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RESEARCH ARTICLE/ARAŞTIRMA MAKALESİ

Incentives or Taxes? A Qualitative Study on Autonomous Vehicle Policies***

Teşvikler mi, Vergiler mi? Otonom Araç Politikaları Üzerine Nitel Bir Çalışma

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ABSTRACT

This study examines policy approaches to the taxation and incentivization of autonomous vehicle (AV) technologies. The scope includes not only the social and economic impacts of AVs but also their potential fiscal consequences for public revenues. The main objective is to analyze the technological features and societal perceptions of AVs, evaluate their position within the current tax system, and discuss possible compensatory mechanisms for expected revenue losses. A qualitative research design was adopted, with semi-structured interviews conducted among tax inspectors, revenue experts, and academics. Data were analyzed using thematic analysis, enabling the development of findings grounded in stakeholder perspectives. Results indicate that most participants support the incentivization of AVs, while some argue that they should be taxed as luxury goods due to their high costs. Furthermore, the findings reveal that the widespread adoption of AVs could lead to significant revenue losses in areas such as fuel taxes, motor vehicle taxes, purchase-related Special Consumption Tax and Value Added Tax, and traffic fines. Overall, the study emphasizes the need for a balanced taxation–incentive framework to facilitate the diffusion of AV technologies while safeguarding fiscal sustainability.

Keywords: Autonomous vehicles, Autonomous driving technologies, Externalities, Taxation, Incentives.

JEL Codes: H21, H23, O33.

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ÖZ

Bu çalışma, otonom araç teknolojilerinin vergilendirilmesi ve teşvik edilmesine yönelik politika yaklaşımlarını incelemektedir. Çalışmanın kapsamı, otonom araçların toplumsal ve ekonomik etkilerinin yanı sıra, bu araçların yaygınlaşmasının kamu gelirleri üzerindeki muhtemel sonuçlarını da içermektedir. Bu doğrultuda araştırmanın amacı, otonom araçların teknolojik özelliklerini ve toplumsal algısını ortaya koymak, mevcut vergi sisteminde nasıl konumlandırılması gerektiğini değerlendirmek ve olası vergi kayıplarına karşı uygulanabilecek telafi mekanizmalarını tartışmaktır. Çalışmada nitel araştırma yöntemi benimsenmiş olup, yarı yapılandırılmış mülakatlar aracılığıyla vergi müfettişleri, gelir uzmanları ve akademisyenlerden veri toplanmıştır. Elde edilen veriler tematik analiz yöntemiyle çözümlenmiş ve katılımcı görüşleri üzerinden bulgular geliştirilmiştir. Bulgular, katılımcıların çoğunlukla otonom araçların teşvik edilmesi gerektiğini savunduğunu, ancak yüksek maliyet nedeniyle lüks bir tüketim kalemi olarak görülmesi gerektiğini düşünenlerin de bulunduğunu ortaya koymaktadır. Ayrıca, otonom araçların yaygınlaşmasının akaryakıt, motorlu taşıt, araç alım vergileri ve trafik cezaları gibi kalemlerde önemli gelir kayıplarına yol açabileceği tespit edilmiştir. Sonuç olarak, çalışmada otonom araç teknolojilerinin yaygınlaştırılması sürecinde dengeli bir vergi-teşvik tasarımına ihtiyaç olduğu vurgulanmaktadır.

Anahtar Kelimeler: Otonom araçlar, Otonom sürüş teknolojileri, Dışsallıklar, Vergilendirme, Teşvikler.

JEL Kodu: H21, H23, O33.

Introduction

Advancements in artificial intelligence and sensor technologies have culminated in the development of autonomous vehicles (AVs), which are expected to fundamentally reshape daily mobility patterns. These transformations extend beyond individual travel behavior to broader domains such as urban planning, logistics, and vehicle ownership. Ultimately, the widespread adoption of AVs is anticipated to enhance accessibility for all segments of society (Ministry of Industry and Technology, 2022).

Autonomous vehicle technology also holds the potential to deliver significant societal benefits. Existing research highlights that AVs can reduce traffic accidents and accident-related fatalities, improve environmental outcomes, enhance fuel efficiency, decrease the demand for urban parking spaces, and mitigate both congestion and travel-time losses (Anderson et al., 2016). The economic value of these benefits is substantial. For example, estimates suggest that in the United States alone, the deployment of fully autonomous vehicles by 2030 could generate societal gains exceeding USD 800 billion (Heineke & Kampshoff, 2019). Although it may be argued that discussing this issue is still premature in the context of Türkiye, public opinion research suggests otherwise. In fact, survey findings indicate that public interest in autonomous vehicles is relatively stronger in Türkiye compared to many other countries(Deloitte, 2019). These anticipated positive externalities underline the necessity of carefully designed public policies, particularly with respect to taxation and incentive mechanisms that can influence the pace and scope of AV adoption.

The primary aim of this study is to examine the nature and implications of autonomous vehicle technologies, with a specific focus on how existing taxation and incentive policies applied to motor vehicles should be adapted in response to their diffusion. Special attention is given to the fiscal treatment of AV-related hardware and software, raising the question of whether current legislation remains sufficient in the face of rapid technological progress in mobility. Furthermore, the study analyzes the potential fiscal consequences of widespread AV deployment by assessing its impact on government revenues and exploring strategies to mitigate possible tax losses. Finally, the research investigates stakeholder perceptions of the external benefits associated with AVs. To achieve this, semi-structured interviews were conducted, providing qualitative insights into stakeholder perspectives on AV adoption and its broader societal and fiscal implications.

The Concept of Autonomous Vehicles and Their Externalities

Autonomous vehicles are defined as systems capable of operating independently without human intervention, utilizing advanced sensors and supporting technologies to perceive their surroundings, process environmental data, and navigate accordingly (Ministry of Industry and Technology, 2022, p. 1).

In autonomous vehicles, the data processed by artificial intelligence are obtained through sensors such as RADAR, LIDAR, cameras, ultrasonic sensors, infrared sensors, the global navigation satellite system (GNSS), and inertial navigation systems (Ministry of Industry and Technology, 2022, pp. 4–14). These vehicles also utilize V2X technologies, enabling communication between vehicles, between vehicles and pedestrians, vehicles and infrastructure, as well as vehicles and networks. This provides an effective communication system (Ministry of Industry and Technology, 2022, p. 16).

The classification of autonomous vehicles varies according to the technologies and features they possess. According to the classification developed by SAE International (2021), autonomous vehicles are categorized into levels ranging from 0 to 5. Features such as automated parking, cruise control, adaptive cruise control, lane-keeping assistance, emergency braking, and automated acceleration and deceleration represent examples of autonomous driving technologies. The range and integration of these functions determine the vehicle's level of autonomy. In other words, as the requirement for human intervention decreases, the degree of autonomy increases.

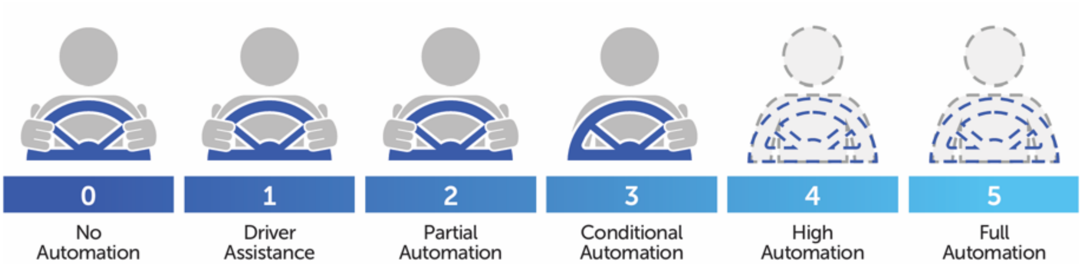

Figure 1. Autonomous Vehicles Levels
Source.: (U.S. Department of Transportation, National Highway Traffic Safety Administration, 2017, p. 4).

Impact on Traffic Congestion

One of the primary objectives of autonomous vehicles is to alleviate traffic congestion (Guerrero-Ibañez et al., 2023, p. 2). By enabling smoother traffic flow, these vehicles have the potential to enhance efficiency in urban mobility (Tamil Selvan & Srirangarajalu, 2023, p. 275; Daily et al., 2017, p. 20). Connected vehicles, in particular, can adjust following distances and optimize lane usage, thereby improving traffic performance and road capacity utilization (Metz, 2018, p. 2). Although the widespread adoption of autonomous vehicles may lower travel costs and potentially increase traffic demand, it is also argued that more efficient driving, higher road capacity, and fewer accidents could offset these effects and help reduce congestion (Anderson et al., 2016, p. 23). Empirical studies confirm these benefits. For instance, Atkins (2016, p. 8) reports that higher penetration of connected and autonomous vehicles (CAVs) significantly reduces average delays and travel times, while improving travel reliability by more than 90% under full CAV deployment. Similarly, Park et al. (2021) show that widespread adoption of autonomous vehicles decreases average delays by up to 31%, and in a fully autonomous scenario, road capacity could increase by 40%, enabling greater throughput alongside reduced congestion. Other studies also support these findings: Neufville et al. (2022) and Wang et al. (2017) highlight reductions in delays with the spread of connected autonomous vehicles, while Wu et al. (2018) suggest that even a modest penetration rate of 6% may be sufficient to stabilize traffic flow.

However, not all evidence points to unqualified benefits. Fujiu et al. (2024) caution that at low penetration rates, traffic conditions may deteriorate, whereas positive effects are more likely at higher levels of adoption. Moreover, some scholars emphasize rebound effects, arguing that the proliferation of autonomous vehicles could stimulate additional travel demand and increase vehicle kilometers traveled (Iravani et al., 2018). While concerns have been raised that the rebound effect, through the substitution of driverless taxis and public transport, could increase the total amount of vehicle travel, it is also expected that declining car ownership and the expansion of vehicle sharing will reduce overall vehicle kilometers traveled (Anderson et al., 2016, p. 37)

Impact on Emission

The widespread adoption of fully autonomous vehicles, most of which are expected to be electric, is projected to contribute to reductions in greenhouse gas emissions (Neufville et al., 2022). Similarly, the large-scale deployment of electric autonomous vehicles could reduce total transport-related emissions by up to 34% by 2050 (Ercan et al., 2022). However, the extent of emission reductions is highly dependent on penetration levels. As shown by Massar et al. (2021), meaningful decreases in greenhouse gas emissions are not achieved under low market penetration but become evident at higher levels of adoption. Furthermore, Rafael et al. (2020) demonstrated that if internal combustion engine autonomous vehicles reach a 30% market share, both NOx and CO_2 levels increase slightly. In contrast, when autonomous vehicles with the same market share are electric, NOx and CO_2 emissions decrease by approximately 30%. Consistently, Rafael et al. (2022) highlighted that the diffusion of autonomous vehicles is likely to reduce NOx and NO_2 emissions. Nevertheless, findings also suggest potential trade-offs. For instance, Nadafianshahamabadi et al. (2021) reported that while higher penetration of autonomous vehicles can increase greenhouse gas emissions due to rising travel demand, it simultaneously improves traffic flow efficiency, leading to reductions in PM2.5 concentrations.

Impact on Fuel Economy

AVs can achieve better fuel efficiency compared to human-driven vehicles, largely due to optimized driving behavior and smoother traffic interactions. Zhang et al. (2022) found that AVs provide 5.6–14.7% higher fuel efficiency relative to conventional vehicles. Similarly, other studies have also confirmed these benefits, reporting that AVs consistently outperform human-driven vehicles in terms of fuel economy (Nazari et al., 2025; Chen et al., 2023; Shao & Sun, 2021).

Impact on Traffic Accidents

The widespread adoption of AVs and driving technologies holds significant potential for improving road safety. According to the (Turkish Statistical Institute, 2025), 90.1% of traffic accidents in 2024 were caused by driver-related errors. AVs, with their ability to detect safety risks, issue warnings, avoid hazards, and make safer decisions to prevent fatal crashes, can substantially enhance traffic safety (Wang et al., 2020). Even a modest reduction in these human-error-related accidents, made possible through advanced sensors and on-board systems, would represent a meaningful contribution to the protection of human life.

Additionally, traffic accidents not only lead to direct damages but also impose broader societal and individual costs, including productivity losses, medical expenses, emergency services, administrative and legal costs, as well as intangible burdens such as pain, suffering, and diminished quality of life (Anderson et al., 2016, p. 10). Research findings generally support the expectation that AVs will help reduce accidents. For instance, Zhou et al. (2024) reported that AVs could potentially lower accident occurrences by 60.91% in an analysis of 363 real-world crashes. Similarly, Ye and Yamamoto (2019) highlighted that AVs contribute to safer traffic conditions by maintaining more cautious following distances and avoiding sudden accelerations.

The Taxation of Autonomous Driving Technologies and Fiscal Revenue Implications

In the Turkish tax system, vehicle-related taxes differ depending on the stage of ownership. At the time of first acquisition, the Special Consumption Tax is levied based on engine capacity and monetary value, while the Motor Vehicle Tax (MVT), applied on ownership, is determined by engine size, vehicle price, and age. Electric vehicles are subject to a 75% reduction in MVT and benefit from lower Special Consumption Tax (SCT) rates compared to internal combustion vehicles. However, within the scope of this study, it is noteworthy that no specific tax incentives are provided for autonomous driving technologies; on the contrary, in certain cases, such technologies may even result in additional tax burdens (Gelir İdaresi Başkanlığı, 2025a, 2025b).

For example, electric cars with an engine power below 160 kW and a taxable base not exceeding 1,650,000 TL are taxed at 25%. Once the taxable threshold is surpassed, however, the rate rises to 55%. Hypothetically, adding advanced safety or autonomous driving packages to a vehicle priced near this threshold may push it into the higher tax bracket, resulting in a significant increase in cost. Similarly, consumers who add non-safety-related features such as sunroofs, special paint, wheels, or interior design options face the same tax implications. Consequently, whether for safety and autonomous driving functions or for purely aesthetic features, additional equipment triggers an equivalent tax burden. This situation represents one of the fiscal obstacles that may hinder the diffusion of autonomous vehicles despite their broader external benefits.

The widespread adoption of autonomous vehicles is expected to have several implications for tax revenues. Potential revenue losses may occur in fuel taxes, motor vehicle taxes, SCT and value-added tax (VAT) collected at the point of purchase, as well as in parking fees and traffic fines. Since autonomous vehicles are assumed to be predominantly electric, revenues derived from fossil fuel taxation are likely to decline. Similarly, a potential reduction in vehicle ownership could lower motor vehicle tax revenues. If these vehicles and autonomous driving technologies are subsidized, the resulting incentives could erode SCT and VAT revenues from vehicle purchases. Moreover, the ability of autonomous vehicles to drive themselves to non-paid parking areas outside city centers could reduce municipal revenues from public parking facilities. In addition, improved compliance with traffic regulations is likely to diminish income from traffic fines.

Furthermore, as Fox (2020, p. 216) notes, structural changes in production and employment can also indirectly affect government revenues. Lower wage levels or shifts in consumer spending patterns may erode income and sales tax bases, while fluctuations in corporate profitability can influence corporate tax receipts. Taken together, these dynamics suggest that both central and local governments may face significant fiscal challenges in terms of reduced revenue streams.

According to Fox (2020), a study conducted across six U.S. states indicated that full adoption of autonomous vehicles could lead to an overall decline in tax revenues of between 2% and 9.2%, while revenues derived specifically from transportation-related taxes could decrease by 60% or more. Similarly, Adler et al. (2018) emphasize that the widespread use of autonomous vehicles is likely to cause substantial losses in both fuel and vehicle-based tax revenues. As these vehicles are predominantly electric, the erosion of revenues generated from fossil fuel taxation appears inevitable, and the possibility of compensating for this loss through electricity-related taxes is considered unlikely.

Based on the 2024 general government budget revenue data (Ministry of Treasury and Finance, 2025), vehicle-related tax categories, including the MVT, SCT on vehicles, fuel, and natural gas, as well as traffic fines, accounted for approximately 12.6% of total revenues. This estimate highlights the significant fiscal weight of automotive and traffic-related tax streams within the Turkish national budget, underscoring the vulnerability of these categories to potential revenue declines.

As potential solutions to declining tax revenues, Fox (2020) proposes the introduction of a general sales tax on all transportation services, a shift toward mileage-based taxation, and the implementation of congestion pricing. Mileage-based taxation could both offset lost revenues and help regulate the increasing demand for travel. Similarly, congestion pricing may simultaneously curb excessive road use associated with rising travel demand while generating additional revenue. Adler et al. (2018) also recommend road pricing based on the “user pays” and “polluter pays” principles. In the same line, Mwamba et al. (2023) suggest mileage-based taxation as a means to compensate for revenue shortfalls from reduced fossil fuel use. Ratner (2018, p. 1073) further advocates for both mileage-based taxation and congestion charges, along with the introduction of a luxury tax on autonomous vehicles. According to Ratner, the early adopters of such technologies tend to be higher-income groups, meaning that such a tax could enhance progressivity while simultaneously compensating for declining revenues.

Methodology

Research Design

This study adopts a qualitative research design to explore expert opinions on the taxation of autonomous vehicles and related technologies. A semi-structured interview technique was employed to collect in-depth data, enabling participants to elaborate on their perspectives while maintaining consistency across interviews.

Participants

The sample study consists of tax experts working in tax offices, tax inspectors from the Tax Inspection Board, and faculty members from university departments of public finance in Turkey.

A total of 15 participants took part in the study, selected through purposive sampling to ensure relevant expertise. The sample comprised:

- 5 tax revenue experts working in tax offices (Coded TRE),
- 5 tax inspectors from the Tax Inspection Board (Coded TI), and
- 5 academics from public finance departments at universities (Coded A).

Participants were selected using purposive sampling to ensure they possess relevant professional knowledge and experience in taxation policies and emerging vehicle technologies.

Data Collection

Data were collected through face-to-face interviews conducted between 10 September 2024 and 13 September 2024 in Turkey. Interviews were audio-recorded with participants' consent and subsequently transcribed verbatim into written form. The interview protocol included open-ended questions designed to capture participants' views on the classification of autonomous vehicles (luxury vs. necessity), their safety features, accessory-related tax implications, possible tax revenue losses, and whether such technologies should be taxed or incentivized. Ethical approval for this research was obtained from the Scientific Research and Publication Ethics Committee of Kirklareli University.

Data Analysis

Thematic analysis was conducted following Braun and Clarke's (2006, p. 87) six-step framework: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. MAXQDA software was used to manage the coding process and visualize the hierarchical code–subcode structures and theory models. Inductive coding approaches were applied, allowing for the emergence of new themes while also aligning with the research questions.

Several strategies were employed to ensure the validity and reliability of the study. In terms of validity, data were collected from different participant groups to achieve triangulation, participants' statements were verified after transcription, and constant comparison was applied during coding and theme development to maintain consistency (R.Gibbs, 2007, pp. 93–100). With regard to reliability, transcription errors were minimized, coding definitions were kept consistent throughout the process, and coding was reviewed at different stages to ensure stability. Moreover, the coding process was conducted collaboratively by the article's authors, who compared the codes and reached consensus, ensuring that the level of agreement exceeded the recommended 70% threshold (Miles & Huberman, 1994, p. 64). These steps ensured that the research process remained consistent, stable, and transparent.

Findings

The qualitative analysis identified several interconnected themes reflecting participants' views on the taxation and incentivisation of autonomous vehicles and related technologies. The findings reveal a wide spectrum of perspectives shaped by professional roles, sectoral knowledge, and perceived policy priorities. Across the interviews, participants addressed not only the current tax framework but also the feasibility of regulation, policy orientations toward incentives or taxation, and the anticipated fiscal implications of widespread adoption. These insights were organised into thematic categories to capture the nuanced positions expressed, ranging from pragmatic considerations of implementation to broader reflections on economic and technological externalities.

Overview of Emerging Themes

This section presents the qualitative data obtained in the study, analyzed through thematic analysis, with the main themes and sub-themes identified from participant statements.

Figure 2. World Cloud

The word cloud in Figure 2 visualizes the most frequently mentioned concepts in participant views, providing an overview of the key topics addressed in the study.

The prominence of terms such as Autonomous and Tax in the word cloud indicates that the study's core focus lies on autonomous vehicles and their taxation. Furthermore, the relatively large appearance of the words Incentive and Government reveals that participants paid attention not only to tax policies but also to incentive mechanisms and the role of the state. It is observed that participant responses are concentrated across interrelated dimensions, namely economic, technological, socio-environmental, and political-regulatory aspects.

During the analysis process, recurring concepts and keywords in participant responses were first identified, and then these expressions were grouped into meaningful categories to form the themes. The thematic analysis revealed five main themes and several sub-themes reflecting participants' perceptions, expectations, and concerns regarding the taxation and incentivization of autonomous vehicles in Türkiye. These themes encompass both economic and social dimensions, as well as policy-related considerations.

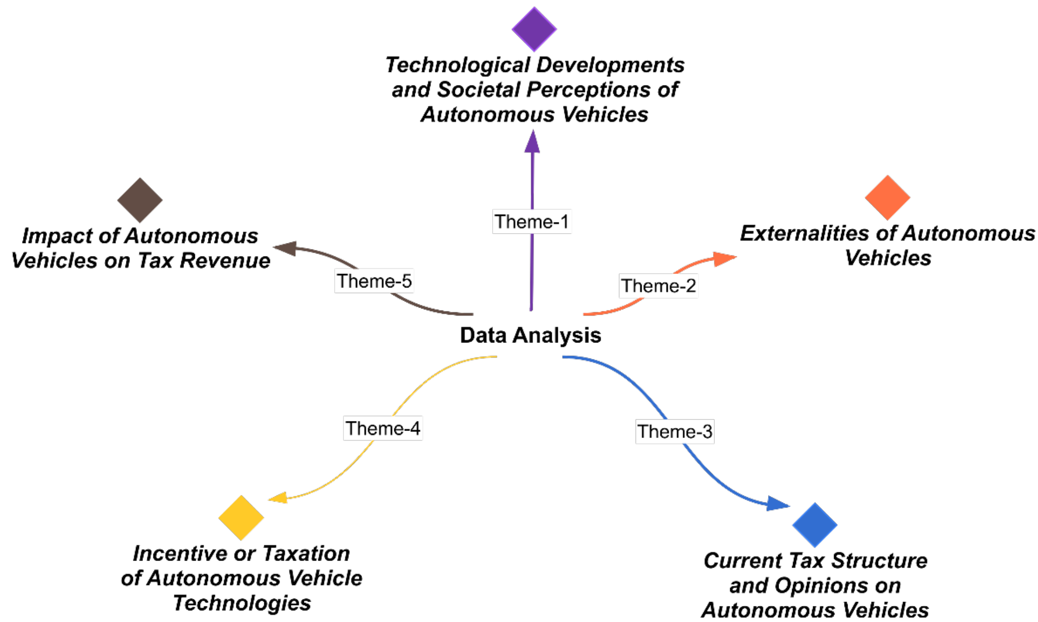

Figure 3. Thematic Structure

Based on this general framework, the following sub-sections present each theme in detail, supported by direct participant quotations and interpretative analysis.

Theme 1: Technological Developments and Societal Perceptions of Autonomous Vehicles

Autonomous vehicles, with their advancing technologies, are perceived in society from multiple dimensions. This theme examines how the technological and environmental features of autonomous vehicles shape public perception through notions of safety and luxury. It also explores how these technologies may be positioned within society in the future.

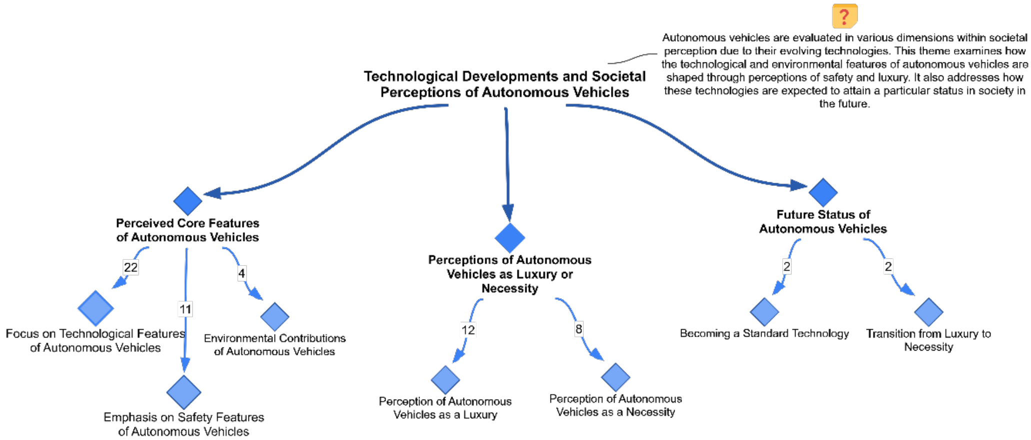

Figure 4. Technological Developments and Societal Perceptions of Autonomous Vehicles

Sub-theme 1.1: Perceived Core Features of Autonomous Vehicles

When participants were asked what comes to mind when they hear “autonomous vehicles” and “autonomous vehicle technologies,” their responses emphasized the technological, environmental, and safety-related features of these vehicles.

One participant highlighted the technological aspect, stating:

“What comes to my mind is systems in which driving is carried out fully or partially by ourselves or directly by a smart technology, artificial intelligence, in a self-driving manner.” (TRE 4)

Another participant focused on environmental benefits, explaining:

“I perceive autonomous vehicles as vehicles that can move on their own, do not require any fossil fuel support, and are generally hybrid or electric.” (TI 1)

A further participant emphasized safety-related opportunities, noting:

“I see them as a technology that incorporates many technologies, minimizes driver attention requirements, and can correct minor mistakes even if the driver is inattentive.” (A 4)

The analysis shows that participants most frequently referred to the technological features of autonomous vehicles, while safety aspects were also prominently highlighted. Although to a lesser extent, the view that autonomous vehicles offer environmental benefits was also expressed. In conclusion, autonomous vehicles are perceived as highly technological, offering significant safety gains, and as more environmentally friendly compared to conventional vehicles.

Sub-theme 1.2: Perceptions of Autonomous Vehicles as Luxury or Necessity

Some participants described autonomous vehicles and their related technologies as a necessity rather than a luxury. For example:

"The advanced safety systems and accident prevention features make autonomous vehicles a necessity for the future." (A 3)

Similarly, another participant stated:

"Not a luxury. I think it is an essential need. Because we are talking about safety. We are talking about safer driving. When we look at the statistics of people dying in traffic accidents, it is something very necessary. That's why I don't call it luxury. I don't think it's a luxury." (TRE 3)

In contrast, some participants considered autonomous vehicles a luxury under current conditions. One explained that their high price and low accessibility at present made them a luxury:

"Why luxury? It can be considered a luxury due to its price. Once it becomes widespread, goes into mass production, and receives a lot of demand, the price will inevitably decrease. At present, its high price can make it appear as a luxury in the eyes of society." (A 1)

Others associated luxury with the comfort enhancements provided:

"Of course, it counts as luxury. As I said earlier, comfort increases. Increased safety also provides comfort to drivers. Therefore, under the current conditions, it is a luxury for me." (TRE 5)

Some participants perceived it as a technology aimed at high-income groups:

"Well, it's like this, it's always the same with everything. New things are first used by the rich. Middle-class or poor people would just walk past an autonomous vehicle, maybe it wouldn't even be in their dreams to buy or use one." (TRE 4)

The findings reveal a clear divergence in perceptions. While some participants see autonomous vehicles as an essential need due to their safety advantages, others currently regard them as a luxury because of high costs, limited accessibility, and their association with affluent users. Comfort enhancements also contribute to their luxury image, even among those who acknowledge their functional benefits.

Sub-theme 1.3: Future Status of Autonomous Vehicles

Some participants envisioned that autonomous driving will become a standard technology in the future:

"Autonomous driving will become the standard in the future, similar to how seat belts or airbags are now mandatory." (TI 4)

Others believed that as technology spreads and costs decrease, the perception will shift from luxury to necessity:

"With the spread of technology and decreasing costs, autonomous vehicles will no longer be a luxury but a necessity." (A 2)

The participants' perspectives suggest a strong expectation that autonomous vehicles will undergo a transformation in societal status. Initially perceived as a high-end technology accessible to few, they are anticipated to follow a trajectory similar to other once-innovative features—eventually becoming standard and indispensable. This shift is closely linked to advancements in production, broader adoption, and reductions in cost, which would enhance accessibility and normalize their presence in everyday transportation.

Theme 2: Externalities of Autonomous Vehicles

In the context of participants' perceptions, the second theme focuses on the perceived advantages and disadvantages of autonomous vehicles. This theme captures the dual nature of participants' evaluations: while some emphasize the potential benefits, such as increased safety, enhanced comfort, technological innovation, and environmental contributions, others highlight concerns related to high costs, limited accessibility, technological risks, and potential societal impacts. By presenting both positive and negative perspectives, this theme provides a balanced understanding of how autonomous vehicles are viewed in terms of their societal, economic, and environmental implications. The subsequent sub-themes detail specific areas of emphasis expressed by participants, reflecting the diversity of views within different stakeholder groups.

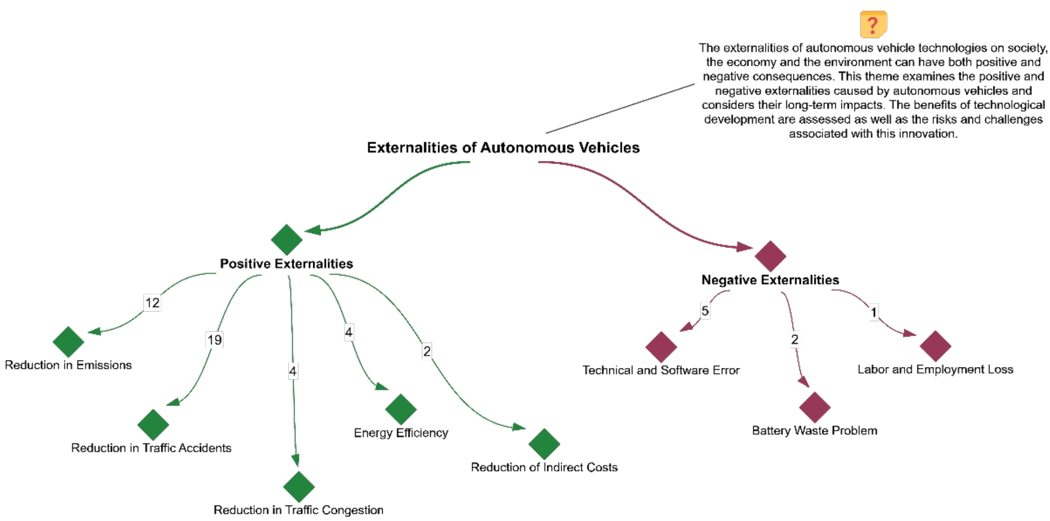

Figure 5. Externalities of Autonomous Vehicles

Sub-theme 2.1: Perceived Positive Externalities of Autonomous Vehicles

Participants highlighted several potential externalities both positive and negative associated with autonomous vehicle adoption.

One frequently mentioned point was the potential reduction in traffic accidents. Many noted that historical accident records largely stem from human error, such as inattention or falling asleep at the wheel. They argued that autonomous driving technologies could prevent such incidents, thereby ensuring safer and more secure travel:

"Throughout history, there have been many accidents and incidents caused by human drivers—due to carelessness, falling asleep at the wheel, and so on. These technologies could prevent such accidents to some extent, allowing for healthier, safer travel from one place to another." (TRE 4)

Some participants also emphasized environmental benefits, particularly reduced carbon emissions if autonomous vehicles replaced human-operated ones:

"With these technologies preventing accidents caused by human drivers, there could also be positive effects such as reduced carbon emissions." (TRE 4)

Another frequently discussed advantage was energy efficiency through lower fuel consumption:

"They may have benefits for fuel consumption." (A 2)

In addition, some participants pointed to reduced traffic congestion as a likely outcome. They highlighted that connected autonomous vehicles could communicate with each other, optimize following distances, adjust speeds, and adapt to weather conditions thereby improving traffic flow:

"Because autonomous vehicles are interconnected, navigation will be much more effective. They will keep distances, accelerate accordingly, slow down in bad weather, and manage traffic much more efficiently." (A 4)

Finally, some participants drew attention to the indirect costs of traffic accidents, particularly the loss of human capital. They noted that fatalities result not only in emotional loss but also in the loss of trained professionals whose education and skills represent significant economic value:

"When a person dies, you lose human life, but also a skilled worker. The state may lose a trained public servant, a pilot, or a doctor. Training these people costs hundreds of thousands or millions of dollars. Even a simple traffic accident can cause this loss. While vehicles aren't the sole cause of accidents, driver error is a major factor." (A 2)

Sub-theme 2.2: Perceived Negative Externalities of Autonomous Vehicles

Some participants expressed concerns about technical and software failures, emphasizing that trust in autonomous driving technology had not yet been fully established. They stressed the importance of ensuring reliable system performance and informing the public about potential risks:

"The vehicle's computer system needs to be very well calibrated so that it doesn't malfunction—so it doesn't accelerate unexpectedly, for example. People also need to be informed about the risks. More importantly, the system needs to inspire trust." (TI 3)

Others highlighted environmental concerns, particularly regarding battery waste from electric autonomous vehicles. They noted that while the technology offers benefits, it also raises questions about the disposal of batteries and their environmental impact:

"Technologically, these will be electric vehicles. But the battery technology—how these batteries will be disposed of, and what their environmental impacts will be—needs to be studied and evaluated." (TI 5)

A further concern was the potential impact on employment in certain sectors, as automation could reduce the demand for human labor in specific occupations:

"It could perhaps lead to an increase in unemployment." (TRE 2)

Participants expressed a wide range of views regarding the potential externalities, both positive and negative, associated with autonomous vehicles. On the positive side, many anticipated substantial safety improvements through the reduction of human error, environmental benefits from lower carbon emissions, fuel efficiency gains, and reduced traffic congestion due to vehicle connectivity and coordinated navigation. Several also emphasized the potential to mitigate broader social and economic losses, such as those caused by fatalities and injuries in traffic accidents.

Conversely, some participants underscored risks and drawbacks, including possible technical and software failures that could undermine trust, environmental challenges related to battery waste management, and labor market disruptions stemming from reduced demand for certain occupations. This dual perspective reflects a nuanced understanding of the technology, recognizing both its transformative potential and the challenges that must be addressed for successful integration into society.

Theme 3: Externalities of Autonomous Vehicles

Under this theme, participants' views are evaluated regarding current legislation on autonomous vehicles, whether safety components in vehicles are considered integral parts of the vehicle or separate equipment for taxation purposes, their knowledge about relevant legal regulations, and their opinions on whether taxation based on equipment would be difficult or easy to implement.

Sub-theme 3.1: Current Tax Status

At present, there is no specific tax differentiation applied to autonomous vehicles and their technologies. Most participants expressed similar views in this regard:

“No, I have not heard of such a regulation so far.” (TI 1)

Some participants, however, noted that the tax system includes incentives solely for electric vehicles:

“Not as autonomous vehicles, but certainly as electric vehicles, there are regulations worldwide. In our country, similar provisions exist in the Special Consumption Tax Law and the Motor Vehicle Tax Law.” (TI 2)

Sub-theme 3.2: Taxation of Security Equipment

Some participants considered that autonomous safety technologies should be regarded as an integral part of the vehicle and taxed as a whole. In their view, safety components are comparable to other parts of the car:

“I think the safety package is the main element. Therefore, it should be assessed together with the vehicle. After all, there is no such thing as less safety or more safety. I believe the safety of the vehicle should be complete, and for that reason, it makes sense to subject it to the same tax burden. These features are ultimately complementary parts of the vehicle, if you know what I mean.” (TI 1)

Other participants, however, believed that safety equipment should be taxed separately from other vehicle components, given its distinct function and public benefit:

“Of course, I do not agree [with taxing it the same way]. Safety can be taxed separately in my opinion. It is something stripped of personal tastes. I think tax rates could be more supportive of safety features.” (TI 5)

Sub-theme 3.3: Legal Regulations and Standarts

According to participants’ views, certain legal regulations have been introduced that require specific safety features to be present in vehicles.

“With the latest legal regulation, some equipment requirements imposed on vehicles are essentially an autonomous requirement. Therefore, this shows that, as a public policy, in motor vehicles and, let’s say, in traffic, we are moving toward a degree of autonomy.” (A 2)

Participants also referred to the introduction of the GSR-2 standards, which made certain safety equipment mandatory, such as lane-keeping systems and adaptive cruise control. These measures were seen as steps toward partial autonomy.

"As far as I know, these GSR-2 standards were introduced after July 7 (2024), making certain safety equipment mandatory. That's also a kind of semi-autonomous feature, such as lane-keeping systems and adaptive cruise control." (TI 4)

Sub-theme 3.4: Opinions on the Implementation of Tax Regulations

This sub-theme focuses on participants' responses to whether taxation on a component basis for autonomous vehicle equipment would be feasible, and whether it would be easy or difficult to implement.

Some participants stated that taxing safety equipment separately from other vehicle components could be implemented with relative ease.

"For the Ministry of Treasury and Finance, this would be very easy. Our current staff could analyse it thoroughly, review the legislation of other countries, and adapt it to our own legal framework. I believe it is a feasible approach." (TRE 3)

However, other participants argued that implementing separate taxation on a component basis would be challenging. The perception that this would be difficult was more frequently emphasised.

"How would such a component-based distinction be tracked from a taxation perspective? Currently, a vehicle has a set value, and both VAT and SCT are calculated on that basis, which is straightforward in practice. If components were to be separated, the calculation would become more complex for the public sector. This could also lead to different types of loss or leakage. That's what comes to mind at the moment. I think it could complicate the administrative process." (TI 4)

Some highlighted that the main issue lies in defining the boundaries between accessories and integral vehicle parts.

"The problem is distinguishing them. It needs to be clearly established what counts as an accessory and what counts as part of the vehicle. The lack of a clear distinction is what leads to such situations. It's odd, really." (TRE 1)

Others emphasised that exempting autonomous technologies from taxation would require intensive monitoring and enforcement mechanisms.

"When I say I want to exempt autonomous technologies from taxation, it requires monitoring and control. As a practitioner, it seems to me that the lack of implementation stems partly from the inability to do this effectively. Perhaps the reason for the lack of very specific and detailed regulations is linked to this." (TRE 3)

Overall, participants' views on the current tax structure and regulatory considerations for autonomous vehicles reveal a consensus that no specific tax differentiation exists for autonomous technologies in Türkiye at present, with current incentives being limited to electric vehicles. While some see safety-related autonomous features as integral parts of a vehicle and thus subject to the same tax burden, others argue for separate taxation to promote safety-oriented technologies. Opinions on legal regulations highlight the gradual integration of semi-autonomous standards, such as GSR-2, into national policy, signalling an incremental shift toward greater automation in transport. However, participants were divided on the practicality of implementing component-based taxation: a minority considered it straightforward, whereas the majority emphasised administrative complexity, the challenge of distinguishing between accessories and integral components, and the need for detailed monitoring mechanisms. Collectively, these findings suggest that while there is awareness of the policy and fiscal implications of autonomous vehicles, significant legislative, administrative, and definitional work remains before a targeted and effective taxation framework can be established.

Theme 4: Incentivizing or Taxing Autonomous Vehicle Technologies

Within this theme, participants presented differing perspectives on whether autonomous vehicles and their associated technologies should be incentivised or taxed.

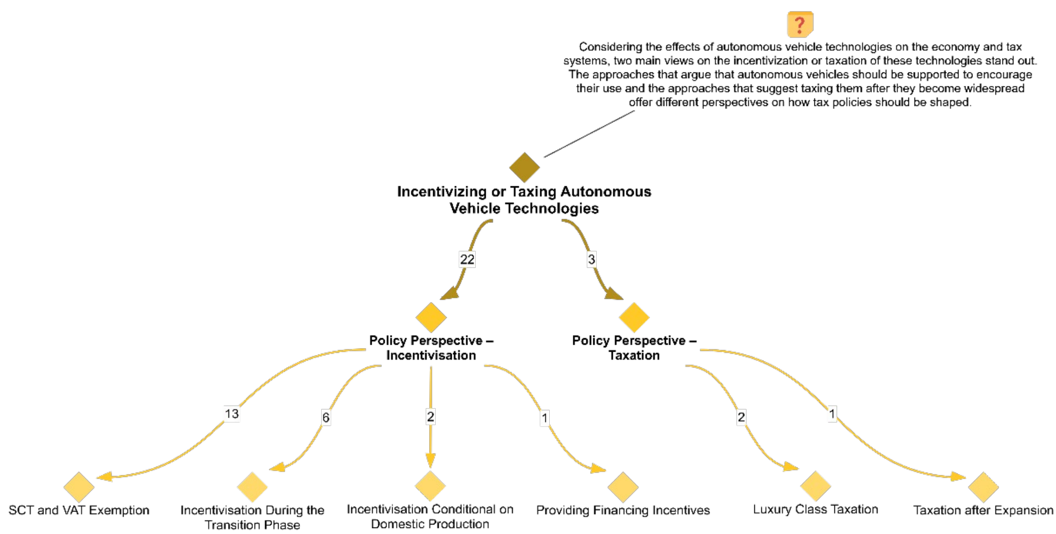

Figure 6. Incentivizing or Taxing Autonomous Vehicle Technologies

Sub-theme 4.1: Policy Perspective – Incentivization

A majority of participants (mentioned 22 times) emphasized that autonomous vehicles should be incentivized. This view is grounded in the belief that the widespread adoption of such technologies would generate societal benefits, particularly during the transition period.

Some participants suggested that reductions in the Special Consumption Tax and Value Added Tax would be among the most effective incentive mechanisms:

“I think they should be incentivized, apparently. At the moment, the first thing that comes to mind is, of course, a possible regulation of the SCT." (TI 4)

Others believed that incentives should be provided during the transition phase, recommending a temporary removal of tax obligations for a specified period:

"For the first five years or three years, depending on the country's budgetary capacity, no taxes should be collected from these vehicles." (TI 1)

One participant emphasized the importance of financial incentives, arguing that high vehicle prices could limit accessibility, thereby necessitating credit support:

"For example, consumers should first be incentivised in terms of credit. Since the total cost of the vehicle is high, individuals will face financing difficulties in acquiring them." (TI 3)

Additionally, several participants stated that incentives should be limited to domestically produced vehicles. According to this perspective, incentivising imported products could widen the current account deficit; therefore, tax exemptions should only apply to local production:

"I am against incentivizing imported goods. Therefore, if it is not domestically produced, I would not advocate for its incentivisation. We should avoid anything that will increase our current account deficit. However, if they are domestically produced, then I would support incentives. Otherwise, tax exemption is not appropriate for me." (TRE 5)

Sub-theme 4.2: Policy Perspective – Taxation

Although fewer in number, some participants expressed the view that autonomous vehicles should not be incentivised but rather taxed. One rationale for taxation was that autonomous vehicles are currently perceived as luxury products.

"Since it is a new technology, at this stage, in terms of taxation, taking more tax from those who earn more is a fairer approach. Therefore, as these vehicles are still rare in the market and not widely distributed, the government has no choice but to proceed this way." (TRE 4)

Another participant stated that taxation should be implemented once widespread adoption is achieved:

"After they become widespread—this will, of course, be a somewhat utopian thought, but if we think of it in an ideal society—then they should be taxed. They should be taxed in every respect." (TI 1)

The majority of participants supported incentivisation, often highlighting fiscal measures such as reductions in Special Consumption Tax and Value-Added Tax, temporary tax exemptions during the transition period, or financial support mechanisms such as favourable loan terms. Some emphasised that incentives should be conditional, for example, prioritising domestically produced vehicles to reduce the current account deficit.

Conversely, a smaller group of participants argued for taxation rather than incentivisation. This stance was primarily grounded in the perception of autonomous vehicles as luxury products, warranting higher taxation at the early stages of market introduction. Another view suggested that taxation should be implemented only after these technologies become widespread, aligning fiscal measures with market maturity.

Theme 5: Incentivizing or Taxing Autonomous Vehicle Technologies

This theme examines participants' perspectives on the potential fiscal consequences of autonomous vehicle adoption, with particular emphasis on areas of possible tax revenue loss and gain, as well as strategies to address such impacts. The discussions reveal both concerns about short-term declines in revenue, especially from fuel taxes, vehicle-related duties, and employment-based income taxes and optimism regarding the long-term potential for technological advances to enhance fiscal capacity. Within this framework, participants offered concrete proposals for mitigating revenue losses and identified pathways through which autonomous vehicles could contribute positively to public finances.

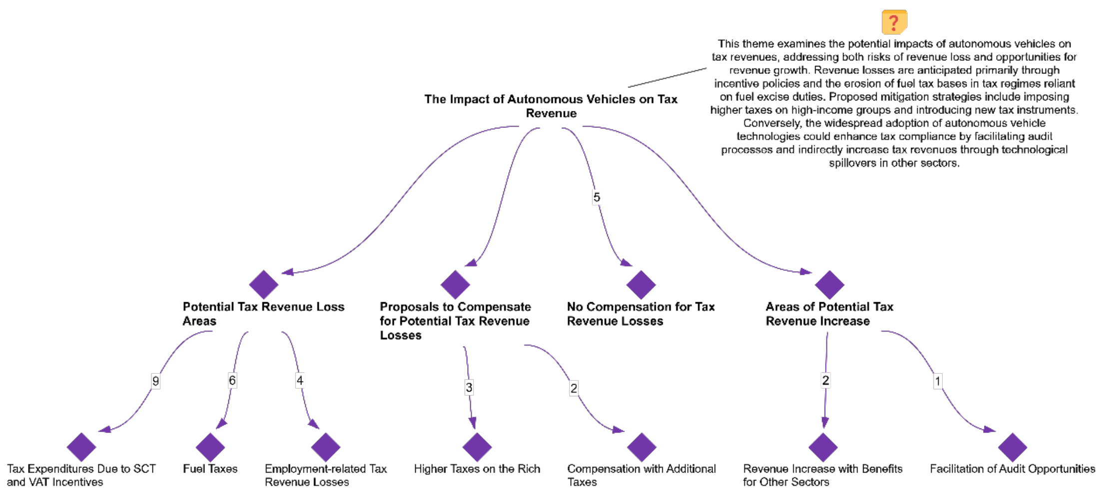

Figure 7. Incentivizing or Taxing Autonomous Vehicle Technologies

Sub-theme 5.1: Potential Tax Revenue Loss Areas

Participants identified several potential channels for tax revenue losses arising from the adoption of autonomous vehicles. These include tax expenditures resulting from VAT and SCT incentives:

"When we talk about tax losses, if tax incentives are provided, there may be a loss in tax revenues. If you grant an incentive on SCT rather than VAT, then you incur a loss there." (A 5)

Others highlighted the possible decline in fuel tax revenues due to reduced fuel consumption:

“I think that, as regular fuel sales decline, the government’s revenues from both SCT and VAT in that area will also decrease.” (TI 1)

A further concern was the potential reduction in income tax revenues resulting from decreased employment in driving-related sectors:

“For example, if companies no longer employ drivers, there might be losses in income tax from them. Nothing else comes to mind.” (TRE 5)

Sub-theme 5.2: Proposals to Compensate for Potential Tax Revenue Losses

Several proposals were put forward to address such potential losses. Some suggested increasing taxation on high-income groups:

“In my opinion, this loss could be compensated by taxing those with higher incomes more, by taking more tax from them.” (A 1)

Others recommended the introduction of new taxes, such as an additional Motor Vehicle Tax:

“Let me put it this way — this could be compensated in any way. For instance, you could introduce an additional Motor Vehicle Tax, just like what happened recently, and collect tax again. In other words, you can collect it in any possible way.” (TI 2)

A minority rejected compensatory measures altogether, arguing against offsetting one tax loss with another:

“I do not find it very favorable to compensate for a tax loss here by collecting from another tax.” (TI 1)

Sub-theme 5.3: Areas of Potential Tax Revenue Increase

Despite concerns over losses, participants also noted areas where autonomous vehicles could increase tax revenues. One avenue is through positive spillover effects in other economic sectors:

“Even if tax revenues from here decrease, this will have positive effects on agriculture, livestock, and many related sectors. I think it will increase production there, and therefore, I see it as beneficial in that sense.” (TI 1)

Another is the facilitation of tax audits and compliance through digital technologies:

“Now, for example, digital audits have emerged... perhaps in the future, maybe 15, 20, or even 30 years from now, if you haven’t paid your motor vehicle tax, you won’t be able to use your vehicle... in the morning, you will go to start it, press the button, and the screen will say: ‘Pay your motor vehicle tax.’” (A 3)

General Discussion

The thematic analysis revealed a complex and multi-dimensional set of perspectives on the taxation, incentivisation, and broader socio-economic implications of autonomous vehicles. Across all themes, participants expressed a heightened awareness of both the potential benefits—such as improved road safety, reduced traffic congestion, lower carbon emissions, and possible economic gains in related sectors—and the associated risks, including technical malfunctions, regulatory challenges, environmental concerns, and potential job displacement.

A recurring pattern was the divergence between policy perspectives that prioritise incentivising the adoption of autonomous vehicle technologies, particularly during the early transition period, and those advocating for immediate or eventual taxation, often grounded in equity considerations or the perception of such vehicles as luxury goods. This dichotomy reflects broader debates in the literature on technology adoption and public finance, where fiscal measures serve not only as revenue tools but also as policy levers to shape market behaviour.

The findings also highlight significant gaps in the current tax framework, with participants noting the absence of specific tax provisions for autonomous vehicles, in contrast to the incentives already available for electric vehicles. Opinions on the taxation of security equipment revealed competing logics: while some viewed these features as integral to the vehicle and subject to the same tax burden, others argued for differentiated tax treatment to encourage safety innovation.

In line with prior studies on the fiscal implications of technological disruption, participants anticipated both revenue losses, stemming from reduced fuel tax revenues, potential declines in employment-related income taxes, and foregone revenues from tax incentives, and revenue gains, particularly through enhanced digital auditing capabilities and spillover effects in other sectors. The tension between these opposing fiscal outcomes underscores the need for forward-looking tax policy design that balances innovation incentives with fiscal sustainability.

Overall, the insights obtained reinforce the necessity of a coherent, adaptive, and evidence-based regulatory and taxation framework for autonomous vehicles. Such a framework should address emerging externalities, ensure equitable tax burdens, and align fiscal policy with broader societal objectives, including environmental sustainability, technological competitiveness, and public safety.

Conclusion and Policy Recommendations

This study has examined the societal perceptions of AVs, their externalities, and the potential impacts on taxation and fiscal policy. The thematic analysis of participants' views revealed that these technologies are not only considered as technical innovations but also as phenomena with broad social, economic, and fiscal implications. Most participants described AVs primarily as a technological product, emphasizing artificial intelligence, sensors, and automation systems rather than their environmental or safety contributions. At the same time, AVs are perceived both as a necessity and a luxury product. On one hand, their safety benefits and potential to reduce traffic accidents make them socially desirable; on the other hand, their high costs, limited accessibility, and comfort-enhancing features generate an image of luxury, particularly among higher-income groups.

Among the most significant positive externalities identified were the reduction of traffic accidents and fatalities and the mitigation of carbon emissions. Considering that over 90% of traffic accidents in Türkiye stem from driver errors, AVs' capacity to prevent human mistakes has critical life-saving potential. However, participants also raised concerns about negative externalities, including safety risks, potential software failures, employment displacement, and the environmental challenges of battery waste. These findings highlight the need to balance technological benefits with broader societal risks.

The study also revealed that there is currently no dedicated tax regulation for autonomous driving technologies in Türkiye, with incentives limited to electric vehicles. A dominant view among participants was that treating safety features under the same tax burden as aesthetic accessories is inequitable, given their clear public benefit. Nonetheless, concerns were raised that implementing taxation on a component-by-component basis would be practically difficult, potentially leading to administrative complexity. At the same time, there was broad agreement that safety and autonomous driving technologies should be incentivized, particularly through exemptions or reductions in SCT and VAT. Some participants argued, however, that because AVs are initially adopted by higher-income groups, they could be subject to luxury taxation, ensuring both fairness and fiscal sustainability.

The widespread adoption of AVs is expected to affect multiple streams of public revenue, including motor vehicle taxes, fuel taxes, purchase-related SCT and VAT, parking revenues, and traffic fines. Particularly under the assumption that most AVs will be electric, substantial losses in fossil fuel–based revenues are anticipated. Reduced vehicle ownership, the growth of the sharing economy, and more compliant driving behaviors are also likely to diminish traffic fines and parking revenues, affecting both central and local government budgets.

In line with the findings of the study, safety-related driving equipment should be addressed separately in taxation policies. Considering both participant perspectives and public interest, it would be an appropriate policy choice to subject such equipment to a distinct tax treatment and even exclude it from the scope of the SCT. These features are regarded not as matters of individual preference but as essential elements of public safety.

If the independent taxation of safety equipment is not practically feasible, the monetary thresholds applied during vehicle purchases in the current system should at least be revised or entirely eliminated. In particular, the fact that safety features increase the taxable value of the vehicle and push it into a higher tax bracket generates adverse consequences in terms of both tax equity and technology diffusion.

Therefore, the pricing of safety equipment should be arranged in such a way that it does not affect the SCT base of the vehicle, meaning it should not cause the vehicle to move into a higher bracket and become subject to a heavier tax burden.

In conclusion, the findings demonstrate that the positive externalities of AVs, such as accident reduction, environmental benefits, fuel efficiency, and time savings, require supportive public policies. However, the design of such policies must carefully balance the need to incentivize innovation with the risk of fiscal erosion. Tax regulations should not only serve as revenue-generating tools but also function as instruments to guide the diffusion of beneficial technologies.

Statement of Research and Publication Ethics

This study has been prepared in accordance with the rules of scientific research and publication ethics. Ethical approval was obtained from the Ethics Committee of Kirklareli University (Decision dated 10.09.2024 and numbered E-35523585-199-133740).

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