COGNITIVE BACKGROUND OF THE RELATIONSHIP BETWEEN AUTONOMOUS VEHICLES AND SUSTAINABLE MOBILITY: A CASE STUDY OF GREEK DRIVERS

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Abstract
The research that is presented concerns the investigation of the background of the cognitive familiarity, regarding the matter of the relationship between autonomous vehicles and Sustainable Mobility. Both the existing background knowledge and the gaps of knowledge are approached in detail, concerning the sustainable side of the future use of autonomous driving of vehicles.

More specifically, research which targets the group of Greek drivers is used as a case study. Within the initial theoretical part of this research, the necessary review of related studies and methods as well, is conducted, so as to link this research topic with the much wider, existing body of research of the international scientific community. Moreover, on its main theoretical part, the conceptual definition of autonomous vehicles and sustainable mobility, as well as other relative terms that lay the initial foundations for understanding, are mentioned for deeper understanding.

Furthermore, the past and current development of some relevant proposals and applications is presented with the purpose of making the suggestions for their future use more understandable. The following case study is specialized in the statistical population of car drivers in the country of Greece, who are approached by a representative sample of some statistical units in the context of primary data collection.

Subsequently, based on their answers and thoughts about the topic in question, the cognitive background regarding the contribution of autonomous vehicles to sustainable mobility is delineated. Finally, specific helpful conclusions are drawn regarding the potential inclusion of autonomous vehicles, related to sustainability, in real road networks, as well as suggestions that have to do with future research work on the topic.

Key words: *autonomous vehicles, sustainable mobility, sustainable development.*

Introduction

Nowadays, there has been an increasing number of research and applications that has to do with the utilization of advanced digital technologies towards the technical enhancement of diverse types of vehicles, based on the principles, ideas, and practices of Sustainable Development. Relative practices are aligned with the universal shift on behalf of governments, the car industry and other stakeholders towards the protection of humanity's resources for the future and indeed on a global level. This is an essential core element that is highlighted on the Sustainable Development agenda, which was redefined with the publication of the "Our Common Future" in the year 1987, a significant publication with regards to environmental thinking in general. Funded by the United Nations, the World Commission on Environment and Development, led by Brundtland H. G., called for the reorganization of institutional stakeholders at a global, national, and local level to promote a type of economic development

that would guarantee the safety, well-being, and strong survival of the planet (WCED, 1987, as cited in Sneddon, 2006). At that point, it was emphasized that the strategies of economic development derived from countries and regions should align with a well-organized systematical approach based on specific principles. These principles should ensure the preservation of both good survival conditions on the planet as well as a better quality of life. It is also worth noting that the publication in question was not based on a local or a national institutional level, but on the foundations of an international discussion among governance representatives. Its global character highlights the significance of the strong need for a wide constructive collaboration among different stakeholders and their efforts from different areas, fields and perspectives. From the above, we can clearly understand the mixed nature of Sustainable Development as a matter that should be approached in a multi-disciplinary manner and not just from its environmental side, as in the "green" strategies of sustainability. Its various perspectives involve different aspects and strategies that are synergistically related to the defense of our resources, but it should be noted that its spectrum is not limited to the natural resources. Specifically, as one of the most accepted definitions of Sustainable Development presents: it is a "… development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, as cited in Halkos & Gkampoura, 2021, p.94).

In the more targeted area of the car development sector, both research and practical approaches are being promoted, integrating concepts and incorporating methods with the overall aim of making mobility more sustainable than it used to be in previous years. Most of these strategies focus on decreasing the negative environmental impact of vehicles, like CO_2 emissions in a much “greener” modification of the conventional manufacturing approaches. A representative example of this approach with which people have recently become more acquainted is the massive breakthrough of electric vehicles, which is becoming more and more an object of discussion. Using electric vehicles instead of the conventional ones can potentially lead to a more sustainable mobility model with an abundance of benefits related to different goals of the Sustainable Development agenda, rather than only “greening” the mobility network. Apart from electric vehicles, mobility-oriented sustainable approaches can also be supported by smart technologies and, in particular, in the urban transport systems, and therefore contributing to Sustainable Mobility and specifically to that of Smart Mobility, which is an essential element in Smart Cities. According to a well-known definition: "A smart city brings together technology, government, and society to enable the following characteristics: a smart economy, smart mobility, a smart environment, smart people, smart living, and smart governance" (IEEE Smart Cities Technical Community, n.d., as cited in Faria, 2017, p. 2). This definition includes the factor of Smart Mobility which describes: “… the use of Information and Communication Technologies in modern transport technologies to improve urban traffic” (Albino et al., 2015, p.11) or alternatively refers to a: “… local and supra-local accessibility, availability of Information and Communication Technologies, modern, sustainable, and safe transport systems” (Vanolo, 2013, p.887). In this conceptual framework, autonomous vehicles are included, which appear to be the most groundbreaking part of research and approaches in the scientific area of Smart Mobility, which should not be regarded as an independent technological achievement or even as a high-level product of the car industry, but as a means for achieving certain goals of Sustainable Development agenda at a universal level.

In this context, an innovative driving model has been created, which is autonomous driving, where, at a partial or total level, human-user control becomes to some extent unnecessary. This new way, beyond road comfort, can also lead to benefits related to the principles of sustainability. Therefore, the present research thematically concerns the conceptual connection of autonomous mobility and sustainability. More specifically, it

concerns the understanding of the positive relationship between these two factors by citizens since they are the potential future users and thus it must be as clarified as possible for them. Subsequently, a primary level study is being conducted to determine actual perceptions about the relationship between autonomous vehicles and Sustainable Development. These perceptions are extremely important since they will shape the background towards the arrival of such vehicles in future adaptations. More specifically, this work is based on securing a body of arguments on specific issues. For this purpose, focused primary research has been carried out on a sample of drivers, in the country of Greece, regarding the above fertile correlation. Based on this research, supplemental suggestions were drawn concerning future work regarding the matter that will be outlined.

Theoretical background

To provide the initial theoretical foundations for the targeted field in question, in this section an introductory presentation will be provided, about several research examples and findings that are thematically associated with the aim of the present research material. These are studies that primarily focus on the beneficial dimension of the integrations of autonomous vehicles in road environments, particularly from the side of Sustainable Mobility. In the previous decade Malik (2017) highlighted the correlation between autonomous driving and sustainability, with classifications that aimed to illustrate the contribution of the autonomous vehicles to the latter. These categories were about: 1) Social level, like through their potential use by social groups, such as the elderly, the disabled and individuals with disorders. 2) Environmental level, emphasized by the increased capacity, reduced traffic congestion, reduction in greenhouse gas emissions etc. Furthermore, the use of their platooning is noted, where in such a scenario air resistance primarily affects the lead-driven vehicle, which appears as a shield for the others of the group. Moreover, elimination of unnecessary accelerations but also decelerations, and the matter of aggressive driving that consumes more fuel, is also mentioned. 3) Economic level describes matters as savings through engagement with other activities, as for instance, work during transport time. Additionally, a broader reduction in costs linked to transportation is also identified, due to the naturally reduced travel time.

Another study of the following year from Bahamonde-Birke (2018) categorized their effects into direct and indirect impacts. The first group included outcomes such as the reduction of costs that are -generally- economically related to transportation, like fuel usage efficiency. Also, the reduction in expenses related to parking services due to the autonomous function of parking of the specific vehicles, is mentioned. Additionally, this study appears to trigger a discussion about a new model of public transportation that is mainly based on the use of smaller vehicles that operate in a denser network. This unfamiliar approach could enhance the appeal to public transport in citizens' preferences as more attractive. Rather than their beneficial effect associated with transportation, positive environmental aspects are noted as well. For instance, matters such as the reduction in a negative environmental footprint, the decrease in the level of exhaust emissions both on a local and global level, and improved safety in road environments. In particular, road safety can positively be assisted by minimizing risks related to human factor behaviors like interactions between drivers (e.g. hostile gestures that can escalate tension and lead to dangerous situations). Lastly, the fact that they can be potentially used by unlicensed drivers or individuals unable to drive (e.g. children, the elderly) is also highlighted in the study.

In addition, in a relative study Williams et al. (2020) presented issues such as the improved efficiency of autonomous vehicles due to reduced congestion, vehicle platooning, smoother driving, and consequently decreased fuel consumption. Moreover, about their

economic dimension, their research pointed out some potentially derived changes like their use in the tourist industry for recreational travel, a more convenient delivery of goods and meals, and cheaper freight transportation which leads to lowering prices of goods, among others. The social dimension is seen as a perspective of increased safety due to the disassociation of driving from drawbacks related to human error, such as distraction, and non-immediate reaction. They can also provide new opportunities for people from low-income backgrounds, for example through ride-sharing systems that can serve as an innovative form of public transport.

Beyond the previous overview, an initial clarification in accordance with the different types of autonomous vehicles, will be provided below, based on their distinct levels. According to SAE International, the driving automation levels are defined as follows: Level 0: No Automation, Level 1: Driver Assistance, Level 2: Partial Automation, Level 3: Conditional Automation, Level 4: High Automation, Level 5: Full Automation. More analytically, Level 0: refers to a state without any automation, where the driver is fully responsible for driving. Level 1: refers to vehicles that integrate basic autonomous functions. These can assist the driver with specific controls, but drivers still have a significant operating role. Level 2: introduces a wider range of autonomous functions and therefore leads to automation in a partial manner. In this level, the vehicle can operate steering, acceleration, and braking, but it needs the driver's supervision for intervention when necessary. Level 3: signifies the start of conditional automation, where the autonomous vehicle can deal on its own functions of driving while monitoring the external environment. Level 4: represents a high-level of autonomous driving and its vehicles can operate independently on some occasions or within specific spaces, without the driver's intervention. Level 5: the ultimate type, where vehicles can deal with all aspects of driving without any involvement on behalf of human factor (SAE, 2016, as cited in Malozzi et al., 2019).

In this direction, the company of Roborace designed autonomous vehicles (Robocars) of the fifth level which were battery-electric vehicles powered by 62kWh lithium-polymer batteries and had specialized sensors to perceive conditions of external environmental factors and other systems of localization and for spatial awareness. They also had peripheral cameras, lidar systems, radars both at the front and rear, seventeen ultrasonic sensors, among other essential technical equipment as well as hardware (Betz et al., 2018). The use of such a vehicle in the context of a Roborace, appears as a representative example of a vehicle's ability to operate under the fifth level's autonomous driving with specific spatial limitations under technically defined circumstances (car race). These limitations primarily concern: 1) The vehicle remaining within a defined spatial entity for their entire performance. 2) The complete disassociation from conventional vehicles, with intelligent interaction occurring only with vehicles of the same type.

A notable related example is the one of the Mercedes-Benz research program for the autonomous F015, emphasizing on the significance of exchanging information with other vehicles, the external environment, as well as passengers. This model is equipped with laser and light projections for visual interactions with pedestrians and other vehicles. Some of its various features are adaptive cruise control and lane keeping. Some of its drawbacks are about braking and self-steering functions which are not yet at an efficient level (Yaqoob, 2019). Several depictions of the F015 show an impressive function of rotating seats so the driver can actively socialize with all the passengers during the entire route. Another case with significance for the Greek road environment was showcased in the city of Trikala, which participated in a program named CityMobil2 that introduced buses without the need for drivers and were integrated into an existing network of transportation. Their route stretched 2.4-kilometers in length, with the aim of presenting the city's landmarks for touristic purposes (Kalliaras, 2018, as cited in Papadima et al., 2020). Specifically, six autonomous buses were

launched in October of 2015, with a capacity for eleven passengers (six seated, four standing, and one spot for a wheelchair user). Until 2016, the buses completed 1,490 trips in a total distance of 4,030 kilometers, and in total they transported 12,138 passengers (Portouli et al., 2017). The afore-mentioned program offers important input as an initial foundation for familiarization with autonomous vehicle performance, within a place of technical supervision and support from the relevant local authorities regarding safety issues. Secondly, to understand the positive impact of such a smart application to promote both cultural heritage and urban scenery.

Projects like the previously mentioned can provide a preparatory background for understanding towards their mass utilization on real road networks. Such an alteration can lead to the redefining of lifestyle and city planning across different sectors. Duarte and Ratti (2018) placed these changes in five fundamental areas: 1) Morphology, as today's vehicles have a specific morphology that derives from their functions and as it will change in the case of autonomous models, the morphology of road scenery will alter as well. 2) Number of vehicles on the roads, because autonomous mobility promotes car-sharing ideas for the simultaneous transportation of multiple passengers. 3) Parking spaces that could be reduced due to the reduction in the number of vehicles that will free up space occupied by conventional cars as parking spots. 4) Relieving travel-related burdens, as they will encourage people to consider living in other areas apart from cities, which will lead to less congestion. 5) Potential lightening of road infrastructures, due to the data exchange between these vehicles and infrastructures, so fewer road systems may be needed to accommodate the same number of people.

In another recent study of Seuwou et al. (2019) other points according to sustainability are summarized into six classes: 1) reduction in pollution, 2) reduction in traffic congestion, 3) increase in citizen's safety, 4) reduction in noise pollution, 5) improvement in travel speed, 6) reduction in transportation costs. The last point is also correlated with car-sharing mode associated with a popular factor found in literature that is MaaS (Mobility as a Service) which essentially, has to do with a model of mobility services delivered from a provider. Such a model could free drivers from owning a vehicle and the costs that are associated with it (Coppola & Silvestri, 2019). Apart from the simpler MaaS an increasing interest is presented related to the more complex MaaS Ecosystem, that includes transportation experts, researchers, and MaaS providers and it can also be related to infrastructure, transportation services and information and payment services (Hietanen, 2014, as cited in Reyes García et al., 2019). In the case of a synergistic scenario that will involve both the concept of MaaS and autonomous vehicles, a system of ASaaS (Autonomous Shuttle as a Service) can be also formed for further extensions, with possibilities like: 1) customization to the needs of users, 2) serving areas with a lack of infrastructure, 3) reduction in noise pollution, 4) enhancement of the existing network of public and private urban mobility services (Bucchiarone et al., 2020).

Regarding the above theoretical overview, it becomes clear that the use of autonomous vehicles can modify or replace the current mobility model to a more sustainable one, indeed towards different axes of sustainability principles. It should also be noted that the introductory understanding provided of such arousing possibilities can only be roughly outlined as autonomous mobility concerns state-of-the-art research of the car industry, with a small body of representative examples and therefore it cannot be strictly specified. Yet, people already form strong opinions upon the existing scenarios and in most of the cases these are mainly associated with the aspects of the user's experience (e.g. road comfort) rather than the ones linked to sustainability, which should be kept in mind for the defense of their future integration in the road environments.

Methodology

The methodological tool selected is of primary level research (data collection) which was carried out on a statistical sample of Greek Drivers (163 people), via an online electronic survey with a questionnaire (form in Google Forms and distributed in June of 2024) upon specific points that need to be checked. These points are based on the research axes, which concern both the corresponding positive outcomes and the concerns that contribute to a partially flawed knowledge regarding the role of autonomous vehicles in sustainable mobility.

Results

The specific section presents the results of the survey and more specifically statistics that illustrate the findings. Apart from the table presented below regarding the first twelve questions, further down four subsequent questions that needed a short-written answer in a more free-thinking manner will be given.

Table 1: Primary level research results linked to the given questionnaire

Questions	**Answers**			
1. Are you familiar with the term Sustainable Development?	No		Yes	
	44,8%		55,2%	
2. Given that Sustainable Development focuses on preserving resources for future generations, with which field do you consider it is inseparably linked?	Society	Economy	Environment	All the mentioned points
	9,8%	12,9%	31,9%	45,4%
3. Sustainable Development constitutes a national "bet" for each state independently of the others and therefore strategic transnational synergies are not required for its achievement.	False		Correct	
	49,7%		50,3%	
4. The achievement of the Sustainable Development Goals is exclusively related to smart systems, technologies (e.g. software, artificial intelligence functions)	False		Correct	
	44,2%		55,8%	
5. What factors do you believe Sustainable Development is inseparably linked to?	Road user safety	Reducing negative environmental footprint	Promotion of active mobility (e.g. walking, cycling)	All the mentioned points
	6,7%	28,8%	16,6%	47,9%
6. The achievement of Sustainable Mobility is inseparably related to smart systems, technologies (e.g. software, artificial intelligence functions).	False		Correct	
	58,3%		41,7%	
7. Which aspect do you think Sustainable Mobility is most ideal	Increasing the network of sustainable private vehicles (e.g.		Increasing the network of sustainable public urban transport	

to be based on?	electric cars)	
	44,8%	55,2%
8. Projects that promote Sustainable Urban Mobility are not implemented within the framework of local government but only on larger administrative urban scales.	False	Correct
	40,5%	59,5%
9. Are you aware of the existence of research and implementations on vehicles capable of navigating without significant or complete human intervention?	No	Yes
	32,5%	67,5%
10. Have you ever driven a vehicle that operates without any human intervention (e.g. steering wheel operation)?	No	Yes
	65%	35%
11. Are you positive about the total or partial replacement of specific functions of conventional vehicles, which you use as a driver, by autonomous functions (e.g. autopilot mode on straight routes for rest?)	No	Yes
	34,4%	65,6%
12. Are you positive about the total or partial replacement of conventional vehicles by autonomous vehicles (e.g. in specific spatial units, such as cultural routes and for designated uses, tracks)?	No	Yes
	25,8%	74,2%

From the 13th question: "Provide an example of identifying the contribution of autonomous vehicles to Sustainability from an environmental perspective (2 to 3 lines)." and onward, a significant degree of freedom was given as short written responses were requested. The overall responses of the 13th question were grouped into the following categories:

1) Group A: Reduction of environmental pollution.
2) Group B: Conversion of occupied stopping and parking spaces into green areas.

Below there are some characteristic responses from each group, which stood out:

1) "Low pollutant emissions into the environment," "Precision on handling to reduce emissions," "Fewer emissions from the vehicle manufacturing stage, as fewer vehicles will be produced."
2) "Promotes prosperity without the simultaneous abuse of land and the squandering of resources," "Reduction of road network sections for cars and their conversion into areas for planting trees and plants."

Regarding the first category, an important finding emerges about the understanding of the variety of polluting functions associated with the traditional vehicles with which these drivers are more familiar. In particular, the first answer is quite common, referring to the direct environmental impact of the car itself, but in addition, the polluting stage prior to its operation -manufacturing- is correctly mentioned, as it has a significant impact on the increase in carbon footprint among other negative aspects. Secondly, there are some references made to address the squandering of valuable spatial units that could be reclaimed by citizens as green spaces.

In the 14th question: "Provide an example of identifying the contribution of autonomous vehicles to Sustainability in terms of the economy (2 to 3 lines)", responses were likewise categorized into the following groups:

1) Group A: Saving money through reduced fuel consumption etc.
2) Group B: Saving money due to a decreased need for private vehicle ownership per individual or family.
3) Group C: Creation of new opportunities and job positions.
4) Group D: Reduction or complete avoidance of taxes related to private vehicles.

The new representative responses from each group were as follows:

1) "Reduction of fuel expenses," "Less fuel due to improved driving behavior," "Lower servicing needs due to fewer accidents."
2) "No need for each family to purchase a car (often more than one vehicle per family)," "Reduction in private cars."
3) "Creation of new jobs," "New synergies with more technologically skilled staff; knowledgeable in modern technologies."
4) "If we use autonomous public transport, we won't be burdened with related taxes," "An end to costly taxes on private vehicles."

This set of responses is especially interesting from the perspective outlined in the first category, as Greek drivers appeared to be positive towards saving on fuel, an issue that has consistently burdened households, particularly in the modern era where costs are becoming higher and there is an increasing interest in exploring alternative, more economical energy sources. At the same time, extra money savings are approached from the side of the reduced necessity in buying a private vehicle. This is a benefit of high importance in the country of Greece, where it is very common for a family to own more than one car, which in many cases is extremely expensive both in terms of purchasing it but also its maintenance, service etc. In the third category of responses, there appears to be a significant interest, as it is shown that Greek drivers do not oppose autonomous vehicles with the typical hostile argument according to which there would be less job positions. On the contrary, they are of the opinion that new jobs will be created, which in many cases might be ideal for technologically skilled individuals. Finally, taxes are also considered, which is logical as the tax system heavily burdens citizens who should be relieved.

In the 15th question: "Provide an example of identifying the contribution of autonomous vehicles to Sustainability from a societal perspective (2 to 3 lines)", the most relevant responses were grouped as follows:

1) Group A: Equal opportunities for access to transport for all.
2) Group B: Protection of public health and well-being through safer road networks.
3) Group C: Releasing occupied urban spaces for other uses.
4) Group D: Ease, comfort, and social interaction.

The most characteristic responses about the above question from each group included:

1) "Easy access for everyone," "Easier vehicle uses for every person."
2) "Fewer accidents," "Compliance with traffic laws."
3) "Bike lanes / walking paths," "Liberation of spaces and their conversion into cultural and recreational areas, etc."
4) "Social well-being," "Ease of driving," "Reduction in traffic congestion and time that individuals spend on the road."

In this group of responses, it appears that individuals have efficiently understood the distinction of the positive social impact of autonomous vehicles compared to other categories of advantages. As it is also derived from many literature sources, many responses refer to the immediate benefit of reducing traffic accidents and the ease of use. Furthermore, a significant number raised the question of the inclusion of individuals who, in this innovative scenario,

would be able to enjoy equal transport opportunities. The spatial impact on the urban environment is also emphasized, particularly the freeing up of spaces that can be reclaimed and repurposed for public use. The specific beneficial aspect strongly underlines the significant social dimension of such a shift in mobility models.

The responses of the final 16th question: "Give an example of identifying the contribution of autonomous vehicles to environmental, economic and social sustainability (2 to 3 lines)", due to its complexity as it requires thinking about a combination of the three axes of Sustainable Development, could not be grouped. Therefore, just two responses are presented which are worth noting since they address all of the main concepts successfully:

"Easier parking, therefore less fuel consumption, pollution, and better mental health."

"Fleets of such vehicles on small Greek islands for tourist routes, as tourists often get into accidents due to intoxication."

The above responses show a fairly good understanding on behalf of Greek drivers regarding the potential different side of benefits that can simultaneously contribute to the essential factors of sustainability, that also lay the foundations for an interesting discussion on future mixed sustainable applications of the specific type.

Conclusions

This research regarding an examination towards the cognitive relationship between autonomous mobility and sustainability, provided representative findings from a sample of Greek drivers. The Greek respondents can be characterized as efficiently being familiar with the given concept and that appears as a positive sign for their transition to the new models of sustainable autonomous mobility. Regarding their current knowledge about the wider nature of sustainability sectors, they recognized it correctly as a matter with several dimensions and not strictly based on the more familiar environmental dimension. Yet, it is not a positive reflection of their understanding that a significant number of participants did not agree on Sustainable Development as a global "bet" that needs international attention and collaboration as well. Moreover, most of the respondents consider Sustainable Development Goals potentially achievable through smart technology rather than without it, which may serve as one of its key elements, but it is not inseparably connected with it. Similarly, it appears that a significant percentage of Greek drivers also consider Sustainable Mobility as a matter that is exclusively associated to smart technology, which is a common misconception most likely associated to the general approach of cars as technological products and not as tools to shape wider sustainable strategies. Via the questions of the most practical section of the questionnaire, it was noted that the majority of the respondents are aware of the partial or total replacement of vehicle functions with autonomous ones, but without hands-on experience. However, it was shown that they are generally not opposed to the idea of partial or full autonomous mobility, which can possibly lead to fertile grounds for future implementations such as the ones that had been mentioned. Finally, as concerns their specific examples about their contribution to sustainability, they emphasized on the reduction of pollution, advantages related to land use, money saving, new jobs, inclusivity and accessibility, road safety, increased social interaction due to the diminished or eliminated role of driving among others. As regards their suggestion about a triple contribution, unfortunately groups of similar answers could not be formed to provide secure conclusions on the matter. Overall, it appears that they have a respectable degree of awareness regarding the principles of Sustainable Development and Sustainable Mobility, but further education on the matter is necessary for a thorough understanding. On the other hand, they seem more theoretically familiar with autonomous vehicles than with their practical use, yet concerning their connection to Sustainable Mobility their knowledge is at a relatively satisfactory level that creates a positive

climate for such a potential future shift. Future research axes were shaped to explore more specific attitudes of Greek drivers towards related applications that have been -successfully or unsuccessfully- implemented in foreign cities for a better understanding via detailed scenarios. Such supplementary research can investigate their views in more detail towards establishing potential Greek versions of autonomous mobility applications based on the former, which will serve as preparatory background towards the more specific applications in Greek road networks, with a focus on the most crucial problems that should be addressed related to the targeted drawbacks in the country of Greece.

References

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 3-21. https://doi.org/10.1080/10630732.2014.942092

Bahamonde-Birke, F. J., Kickhöfer, B., Heinrichs, D., & Kuhnimhof, T. (2018). A systemic view on autonomous vehicles: Policy aspects for a sustainable transportation planning. *disP - The Planning Review*, *54*(3), 12-25. https://doi.org/10.1080/02513625.2018.1525197

Betz, J., Wischnewski, A., Heilmeier, A., Nobis, F., Stahl, T., Hermansdorfer, L., Lohmann, B., & Lienkamp, M. (2019). What can we learn from autonomous level-5 motorsport?. In P. Pfeffer (Ed.), *Proceedings. 9th International Munich Chassis Symposium 2018: chassis.tech plus* (pp. 123-146). Springer Vieweg Wiesbaden. https://doi.org/10.1007/978-3-658-22050-1_12

Bucchiarone, A., Battisti, S., Marconi, A., Maldacea, R., & Ponce, D. C. (2020). Autonomous shuttle-as-a-service (ASaaS): Challenges, opportunities, and social implications. *IEEE Transactions on Intelligent Transportation Systems*, *22*(6), 3790-3799. https://doi.org/10.1109/TITS.2020.3025670

Coppola, P., & Silvestri, F. (2019). Autonomous vehicles and future mobility solutions. In P. Coppola & D. Esztergár-Kiss (Eds.), *Autonomous vehicles and future mobility* (pp. 1-15). Elsevier. https://doi.org/10.1016/B978-0-12-817696-2.00001-9

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

Faria, R., Brito, L., Baras, K., & Silva, J. (2017). Smart mobility: A survey. *2017 International Conference on Internet of Things for the Global Community (IoTGC), Portugal*, 1-8. IEEE. https://doi.org/10.1109/IoTGC.2017.8008972

Halkos, G., & Gkampoura, E. C. (2021). Where do we stand on the 17 Sustainable Development Goals? An overview on progress. *Economic Analysis and Policy*, *70*, 94-122. https://doi.org/10.1016/j.eap.2021.02.001

Malik, F. A. (2017). Autonomous vehicles: Safety, sustainability, and fuel efficiency. *i-manager's Journal on Future Engineering and Technology*, *12*(4), 1-7. https://doi.org/10.26634/jfet.12.4.13625

Mallozzi, P., Pelliccione, P., Knauss, A., Berger, C., & Mohammadiha, N. (2019). Autonomous vehicles: State of the art, future trends, and challenges. In Y. Dajsuren & M. van den Brand (Eds.), *Automotive systems and software engineering: State of the art and future trends*, (pp. 347-367). Springer. https://doi.org/10.1007/978-3-030-12157-0_16

Papadima, G., Genitsaris, E., Karagiotas, I., Naniopoulos, A., & Nalmpantis, D. (2020). Investigation of acceptance of driverless buses in the city of Trikala and optimization of

the service using Conjoint Analysis. *Utilities Policy*, *62*, 100994. https://doi.org/10.1016/j.jup.2019.100994

Portouli, E., Karaseitanidis, G., Lytrivis, P., Amditis, A., Raptis, O., & Karaberi, C. (2017, June). Public attitudes towards autonomous mini buses operating in real conditions in a Hellenic city. *2017 IEEE Intelligent Vehicles Symposium (IV), USA,* 571-576. https://doi.org/10.1109/IVS.2017.7995779

Reyes García, J. R., Lenz, G., Haveman, S. P., & Bonnema, G. M. (2019). State of the art of mobility as a service (MaaS) ecosystems and architectures—An overview of, and a definition, ecosystem and system architecture for electric mobility as a service (eMaaS). *World Electric Vehicle Journal*, *11*(1), 7. https://doi.org/10.3390/wevj11010007

Seuwou, P., Banissi, E., & Ubakanma, G. (2020). The future of mobility with connected and autonomous vehicles in smart cities. In M. Farsi, A. Daneshkhah, A. Hosseinian-Far, & H. Jahankhani (Eds.), *Digital twin technologies and smart cities*, (pp. 37-52). Springer. https://doi.org/10.1007/978-3-030-18732-3_3

Sneddon, C., Howarth, R. B., & Norgaard, R. B. (2006). Sustainable development in a post-Brundtland world. *Ecological Economics*, *57*(2), 253-268. https://doi.org/10.1016/j.ecolecon.2005.04.013

Vanolo, A. (2014). Smartmentality: The smart city as disciplinary strategy. *Urban studies*, *51*(5), 883-898. https://doi.org/10.1177/0042098013494427

Williams, E., Das, V., & Fisher, A. (2020). Assessing the sustainability implications of autonomous vehicles: Recommendations for research community practice. *Sustainability*, *12*(5), 1902. https://doi.org/10.3390/su12051902

Yaqoob, I., Khan, L. U., Kazmi, S. M. A., Imran, M., Guizani, N., & Hong, C. S. (2019). Autonomous driving cars in smart cities: Recent advances, requirements, and challenges. *IEEE Network*, *34*(1), 174-181. https://doi.org/10.1109/MNET.2019.1900120