

CIVIL LIABILITY OF AUTONOMOUS VEHICLES: A REVIEW OF LITERATURE

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ABSTRACT

Autonomous vehicles are seen as a recent trend that has brought about changes in conventional driving. Although autonomous vehicles may bring a significant increase in safety, mobility, and productivity, it is not entirely fool proof and there can still be unfortunate incidents. In a normal car, the driver oversees the vehicle and may be liable both criminally and civilly if he fails to control his vehicle. However, in cases involving autonomous vehicles, the driver alone may not be in control of the vehicle; instead, the autonomous vehicle software navigates the car. This paper adopts a doctrinal methodology to conduct an issue-based literature review pertaining to civil liability issues for road accidents involving autonomous vehicles. The issues identified are: liability, the standard of liability, the safety regulation of autonomous vehicles, and insurance as the compensation mechanism for accidents. The review helps to organise the literature according to the themes and to derive lessons learnt from the literature.

Keywords: Autonomous vehicles, Civil liability, Tort law, Regulation, Insurance.

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LIABILITI SIVIL KENDERAAN AUTONOMI: KAJIAN LITERATUR

ABSTRAK

Kenderaan autonomi merupakan trend terbaru mengikut peralihan semasa yang dilihat berbeza daripada pemanduan konvensional. Walaupun kenderaan autonomi dapat memberikan peningkatan dari segi keselamatan, mobiliti dan produktiviti, ia tidak memberi jaminan sepenuhnya dari segi keselamatan dan masih boleh terdedah kepada kemalangan. Dalam pemanduan kereta biasa, pemandu bertanggungjawab terhadap pemanduan kereta dan akan didapati bersalah dari segi undang-undang jenayah dan sivil jika terbukti bahawa pemandu tersebut gagal mengawal kenderaannya. Walaubagaimanapun, ia berbeza bagi kenderaan autonomi kerana pengawalan kereta bukan hanya tertakhluk kepada pemandu sahaja. Sebaliknya, sistem atau perisian adalah bertanggungjawab untuk mengawal kenderaan tersebut. Artikel ini menggunakan kaedah doktrinal untuk mengkaji makalah-makalah yang diterbitkan berkaitan dengan isu liabiliti sivil bagi kemalangan yang melibatkan kenderaan autonomi. Antara persoalan yang dikaji adalah (i) liabiliti siapa, (ii) standard liabiliti (iii) regulasi keselamatan yang ditetapkan berkaitan kenderaan autonomi, dan (iv) insurans sebagai mekanisme pampasan bagi kenderaan autonomi. Sumbangan artikel ini adalah untuk mengatur makalah-makalah yang berkaitan dengan kenderaan autonomi kepada tema tertentu dan juga untuk memperoleh pengajaran daripada makalah-makalah yang dikaji.

Kata Kunci: Kenderaan Autonomi, Liability Sivil, Undang-Undang Tort, Regulasi, Insurans.

INTRODUCTION

Continuous advancement in technology has greatly assisted human capabilities. Autonomous systems such as robots, drones, and vehicles can carry out tasks from routine work to highly specialised ones. In this paper, we will review the literature related to the law on autonomous vehicles in the form of self-driving cars.

Various terminologies have been used in relation to the concept of 'autonomous vehicles'. The idea of 'autonomous vehicles' is made popular after the US Defense Advanced Research Projects

Agency (DARPA) grand challenge for autonomous ground vehicles in 2004.¹

In today's practice, the term "autonomous vehicles" generally refers to cars which are driven with the help of an artificial intelligence system.² Other terms that have synonymously been used are "automation" and "automated vehicles". "Automation" refers to "the use of electronic or mechanical devices to replace human labour, in this case, to replace the human labour applied to driving a road vehicle."³ On the other hand, "automated vehicles" uses "robotics to execute some or all of the driving tasks normally performed by the human driver."⁴ In some authors' views, automated vehicles will only become "autonomous" if "the dynamic driving tasks, at all driving environment, can be performed by the vehicle's automated system."⁵ The term "automated vehicles" has been used in the United Kingdom's Automated and Electric Vehicles Act 2018. Meanwhile, electric vehicles are introduced in the automotive market to avoid the concentration of air pollutants such as carbon dioxide.⁶ Since both autonomous vehicles and electric vehicles are expected to play a significant role in the automotive industry, some researchers have suggested that autonomous vehicles and electric vehicles should be integrated together to form autonomous electric vehicles.⁷

¹ Asif Faisal et al., "Understanding Autonomous Vehicles: A Systematic Literature Review on Capability, Impact, Planning and Policy," *Journal of Transport and Land Use* 12, no. 1 (2019): 45–72.

² Alexandre Moreira Nascimento et al., "A Systematic Literature Review about the Impact of Artificial Intelligence on Autonomous Vehicle Safety," *IEEE Transactions on Intelligent Transportation Systems* 21, no. 12 (2020): 4928–46.

³ Jonathan Petit and Steven E. Shladover, "Potential Cyberattacks on Automated Vehicles," *IEEE Transactions on Intelligent Transportation Systems* 16, no. 2 (2015): 546–56.

⁴ Steven Underwood, "Automated, Connected, and Electric Vehicle Systems," 2015.

⁵ Faisal et al., "Understanding Autonomous Vehicles: A Systematic Literature Review on Capability, Impact, Planning and Policy."

⁶ Julio A. Sanguesa et al., "A Review on Electric Vehicles: Technologies and Challenges," *Smart Cities* 4, no. 1 (2021): 372–404.

⁷ Jingwen Wu et al., "The Role of Environmental Concern in the Public Acceptance of Autonomous Electric Vehicles: A Survey from China," *Transportation Research Part F: Traffic Psychology and Behaviour* 60

According to SAE International (previously known as the Society of Automotive Engineers), automation in autonomous vehicles can be classified into six levels, namely level 0 to level 5.⁸ Level 0 means that the vehicle has no automation either in the form of cruise control and lane-keeping capabilities. Level 1 and Level 2 are for semi-autonomous vehicles which require a human driver to be in some form of control of the vehicle while driving;⁹ whereas in Levels 3, 4 and 5, the vehicles are so automated that a driver need not be in control. When an autonomous vehicle reaches Level 5, it is assumed that the vehicle can drive on its own under all conditions.¹⁰

Although the *raison d'être* for autonomous vehicles is the potential to reduce the risk of accidents due to human errors and human fatigue,¹¹ the legal fraternity remains wary of potential liability from this kind of artificial intelligence-driven automation. This article will review the legal literature on autonomous vehicles from the perspectives of parties owing a liability, type and standard of liability, the regulation of autonomous vehicles, and the role of insurance as a compensation mechanism.

The methodology used for this article is doctrinal with a review of relevant literature on road accidents and autonomous vehicles. Initially, the identification of the relevant literature was obtained through the search engine Google Scholar. The relevant keywords used are “autonomous vehicles law”, “autonomous vehicles liability” “autonomous vehicles regulation”, and “autonomous vehicles insurance”, together with the names of countries that are relevant to autonomous vehicles. The countries include Singapore, the United Kingdom, the United States of America, Australia, and Malaysia as these countries discuss the developments of laws concerning autonomous vehicles. The search was supplemented by looking at relevant references from the downloaded articles for further research. Research published from 2000 to 2022 was obtained, read, and

(2019): 37–46.

⁸ SAE International, “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,” 2021.

⁹ SAE International.

¹⁰ SAE International.

¹¹ Mark Mario Morando et al., “Studying the Safety Impact of Autonomous Vehicles Using Simulation-Based Surrogate Safety Measures,” *Journal of Advanced Transportation* (2018): 1–11.

analysed. Similar themes and arguments concerning autonomous vehicles are grouped together in writing this article. The methodology used for this article is different from the systematic literature review which is a scientific way of synthesizing research findings in a systematic way.¹²

The article is divided into six parts. Part one discusses the introduction of the concept of autonomous vehicles, while part two outlines the liability issues concerning autonomous vehicles by discussing the possible persons that may be liable together with the type and standard of liability. Part three outlines the regulation of autonomous vehicles in different countries. Part four examines insurance as a compensation mechanism for autonomous vehicles. Part five considers the lessons that can be learnt from the analysed literature. Lastly, part six concludes that the gaps, liability, regulation to ensure the safety of autonomous vehicles, and insurance as a compensation scheme need to be determined.

The significance of this article is to give an overview of the literature on the issue of liability, regulation, and insurance as the compensation mechanism concerning autonomous vehicles. Based on the literature review, lessons are derived and analysed. It is interesting to note that different authors have different takes and solutions on a particular issue.

LIABILITY ISSUES CONCERNING AUTONOMOUS VEHICLES

The question of liability in relation to accidents involving autonomous vehicles is the most discussed topic in the relevant literature. In relation to this, the two primary questions are “Who is liable in the event of an accident?” and “What standard of liability is applicable?”. Imposing liability on the relevant parties is premised on the idea that there is a need to compensate victims and to incentivise manufacturers to produce safe autonomous vehicles or drivers and owners to make sure that the autonomous vehicle operates safely.

¹² Hannah Snyder, “Literature Review as a Research Methodology: An Overview and Guidelines,” *Journal of Business Research* 104, August (2019): 333–39.

Marchant and Lindor propose that, in the United States of America, liability for autonomous vehicles may be determined by considering three key factors: who will be liable, the weight of evidence given to the comparative safety of the autonomous vehicles, and whether the purported defect in the autonomous vehicles leads to an increase in accidents compared to non-autonomous vehicles.¹³

Whose Liability?

The complexity in allocating liability when multiple parties are involved is discussed by Pearl, Taeihagh and Lim, Punev and Srinivasamurthy in their articles.¹⁴ In this regard, various views have been forwarded. Pearl compares the case of a plane in autopilot mode to autonomous vehicles.¹⁵ Unfortunately, the author raises the question, without answering it, on whether an accident would be attributable to the manufacturer, the software programmer or the driver.¹⁶

Meanwhile, Colonna, Wong, and Kalra, Anderson and Wachs are of the view that manufacturers should be wholly liable as autonomous vehicles can be considered as manufactured products.¹⁷

¹³ Gary E Marchant and Rachel A Lindor, "The Coming Collision Between Autonomous Vehicles and the Liability System," *Santa Clara Law Review* 52, no. 4 (2012): 1321–40.

¹⁴ Tracy Hresco Pearl, "Compensation at the Crossroads: Autonomous Vehicles & Alternative Victim Compensation Schemes," *William & Mary Law Review* 60, no. 5 (2019): 1827–92; Araz Taeihagh and Hazel Si Min Lim, "Governing Autonomous Vehicles: Emerging Responses for Safety, Liability, Privacy, Cybersecurity, and Industry Risks," *Transport Reviews* 39, no. 1 (2019): 103–28; Anastas Punev, "Autonomous Vehicles: The Need for a Separate European Legal Framework," *European View* 19, no. 1 (2020): 95–102; Mythili Srinivasamurthy, "Autonomous Vehicles and Complexities in Allocation of Liability," *Jus Corpus Law Journal* 1 (2021): 360.

¹⁵ Pearl, "Compensation at the Crossroads: Autonomous Vehicles & Alternative Victim Compensation Schemes."

¹⁶ Pearl.

¹⁷ Kyle Colonna, "Autonomous Cars and Tort Liability," *Journal of Law, Technology & The Internet* 4, no. 4 (2012): 81–130; Keith Wong, "Considerations in an Autonomous Era," *Singapore Law Review* 9 (2018): 2–8; Nidhi Kalra, James Anderson, and Martin Wachs, *Liability and Regulation of Autonomous Vehicle Technologies* (RAND

Cowger disagrees by arguing that for the manufacturer to be liable, it should be reasonably foreseeable that the victim would be injured by the manufacturer's product which includes autonomous vehicles.¹⁸ This would depend on the choice of safety features which is another uncertainty as the technology for autonomous vehicles is evolving rapidly.

A novel idea proposed by some authors such as Kalra, Anderson and Wachs, Prakken and Pearl is to treat the autonomous vehicle as a legal person and ascribe liability directly to the autonomous vehicle itself.¹⁹ Colonna has a different view and suggests that it is highly unlikely that computer software or hardware may be held liable for negligence as it will be absurd to impose tort liability on a machine.²⁰ The idea of machine liability is probably too advanced at the present moment because autonomous vehicles do not have the capability to generate income, hold wealth and property, make decisions on investment and pay damages.

Abdullah and Manap consider the possibility of owners of the autonomous vehicles to be tortiously liable.²¹ The authors provided an analogy that the liability of autonomous vehicles owners may be similar to keeping a dangerous animal as a pet.²² The consequence of keeping a dangerous pet will make the owner strictly liable.²³ This proposition is similar to the analysis of the Islamic law position on

Corporation, 2009).

¹⁸ Alfred R. Jr. Cowger, "Liability Considerations When Autonomous Vehicles Choose the Accident Victim," *Journal of High Technology Law* 9, no. 1 (2018): 2–60.

¹⁹ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Henry Prakken, "On the Problem of Making Autonomous Vehicles Conform to Traffic Law," *Artificial Intelligence and Law* 25, no. 3 (2017): 341–63, <https://doi.org/10.1007/s10506-017-9210-0>; Pearl, "Compensation at the Crossroads: Autonomous Vehicles & Alternative Victim Compensation Schemes."

²⁰ Colonna, "Autonomous Cars and Tort Liability."

²¹ Azrol Abdullah and Nazura Abdul Manap, "The Malaysian Perspective on Imposing Civil Liabilities in Road Accidents Involving Autonomous Vehicle," *UUM Journal of Legal Studies* 12, no. 2 (2021): 203–28.

²² Abdullah and Manap, "The Malaysian Perspective on Imposing Civil Liabilities in Road Accidents Involving Autonomous Vehicle."

²³ Abdullah and Manap, "The Malaysian Perspective on Imposing Civil Liabilities in Road Accidents Involving Autonomous Vehicle."

autonomous vehicle.²⁴ Hence, if an autonomous vehicle causes harm to humans, the owner may be held liable if the vehicle is under the owner's custody.²⁵ Conversely, Colonna fears that imposing liability on owners and consumers of autonomous vehicles will affect the social acceptance of autonomous vehicles as they have no control over the technology.²⁶

Finally, Hashim and Omar, and Taeihagh and Lim share the opinion that it is difficult to ascribe liability to any party as there seems to be an absence of a law or regulation presuming liability in relation to autonomous vehicles.²⁷ Hashim and Omar raised the need for a policy or regulation on autonomous vehicles to ensure the safety measures in autonomous vehicles.

Types and Standard of Liability

Generally, under tort law, the headings for types of liability can be accident law or product liability. For accidents involving autonomous vehicles, the standard of liability for accidents are fault-based, such as under a negligence rule, or non-fault based, which is strict liability. The former requires proof of fault on the part of the defendant, such as acting in what a reasonable person would not do. On the other hand, product liability can be treated as a separate category of liability, whereby the standard can be fault-based under a negligence rule,²⁸ or non-fault based under a statutory product liability regime. For instance, in Malaysia, section 68(1) of the Consumer Protection Act 1999 adopts the strict liability standard which is *in pari materia* with the United Kingdom's Consumer Act 1987.

²⁴ Olalekan, Omoola Sodiq. "Autonomous vehicles and tortious liability: an Islamic perspective." *Jurnal Syariah* 26, no. 1 (2018): 99-122.

²⁵ Abdullah and Manap, "The Malaysian Perspective on Imposing Civil Liabilities in Road Accidents Involving Autonomous Vehicle."

²⁶ Colonna, "Autonomous Cars and Tort Liability."

²⁷ H. H. Hashim and M. Z. Omar, "Towards Autonomous Vehicle Implementation: Issues and Opportunities," *Journal of the Society of Automotive Engineers Malaysia* 1, no. 2 (2017): 111-23; Si Ying Tan and Araz Taeihagh, "Adaptive and Experimental Governance in the Implementation of Autonomous Vehicles: The Case of Singapore," in *4th International Conference on Public Policy*, vol. 30, 2019, 1-26.

²⁸ For example, *Donoghue v. Stevenson* [1932] AC 562 (House of Lords).

Marchant and Lindor suggest that negligence and strict liability may be considered for autonomous vehicles.²⁹ The authors, besides reviewing the theories of liabilities on negligence and strict liability, suggest the concept of product liability as an alternative heading of liability. Conversely, Pearl thinks that negligence and product liability are not suitable for autonomous vehicles because autonomous vehicles and artificial intelligence often raise novel liability questions that tort law and product liability are not well-equipped to handle.³⁰

Negligence

Liability in negligence is commonly imposed on vehicular accidents. Kalra, Anderson and Wachs, as well as Wong propose that negligence may be imposed in accidents involving both human-driven vehicles and autonomous vehicles.³¹ Imposing negligence to persons may be simple and straight-forward, but when hardware and software are involved, tortious liability based on negligence is questionable.³²

For vehicles which are yet to be fully autonomous, Wong suggests that liability cannot be passed on to the manufacturer under the doctrine of *novus actus interveniens*, such as in the case of a driver falling asleep when the autonomous vehicle is driving itself on a congested highway.³³ The doctrine of *novus actus interveniens* states that a defendant is no longer liable for his action if an intervening act, such as the action of a third party, breaks the chain of causation between the defendant's action and damage suffered by the plaintiff.³⁴ It is difficult to determine whether the driver in an autonomous vehicle

²⁹ Marchant and Lindor, "The Coming Collision Between Autonomous Vehicles and the Liability System."

³⁰ Pearl, "Compensation at the Crossroads: Autonomous Vehicles & Alternative Victim Compensation Schemes."

³¹ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Wong, "Considerations in an Autonomous Era."

³² Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

³³ Wong, "Considerations in an Autonomous Era."

³⁴ Deakin, Johnston and Markesinis, *Markesinis and Deakin's Tort Law*. (Oxford, United Kingdom: Oxford University Press, 2013) 584.

is at fault unless the driver is required to monitor the driving and cannot fully depend on autonomous vehicle driving itself.

Most authors such as Colonna and Wong are doubtful of whether the negligence rule, such as the one under the English case of *Donoghue v Stevenson*, is applicable to accidents involving autonomous vehicles.³⁵ The difficulty in adopting a negligence standard occurs when the reasonable man test is applied to artificial intelligence systems.

Strict Liability and Product Liability

Since the use of negligence rule raises difficulties, the strict liability standard may be imposed as an alternative solution to bypass the reasonable man test. In practice, strict liability standard is usually found in some form of product liability law.³⁶

In the US context, Riehl identifies the application of strict liability in autonomous vehicles in relation to manufacturing defects, design defects, and failures to warn.³⁷ When strict liability is applied, the manufacturer is liable despite reasonable care being exercised.³⁸ The main question would be whether the manufacturing defect would be dangerous to autonomous vehicles users. According to Riehl, if the defect is a design defect, then the strict liability standard does not apply because the courts must consider whether reasonable care has been taken in designing the product.³⁹ A question arises on whether a programming error is a manufacturing defect or a design defect. It has been suggested that there is little chance of manufacturers being held

³⁵ Colonna, "Autonomous Cars and Tort Liability"; Wong, "Considerations in an Autonomous Era."

³⁶ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Damien A. Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy," *The Computer & Internet Lawyer* 35, no. May 18 (2018): 1.

³⁷ Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy."

³⁸ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy."

³⁹ Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy."

liable for defects unless the defect is on a particular component.⁴⁰ Finally, in a failure to warn scenario, issues that may arise is what type of warning is deemed sufficient.⁴¹

Strict liability will also be imposed generally on manufacturers even though they are not negligent as they are aware of the risks involved because the consumers are exposed to ultra-hazardous risks.⁴² However, in the event that the manufacturers are held strictly liable, there is a risk that it may lead to high prices for autonomous vehicles since the manufacturer have to pass on the cost of payment of compensation to purchasers.⁴³

Product liability naturally arises since the driving decisions of autonomous vehicles are very much dependent on the artificial intelligence system rather than human drivers.⁴⁴ Manufacturers will insure the autonomous vehicle users against all harms that originate from their products regardless of their fault. Like Riehl, and Kalra, Anderson and Wachs, Marchant and Lindor also categorise product liability as a form of strict liability for manufacturing defect and design defect. The authors also show that similar cases involving other technologies, such as non-functioning car brakes in cruise control and airplane crashes in autopilot mode, were litigated under product liability law.⁴⁵ On the other hand, in the case of autopilot mode in an airplane, there is a possibility that liability may still be attributed to the pilot rather than to the design of the autopilot, as the pilot has a responsibility to monitor the flight even on an autopilot mode.⁴⁶ Smith agrees that although the current product liability regime is imperfect, it may still be adopted for autonomous vehicles.⁴⁷ In order to instil

⁴⁰ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

⁴¹ Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy."

⁴² Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

⁴³ Kalra, Anderson, and Wachs.

⁴⁴ Kalra, Anderson, and Wachs.

⁴⁵ Marchant and Lindor, "The Coming Collison Between Autonomous Vehicles and the Liability System."

⁴⁶ Marchant and Lindor.

⁴⁷ Bryant Walker Smith, "Automated Driving and Product Liability," *Michigan State Law Review* 1 (2017): 2–74.

confidence in consumers, Volvo has boldly declared that it “will accept full liability whenever one of its cars is in autonomous mode.”⁴⁸

Cowger disagrees with the application of product liability law for collision cases involving autonomous vehicles because according to him, product liability law applies to products that remain unchanged after the products have been manufactured and under the control of the consumers.⁴⁹ Since there is a possibility of autonomous vehicles making their own decisions, product liability law cannot be used as a basis for liability.⁵⁰ Cowger suggests that some form of no-fault insurance be set up by the government and insurance industry to compensate victims of autonomous vehicles.⁵¹ Notwithstanding this, it is likely that autonomous vehicles will be considered as a product under a product liability law.

REGULATION OF AUTONOMOUS VEHICLES

Apart from using tort liability to incentivise manufacturers to produce safe autonomous vehicles, regulation through statutes and administrative decrees may be used to supplement the safety function of tort law. In the literature, issues of regulation of autonomous vehicles in Singapore, Malaysia, the United Kingdom, and the United States have been discussed. The first part focuses on the need for governing strategies, followed by the regulation of autonomous vehicles in various countries.

Ilková and Ilka, as well as Punev, state that to clear public doubts about autonomous vehicles technology, there is no other way than to establish a clear legal framework for autonomous vehicles.⁵² Lawmakers, insurance companies as well as manufacturers are

⁴⁸ Matthew Channon and Lucy McCormick, “Look, No Hands!,” *New Law Journal* 166, no. 7708 (2016): 12.

⁴⁹ Cowger, “Liability Considerations When Autonomous Vehicles Choose the Accident Victim.”

⁵⁰ Cowger.

⁵¹ Cowger.

⁵² Viktoria Ilková and Adrian Ilka, “Legal Aspects of Autonomous Vehicles—An Overview,” *Proceedings of the 2017 21st International Conference on Process Control, PC 2017*, June (2017): 428–33; Punev, “Autonomous Vehicles: The Need for a Separate European Legal Framework.”

compelled to address the legal and regulatory issues concerning autonomous vehicles to reduce mass injuries and road fatalities, among other purposes.⁵³ Although Riehl agrees that the law should be shaped proactively through legislation, the other option is to wait until the technology is fully developed so that regulations may be made thoroughly after fully understanding the technology.⁵⁴ On the other hand, since the technology for autonomous vehicles is evolving, it is better to adopt responsive regulation in line with new developments instead of waiting for the technology to finally mature before regulations are made.

Taeihagh and Lim recognise that it is imperative for governments to regulate autonomous vehicles in order to manage the risks and ensure that society could benefit from the technology.⁵⁵ There are several different strategies that can be taken by policymakers. In a no-response strategy, policymakers do not take any action to address the risks posed by autonomous vehicles or delay actions due to the indeterminate nature of autonomous vehicles, although it is believed that those who adopt a no-response strategy are oblivious to the possible negative repercussion of the risks involved.⁵⁶ For a prevention-oriented strategy, risks are prevented by taking preventive action.⁵⁷ For a control-oriented strategy, policymakers take steps to control the risk by introducing policies and regulations.⁵⁸ Further, under a toleration-oriented strategy, a good example of which is from the United Kingdom, policymakers seek to address various situations concerning autonomous vehicles in order to mitigate potential consequences by providing alternate solutions.⁵⁹ Lastly, for an adaptation-oriented strategy, the government seeks to improve the

⁵³ Ilková and Ilka, “Legal Aspects of Autonomous Vehicles—An Overview.”

⁵⁴ Riehl, “Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy.”

⁵⁵ Taeihagh and Lim, “Governing Autonomous Vehicles: Emerging Responses for Safety, Liability, Privacy, Cybersecurity, and Industry Risks.”

⁵⁶ Taeihagh and Lim.

⁵⁷ Taeihagh and Lim.

⁵⁸ Taeihagh and Lim.

⁵⁹ Taeihagh and Lim.

performance of the system by accepting the risks instead of ignoring, suppressing, controlling or tolerating the risks.⁶⁰

Another aspect of regulation is to permit the testing of autonomous vehicles during their developmental stage. Countries such as China, France, Japan, Korea, the Netherlands, and Singapore have approved such testing of autonomous vehicles.⁶¹ Conversely, most countries have yet to make any specific laws on autonomous vehicles. Although plans are afoot to commercialise autonomous vehicles in Malaysia under its National Automotive Policy 2020, the Malaysian government has yet to make much progress on its regulatory side.⁶²

Singapore

In February 2017, the Singapore Road Traffic Act 1961 was amended to recognise ‘autonomous motor vehicle’ which does not require a human driver.⁶³ Tan and Taeihagh mention the implementation of a five-year regulatory sandbox in Singapore from 2017 to encourage the innovation of autonomous vehicles.⁶⁴ In adopting the control-oriented strategy, the Minister of Transport is free to create laws or rules on autonomous vehicle testing as well as acquire data and set standards concerning the designs of autonomous vehicles.⁶⁵ Before trials are initiated, there is a requirement to obtain liability insurance or place security deposits under Section 6C (1) (b) (ii) of the Singapore’s Road Transport Act 1961.⁶⁶

United Kingdom

The Automated and Electric Vehicles Act 2018 regulates autonomous vehicles in Great Britain as well as to regulate the insurance and

⁶⁰ Taeihagh and Lim.

⁶¹ Eric Phillips, “The Future of Autonomous Vehicles in American Cities,” *NYU Journal of Legislation and Public Policy* 21, no. 1 (2018): 287–336.

⁶² Ministry of International Trade and Industry, “National Automotive Policy,” *Ministry of International Trade and Industry*, 2020.

⁶³ Tan and Taeihagh, “Adaptive and Experimental Governance in the Implementation of Autonomous Vehicles: The Case of Singapore.”

⁶⁴ Tan and Taeihagh.

⁶⁵ Tan and Taeihagh.

⁶⁶ Tan and Taeihagh.

allocate liability of accident involving autonomous vehicles.⁶⁷ Kouroutakis states that insurers are responsible to cover damages caused by autonomous vehicles in a self-driving mode.⁶⁸ In cases where the autonomous vehicles did not have insurance coverage, the owners of autonomous vehicles will be held liable instead under Section 2(2) of the Automated and Electric Vehicles Act 2018.⁶⁹ As for safety regulations, Taeihagh and Lim state that the United Kingdom adopts a light control strategy by establishing an autonomous vehicles code of practice.⁷⁰

United States of America

According to Sheinberg, the state of Nevada [Assembly bill 511 (36-6)] is the first jurisdiction in the United States to pass a law in 2011 to legalise autonomous vehicles, while other states such as California (Division 16.6 (beginning with § 38750) of the California Vehicle Code), Michigan (Michigan Senate Bill 706), Florida (Florida State Uniform Traffic Control) and the District of Columbia (Code of District of Columbia, Chapter 23A. Autonomous Vehicles) have also enacted legislation on the testing of autonomous vehicles in their respective states.⁷¹ Meanwhile, other states such as Illinois, Texas, Tennessee and North Carolina have pre-empted the local government from taking any actions concerning autonomous vehicles.⁷² According to Roth, The National Highway Traffic Safety Administration (NHTSA) which regulates the safety and manufacturing standards for

⁶⁷ Antonios E. Kouroutakis, “Autonomous Vehicles: Regulatory Challenges and the Response from Germany and UK,” *Mitchell Hamline Law Review* 46, no. 5 (2020): 1103–21.

⁶⁸ Kouroutakis.

⁶⁹ Kouroutakis.

⁷⁰ Taeihagh and Lim, “Governing Autonomous Vehicles: Emerging Responses for Safety, Liability, Privacy, Cybersecurity, and Industry Risks.”

⁷¹ Katelyn Sheinberg, “Embracing the Imminent: Proposed Legislation for Automated Cars in Pennsylvania,” *Pittsburgh Journal of Technology Law and Policy* 15, no. 2 (2015): 265–75, <https://doi.org/10.5195/tlp.2015.171>.

⁷² Matthew L. Roth, “Regulating the Future: Autonomous Vehicles and the Role of Government,” *Iowa Law Review* (University of Iowa, March 1, 2020).

vehicles has yet to make any regulations relating to autonomous vehicles.⁷³ Since different states have different regulations, the inconsistencies may hinder market growth and application of autonomous vehicles.⁷⁴ To resolve the issue, Roth is of the view that the federal government should regulate matters concerning autonomous vehicles instead.⁷⁵

Australia

In South Australia, the Motor Vehicles (Trials of Automotive Technologies) Amendment Act 2016 was introduced to allow manufacturers to conduct testing of autonomous vehicles on the road.⁷⁶ Lazarus is of the view that although it is unrealistic to create an entirely new legal framework for limited trials, this law will help to give some clarity on how liability would be placed in case of accidents.⁷⁷ The purpose of the 2016 Act is “to strike a balance between the competing goals of commencing productive tests of driverless cars on public roads and the protection of existent road users.”⁷⁸

Malaysia

Abu Kassim, Mohd Jawi and Nasruddin warn that since autonomous cars could appear in Malaysia soon, it is important to develop a regulatory framework to ensure the smooth adoption of autonomous vehicles in Malaysia.⁷⁹ Hashim and Omar observe that the government of Malaysia remains silent on any regulation concerning autonomous vehicles.⁸⁰ KPMG (Klynveld Peat Marwick Goerdeler), a professional

⁷³ Roth.

⁷⁴ Roth.

⁷⁵ Roth.

⁷⁶ Anna Lazarus, “New Laws for Trials of Driverless Motor Vehicles in Australia,” *Internet Law Bulletin*, 2016.

⁷⁷ Lazarus.

⁷⁸ Lazarus.

⁷⁹ K. A. Abu Kassim, Z. Mohd Jawi, and M. A. Nasruddin, “Is Malaysia Ready to Adopt Autonomous Vehicles?,” *Journal of the Society of Automotive Engineers Malaysia* 3, no. 1 (2019): 84–88.

⁸⁰ Kassim, Mohd Jawi, and Nasruddin; Hashim and Omar, “Towards Autonomous Vehicle Implementation: Issues and Opportunities.”

service and auditing company, identifies four significant factors in assessing a country's readiness to adopt autonomous vehicles: technological innovation, infrastructure, consumer acceptance, and policy and legislation; which unfortunately, all are lacking or insufficient in Malaysia.⁸¹

Technically, the Road Transport Act 1987 currently prohibits the operation of autonomous vehicles.⁸² The term 'driver' in Section 2 of the Road Transport Act 1987 means "a person ... driving a motor vehicle" and does not extend to autonomous vehicles. Despite the presence of some assisted-driving vehicles on the road, there are still no prescribed standard for the design and performance of autonomous vehicles in Malaysia.⁸³ Thus, as the authors noted, amendments need to be made to the Road Transport Act 1987 to legalise the operation of autonomous vehicles in Malaysia. There is also a need to review the current Vehicle Type Approval in Malaysia to include autonomous vehicles.⁸⁴ One interesting issue is whether a non-driving passenger in the driver's seat needs a driving license when using an autonomous car.

Dremluiga and Mohd Rusli find certain similarities in the laws adopted by some of the countries.⁸⁵ Also, two regulatory approaches can be observed: one, regulation which provides for legal specifications which need to be adhered to, such as safety and cybersecurity standards; and secondly, light regulation which leaves space for experiments and innovation by the industry.⁸⁶

⁸¹ Kassim, Mohd Jawi, and Nasruddin, "Is Malaysia Ready to Adopt Autonomous Vehicles?"

⁸² Hashim and Omar, "Towards Autonomous Vehicle Implementation: Issues and Opportunities."

⁸³ Hashim and Omar.

⁸⁴ Hashim and Omar.

⁸⁵ Roman Dremluiga and Mohd Hazmi bin Mohd Rusli, "The Development of the Legal Framework for Autonomous Shipping: Lessons Learned from a Regulation for a Driverless Car," *Journal of Politics and Law* 13, no. 3 (2020): 295, <https://doi.org/10.5539/jpl.v13n3p295>.

⁸⁶ Dremluiga and Rusli.

INSURANCE AS A COMPENSATION MECHANISM

There is a need to include insurance to compensate victims of accidents involving autonomous vehicles.⁸⁷ However, one issue is who should pay the insurance premium, i.e. the vehicle owners or manufacturers. Insurance as a compensation mechanism is often a key issue that is being discussed together the liability and regulation of autonomous vehicles. Since autonomous vehicles in self-driving mode do not require a human driver, the cause of accident is attributed to the vehicle itself and not its owner or the person in the driver seat, thus liability may be attributed to the manufacturer who will have to cover the cost of insurance.⁸⁸

Currently, in most countries, it is compulsory to obtain a motor vehicle insurance. Hashim and Omar are of the view that a different insurance scheme must be developed to accommodate autonomous vehicles.⁸⁹ They suggest that manufacturers should take up an insurance policy for the autonomous vehicles upon production.⁹⁰ Presumably, this is to incentivise manufacturers to lower the cost of insurance by improving safety of the autonomous vehicles. It is suggested that the insurance premium for autonomous vehicles would be lower than that of non-autonomous vehicles as the use of autonomous vehicles may reduce road accidents typically resulting from human errors.⁹¹ Kasim, Anwar and Hizal moot the idea that insurance premium may be paid on a pay-per-ride basis instead of annually.⁹² Since all autonomous vehicles have a Global Positioning System (GPS) , it may make sense to also charge the insurance premium by mileage. In the European Union, autonomous vehicles are covered under the Motor Insurance Directives 2009/103/EC, which

⁸⁷ Kouroutakis, "Autonomous Vehicles: Regulatory Challenges and the Response from Germany and UK."

⁸⁸ Hashim and Omar, "Towards Autonomous Vehicle Implementation: Issues and Opportunities."

⁸⁹ Hashim and Omar.

⁹⁰ Hashim and Omar.

⁹¹ Hashim and Omar; Abu Kassim, Khairil Anwar, and Hashim Hizal, "Advancement in Vehicle Safety in Malaysia from Planning to Implementation," *Asian Transport Studies* 4, no. 4 (2017): 704–14.

⁹² Kassim, Anwar, and Hizal, "Advancement in Vehicle Safety in Malaysia from Planning to Implementation."

requires all vehicles including autonomous vehicles to be covered under compulsory motor insurance.⁹³

Channon and McCormick, as well as Kalra, Anderson and Wachs point out that victims of autonomous vehicles accident may benefit from a no-fault insurance scheme whereby a claimant or victim is not required to establish negligence on the part of the defendant to successfully mount a claim.⁹⁴ The concept of ‘no-fault’ insurance can be viewed from two different perspectives. Commonly in many countries such as Israel, New Zealand, Sweden, Australia, Canada and the United States, an accident victim can claim against his own insurer for accidents caused by others under a traditional ‘no-fault’ insurance scheme, without having to go to the court to prove the fault of the tortfeasor.⁹⁵ This form of no-fault insurance scheme is applicable to human-driven vehicles.

For example, in some states in the United States, victims of motor vehicle accidents can recover their losses through their own insurer if the claim amount falls below a certain monetary or subjective threshold; in other cases, they have to claim from the tortfeasor’s insurer.⁹⁶ The concept of ‘no-fault’ applies when claimants can avoid suing tortfeasors to obtain compensation for their losses, which reduces the cost of lawsuits.⁹⁷ An insurance adjuster determines liability by a simple set of rules rather than finding the fault of a driver under a negligence rule.⁹⁸

A second way of thinking about a ‘no-fault’ insurance is closer to how strict liability works, whereby the insurer for the owner or manufacturer of an accident-causing autonomous vehicle will pay compensation to victims without the latter proving negligence on the part of the owner or manufacturer. Channon and McCormick suggest having a central fund to act as the insurer, through the collection of

⁹³ Channon and McCormick, “Look, No Hands!”

⁹⁴ Channon and McCormick; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

⁹⁵ Maurice Schellekens, “No-Fault Compensation Schemes for Self-Driving Vehicles,” *Law, Innovation and Technology* 10, no. 2 (2018): 314–33, <https://doi.org/10.1080/17579961.2018.1527477>.

⁹⁶ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

⁹⁷ Kalra, Anderson, and Wachs.

⁹⁸ Kalra, Anderson, and Wachs.

premiums from purchasers of autonomous vehicles.⁹⁹ Although this type of no-fault insurance scheme provides a simpler approach to the liability question of autonomous vehicles, Channon and McCormick are worried that this no-fault insurance scheme will open more questions, such as the amount of contribution by each purchaser to the fund, and who will manage the fund. It has also been predicted that a no-fault scheme is highly expensive since no litigation inevitably leads to more payouts.¹⁰⁰

LESSONS TO BE LEARNT

After reviewing the literature, it is essential to take note of the lessons that can be learned from the liability, regulation, and insurance issues of autonomous vehicles. Currently, strict liability is the preferable theory of liability compared to negligence due to the uncertainty and technical features of autonomous vehicle technology. In establishing liability, regulation is also needed to provide uniformity and guidelines for the usage of autonomous vehicles on the roads. Suitable regulations may provide assurance to consumers that autonomous vehicles are indeed safe for passengers and other road users. Since autonomous vehicles are not solely controlled by the drivers, a different type of insurance may need to be developed for victim compensation.

The Liability Question

The liability question for autonomous vehicles remains uncertain, particularly with respect to whose liability and the standard of liability that is applicable. The literature does not identify a specific party to be held liable but rather identifies a list of possible parties according to various situations that are to be judged on a case-to-case basis. These parties include the manufacturers, drivers, technology suppliers, software developers, and software operators. In addition, it is also possible to consider the owners of autonomous vehicles to be included in this list. Most literature such as Colonna, Wong, and Kalra, Anderson and Wachs suggests that the manufacturers should be the

⁹⁹ Channon and McCormick, "Look, No Hands!"

¹⁰⁰ Nora Freeman Engstrom, "When Cars Crash: The Automobile's Tort Law Legacy," *Wake Forest Law Review* 53 (2018): 293.

primary party to be held responsible for accidents caused by autonomous vehicles,¹⁰¹ since they are responsible for the design and production of the autonomous vehicles, and it would not be fair to extend the responsibility to the driver of a vehicle who was not in control of the vehicle at that time.

In relation to the standard of liability, i.e. whether a negligence rule or a strict liability rule should apply, most literature including Riehl, and Kalra, Anderson and Wachs, Marchant and Lindor favours the latter.¹⁰² In fact, it is difficult to apply the negligence rule to autonomous vehicles because the vehicles are not natural persons, and it is not clear how the reasonable person standard can be used to adjudge the decision-making process of an autonomous vehicle.

Riehl, and Kalra, Anderson and Wachs, Marchant and Lindor suggest that the strict liability rule should be applied in accidents involving autonomous vehicles.¹⁰³ One explanation for preferring the strict liability rule is that accidents involving autonomous vehicles are seen more as a product failure than as a tortious action of a human tortfeasor. Typically, statutory product liability laws apply a strict liability rule on the manufacturer of a defective product.

Many pieces of literature consider the applicability of the existing civil liability rules on the liability question involving autonomous vehicles.¹⁰⁴ In cases of non-autonomous vehicles, the

¹⁰¹ Colonna, “Autonomous Cars and Tort Liability”; Wong, “Considerations in an Autonomous Era”; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*.

¹⁰² Riehl, “Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy”; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Marchant and Lindor, “The Coming Collision Between Autonomous Vehicles and the Liability System.”

¹⁰³ Riehl, “Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy”; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Marchant and Lindor, “The Coming Collision Between Autonomous Vehicles and the Liability System.”

¹⁰⁴ Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Cowger, “Liability Considerations When Autonomous Vehicles Choose the Accident Victim”; Riehl, “Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy.”

negligence rule may be applicable, and liability is on the driver. Since there is a possibility of applying product liability for accidents involving autonomous vehicles, and the strict liability standard is used for product liability, it would appear that liability may rest on manufacturers instead. Riehl, and Kalra, Anderson and Wachs, Marchant and Lindor are satisfied with this conclusion on the liability question.¹⁰⁵

In the case of the United Kingdom's Automated and Electric Vehicles Act 2018, if there is an accident involving autonomous vehicle, the insurer is liable to pay for the losses;¹⁰⁶ if the vehicle is uninsured, the owner is then liable. Unfortunately, the standard of liability is not explicitly mentioned, although the use of the term 'accident' may suggest that the usual standard for accident in the English common law, i.e. negligence, is applicable.

Since accidents in autonomous vehicles are likely not the action or omission of drivers, it does not necessarily follow that the negligence standard is the appropriate standard to apply. Furthermore, there is the complication that such accidents can be considered as a failure of a consumer product. It is recommended that legislatures make laws to explicitly allocate the responsibility to pay compensation for accidents involving autonomous vehicles as well as to define the applicable standard for liability.

Regulation

Singapore, the United Kingdom, and several states in Australia and in the United States are among the jurisdictions that have adopted regulations involving autonomous vehicles. Since autonomous vehicles technology is still at a developmental stage, it is necessary to allow testing, development and local customisation of autonomous vehicles to operate on local roads. One option is to use regulatory

¹⁰⁵ Riehl, "Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy"; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Marchant and Lindor, "The Coming Collision Between Autonomous Vehicles and the Liability System."

¹⁰⁶ "Automated and Electric Vehicles Act 2018," accessed August 4, 2022, <https://www.legislation.gov.uk/ukpga/2018/18/contents/enacted>.

sandbox to temporarily allow manufacturers to conduct trial runs of autonomous vehicles before commercial release.

The Vienna Convention on Road Traffic 1968 provides for the uniform regulation of road traffic around the world. An amendment to the Vienna Convention was proposed in 2020 to recognise automated driving, which came into force on 14 July 2022.¹⁰⁷ Pursuant to the amendment, the driving task is allowed to be transferred to autonomous vehicles and an automated driving system can be considered equivalent to a driver.¹⁰⁸ In view of this development, countries should amend their road traffic laws to recognise the existence of autonomous vehicle technology.

Another role that regulation can play is to mandate periodic updates to the artificial intelligence systems as well as to require minimum safeguards in relation to safety. Similar to computer software such as operating systems which requires regular updates with security patches and anti-virus data files, the software and data, autonomous vehicles should also be updated as and when necessary to ensure safety and efficiency of the vehicles when they are on the roads.

Insurance as a Compensation Mechanism

The role of insurance in accidents involving autonomous vehicles may be one way of solving the liability question. The United Kingdom's Automated and Electric Vehicles Act 2018 is an example of a regulation which places the responsibility of compensating victims on the insurers of the car owners. This operates like a no-fault insurance whereby both the insured and third-party victims are covered by the same insurance.

Alternatively, it is possible for a law to declare that manufacturers are liable for accidents caused by autonomous vehicles, as a form of product liability, on the ground that manufacturers are responsible for the design of the vehicles and the artificial intelligence system. In such a case, it is likely that manufacturers will find some

¹⁰⁷ United Nations, "Acceptance of Amendment to Article 1 and New Article 34 Bis to the Convention," vol. 19, 2022.

¹⁰⁸ United Nations Economic Commission for Europe, "Report of the Global Forum for Road Traffic Safety on Its Eighty-First Session," vol. 16842, 2020.

ways to insure themselves against liabilities. This will also incentivise manufacturers to ensure the safety of autonomous vehicles.

Another possibility is for the law to declare that both owners and manufacturers share the cost of liability. In some instances, a national compensation fund may be established from the autonomous vehicle owners or manufacturers to ensure that the victims get compensation regardless of the existence of private insurance.

CONCLUSION

After analysing the legal literature involving autonomous vehicles, several issues relating civil liability, regulation and insurance have been uncovered. Generally, the literature identified and discussed the relevant issues despite the absence of clear legal positions in most jurisdictions.

Victims of accidents involving autonomous vehicles will be disadvantaged if the issues of liability are not addressed in time. Since liability issues involving decision-making by artificial intelligence are novel, it is better for the legislature to resolve them through legislation than waiting for case law to develop over time. Most authors lean towards some form of product liability law with the view that manufacturers are responsible for compensating victims of accidents.¹⁰⁹

Furthermore, regulations may be used to mandate safety measures in autonomous vehicles. Countries need to prepare to implement regulatory sandboxes for the development and testing of autonomous vehicles for the purpose of customisation of the technology to local road conditions and driving practices. Finally, the insurance question should also be reviewed because conventional motor vehicle insurance relies on identifying the fault of a driver. Hence, to address the gaps, liability, regulation to ensure the safety of

¹⁰⁹ Riehl, “Car Minus Driver: Autonomous Vehicles Driving Regulation, Liability and Policy”; Kalra, Anderson, and Wachs, *Liability and Regulation of Autonomous Vehicle Technologies*; Marchant and Lindor, “The Coming Collision Between Autonomous Vehicles and the Liability System.”

autonomous vehicles, and insurance as a compensation scheme need to be determined.