while allowing them to deliver unbiased, self-directed remarks. The data was collected from 24 participants selected from law enforcement agencies. Law enforcement officers have significant knowledge and experience with traffic-related issues, such as the safety of AVs. Since AV use is expected to rise, the influence of AVs on the typical citizen is also examined in this study. Through qualitative research, the researcher investigated themes connected to AVs, their supervision, and their impact on society. The researcher employed thematic analysis to code and analyze the data. The researcher developed themes such as the need for training, legislative changes, cybersecurity enhancement, public and police training and education, and crime prevention.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this qualitative study is to explore the effects and implications of AVs on law enforcement and society at large. This chapter integrates a discussion of major findings in the literature supporting the development, adoption, and use of AVs. It also includes a discussion of the main findings related to the responses from the research participants. This chapter maps the connections between these findings and the theoretical and conceptual framework of the study. This chapter concludes with a discussion of the implications, limitations, and recommendations for future research.

Research Questions

This chapter includes a discussion of the research findings that aim to answer the research questions:

Q1. Will images taken by self-driving cars be used by the police to solve a crime?

Q2. Does transforming conventional vehicles into fully autonomous vehicles contribute to cybercrime?

Q3. Can autonomous vehicles be used as witnesses in cybercrimes?

Q4. Are there safety measures in place to safeguard against data breaches that may jeopardize AV operations?

Q5. Are there areas of cyber security that are essential in the development of AV?

Q6. Can law enforcement agencies be integrated into the development and operations of AV?

Q7. Does the development of AVs contribute to the proliferation of cybercrimes?

Q8. Are there policies and regulations governing AVs' use and manufacture regarding their safety and security?

Q9. Does transforming conventional vehicles into fully autonomous vehicles affect the sustainability of the automobile industry in terms of employment and workforce?

These research questions provide a framework for evaluating the impacts and implications of AVs on society and the criminal justice system. Traditionally, AVs are an important innovation in the world, particularly in terms of enhancing sustainability through managing climate change. Despite the perceived benefits, AVs can have significant implications for society and the criminal justice system. This research explores these impacts.

Summary of Findings

AVs

Individuals who participated in the survey shared their experiences or observations regarding their interactions with AVs. As the data was made available to the public without charge, the providers transformed the descriptive variable into a five-level categorical variable. From the research findings, only 6% of the respondents reported that they have interacted with AVs and have significant information and knowledge about their functionality. Nearly seventy percent of the respondents who reported having interacted with AVs said they had never had a bad encounter with one or noticed any difference between an AV and a human driver. Approximately twelve percent of the respondents who had interacted reported that they had encountered autonomous vehicles (AVs) being more cautious or that they had trouble anticipating the movement of AVs.

Levels of Autonomous Vehicles

The main designations of AVs include driverless, self-driving, or robotic vehicles. These designations represent the balance of the dynamic driving roles between humans and machines. The several categories of autonomous or self-driving technologies used in this research study

were defined as follows: Level 0: No technology for driverless cars. This level also incorporates automatic auxiliary functions like wipers or headlights or only automated warnings. Level 1: The vehicle is in charge of one or more safety-critical systems, but each system is run separately. The driver is still in charge overall. Level 2: At this level, two or more technologies from Level 1 are combined and work together in unison. The driver is still in charge overall. Level 3: This level offers a restricted range of autonomous vehicles. All safety-critical operations can be left in the hands of the car, requiring the driver to take only infrequent control over them. Level 4: A fully autonomous car. Throughout the journey, the vehicle will be in charge of all safety-critical operations. The respondents expressed their knowledge of various levels of autonomation, with the majority of them having no information on the different levels of autonomation. The research findings indicate that the respondents are less conversant with the various levels of automation in AVs.

The Impacts of AVs

Vehicle Design Challenges

There are obstacles and other considerations delaying the widespread use of AVs. Some of them are the outcome of societal views, preferences, and methods about the use of this kind of vehicle. According to the information provided, a significant portion of potential users do not feel comfortable driving a car alone. They also don't want to give up the autonomy and freedom that come with owning and operating a car of their own. However, prospective users worry about the necessity of controlling and responding fast in emergency scenarios, including an automation breakdown or the vehicle going beyond its functional limitations.

Cybersecurity Vulnerabilities of AVs

The research findings in this study show that AVs are already targets of cybercriminals. The majority of the research participants expressed their concerns regarding the potential for attack by cybercriminals. Cybercriminals manipulate AVs' communication systems to control the multimedia system and vehicle dynamics and reconfigure the airbag systems. One important discovery is that there are many different methods in which autonomous vehicle assaults target network infrastructure and functionalities. From the findings, it is evident that a successful intrusion enables data exfiltration and occupant reconnaissance through direct control of the car while it is being driven. This can result in traffic jams, vehicle diversion, malware installation on demand, and modifications to the operation of safety systems. Numerous attack techniques can be used to manipulate the firmware directly. Passengers and the transportation industry are put at serious risk by the infection. In order to sniff transferred data, hackers can install hacking apps, malware, and viruses via V2V and V2I communication networks.

Exfiltrated data can result in death threats and ransom demands from terrorist organizations or other nation-state actors. The research has demonstrated that regulations are useful for security objectives. The final noteworthy conclusion concerns the incidence response of autonomous vehicle attacks. It is critical for stakeholders to be aware of the possible source of cyberattacks on the autonomous car sectors. Cyberattacks can be prevented by raising awareness and providing training on best practices. To address the problems and counteract cyberattacks, law enforcement organizations ought to cooperate with one another. In order to protect public safety and address concerns about cybersecurity and privacy, policies and laws pertaining to the development and usage of autonomous vehicles can be crucial.

Impact of AVs on Traffic

Various respondents provided their views and perceptions on the impacts of AVs on traffic, including the increased complexity in the composition and management of traffic. From a legal perspective, the current dynamic and static control measures of road safety and usage are centered on human drivers. However, according to the respondents, the current composition of traffic users integrates human drivers and different levels of AVs. Therefore, there is an increased need to develop and determine more complex requirements to accommodate the new traffic composition. This element suggests the modification of traffic laws, legislation, and regulations. The respondents believe that new laws should be changed to integrate how AVs can be used. AVs may cause many people to lose their jobs. The lack of policies to regulate AVs presents a headache to lawmakers. The legal system will rely on drivers, AV firms, autonomous automakers, and state officials to traverse this unfamiliar territory and resolve the criminal and civil problems that will undoubtedly occur. The involvement of judges will be crucial in this process.

Social and Economic Benefits of AVs

According to the research findings, AVs are set to enhance the travel experience for many people, including those who cannot drive due to various challenges. For instance, people with disabilities would not need to modify the AVs to suit their driving needs and environment since the AVs will assume the driving roles. Children and elderly people will enjoy seamless transport systems and experiences without worrying about their driving competencies. AVs also reduce traffic congestion, enhancing road safety by reducing accident-related injuries.

Discussion

This study explores the impacts of AVs on society, particularly on law enforcement agencies and organs. Generally, law enforcement plays a vital role in regulating the manufacture

and use of AVs. The current legal environment integrates the laws and regulations pertaining to classical transport models and vehicles. Therefore, it is essential to implement newer regulations and legislation to incorporate the legal requirements of AVs. The findings of this study stress the need to implement newer legislation to enhance the efficiency of AVs and traffic operations. These regulations must consider various elements, including public usage, manufacturing laws, the role of the CJS, and individual liability (Abraham & Rabin, 2019). Research projects a continuous increase in the manufacture and adoption of AVs. The migration from classical transport models and vehicles to AVs will be slow and costly. This study provides a framework for assessing the societal impacts of AVs.

Levels of Autonomous Vehicles

AVs are one of the most promising innovations in the 21st century. This innovation comes in at one of the critical moments when the world is concerned with various pressing issues, including the demands on reducing traffic congestion, accidents, emissions, and energy consumption. AVs provide an important platform for addressing these critical social and environmental issues (Alijauskaitė, 2020). It is important to understand the meaning of an automated vehicle and how they function. According to Bansal and Kockelman (2018), an autonomous vehicle integrates advanced technologies that assist human drivers and users in controlling the vehicle independently. Depending on the level of automation, human interference may or may not be required (Bansal & Kockelman, 2018). The control decisions, including decelerating, accelerating, parking, and changing lanes, are executed differently in AVs based on the levels of automation. They can be executed by a human driver or an autonomous system. Regardless of the individual or system responsible for making these decisions, the perception results of the surrounding environment, including weather, cyclists, pedestrians, other vehicles,

school zones, and traffic signals, must be considered when making these decisions (Bakioglu & Atahan, 2021). Vehicle automation can be divided into several levels, including no automation, partial automation, high automation, or full automation.

These levels are based on the level of involvement of human drivers and automated systems in evaluating and monitoring the surrounding environment to enhance the efficiency of controlling the vehicle. The most common levels of automation in AVs include level 0, level 1, level 2, level 3, level 4, and level 5 (Feng et al., 2021). In level 0, the driving and control tasks are fully managed and accomplished by the human driver. Level 1 is also known as driver assistance. At this level, the human driver leverages the capabilities of the AV technologies to run and handle various driving and control tasks. The human driver and AV system handle driving tasks in level 2 (partial driving automation. The primary task of the human driver is to monitor the environment and control procedures to enhance efficiency and safety. Level 3 is a conditional driving automation level, where the AV is in charge of driving.

However, the human driver must be ready to take over in case the AV system fails. Level 4, high driving automation integrates a state-of-the-art AV system that is capable of driving and monitoring all environmental conditions, including weather, cyclists, pedestrians, other vehicles, school zones, and traffic signals. However, despite this high level of automation, human drivers can still operate level 4 AVs. Level 5 AVs are fully autonomous. The AV systems can handle all driving tasks in all conditions. Based on the research findings, only a few people have interacted with AVs, which explains the high level of ignorance of the various levels of automation in AVs. The research findings highlight the need to increase awareness of AVs among law enforcement authorities and the public.

Vehicle Design

The autonomous technology employed in AVs is a gateway to experiencing various opportunities to mitigate and eliminate various transportation-related economic, social, and environmental issues. This phenomenon has provided a great opportunity for various researchers and experts to explore autonomous vehicles and their components, including the mechanism of action, design, technological features, and impacts. AV technologies are capable of enhancing and completely transforming the classic transport model and frameworks. For instance, their impacts can be realized through improving road safety by eliminating or reducing human errors. According to (Boggs et al., 2020), human errors are responsible for nearly 95% of the total road accidents in the US. AV technologies can also enhance the commuter experience by replacing human drivers with autonomous systems. This process allows humans to explore other activities like entertainment instead of driving. They also could shorten the commute time by eliminating traffic issues related to human errors. AV technologies integrate the new digital technologies in communication and robotics.

AVs employ the three-phase working mechanism that integrates sense, plan, and act operations. AVs are required to make sense of complex and dynamic driving environments, including various features and items like weather, cyclists, pedestrians, other vehicles, school zones, and traffic signals. Therefore, AVs are equipped with various technological devices and features to enable three-phase operations. They include sensors, radars, cameras, electromagnetic interference (EMI), machine learning, and scenario operation. These technologies allow the AVs to obtain raw data and information from the surrounding environment and process it to facilitate data-driven decision-making. This process allows the AVs to make informed and accurate decisions related to various driving operations, including parking, overtaking, lane changing, stopping, accelerating, and braking (Bakioglu & Atahan, 2021).

Cybersecurity Vulnerabilities

AVs are prone to cybercrime and cyberattacks. These vehicles use various computer-aided systems that are a high target of cybercriminals. AVs are computer-reliant since they depend on a number of software components to operate. This feature makes them vulnerable to software-related security issues, including cyber-attacks and hacking. Central to their operating system is the connection to a strong and reliable internet connection. Due to their heavy connectivity through the internet, AVs are susceptible to cyber threats such as remote hacking, vehicle spoofing, data breaches, tampering with sensor data, insider threats, and tampering with software updates. Hackers may manipulate the AVs to control various functions such as driving, accelerating, and breaking.

This may cause significant issues and damages, especially if the criminals manipulate the software vulnerabilities of AVs to perform various malicious and criminal offenses like killing, kidnapping, and robbery. Vehicle spoofing is another common cyber threat facing many AVs. It involves confusing the vehicle's navigation systems and making AVs choose an undesired scenario or location. Similar to remote hacking, vehicle spoofing can be used to instigate various criminal offenses, including kidnapping human users, killing, causing havoc, causing road accidents, and disrupting traffic flow and operations.

AVs collect and store a wide array of data, including location, driver's information, traffic conditions, and vehicle registration details. Cybercriminals may hack into the AV storage system to access this sensitive information. They can use this information for various malicious purposes, including demanding ransom, exploiting, and theft. They could also access an individual's location by hacking into the AVs' navigation and GPS systems. Criminals can also manipulate the vehicles' sensing technologies to confuse and trick their vision with false images

and objects projected on the roads. Since AVs depend on various software applications and solutions, it is important to ensure regular updates to keep up with the current features and advancements in technology. However, cybercriminals may tamper with the software updates, forcing the AVs to function with outdated software packages. Insider threats are instigated by the manufacturers of AVs. While these cases are minimal, they still pose a significant amount of threat to AV users and owners. Insider threat occurs when an employee accesses sensitive information such as the AV chassis number, registration details, owner's details, and GPS and location details. They can sell or use this information to instigate and purport various malicious and criminal activities.

Generally, AVs collect and process huge loads of data, including environmental conditions, legal requirements, and personal information such as driver's name, location, and other pertinent personal information. The need to protect and safeguard a driver's personal information and data warrants the enhancement of cybersecurity measures in AVs. These measures will enhance the safety and privacy of such sensitive and personal information by preventing unauthorized access and sharing of such data. From the research findings, it is evident that there is a need to increase cybersecurity measures relative to the production and usage of AVs. AVs use computer systems that are vulnerable to cyberattacks. However, the benefits of AVs to society and the environment make them a worthy innovation. Thus, instead of eliminating AVs, it is important to upgrade and enhance their security features to enhance their efficiency and safety. A common adverse effect related to cybersecurity vulnerabilities of AVs is safety concerns. Cybercriminals may compromise the numerous systems integrated into AVs to alter their functionality, thus causing accidents. This causes safety issues that may reduce the efficiency of AVs.

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Law Enforcement

Despite the rapid adoption of AVs in the US, law enforcement measures related to these vehicles are lacking. Currently, many law enforcement agencies and authorities are less informed about the functionality and nature of AVs. Law enforcement authorities and agencies are in charge of ensuring all vehicles and road users adhere to the various laws and regulations. As a result, there is an increased need to enhance collaboration between law enforcement, automotive manufacturers, and communities to enhance the safety and security of AVs and other road users. This partnership would facilitate the development of proactive measures to respond to law enforcement issues surrounding AVs. However, from the research findings, law enforcement authorities have little knowledge about the various aspects of AVs, including how they function and the levels of automation. Law enforcement authorities should also advance their techniques and processes to suit the requirements of crime investigation and punishment for AVs (Bansal & Kockelman, 2018). Typically, law enforcement agencies will require competencies in technology, particularly the functionality of AVs, to explore the crime involvement of AVs and the protection of personal and intellectual rights.

The main challenges law enforcement agencies will face when dealing with crime related to AVs include technology, constitutional authorities, and procedures. These challenges occur especially due to the difference in the levels of automation of AVs. The first step in solving a crime related to AVs is determining whether the AV in question is operating with or without a human operator. This element is important since it can help the law enforcement officers to determine the relevant causes.

Legislation

One of the most crucial impacts of AVs is changes in legislation. The current traffic control and criminal offense laws are centered on classical traffic models, integrating human-driven cars. With the rapid adoption and development of AVs, there is an increased need to integrate newer regulations to govern the manufacture and use of AVs. According to Pattinson et al. (2020), the legal issues related to the use of AVs stem from the integration of different levels of automation in AVs. Most AVs employ a system that requires a shared driving experience between the human operator and the autonomous system (Pattinson et al., 2020). This structure creates operational and technical challenges, especially regarding who is liable for criminal offenses involving AVs. Therefore, there is a need to implement new regulations that outline the procedures to share operational responsibility and delineate legal responsibilities between the AV, the manufacturer, and users in case of criminal offenses, traffic rule violations, or accidents (Pattinson et al., 2020). Another important inclusion would be developing an interactive digital interface that allows human drivers to take over control of the driving tasks and operations in the event that an AV encounters a situation on the road that is beyond its capacity.

Training

The development of new laws and law enforcement procedures warrants training of the public and members of law enforcement agencies. Such training is important since it helps various stakeholders understand how AVs operate and the various requirements needed by human drivers. Research shows that most law enforcement authorities lack sufficient information and knowledge regarding the functionality of AVs (Freemark et al., 2019). This knowledge gap is critical, especially when considering its implications for achieving criminal justice system objectives and goals. The lack of information hinders the proper functionality of law

enforcement agencies, leading to a high prevalence of crime. Training should occur at various stages of recruitment to help law enforcement agencies gain sufficient knowledge about AVs and their functionalities. This process will streamline the interaction between law enforcement agencies and AVs, leading to better crime outcomes.

Safety

Safety is an important consideration of AVs. AVs depend on various computer systems integrating hardware and software components. These components, like any other computer systems, are prone to systemic failures. While these failures are common and a normal phenomenon, they may pose significant threats to the safety of road users, including pedestrians, drivers, and cyclists (Geary & Danks, 2019). Generally, the safety issues of AVs revolve around the reliability of the architecture of AV automation systems, including the associated hardware and software components. The AV architecture is highly dependent on the level of automation of AVs. The AV architectures often consist of a sensor-based perception system, an actuator-based actuation system, and an algorithm-based decision system, as well as the interconnections between systems (He et al., 2020). The safety issues of AVs can be caused by a number of problems, including perception errors, decision errors, action errors, and accidents caused by other road users. Perception errors relate to the issues associated with sensing devices such as light detection and ranging (LIDAR) sensors, ultrasonic sensors, radars, cameras, contact sensors, and global positioning systems (GPS) that collect real-time information about the environmental condition of the roads. If these sensors fail to collect information as required, the decision-making system will not function appropriately, leading to errors in executing driving commands and operations.

Implications

Experts believe that AVs would be more appealing if they devised a method that allows people to customize their driving styles. With the prospective benefits of AVs, such as developing smart cities, avoiding road accidents, and reducing the gap for those who are not drivers, the prospective adverse impacts must be considered (Campisi et al., 2021). The failure or success of AVs has a variety of consequences for the CJS, notably new cybercrimes such as AV hacking, novel traffic regulations and procedures, and the prospect of utilizing AVs to combat crime.

Delimitations and Limitations

The researcher will only interview law enforcement officials. These experts will be interviewed since they are knowledgeable about AV repercussions on law enforcement (Busetto et al., 2020). A limitation of the study is that the interviewees will only be obtained from one region, namely Virginia. Obtaining participants from one region can be alarming as the participants could be biased; hence, the data collected is only based on a group of people and fails to collect ideas from participants from other regions.

Recommendations for Future Research

Some of the topics that should be covered include those about AVs and accidents involving AVs. A descriptive research design is best suited since it has the most negligible margin of error and does not require internal validity. Additional research into the impact of AVs on alcohol-related accidents is needed. Furthermore, AV ride-sharing has possible gains (Fell, 2020). Future research should involve opinions from other people, not only from Virginia. Future research also should consider the opinion of people who do not have experience in AVs.

Summary

There is a need to evaluate current rules to reflect the changes brought on by AVs and innovation. There will be regulations involving AVs for automobile owners and automakers, making the legislative process difficult for all parties. New legal rules to control the operation of AVs on the road are required (Bikeev et al., 2019). A new compensation mechanism that is theoretically lucrative to manufacturers should provide them with protection, compensate victims of AV accidents, and lessen the burden on the CJS. Victims of injury caused by AVs would be rapidly reimbursed, manufacturers would be adequately protected, and the judicial system would have time to adjust to new rules and challenges offered by AVs under a "no-fault quasi-judicial victim compensation plan." Like any other judicial process, awarding legal status to AVs will require a lengthy process that includes definition, tiers of AVs and their capabilities, methods for obtaining the use, reporting protocols, and, most notably, the automakers' guarantee of the safety of AVs. In this regard, the AV maker would bear a more significant share of the blame for AV failures and hazards.

References

Abraham, K. S., & Rabin, R. L. (2019). Automated vehicles and manufacturer responsibility for accidents. *Virginia Law Review, 105*(1), 127-171. http://doi.org/10.2139/ssrn.3159525

Alijauskaitė, A. (2020). Robot Ethics 2.0. From Autonomous Cars to Artificial Intelligence—Edited by Patrick Lin, Keith Abney, Ryan Jenkins. New York: Oxford University Press, 2017. Pp xiii+ 421. Doi: http://doi.org/10.1007/s10670-020-00331-3

Atkinson, K. (2020). Autonomous cars: A driving force for change in motor liability and AV. *SCRIPTed*, *17*, 125. Doi: http://doi.org/10.2966/scrip.170120.125

Bakioglu, G., & Atahan, A. O. (2021). AHP integrated TOPSIS and VIKOR methods with Pythagorean fuzzy sets to prioritize risks in self-driving vehicles. *Applied Soft Computing*, *99*, 106948. https://doi.org/10.1016/j.asoc.2020.106948

Bansal, P., & Kockelman, K. M. (2018). Are we ready to embrace connected and self-driving vehicles? A case study of Texans. *Transportation*, *45*(2), 641-675. Doi: http://doi.org/10.1007/s11116-016-9745-z

Bikeev, I., Kabanov, P., Begishev, I., & Khisamova, Z. (2019, December). Criminological risks and legal aspects of artificial intelligence implementation. In *Proceedings of the International Conference on Artificial Intelligence, Information Processing and Cloud Computing* (pp. 1-7). Doi:http://doi.org/10.1145/3371425.3371476

Boggs, A. M., Wali, B., & Khattak, A. J. (2020). Exploratory analysis of automated vehicle crashes in California: A text analytics & hierarchical Bayesian heterogeneity-based approach. *Accident Analysis & Prevention*, *135*, 105354. https://doi.org/10.1016/j.aap.2019.105354

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health*, *11*(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, *2*, 1-10. https://doi.org/10.1186/s42466-020-00059-z

Campisi, T., Severino, A., Al-Rashid, M. A., & Pau, G. (2021). The development of the smart cities in the connected and autonomous vehicles (CAVs) era: From mobility patterns to scaling in cities. *Infrastructures*, *6*(7), 100. http://doi.org/10.3390/infrastructures6070100

Cascio, M. A., Lee, E., Vaudrin, N., & Freedman, D. A. (2019). A Team-based Approach to Open Coding: Considerations for Creating Intercoder Consensus. *Field Methods*. https://doi.org/10.1177/1525822X19838237

Classen, S., Li, Y., Giang, W., Winter, S., Wei, J., Patel, B., & Ramirez-Zamora, A. (2022). RCT protocol for driving performance in people with Parkinson's using autonomous in-vehicle technologies. *Contemporary Clinical Trials Communications*, 100954. https://doi.org/10.1016/j.conctc.2022.100954

Chen, S. Y., Kuo, H. Y., & Lee, C. (2020). Preparing society for automated vehicles: Perceptions of the importance and urgency of emerging issues of governance, regulations, and wider impacts. *Sustainability*, *12*(19), 7844. https://www.mdpi.com/2071-1050/12/19/7844

Cohen, T., Stilgoe, J., & Cavoli, C. (2018). Reframing the governance of automotive automation: insights from UK stakeholder workshops. *Journal of Responsible Innovation*, *5*(3), 257-279. https://www.tandfonline.com/doi/full/10.1080/23299460.2018.1495030

Cohen, T., & Cavoli, C. (2019). Automated vehicles: exploring possible consequences of government (non) intervention for congestion and accessibility. *Transport Reviews*, *39*(1), 129-151. Doi:http://doi.org/10.1080/01441647.2018.1524401

Cuthbertson, A. (2019). Self-driving cars more likely to drive into black people, study claims. *Independent Newspaper*. https://www.independent.co.uk/tech/self-driving-car-crash-racial-bias-black-people-study-a8810031.html

Dia, Hussein (2017). Autonomous vehicles and shared mobility: shaping the future of urban transport. Low Carbon Mobility for Future Cities: Principles and applications, 241-276. Doi: http://doi.org/10.1049/pbtr006e_ch11

Do, W., Rouhani, O. M., & Miranda-Moreno, L. (2019). Simulation-based connected and automated vehicle models on highway sections: a literature review. *Journal of Advanced Transportation, 2019*. https://www.hindawi.com/journals/jat/2019/9343705/

Duarte, F., &Ratti, C. (2018). The impact of autonomous vehicles on cities: A review. *Journal of Urban Technology*, *25*(4), 3-18. Doi:http://doi.org/10.1080/10630732.2018.1493883

Dupont, C. G., Schultz, T., & Yackee, J. W. (2019). Investment arbitration and political systems theory. *Oxford Handbook of International Arbitration, OUP*. https://dx.doi.org/10.2139/ssrn.3351343

Etzioni, S., Hamadneh, J., Elvarsson, A. B., Esztergár-Kiss, D., Djukanovic, M., Neophytou, S. N., & Shiftan, Y. (2020). Modeling cross-national differences in automated vehicle acceptance. *Sustainability*, *12*(22), 9765. https://doi.org/10.3390/su12229765

Evans, K., de Moura, N., Chauvier, S., Chatila, R., & Dogan, E. (2020). Ethical decision making in autonomous vehicles: The AV ethics project. *Science and engineering ethics*, *26*, 3285-3312. https://link.springer.com/article/10.1007/s11948-020-00272-8

Fell, J. C. (2020). Approaches for reducing alcohol-impaired driving: evidence-based legislation, law enforcement strategies, sanctions, and alcohol-control policies. In *Alcohol, Drugs, and Impaired Driving* (pp. 653-689). CRC Press. Doi: http://doi.org/10.4324/9781003030799-22

Feng, S., Yan, X., Sun, H., Feng, Y., & Liu, H. X. (2021). Intelligent driving intelligence test for autonomous vehicles with naturalistic and adversarial environment. *Nature Communications*, *12*(1), 1-14. Doi: https://doi.org/10.1038/s41467-021-21007-8

Freemark, Y., Hudson, A., & Zhao, J. (2019). Are cities prepared for autonomous vehicles? Planning for technological change by US local governments. *Journal of the American Planning Association*, *85*(2), 133-151. Doi: http://doi.org/10.1080/01944363.2019.1603760

Gambi, A., Huynh, T., & Fraser, G. (2019, May). Automatically reconstructing car crashes from police reports for testing self-driving cars. In *2019 IEEE/ACM 41st International Conference on Software Engineering: Companion Proceedings (ICSE-Companion)* (pp. 290-291). IEEE. Doi: http://doi.org/10.1109/icse-companion.2019.00119

Gambi, Alessio, Tri Huynh, and Gordon Fraser (2019). "Generating effective test cases for self-driving cars from police reports." Proceedings of the 2019 27th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering, 2019. Doi: http://doi.org/10.1145/3338906.3338942

Gambi, Alessio, Marc Mueller, and Gordon Fraser. (2019) "Automatically testing self-driving cars with search-based procedural content generation." Proceedings of the 28th ACM SIGSOFT International Symposium on Software Testing and Analysis Doi: http://doi.org/10.1145/3293882.3330566

Geary, T., &Danks, D. (2019, January). Balancing the benefits of autonomous vehicles. In *Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society* (pp. 181-186) https://doi.org/10.1145/3306618.3314237

Giuffrida, I. (2019). Liability for AI decision-making: some legal and ethical considerations. *Fordham L. Rev.*, *88*, 439. https://heinonline.org/HOL/LandingPage?handle=hein.journals/flr88&div=18&id=&page=

Gopalswamy, S., & Rathinam, S. (2018, June). Infrastructure enabled autonomy: A distributed intelligence architecture for autonomous vehicles. In *2018 IEEE Intelligent Vehicles Symposium (IV)* (pp. 986-992). IEEE. Doi:http://doi.org/10.1109/ivs.2018.8500436

Hallevy, P. (2019). The Basic Models of Criminal Liability of AI Systems and Outer Circles. *The Basic Models of Criminal Liability of AI Systems and Outer Circles (June 11, 2019)*. https://dx.doi.org/10.2139/ssrn.3402527

Hasfar, M., Militina, T., & Achmad, G. N. (2020). Effect of customer value and customer experience on customer satisfaction and loyalty PT meratus samarinda. *International Journal of Economics, Business and Accounting Research (IJEBAR)*, *4*(01). https://www.jurnal.stie-aas.ac.id/index.php/IJEBAR/article/view/909

Hayward, K. J., & Maas, M. M. (2021). Artificial intelligence and crime: A primer for criminologists. *Crime, Media, Culture*, *17*(2), 209-233. Doi: http://doi.org/10.1177/1741659020917434

He, Q., Meng, X., Qu, R., & Xi, R. (2020). Machine learning-based detection for cyber security attacks on connected and autonomous vehicles. *Mathematics*, *8*(8), 1311. https://doi.org/10.3390/math8081311

Holstein, T., Dodig-Crnkovic, G., &Pelliccione, P. (2018). Ethical and social aspects of self-driving cars. *arXiv preprint arXiv:1802.04103*. Doi: http://doi.org/10.29007/mgcs

Hussain, N., Rani, P., Chouhan, H., & Gaur, U. S. (2022). Cyber security and privacy of connected and automated vehicles (CAVs)-based federated learning: challenges, opportunities, and open issues. *Federated Learning for IoT Applications*, 169-183. https://www.somao.com/literature/detail/bcb22d72cb82d823f4f60c1b5788782d.html

Huynh, T., Gambi, A., & Fraser, G. (2019, May). AC3R: automatically reconstructing car crashes from police reports. In *2019 IEEE/ACM 41st International Conference on Software Engineering: Companion Proceedings (ICSE-Companion)* (pp. 31-34). IEEE. Doi: https://doi.org/10.1109/ICSE-Companion.2019.00031

Jackson, K., & Bazeley, P. (2019). *Qualitative data analysis with NVivo*. Sage.

Jha, S., Tsai, T., Hari, S., Sullivan, M., Kalbarczyk, Z., Keckler, S. W., & Iyer, R. K. (2019). Kayotee: A fault injection-based system to assess the safety and reliability of autonomous vehicles to faults and errors. *arXiv preprint arXiv:1907.01024*. https://doi.org/10.48550/arXiv.1907.01024

Joh, E. E. (2019). Automated Seizures: Police Stops of Self-Driving Cars. *NYUL Rev. Online*, *94*, 113. doi: https://doi.org/10.2139/ssrn.3354800

Kammersgaard, T. (2019). Harm reduction policing: From drug law enforcement to protection. *Contemporary Drug Problems*, *46*(4), 345-362. Doi. http://doi.org/10.1177/0091450919871313

Karnouskos, S. (2018). Self-driving car acceptance and the role of ethics. *IEEE Transactions on Engineering Management*, *67*(2), 252-265. Doi: http://doi.org/10.1109/tem.2018.2877307

Khan, S. K., Shiwakoti, N., & Stasinopoulos, P. (2022). A conceptual system dynamics model for cybersecurity assessment of connected and autonomous vehicles. *Accident Analysis & Prevention*, *165*, 106515. https://doi.org/10.1016/j.aap.2021.106515

Kim, K., Kim, J. S., Jeong, S., Park, J. H., & Kim, H. K. (2021). Cybersecurity for autonomous vehicles: Review of attacks and defense. *Computers & Security*, *103*, 102150. https://doi.org/10.1016/j.cose.2020.102150

Kirpichnikov, D., Pavlyuk, A., Grebneva, Y., & Okagbue, H. (2020). Criminal Liability of the Artificial Intelligence. In *E3S Web of Conferences* (Vol. 159, p. 04025). EDP Sciences. https://doi.org/10.1051/e3sconf/202015904025

Kopelias, P., Demiridi, E., Vogiatzis, K., Skabardonis, A., & Zafiropoulou, V. (2020). Connected & autonomous vehicles–Environmental impacts–A review. *Science of the Total Environment*, *712*, 135237. https://www.sciencedirect.com/science/article/abs/pii/S0048969719352295

Kuokkanen, H., & Sun, W. (2020). Companies, meet ethical consumers: Strategic CSR management to impact consumer choice. *Journal of Business Ethics*, *166*(2), 403-423. https://doi.org/10.1007/s10551-019-04145-4

Lawlor, D., & Sher, M. (2021). Socio-technical systems. In *An Introduction to Systems Psychodynamics* (pp. 247-260). Routledge.

Leuzzi, F., Del Signore, E., & Ferranti, R. (2017, October). Towards pervasive and predictive traffic police. In *Italian Conference for the Traffic Police* (pp. 19-35). Springer, Cham. Doi: http://doi.org/10.1007/978-3-319-75608-0_3

Li, G., Yang, Y., Zhang, T., Qu, X., Cao, D., Cheng, B., & Li, K. (2021). Risk assessment based collision avoidance decision-making for autonomous vehicles in multi-scenarios. *Transportation Research Part C: Emerging Technologies*, *122*, 102820.

Linkov, V., Zámečník, P., Havlíčková, D., & Pai, C. W. (2019). Human factors in the cybersecurity of autonomous vehicles: Trends in current research. *Frontiers in Psychology*, *10*, 995. https://doi.org/10.3389/fpsyg.2019.00995

Liu, N., Nikitas, A., & Parkinson, S. (2020). Exploring expert perceptions about the cyber security and privacy of Connected and Autonomous Vehicles: A thematic analysis approach. *Transportation research part F: traffic psychology and behaviour*, *75*, 66-86. https://doi.org/10.1016/j.trf.2020.09.019

Marletto, G. (2019). Who will drive the transition to self-driving? A socio-technical analysis of the future impact of automated vehicles. *Technological Forecasting and Social Change*, *139*, 221-234. https://www.sciencedirect.com/science/article/abs/pii/S0040162517312702

Menon, C., & Alexander, R. (2020, January). A safety-case approach to the ethics of autonomous vehicles. In *Safety and reliability* (Vol. 39, No. 1, pp. 33-58). Taylor & Francis. https://doi.org/10.1080/09617353.2019.1697918

Nastjuk, I., Herrenkind, B., Marrone, M., Brendel, A. B., & Kolbe, L. M. (2020). What drives the acceptance of autonomous driving? An investigation of acceptance factors from an end-user's perspective. *Technological Forecasting and Social Change*, *161*, 120319. https://doi.org/10.1016/j.techfore.2020.120319

Pattinson, J., Chen, H., & Basu, S. (2020). Legal issues in automated vehicles: Critically considering the potential role of consent and interactive digital interfaces. *Humanities*

and Social Sciences Communications, *7*(1), 1-10. https://doi.org/10.1057/s41599-020-00644-2

Pearl, T. H. (2018). Hands-on the wheel: a call for greater regulation of semi-autonomous cars. *Ind. LJ*, *93*, 713. Doi: http://doi.org/10.2139/ssrn.2930125

Pearl, T. H. (2019, January). Compensation at the crossroads: autonomous cars and alternative victim compensation schemes. In *Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society* (pp. 187-193). Doi: http://doi.org/10.2139/ssrn.3148162

Pisarov, J. L., & Mester, G. (2022). Self-Driving Robotic Cars: Cyber Security Developments. In Research Anthology on Cross-Disciplinary Designs and Applications of Automation (pp. 969-1001). IGI Global. https://doi.org/10.4018/978-1-6684-3694-3.ch048

Pribyl, O., & Lom, M. (2019, May). Impact of Autonomous Vehicles in Cities: User Perception. In *2019 Smart City Symposium Prague (SCSP)* (pp. 1-6). IEEE. Doi: http://doi.org/10.1109/scsp.2019.8805717

Raiyn, J. (2018). Data and cyber security in autonomous vehicle networks. Transport and Telecommunication, 19(4), 325-334. http://dx.doi.org/10.2478/ttj-2018-0027

Ribeiro, M. A., Gursoy, D., & Chi, O. H. (2022). Customer acceptance of autonomous vehicles in travel and tourism. *Journal of Travel Research*, *61*(3), 620-636. https://doi.org/10.3390/s21062140

Ryan, M. (2020). The future of transportation: ethical, legal, social and economic impacts of self-driving vehicles in the year 2025. *Science and engineering ethics*, *26*(3), 1185-1208. https://link.springer.com/article/10.1007/s11948-019-00130-2

Saldaña, J. (2021). *The coding manual for qualitative researchers*. sage. ISBN 9781529755992

Sama, R. (2019). Impact of media advertisements on consumer behaviour. *Journal of Creative Communications*, *14*(1), 54-68. https://doi.org/10.1177/0973258618822624

Scalas, M., & Giacinto, G. (2019, October). Automotive cybersecurity: Foundations for next-generation vehicles. In 2019 2nd International Conference on new Trends in Computing Sciences (ICTCS) (pp. 1-6). IEEE. https://doi.org/10.1109/ICTCS.2019.8923077

Seuwou, P., Banissi, E., &Ubakanma, G. (2020). The future of mobility with connected and autonomous vehicles in smart cities. In *Digital Twin Technologies and Smart Cities* (pp. 37-52). Springer, Cham. Doi: http://doi.org/10.1007/978-3-030-18732-3_3

Shariff, A., Bonnefon, J. F., &Rahwan, I. (2017). Psychological roadblocks to the adoption of self-driving vehicles. *Nature Human Behaviour*, *1*(10), 694-696. Doi: http://doi.org/10.1038/s41562-017-0202-6

Sifakis, J. (2018). System Design in the Era of IoT---Meeting the Autonomy Challenge. *arXiv preprint arXiv:1806.09846*. Doi: http://doi.org/10.4204/eptcs.272.1

Sinha, A., Vu, V., Chand, S., Wijayaratna, K., & Dixit, V. (2021). A crash injury model involving autonomous vehicle: Investigating of crash and disengagement reports. *Sustainability*, *13*(14), 7938. https://doi.org/10.3390/su13147938

Sony, M., & Naik, S. (2020). Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model. *Technology in society*, *61*, 101248.

Stilgoe, J. (2018). Machine learning, social learning and the governance of self-driving cars. *Social studies of science*, *48*(1), 25-56. Doi:http://doi.org/10.2139/ssrn.2937316

Stocco, A., Weiss, M., Calzana, M., & Tonella, P. (2020, June). Misbehaviour prediction for autonomous driving systems. In Proceedings of the ACM/IEEE 42nd international

conference on software engineering (pp. 359-371). https://doi.org/10.1145/3377811.3380353

Taeihagh, A., & Lim, H. S. M. (2019). Governing autonomous vehicles: emerging responses for safety, liability, privacy, cybersecurity, and industry risks. *Transport Reviews, 39*(1), 103-128. https://doi.org/10.1080/01441647.2018.1494640

Tan, X., & Leon-Garcia, A. (2018, October). Autonomous mobility and energy service management in future smart cities: An overview. In *2018 4th International Conference on Universal Village (UV)* (pp. 1-6). IEEE. Doi: http://doi.org/10.1109/uv.2018.8642141

Tennant, C., &Stilgoe, J. (2021). The attachments of 'autonomous' vehicles. *Social Studies of Science, 51*(6), 846-870. https://doi.org/10.1177%2F03063127211038752

Ulybyshev, D., Alsalem, A. O., Bhargava, B., Savvides, S., Mani, G., &Othmane, L. B. (2018, July). Secure data communication in autonomous v2x systems. In *2018 IEEE International Congress on Internet of Things (ICIOT)* (pp. 156-163). IEEE. Doi: http://doi.org/10.1109/iciot.2018.00029

Voas, R. B. (2020). Vehicle safety features aimed at preventing alcohol-related crashes. *Alcohol, Drugs, and Impaired Driving*, 611-652. https://pubmed.ncbi.nlm.nih.gov/32007928/

Wang, J., Zhang, L., Huang, Y., Zhao, J., & Bella, F. (2020). Safety of autonomous vehicles. *Journal of Advanced Transportation, 2020*, 1-13. https://doi.org/10.1155/2020/8867757

Wendehorst, C. (2020). Strict liability for AI and other emerging technologies. *Journal of European Tort Law*, *11*(2), 150-180. https://doi.org/10.1515/jetl-2020-0140

Wiseman, Y. (2018). In an era of autonomous vehicles, rails are obsolete. *International Journal of Control and Automation*, *11*(2), 151-160.

Doi: http://doi.org/10.14257/ijca.2018.11.2.13

Wiseman, Y. (2022). Autonomous vehicles. In *Research Anthology on Cross-Disciplinary Designs and Applications of Automation* (pp. 878-889). IGI Global. DOI: 10.4018/978-1-6684-3694-3.ch043

Wu, Y., Kihara, K., Takeda, Y., Sato, T., Akamatsu, M., & Kitazaki, S. (2019). Effects of scheduled manual driving on drowsiness and response to take over request: A simulator study towards understanding drivers in automated driving. *Accident Analysis & Prevention*, *124*, 202-209. https://www.sciencedirect.com/science/article/abs/pii/S0001457519300661

Xiong, J., Bi, R., Zhao, M., Guo, J., & Yang, Q. (2020). Edge-assisted privacy-preserving raw data sharing framework for connected autonomous vehicles. *IEEE Wireless Communications*, *27*(3), 24-30. https://ieeexplore.ieee.org/document/9116084

Yeong, D. J., Velasco-Hernandez, G., Barry, J., & Walsh, J. (2021). Sensor and sensor fusion technology in autonomous vehicles: A review. *Sensors*, *21*(6), 2140. https://doi.org/10.3390/s21062140

Yokoi, R., & Nakayachi, K. (2021). Trust in autonomous cars: Exploring the role of shared moral values, reasoning, and emotion in safety-critical decisions. *Human Factors*, *63*(8), 1465-1484. Doi: http://doi.org/10.1177/0018720820933041

Zhu, X., Gu, Z., & Wang, Z. (2021). Ethical challenges and countermeasures of autonomous vehicles. In *E3S Web of Conferences* (Vol. 233, p. 04016). EDP Sciences. https://www.e3s-conferences.org/articles/e3sconf/abs/2021/09/e3sconf_iaecst20_04016/e3sconf_iaecst20_04016.html

Glossary of Keywords

Artificial intelligence replicates human intelligence in robots directed to make decisions resembling humans or any equipment that portrays human-like traits such as intellect and problem-solving (Kirpichnikov et al., 2020).

An automobile is a vehicle not driven by individuals but operated by them (Wiseman, 2018).

Autonomous Vehicles are capable of functioning without the aid of humans. A person is not poised to drive the vehicle at any moment, and a passenger is not mandated to be in the vehicle. A self-driving automobile can go wherever a standard vehicle can and accomplish all of a competent driver's jobs (Atkinson, 2020).

Autonomous driving is self-driving vehicles or means of transport that operate without the involvement of a motorist (Atkinson, 2020).

Cybersecurity refers to the act of protecting and safeguarding computers, networks, data, mobile devices, and electronic systems from digital attacks (Taeihagh & Lim, 2019). Cybercriminals attack computer systems to access, alter, or destroy sensitive information, manipulate people through ramsons, or disrupt normal business operations.

Data analysis is the procedure for gathering, analyzing, and evaluating data to gain information that aids choice. The term is the adoption of statistical or logical tools to articulate, depict, sum up, synthesize, and appraise data.

Data privacy is a people's capacity to choose when, how, and to what degree private details pertaining to them are transmitted to others (Xiong et al., 2020). These private details can incorporate a person's elements.

Laws are a society's obligatory custom or practice: a predetermined or formally recognized as enforceable or implemented set of ethics or activity by a governing authority (Pattinson et al., 2020).

Law enforcement officers are the entities and personnel responsible for enforcing laws, maintaining social stability, and protecting citizens (Pattinson et al., 2020).

Research methodical research and analysis of sources and methods to set up facts and reach new conclusions.