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Rethinking Producer Liability in Autonomous Vehicle Accidents: Civil Law Causation Theories in Indonesia and Kuwait

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Abstract

Introduction: *Regulations regarding autonomous vehicles have not yet been comprehensively regulated in various countries, particularly Indonesia and Kuwait.*
Purposes of the Research: *Analyzing manufacturer liability in autonomous vehicle accidents in relation to civil law causality theory in Indonesia and Kuwait.*
Methods of the Research: *Normative legal research with conceptual, comparative and legislative approaches.*
Results Main Findings of the Research: *This study shows that the absence of explicit regulations regarding autonomous vehicles in the Traffic and Road Traffic Law creates uncertainty and potential injustice in determining the responsible subject and the applicable liability regime in the event of an accident, because the normative construction that still centers on the figure of the human driver is no longer adequate to respond to the complexity of decision-making by artificial intelligence systems. On the other hand, a comparative analysis of Indonesia and Kuwait shows that the causal relationship between the actions or negligence of manufacturers and the losses of victims of autonomous vehicle accidents has not been constructed in traffic law, but has been allowed to shift to the realm of general civil law and the product defect regime, so that the theory of civil law causality functions outside the framework of traffic law to assess whether the design, production, or failure of warnings by manufacturers is a sufficient cause of the victim's losses. Thus, this study emphasizes the urgency of adjusting, reinterpreting, and establishing specific regulations regarding autonomous vehicles that explicitly regulate manufacturer responsibility and clarify the construction of causality, so that legal protection, certainty of the rights and obligations of the parties, are guaranteed as autonomous vehicle technology develops.*

Keywords: Autonomous Vehicles; Legal Void; Manufacturer Responsibility.

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INTRODUCTION

The development of law cannot be separated from technological progress. This is because law must be an instrument capable of accommodating technological developments so that technological progress can provide benefits to humanity in general.[1] The relevance between law and technological development can be deeply understood through the lens of Satjipto Rahardjo's thinking on progressive law, which emphasizes that law is not merely a static and formalistic entity but must be responsive, dynamic, and brave enough to break away

[1] Mutia Qori Dewi Masithoh et al., "AI in Law: How Artificial Intelligence Is Transforming the Legal Profession in Indonesia," *Justitia Jurnal Hukum* 7, no. 2 (2023): 137–52, https://doi.org/10.30651/justitia.v7i2.17832.

from conventional dogma to achieve substantive justice for society.[2] Law in general is described as an instrument that must adapt to the rapid socio-technological dynamics rather than merely a rigid vessel of legislation.[3]

This view is relevant to the evolution of law in response to the 4.0 and 5.0 industrial revolutions, where regulatory lag in the field of technology is one form of failure of conventional law, thus driving legal reform to accommodate technological developments.[4] One form of technological development that must be facilitated by law is related to the advancement of autonomous vehicles. Autonomous vehicles, or self-driving cars, are a type of vehicle that can operate independently without direct intervention from a human driver, relying on a combination of advanced sensors such as LiDAR, radar, cameras, and artificial intelligence (AI) systems to detect the surrounding environment, process data in real-time, and make decisions regarding navigation, acceleration, braking, and obstacle avoidance.[5]

This technology is classified into six levels of automation by SAE International, ranging from Level 0 (no automation, fully controlled by humans) to Level 5 (full automation in all conditions without a steering wheel or pedals), where currently most prototype vehicles such as Waymo One or Tesla Autopilot are at Levels 3-4, which still require human supervision in complex situations.[6] Autonomous vehicles are not specifically regulated in Law Number 22 of 2009 concerning Traffic and Road Transportation (Traffic Law), which still assumes the presence of a human driver in the operational definition of motor vehicles. The current Traffic Law is inadequate for self-driving technology, so autonomous vehicles must comply with general provisions such as safety and human driver liability. Some countries have accommodated autonomous vehicle regulations through special laws or regulations for testing and commercial operations, such as the United States, Germany, and China.

In general, it can be seen that the countries that have accommodated autonomous vehicle regulations are developed countries. This confirms that there are no developing countries that have specifically and comprehensively regulated autonomous vehicles. One important aspect in the development of autonomous vehicles relates to manufacturers' liability in autonomous vehicle accidents. This study specifically analyzes manufacturers' liability in autonomous vehicle accidents in relation to the theory of civil law causation in Indonesia and Kuwait. This study specifically addresses two legal issues, namely: (i) the legal implications of the regulatory gap regarding autonomous vehicles in Indonesia; and (ii) manufacturers' liability in autonomous vehicle accidents in relation to the theory of civil law causation: a comparative legal analysis of Indonesia and Kuwait.

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[2] Muh. Ali Masnun et al., "Legal Reform of Legal Profession Amidst the Development of Artificial Intelligence in Indonesia: The Perspective of Mesu Budi's Philosophy of Law," *Novum: Jurnal Hukum* 12, no. 2 (2025): 277–87, https://doi.org/https://doi.org/10.2674/novum.v12i02.72355.

[3] Merwan Abdullah, Iseu Lismiati, and Asep Sapsudin, "The Task of Legal Protection for Indonesian Citizens from Online Gambling Exploitation in the Perspective of Law Enforcement in the Digital Era," *Journal of Law, Politic and Humanities* 5, no. 5 (2025): 3876–86, https://doi.org/10.38035/jlph.v5i5.1947.

[4] Rahul Sharma, "Legal Challenges and Enforcement Mechanisms in India ' s Contract Act , 1872 for E-Commerce Transactions," *Eduzone* 12, no. 2 (2023): 236–43.

[5] Adrian Domenteanu et al., "The Road to Autonomy: A Systematic Review Through AI in Autonomous Vehicles," *Electronics* 14, no. 21 (October 25, 2025): 4174, https://doi.org/10.3390/electronics14214174.

[6] De Jong Yeong, Krishna Panduru, and Joseph Walsh, "Exploring the Unseen: A Survey of Multi-Sensor Fusion and the Role of Explainable AI (XAI) in Autonomous Vehicles," *Sensors* 25, no. 3 (2025): 856, https://doi.org/10.3390/s25030856.

METHODS OF THE RESEARCH

This study, which focuses on manufacturers' liability in autonomous vehicle accidents in relation to the theory of civil law causation in Indonesia and Kuwait, is a normative legal research. Normative legal research or doctrinal law study prioritizes the use of legal principles, theories, and concepts to solve legal problems.[7] The approaches used to address the legal issues in this study are conceptual, statutory, and comparative approaches. The primary legal materials used are Law Number 22 of 2009 concerning Traffic and Road Transportation (Traffic Law) and similar regulations in Kuwait. The secondary legal materials used are books, journal articles, and research findings that discuss autonomous vehicles and manufacturers' liability in civil law. Non-legal materials used are legal dictionaries. The available legal materials are then analyzed prescriptively to formulate legal issues from the existing legal problems.[8]

RESULTS AND DISCUSSION

A. Legal Implications of the Regulatory Void Regarding Autonomous Vehicles in Indonesia

The development of autonomous vehicles worldwide has shown a major transformation over the past decade, marked by rapid advances in artificial intelligence technology, sensors, edge computing, as well as integration with the electric vehicle ecosystem and internet-of-things (IoT) connectivity.[9] Conceptually, the idea of driverless cars has existed since the early 20th century and was introduced at various automotive exhibitions as a vision of the future, but its technological realization only truly made significant leaps starting around the early 2000s when machine learning algorithms, digital image processing, radar, lidar, and GPS began to reach a level of precision that allowed vehicles to "read" the environment in real time and make driving decisions without direct human intervention.[10] In this era, autonomous vehicles are no longer viewed merely as automotive products, but as complex cyber-physical systems that combine hardware (sensors, actuators, computing modules) and software (AI algorithms, mapping, route planning, object detection, and decision-making systems). Thus, the global discourse on AVs has shifted from being merely a technical issue to also touching on legal, ethical, economic, and public safety governance aspects.

Technologically, the development of autonomous vehicles can be traced through the automation level framework developed by SAE (Society of Automotive Engineers), ranging from Level 0 (no automation) to Level 5 (full automation) — which has now become an international reference for industry, regulators, and academics when discussing the capabilities of driverless vehicles.[11] Many car manufacturers and technology companies

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[7] Maalikatussofa Masnun, Muh. Ali, Prasetio, Dicky Eko, "Reconstruction of the Normative Legal Research Paradigm in Responding to Global Challenges: An Epistemological Analysis," *Novum: Jurnal Hukum* 12, no. 3 (2025): 372–84, https://doi.org/https://doi.org/10.2674/novum.v12i03.74364.

[8] Achmad Irwan Hamzani et al., "Legal Research Method: Theoretical and Implementative Review," *International Journal of Membrane Science and Technology* 10, no. 2 (2023): 3610–19.

[9] Li et al., "Role of Policy and Consumer Attitudes in People's Intention to Use Autonomous Vehicles: A Comparative Study in China and the USA."

[10] Yeong, Panduru, and Walsh, "Exploring the Unseen: A Survey of Multi-Sensor Fusion and the Role of Explainable AI (XAI) in Autonomous Vehicles."

[11] Thaar Alqahtani, "Recent Trends in the Public Acceptance of Autonomous Vehicles: A Review," *Vehicles* 7, no. 2 (2025): 45, https://doi.org/10.3390/vehicles7020045.

currently operate in the range of Level 2 to Level 4 — from advanced driver assistance systems (ADAS) that combine adaptive cruise control and lane keeping, to vehicles that can operate independently in specific geo-fenced areas, such as robotaxi services in certain cities in the United States.[12] Testing and limited operation of autonomous vehicles are carried out in various jurisdictions — for example, Waymo's driverless taxi service in Phoenix since 2018 and the expansion of similar services by other companies such as Cruise in San Francisco. This shows that in practice, this technology is already capable of handling certain urban traffic conditions, although it is still under strict regulatory oversight and has not been implemented universally.[13]

The global autonomous vehicle market is projected to grow very aggressively, with an estimated market value of tens of billions of US dollars in the mid-2020s and the potential to exceed 400 billion US dollars by 2030, with a compound annual growth rate of around 40 percent reflecting the scale of investment and economic expectations in this sector.[14] This growth is driven by several key factors, including the declining cost of critical components such as lidar sensors and cameras, improved capabilities of specialized AI computing chips, and policies in many countries that promote the transition to electric vehicles and smart transportation to reduce emissions and congestion. On the other hand, global technology shows like CES every year serve as an important stage for automotive manufacturers and technology companies to launch new prototypes, autonomous vehicle computing platforms, and robotaxi concepts including the launch of the latest generation of automotive AI platforms by major semiconductor companies partnering with European car manufacturers to introduce driverless cars and commercial robotaxi services in the near future.[15]

The implementation of autonomous vehicles in several cities around the world shows a trend that autonomous vehicles are first developed for specific, relatively controlled use cases such as autonomous taxi services in limited urban areas, last-mile delivery and logistics using small driverless vehicles, or operations on dedicated lanes in industrial and campus environments.[16] This phased approach is chosen to minimize safety risks and facilitate regulatory adaptation, as each jurisdiction must revise safety standards, legal liability for accidents, data governance, and the integration of AVs with existing public transportation systems. Several US states, such as California, Arizona, and Nevada, have become policy and technology laboratories by granting permits for on-road testing, while in Europe and Asia, a number of countries have adopted special permit regimes, regulatory sandboxes, or new legal frameworks that explicitly recognize the operation of vehicles with high-level automated driving systems.[17]

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[12] Adnan Akhunzada et al., "Design and Performance of an AI-Enabled Threat Intelligence Framework for IoT-Enabled Autonomous Vehicles," *Computers and Electrical Engineering* 119, no. 1 (2024): 109609, https://doi.org/10.1016/j.compeleceng.2024.109609.

[13] Luigi Di Lillo et al., "Comparative Safety Performance of Autonomous- and Human Drivers: A Real-World Case Study of the Waymo Driver," *Heliyon* 10, no. 14 (2024): e34379, https://doi.org/10.1016/j.heliyon.2024.e34379.

[14] Rohit Goyal et al., "Advanced Air Mobility: Demand Analysis and Market Potential of the Airport Shuttle and Air Taxi Markets," *Sustainability* 13, no. 13 (2021): 7421, https://doi.org/10.3390/su13137421.

[15] Mohammed-Javed Padinhakara, "Navigating Regulatory Divergence: A Comparative Analysis of Autonomous Vehicle and Robotaxi Governance Frameworks Across Global Jurisdictions," *Journal of Computer Science and Technology Studies* 7, no. 5 (2025): 746–56, https://doi.org/10.32996/jcsts.2025.7.5.83.

[16] Daniel J. Mallinson et al., "The Future of AI Is in the States: The Case of Autonomous Vehicle Policies," *Business and Politics* 26, no. 2 (2024): 180–99, https://doi.org/10.1017/bap.2023.19.

[17] Mohammad El-Yabroudi et al., "Harnessing Generative AI for Text Analysis of California Autonomous Vehicle Crashes OL316 (2014–2024)," *Electronics* 14, no. 4 (2025): 651, https://doi.org/10.3390/electronics14040651.

In terms of design and user experience, the emergence of innovations such as retractable steering wheels in new-generation autonomous vehicle models shows that the changes taking place are not only in "driving capabilities" but also in the reimagining of cabin space and human-vehicle interaction. When full autonomous mode is activated, the driving space is gradually engineered into a multifunctional area for working, resting, or entertainment so that the future car is seen as a connected, mobile computing space, rather than merely a means of transport from one point to another.[18] The fundamental difference between autonomous vehicles and conventional motor vehicles lies in the way they are controlled, their technological architecture, and the role of humans in the driving process. Conventional motor vehicles are essentially fully dependent on the human driver's ability to observe the environment, make decisions, and operate the steering wheel, gas pedal, brakes, and other features while autonomous vehicles are designed to take over some or even all of these functions through a combination of sensors, software, and artificial intelligence.[19]

In terms of control and perception systems, conventional motor vehicles generally use human senses such as sight, hearing, and spatial awareness as the main sources of information, while vehicle sensors (such as turn signals, side mirrors, or rearview cameras) only serve as auxiliary tools with limited functions. Autonomous vehicles, on the other hand, rely on a far more complex array of sensors — including cameras, radar, lidar, GPS, and inertial measurement units which continuously capture data about the surrounding environment to be processed by artificial intelligence algorithms, in order to recognize objects, read road markings and signs, detect pedestrians, and even predict the movements of other road users.[20] Here, the vehicle's "senses" shift from humans to electronic systems, so perception capabilities no longer depend solely on the driver's alertness, physical condition, or experience but on sensor quality, modeling accuracy, and software reliability.

In terms of decision-making autonomy, conventional vehicles rely entirely on human judgment to determine when to accelerate, brake, change lanes, or avoid danger — meaning human error is the dominant factor in many traffic accidents.[21] Autonomous vehicles are designed to transfer these decision-making functions from the human brain to on-board computing systems that automatically run route planning, trajectory control, and risk management algorithms based on real-time processing of sensory data. At higher levels of autonomy (Levels 4–5), the system can even plan and execute a journey from start to finish without driver intervention — including selecting routes, adjusting speed to traffic conditions, and performing emergency stops when a potential collision is detected so the human role shifts from primary controller to merely a passenger.

Another difference is evident in the technological architecture and software integration. Conventional motor vehicles use relatively separate, functional electronic systems such as ABS, ESC, or cruise control, which operate in limited scenarios and do not "learn" deeply

[18] Divya Garikapati and Sneha Sudhir Shetiya, "Autonomous Vehicles: Evolution of Artificial Intelligence and the Current Industry Landscape," *Big Data and Cognitive Computing* 8, no. 4 (2024): 42, https://doi.org/10.3390/bdcc8040042.

[19] Prihatin Effendi and Yonifan Theo Widiabriade, "Angkutan Umum Kendaraan Bermotor Roda Dua Menurut Undang-Undang Lalu Lintas Dan Angkutan Jalan," *Jurnal Pro Hukum : Jurnal Penelitian Bidang Hukum Universitas Gresik* 10, no. 1 (2021): 46–52, https://doi.org/10.55129/jph.v10i1.1435.

[20] Md Mohsin Kabir, Jamin Rahman Jim, and Zoltán Istenes, "Terrain Detection and Segmentation for Autonomous Vehicle Navigation: A State-of-the-Art Systematic Review," *Information Fusion* 113 (2025): 102644, https://doi.org/10.1016/j.inffus.2024.102644.

[21] Vitriyah Arafah Surachman, Rahtami Susanti, and Shah Kamarudin, "Analisis Perbandingan Penegakan Hukum Tindak Pidana Kecelakan Lalu Lintas Oleh Anak Di Indonesia Dan Malaysia," *Proceedings Series on Social Sciences & Humanities* 17, no. 1 (2024): 463–68, https://doi.org/10.30595/pssh.v17i.1176.

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from journey data.[22] Autonomous vehicles, by contrast, adopt a software-centric architecture where modules such as perception, localization, mapping, path planning, and speed control are interconnected — and often supported by machine learning techniques, so their performance can improve as operational data increases. This makes autonomous vehicles more like mobile computing systems on wheels that continuously process large amounts of data, connect to networks (for map updates, software upgrades, or telemetry), and in many cases are closely linked to the digital ecosystem of manufacturers or service providers while conventional vehicles tend to be more self-contained and less dependent on connectivity. From the perspective of human-vehicle interaction and legal liability, conventional motor vehicles place the driver as the primary subject responsible for all on-road actions, from complying with traffic signs to the consequences of accidents caused by negligence. In autonomous vehicles, the line between the liability of the driver, manufacturer, and software developer becomes far more complex, as some actions are taken by the automated system while in certain operating modes, humans are only required to be "on standby" to take over if requested by the system.

Ergonomically, the interior layout of autonomous vehicles also tends to shift from a "driver-focused" to a "passenger-focused" orientation — for example, with the reduced role of the steering wheel and pedals at high autonomy levels, more flexible seating arrangements, and an interface design that emphasizes setting destinations and travel preferences rather than manual control of every maneuver. Thus, the difference between autonomous vehicles and conventional motor vehicles is not merely a matter of adding advanced features, but a paradigm shift from human-controlled transportation to a smart mobility system that gradually automates driving functions. The development of autonomous vehicles in Indonesia is still in the early, experimental stage, but has already shown a fairly clear direction through a combination of research initiatives, limited testing, and regulatory preparations by the government. At the policy level, the Ministry of Transportation emphasizes that autonomous vehicles are seen as one of the main pillars of the future transportation system especially within the framework of developing smart transportation and integrating it with electric vehicles so the ministry has begun preparing implementing regulations and technical standards to anticipate the operation of driverless vehicles on public roads.[23]

The Ministry of Transportation, through its relevant units, has been drafting standards and eligibility tests for autonomous vehicles — including those related to management systems, human-machine interface (user interface), radar and sensor performance, and overall system security before such vehicles are permitted to operate more widely. The government is also formulating a draft guideline for the implementation of electric-powered autonomous public transportation, which serves as a reference for manufacturers and operators to conduct vehicle readiness testing, covering automation levels, system safety, and operational reliability in Indonesia's road environment. This draft guideline is developed by comparing standards and practices from various countries such as the United States, Canada, Japan, the European Union, Singapore, Israel, and the United Kingdom,

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[22] Pedro Robles and Daniel J. Mallinson, "Policy Learning and the Diffusion of Autonomous Vehicle Policy in the American States," *State and Local Government Review* 56, no. 4 (2024): 335–58, https://doi.org/10.1177/0160323X241262816.

[23] Muhammad Ali Ahmad et al., "Customer Attitude Towards Car Sharing, Electric Vehicles and Autonomous Driving: Evidence from Indonesia," *Journal of Asian Development Studies* 14, no. 3 (2025): 753–66, https://doi.org/10.62345/jads.2025.14.3.62.

then adapted to the national context so that Indonesia can not only be a user market but also participate in the development of the technology and its industry.[24]

In terms of practical implementation, Indonesia has conducted several limited-scale autonomous vehicle tests, which are usually carried out in areas with a relatively controlled ecosystem. One frequently mentioned example is the operation of the Navya Arma autonomous electric vehicle in the BSD City area, which functions as a driverless shuttle in a specific environment, as well as the development of the iCar autonomous car by the Sepuluh Nopember Institute of Technology (ITS) as part of university research on automated driving systems.[25] Testing in such closed areas is important to test the performance of sensors, algorithms, and integration with infrastructure without having to directly face the complexity of Indonesia's dense and not always orderly urban traffic. In addition, the National Research and Innovation Agency (BRIN) is also developing several autonomous vehicle prototypes, such as small vehicles for mobility in specific areas — which shows that domestic research capacity is starting to move towards mastering core technology, not just importing finished products.

The national strategic plan for autonomous vehicles is closely related to the development of the Nusantara Capital City (IKN), as this area is designed from the start with the concept of a green and smart city making it much easier to arrange an autonomous vehicle ecosystem compared to old cities whose infrastructure has already been established.[26] The government through studies by the Ministry of Transportation and the Ministry of Public Works and Housing has designated the Nusantara Capital City as a priority location for the initial implementation of autonomous vehicles, among other things because investments for building routes, communication systems, and supporting equipment for autonomous vehicles can be synchronized from the city's planning phase. In the Nusantara Capital City it is envisioned that there will be electric-based autonomous public transportation networks such as trams or shuttles operating on specific corridors, so that they can serve as a showcase for the implementation of Indonesian autonomous vehicle technology as well as a policy and regulation laboratory before being expanded to other cities. In general, efforts to accommodate autonomous vehicles in Indonesia still face various structural challenges, including inconsistent road infrastructure and marking conditions, often unruly traffic patterns, and the need for large investments to build supporting ecosystems such as data centers, reliable communication networks, and special testing facilities. From the regulatory and governance side, issues of safety standards, licensing mechanisms, legal liability in case of accidents, to cybersecurity and data protection regulations are still in the formulation and development stage, so for the time being autonomous vehicles in Indonesia are more in the form of research and pilot projects than large-scale commercial services. However the government has openly stated its hope that Indonesia will not only be a user, but also a producer of autonomous vehicle technology, so going forward collaboration between the

[24] Naufal Hasanuddin Djohan, Erlyn Indarti, and Muhammad Fahad Malik, "Legal Reconstruction For Autonomous Vehicle Use In Indonesia: Challenges And Solutions In The Age of Artificial Intelligence," *Masalah-Masalah Hukum* 54, no. 1 (2025): 13–24, https://doi.org/10.14710/mmh.54.1.2025.13-24.

[25] Djoko Purwanto Mannarul Hidayah, Astria Nur Irfansyah, "Deteksi Objek Pada Mobil Otonom Dengan Kamera Termal Inframerah," *Teknik ITS* 11, no. 3 (2022): 204–9.

[26] Eko Agus Prasetio, Dita Novizayanti, and Aghnia Nadhira Aliya Putri, "Cluster Analysis of Potential Autonomous Vehicle (AV) Adopters in Indonesia's New Capital," *Transportation Research Interdisciplinary Perspectives* 29, no. 1 (2025): 101318, https://doi.org/10.1016/j.trip.2024.101318.

government, universities, research institutions, and industry is expected to accelerate the transition from trials to a more mature smart mobility ecosystem.

The main issue regarding the development of autonomous vehicles is the still existing regulatory gap regarding the regulation of autonomous vehicle development in Indonesia as stipulated in the Road Traffic and Transportation Law. Basically the Road Traffic and Transportation Law still emphasizes the presence of a human driver in every motor vehicle, so it is not yet fully compatible with the concept of vehicles that can operate without a driver such as autonomous vehicles. The existence of this regulatory gap regarding the regulation of autonomous vehicle development in Indonesia which is not regulated in the Road Traffic and Transportation Law can give rise to comprehensive legal implications. Legal implications are basically all juridical consequences or effects arising from a particular event, policy, action, or regulation according to the applicable legal system.[27] The legal implications of a particular act or legal event require adjustment, interpretation, or the formulation of new legal rules to ensure legal protection and its relevance to the rights and obligations of the parties involved.

The legal implications of the regulatory gap regarding autonomous vehicles in Indonesia basically refer to all juridical consequences that arise when a new social-technological phenomenon — in this case, vehicles that can operate independently with the help of artificial intelligence and sensor systems — functions in society, while the existing positive legal framework does not explicitly regulate their existence. Indonesia's current legal structure still relies on the Road Traffic and Transportation Law, which conceptually assumes that every motor vehicle on public roads is always driven by a human. This is evident from various provisions that always refer to the "driver" as the subject who controls the vehicle and bears the obligations and responsibilities for every traffic-related act.

The legal implications of the regulatory gap regarding autonomous vehicles in Indonesia also affect the areas of criminal law and civil law. In traffic criminal law, core concepts such as intent, negligence, and causality were originally formulated with the assumption of a human actor actively controlling the vehicle. When driving functions are transferred to an autonomous system, questions arise as to whether negligence can be attributed to a person who merely activates the autonomous mode without fully understanding how the system makes decisions, or whether fault should be sought at the corporate level as the producer and algorithm designer. Without specific regulations, law enforcement agencies may impose criminal provisions designed for traditional contexts, which could lead to disproportionate criminalization of users or, conversely, de facto impunity for businesses due to the absence of an explicit basis to hold them accountable. In civil law, the regulatory gap complicates the application of the liability principle because the most appropriate liability model — whether fault-based, strict liability, or a mixed regime — is not clearly defined. This results in the burden of proof often falling on the victim to demonstrate the complexity of technical faults, even though realistically the victim has neither the technical ability nor access to vehicle system log data.

B. Manufacturers' Liability in Autonomous Vehicle Accidents in Relation to the Theory of Civil Law Causality: A Comparison of Laws in Indonesia and Kuwait

[27] Hananto Widodo et al., "Legal Implications of the Authority of Acting Regional Heads Based on Policy Regulations," *Indonesian Journal of Administrative Law and Local Government* 1, no. 1 (2024): 65–81, https://doi.org/10.26740/ijalgov.v1i01.35774.

The producer's liability in autonomous vehicle accidents from a civil law perspective cannot be separated from the discussion of causality theory, as the causal relationship between the producer's act or negligence and the loss suffered by the victim constitutes the main basis for the emergence of compensation obligations.[28] In conventional vehicles, the structure of civil liability is relatively simpler: a negligent driver is considered the primary actor, while the producer is only held liable if a product defect is proven to have directly caused the loss. However, in autonomous vehicles, the line between "human error" and "system defect" becomes blurred, as the driving process is partially or fully carried out by hardware, software, and artificial intelligence algorithms designed, produced, and controlled by the producer or other entities in the production and service chain. Therefore, causality theories in civil law — whether in the form of the conditio sine sine qua non theory, adequate causation (sufficient cause), or other causality limitation theories — become important tools to determine the extent to which a producer's act or negligence can be regarded as a sufficient legal cause (juridische oorzaak) to bear compensation liability for accidents involving autonomous vehicles.[29]

In the framework of the conditio sine qua non theory, an act is considered a cause if the loss would not have occurred without that act, so every element in the sequence of events is viewed as an inseparable condition. Applied to autonomous vehicles, the design of the control system, installation of sensors, writing of software code, safety testing, and even over-the-air updates can be seen as factors that, if any one of them were removed or properly carried out, might have prevented the accident. From this perspective, the producer both as the designer of the physical vehicle and the developer of the autonomous system is almost always part of the causal chain, because without the production and marketing of the vehicle, accidents specific to autonomous vehicles (such as a sensor's failure to detect a pedestrian) would not have occurred. However, the conditio sine qua non theory is too broad, so in civil practice it is usually complemented by the adequate causation (sufficient cause) theory, which only recognizes as legal causes those factors that, according to common experience, could reasonably give rise to the loss that occurred.[30] In this context, the producer's liability will only be imposed if the accident that occurs is a manifestation of a risk that could reasonably be predicted from a design defect, manufacturing defect, or information defect (for example, the absence of adequate warnings about the limitations of the autonomous system) — not from an extraordinary event that is completely beyond reasonable technical expectations.

Causality theory also serves to distinguish and weigh the contributions of various involved factors, such as user negligence, road conditions, third-party interference (e.g., hacking), and the autonomous system defect itself.[31] In autonomous vehicle accidents, there is often a combination of factors: the user may activate autonomous mode in an unadvised

[28] Ushie Abel Idagu and Ushingio Peter Ushingio, "The Right To Private Property In John Locke And Humanising The Human Nature," *Global Journal of Social Sciences* 23, no. 1 (2024): 89–96, https://doi.org/10.4314/gjss.v23i1.7.

[29] Rifqi Muhammad and Lita Tyesta Addy Listya Wardhani, "Analysis of Changes on Regulations of Limited Liability Companies in Law Number 11 of 2020: Cybernetics Theory in Legal Politics," *International Journal of Law and Politics Studies* 4, no. 2 (2022): 149–56, https://doi.org/10.32996/ijlps.2022.4.2.16.

[30] Nynda Fatmawati Octarina, Sudiawati Sudiawati, and Mardika Mardika, "The Application of the Conditio Sine Qua Non Principle on the Crime of Damage through Social Media," *Lambung Mangkurat Law Journal* 7, no. 1 (2022): 74–92, https://doi.org/10.32801/lamlaj.v7i1.303.

[31] Hadi Tuasikal and Johana Asmuruf, "Handling Children Who Commit Crimes Under the Criminal Justice System," *Journal of Law Justice (JLJ)* 2, no. 2 (2024): 150–61, https://doi.org/10.33506/jlj.v2i2.3414.

environment, while the system also fails to provide adequate warnings or take mitigating measures. Through a causality approach, judges or legal interpreters can assess whether the producer's actions such as releasing a system with limited perception capabilities without clear usage boundaries constitute a dominant or substantial factor sufficient to hold the producer liable, even if there is concurrent fault on the part of the user. On the other hand, if it is proven that the producer has met the applicable highest technical standards, provided clear usage guidelines, and the accident occurred solely due to improper use or unforeseeable third-party interference, the causal chain linking the producer can be broken or at least qualified, thereby reducing their liability. Thus, causality theory not only answers "whether" the producer caused the loss, but also "to what extent" and "in what proportion" their contribution to the loss is recognized as a legal cause.

In the doctrine of product liability, defects in autonomous vehicles can take the form of design defects, manufacturing defects, or instruction/warning defects — each giving rise to a different causality pattern in relation to the accident.[32] A design defect occurs when the autonomous system's configuration is inherently unable to handle reasonably foreseeable traffic scenarios such as consistent difficulty in detecting motorcyclists or pedestrians at night, so accidents arising from this systemic weakness are directly causally linked to the producer's design policy. A manufacturing defect arises when the design is generally safe, but a specific unit is produced with errors such as a sensor installed imprecisely or an electronic brake module not functioning as intended, so the causal relationship centers on a failure in quality control. Meanwhile, an instruction/warning defect occurs when the producer fails to provide adequate information about the autonomous system's limitations, does not explain that the system is not designed for certain conditions, or even markets the product with claims that the vehicle can "drive itself" without supervision, despite technically still requiring human attention; in this case, causality theory connects the accident to the misperceptions shaped by the producer's communication and marketing.

The application of causality theory in the liability of autonomous vehicle producers also intersects with the choice of liability regime in civil law: whether it is fault-based liability or strict liability.[33] If a fault-based approach is adopted, the victim must prove that the producer was negligent for example by showing that the producer failed to meet prevailing design, manufacturing, or testing standards, so that this negligence became a sufficient cause of the accident.[34] In a strict liability regime, it is sufficient to prove the existence of a product defect and a causal link between that defect and the damage, without the need to prove subjective negligence; this approach is often considered more appropriate for complex technologies such as autonomous vehicles, where users are almost impossible to access and understand the internal technical conditions of the system. In both regimes, the theory of causation remains central: even in strict liability, the plaintiff must still show that the accident was a manifestation of the product's typical risk not merely the result of unreasonable external conduct for the manufacturer to be held legally liable.

[32] Deviana Yuanitasari, Hazar Kusmayanti, and Agus Suwandono, "A Comparison Study of Strict Liability Principles Implementation for the Product Liability within Indonesian Consumer Protection Law between Indonesia and United States of America Law," *Cogent Social Sciences* 9, no. 2 (2023): 1–9, https://doi.org/10.1080/23311886.2023.2246748.

[33] Nick Sage, "Relational Wrongs and Agency in Tort Theory," *Oxford Journal of Legal Studies* 41, no. 4 (2021): 1012–39, https://doi.org/10.1093/ojls/gqab009.

[34] Uthej Vattipalli, "Aviation Laws and Air Carrier Liabilities in India," *Transportation Research Procedia* 48, no. 2018 (2020): 60–73, https://doi.org/10.1016/j.trpro.2020.08.006.

From the perspective of risk distribution and justice, the application of causation theory to the liability of autonomous vehicle manufacturers reflects a paradigm shift: from placing human drivers at the center of fault to recognizing that the design and risk control of technology by manufacturers play a significant causal role. Manufacturers are in the best position to anticipate and minimize risks, as they control technical information, conduct testing, and determine how the system responds in various scenarios; therefore, when an accident occurs as a realization of a risk that was foreseeable from a technical perspective, causation theory becomes the basis for concluding that the manufacturer should legally bear most of the consequences. Conversely, causation theory also protects manufacturers from unfounded claims, as it allows for the separation of cases where damage stems solely from completely improper use, sabotage, or emergency situations entirely beyond the manufacturer's control. In this way, a carefully drawn causal link between autonomous system defects and concrete damage enables civil law to balance two interests: promoting innovation and technological development on one hand, and ensuring an effective and fair liability mechanism for accident victims on the other. The provisions in Law Number 22 of 2009 on Road Traffic and Transportation have not yet explicitly regulated manufacturer liability in the context of accidents involving autonomous vehicles, as its normative structure is still based on the assumption that every motor vehicle is always controlled by a human driver subject. It defines motor vehicles and drivers, and establishes drivers' obligations such as driving carefully, complying with traffic signs, and ensuring the safety of other road users, then links violations or negligence of these obligations to administrative and criminal sanctions, so that liability for traffic accidents is first and foremost directed at the driver as the direct actor on the road. In this framework, vehicle manufacturers are generally only indirectly involved through provisions on technical requirements and roadworthiness, obligations to meet safety standards, and type approval and certification mechanisms—violations of which may result in administrative sanctions, license revocation, or operational bans, but not as the main subject held civilly or criminally liable for traffic accidents under the current scheme.

As a result, when the concept of autonomous vehicles enters discourse and practice, its position creates a normative gap: existing rules do not recognize the autonomous system manufacturer as a party that can specifically be held liable for failures of the automatic driving system that cause accidents. In situations where driving functions shift from humans to algorithms and sensors designed and controlled by manufacturers, it still designates the human driver as the liable party in the event of negligence or accident, because artificial intelligence and autonomous vehicles are not recognized as legal subjects that can be held liable. Thus, for accidents involving vehicles with self-driving or autopilot features, it has not provided provisions that explicitly transfer or share liability from the driver to the manufacturer, either for technical defects in the autonomous system or for new risks inherent in the design and software of autonomous vehicles. In practice, this gap has led the issue of manufacturer liability to be pushed out of it and into other legal regimes, especially general civil law and, to a limited extent, consumer protection law—while it itself remains a traffic framework focused on driver behavior on the road. Academic analysis of accidents involving automatic driving technology shows that under the current structure, the party that can be held criminally liable for traffic negligence remains the driver, while artificial intelligence and autonomous systems are positioned only as non-liable tools. On the other hand, policy documents discussing the core issues of its revision have identified the need for specific regulations for electric and autonomous vehicles, including aspects of safety, software security, vehicle communication, and data protection—implicitly recognizing that in the long term, a new, clearer normative framework must be built regarding the role and liability of manufacturers in the autonomous vehicle ecosystem. However, until such legislative changes occur, it can be concluded that it has not specifically regulated manufacturer liability in autonomous vehicle accidents, so filling the gap still relies heavily on systemic interpretation with civil law and other sectoral policies.

In Kuwait, provisions in traffic law have not yet established a specific regime that explicitly regulates manufacturer liability in autonomous vehicle accidents, as its regulatory framework still focuses on conventional traffic, human driver behavior, traffic violations, and administrative and criminal sanctions for road users. The Kuwait Traffic Law often referred to as Traffic Law Number 67/1976 along with its implementing regulations, later updated through various amendments and ministerial decisions regulates matters such as the obligation to hold a driving license, compliance with speed limits, prohibition of reckless driving, sanctions for red light violations, accident reporting procedures, and the obligation of owners/drivers to ensure roadworthiness of vehicles.[35] In this regulatory framework, the focus of legal liability for accidents remains on the driver operating the vehicle and, to a certain extent, on the vehicle owner, rather than on the manufacturer as the main subject.

Within this context, the manufacturer's role is more indirectly manifested through provisions on vehicle technical requirements, periodic inspections, and the obligation that vehicles allowed to operate on Kuwaiti roads must meet safety and roadworthiness standards set by traffic authorities through implementing regulations or ministerial decisions for example, a Ministerial Decision governing vehicle technical standards and inspection procedures. If a vehicle fails to meet these standards, sanctions generally take the form of operational bans, registration revocation, or vehicle impoundment. Meanwhile, disputes concerning product defects, electronic system failures, or design flaws (which are highly crucial in the context of autonomous vehicles) generally fall under the scope of Kuwait's general civil and commercial law, rather than being resolved specifically through provisions in traffic laws. In other words, while Kuwait has indeed tightened and modernized its traffic laws in recent times — for instance, through increased fines, the use of smart cameras, and new administrative rules there are as yet no explicit provisions mentioning autonomous vehicles or articles that clearly shift or allocate accident liability from the driver to the autonomous driving system manufacturer. This issue will still rely heavily on general interpretations of product defects and civil liability outside of traffic laws. Below is a table comparing and contrasting the regulations on manufacturer liability in autonomous vehicle accidents in Indonesia and Kuwait, viewed from the perspective of the applicable traffic law/road traffic act frameworks in each country.

Table 1. Similarities and Differences in Regulations Regarding Manufacturer Liability in Autonomous Vehicle Accidents in Indonesia and Kuwait

Aspect	Indonesia (Traffic Law)	Kuwait (Traffic Law)	Similarities/Differences

[35] Sam Toglaw, Andri Ottesen, and Yamen Nissi, "Autonomous Vehicles: A Value Proposition for Emerging Markets—The Case of Kuwait," in *International Scientific Conference on Digital Transformation in Business: Challenges and New Opportunities* (Basel Switzerland: MDPI, 2023), 35, https://doi.org/10.3390/proceedings2023085035.

Main focus of the setup	Focusing on drivers, vehicle owners, and transportation companies as the subjects of obligations and responsibilities for traffic accidents; manufacturers are not regulated as the main subjects in the Road Traffic and Transport Act regime.	Focusing on drivers and vehicle owners as parties who are obliged to comply with driving regulations, roadworthiness, and are responsible for violations and accidents; manufacturers are not the direct focus of traffic law.	Both focus accident liability on the driver/owner in traffic law; manufacturer liability is not explicitly regulated at the traffic law level.
Explicit recognition of autonomous vehicles	The Road Traffic and Transport Act does not explicitly mention autonomous vehicles or autopilot systems; its application to AVs is limited to interpreting motor vehicle categories and driver obligations.	Kuwait's Traffic Law and existing implementing regulations focus on conventional vehicles; there are no explicit provisions for autonomous vehicles in the existing traffic regulations.	Both countries are at a stage where traffic laws do not yet explicitly recognize the category of autonomous vehicles.
Position of producers in the law/traffic law	Manufacturers are not stated as subjects bearing direct responsibility for accidents in the Road Traffic and Transport Act; the role of manufacturers is only touched upon through obligations to meet technical standards, type testing, and roadworthiness, violations of which tend to result in administrative sanctions, rather than accident compensation schemes.	Manufacturers appear implicitly through the obligation that vehicles in operation must meet the safety standards and technical requirements set out in implementing regulations; violations result in operational bans or administrative sanctions, not the construction of accident liability in traffic law.	Both place manufacturers indirectly through technical standards, not as the main subject of accident responsibility in traffic law.
Regulation of civil liability of manufacturers regarding AV accidents	Manufacturers' liability for defects in autonomous systems or product defects in general is not regulated in the Road Traffic and Transport Act, but must be derived from general civil law and consumer protection law; the Road	Kuwait's Traffic Law does not contain a specific regime for manufacturers' civil liability for vehicle or autonomous system defects; product defect disputes and casualty damages are generally	In both countries, manufacturers' civil liability for AV accidents falls outside the framework of traffic law and relies more on general civil/product law.

	Traffic and Transport Act only regulates the obligations/responsibilities of drivers, owners, and transportation companies (e.g., Article 234 concerning liability for compensation by drivers, owners, and/or transportation companies).	handled under Kuwait's general civil and commercial laws outside of traffic law.	
The main person responsible for the accident according to positive traffic law	According to academic constructions and practices referring to the Road Traffic and Transport Act, traffic accidents involving vehicles with autopilot features are still positioned as the responsibility of the driver (and owner/transportation company), because AI/autonomous systems are not recognized as legal subjects; manufacturers are not mentioned as directly responsible in the Road Traffic and Transport Act.	Under the Kuwaiti Traffic Law framework, responsibility for traffic violations and accidents rests with the driver and vehicle owner; there is no explicit provision shifting responsibility for accidents to the manufacturer, even if the vehicle technology is advanced.	Similarities: the driver/owner remains primarily responsible for accidents in traffic law; there is no explicit shift to the manufacturer in the AV context.
Direction of reform or discourse of renewal	Policy documents and discussions on the revision of the Road Traffic and Transport Act have identified autonomous vehicles as a future challenge and addressed liability and insurance issues in the transition from human driver to autonomous systems, but have not yet produced positive articles that specifically regulate the responsibilities of manufacturers.	The recently reported amendments to Kuwait's traffic law place greater emphasis on tightening fines, limiting driving licenses, and utilizing monitoring technology (cameras, radar), without any indication of establishing a specific regime regarding manufacturer liability for autonomous vehicles.	Indonesia has more explicitly included AVs as an issue in its revision discourse, while Kuwait has focused more on tightening traffic enforcement; however, neither has yet reached a positive regulation governing the responsibilities of AV manufacturers.
Cross-regime space (relationship	The regulatory gap in the LLAJ Law encourages the liability of AV manufacturers to be shifted	In the Kuwaiti context, issues of product defects and losses resulting from vehicle	Both show the same pattern: traffic law is not used as the main basis for holding AV

with other laws)	to other legal regimes: civil law (product defects), consumer protection law, and potential future special regulations related to AI/AV.	defects are handled under civil/commercial law, while traffic law serves as a framework for traffic discipline; this will also apply to AVs in the absence of specific regulations.	manufacturers responsible, but rather civil/product law outside of traffic law.

(**Source: Author's Analysis**)

This table shows that both Indonesia and Kuwait have yet to establish explicit regulations in their traffic laws that position manufacturers as direct liable parties for autonomous vehicle accidents. Thus, the determination of manufacturer liability still relies on civil law and regulatory reform discourse in each country. Regulations on manufacturer liability in autonomous vehicle accidents in Indonesia and Kuwait exhibit a similar general pattern: the traffic law frameworks in both countries remain centered on the driver and vehicle owner as the main subjects of obligations and liability, while manufacturers are not explicitly positioned as parties bearing direct liability for accidents under the applicable traffic laws. In Indonesia, Law Number 22 of 2009 on Traffic and Road Transportation (Road Traffic and Transport Act) defines drivers, owners, and transportation companies as parties obligated to ensure safety and liable for accidents — including through provisions on compensation obligations by drivers, owners, and/or transportation companies. Meanwhile, manufacturers are only indirectly referenced through obligations to meet technical standards, type tests, and roadworthiness requirements, whose violations typically result in administrative sanctions rather than a civil liability scheme for accidents. In Kuwait, the Traffic Law and its implementing regulations take a similar approach by focusing on provisions related to driving license requirements, compliance with speed limits and signs, and sanctions for violations and accidents imposed on drivers and vehicle owners. Manufacturers only appear implicitly through the obligation that vehicles must meet safety standards and technical requirements set by traffic authorities, so disputes over product defects and victim losses are transferred to the general civil and commercial law regime.

To date, both Indonesia and Kuwait have not explicitly recognized the category of autonomous vehicles in the text of their traffic laws. Thus, the application of rules to vehicles with self-driving features or autopilot systems is still carried out through the interpretation of ordinary motor vehicle categories and the obligations of human drivers. In the Indonesian context, academic studies emphasize that artificial intelligence and autonomous systems are still positioned as auxiliary tools. Therefore, in the event of an accident, the parties targeted by Road Traffic and Transport Act remain the driver and vehicle owner, not the autonomous system manufacturer. Manufacturer liability for system or software defects must be construed through general civil law, consumer protection law, and product defect doctrine outside of Road Traffic and Transport Act. The same pattern is evident in Kuwait, where the Traffic Law does not contain a specific regime for manufacturer liability for electronic or autonomous system failures. Thus, the legal relationship between victims and manufacturers is more appropriately placed within the contractual or non-contractual framework of civil/commercial law, while traffic rules only regulate driving behavior and administrative/criminal sanctions for road offenders.

Accordingly, both countries show that traffic law has not yet been made the primary instrument for regulating autonomous vehicle manufacturer liability. This issue still lies at the intersection of traffic law, civil law, and regulatory reform discourse — with Indonesia slightly more advanced in terms of discourse on revising Road Traffic and Transport Act, which has begun to include autonomous vehicles as a policy issue, while Kuwait is more focused on tightening traffic enforcement without specifically addressing the issue of manufacturer liability in the context of autonomous vehicles.

CONCLUSION

The legal implication of the absence of regulations on autonomous vehicles in Road Traffic and Transport Act is the emergence of uncertainty and potential injustice in determining liable parties and the applicable liability regime when accidents or disputes occur. This is because the normative framework, which still centers on the human "driver" figure, is no longer sufficient to address the complexity of decision-making by artificial intelligence systems. This situation demands adjustments, re-interpretations, and the establishment of specific regulations to ensure that legal protection, certainty of the rights and obligations of all parties, and the effectiveness of criminal and civil law enforcement remain guaranteed as autonomous vehicles are developed and operated in Indonesia. Manufacturer liability in autonomous vehicle accidents, in relation to civil law causality theory, shows that when comparing Indonesia and Kuwait, the causal link between the manufacturer's actions and the victim's loss has not been constructed through traffic law in either country — instead, it is left to the realm of general civil law and product defect regimes. Thus, in both Indonesia and Kuwait, civil law causality theory operates outside of traffic law: in Indonesia, it is used to assess whether the manufacturer's actions or negligence (in design, production, or warning provision) adequately caused the autonomous vehicle accident, thereby giving rise to compensation liability. In Kuwait, the same theory is applied within the framework of commercial civil disputes when victims face manufacturers over vehicle technical defects, while each country's traffic law continues to maintain its traditional focus on the driver and owner as the primary parties causally and normatively liable for road accidents.

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