Shared autonomous vehicles:
A case study on Waymo

Sustainability Transitions and Responsible Innovation (0EM150)

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Image source: https://waymo.com/community/articles/the-places-youll-go-discover-chandler/

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1. Introduction

The portfolio is a collaborative effort and a crucial part of our overarching class. It is an opportunity for students to form groups and select a controversial, sustainable, and responsible innovation currently applied in real life. Our group comprises students from the EIT Urban Mobility Master School programmes and one studying chemical engineering. We come from diverse backgrounds and cover a wide range of skill sets and disciplines, each of which is integral to the success of our project. This diversity enriches our learning environment and ensures that each student's unique perspective is valued.

During the first week, groups chose their case and submitted a 2-page paper summarizing the study on the theme application to their case. Then, using the information gathered weekly, our group put together an 8-minute presentation to explain their chosen case during the World Cafe. This platform allowed for a focused presentation and played a crucial role in providing an invaluable opportunity for peer feedback.

Towards the end of the course, based on all the assignments, presentations, and feedback received during the course, the process begins with creating the group portfolio. The aim is to critically reflect on the use of theoretical perspectives in analyzing the critical themes in the selected empirical case. The portfolio assignment requires a comprehensive document demonstrating the group's thorough understanding of the course material and its application to a specific case.

2. The Case Study

Today, autonomous vehicles are among the most innovative sustainable innovations of the 21st century. However, the future of AVs poses challenges and raises controversy regarding the socio-technical transition. The project explores the innovation of full automation of cars, specifically in shared autonomous vehicles (SAVs). Over many years, companies have been experimenting with partially self-driving vehicles and integrating driver aids into modern cars. However, full automation continues to be a technological and legal challenge. The case study will examine the potential of vehicles with at least the Society of Automotive Engineers (SAE) level four automation, thus not requiring human intervention at any point during the trip (SAE International, 2021).

The history of autonomous vehicles stretches back to the 16th century when Leonardo da Vinci designed a self-propelled cart, laying the groundwork for self-driving machines. Over the centuries, technological advancements moved the dream forward, with key milestones like the radio-controlled car in 1925 and the "Futurama" exhibit at the 1939 World's Fair showcasing early AV visions. The mid-20th century saw academic contributions, including Stanford's lunar cart and Japan's self-driving passenger vehicle. Significant progress came in the 1990s and 2000s through DARPA's defense projects, culminating in the DARPA Grand Challenges, which proved the viability of AVs (Mahdavian et al., 2020). In recent decades, companies like Waymo and Mobileye have further developed the building blocks of autonomous driving technology, pushing the dream of fully self-driving vehicles closer to reality (Waymo, 2024a; Mobileye, 2023).

SAVs designed for ride-sharing could disrupt the current mobility scheme centered around private vehicle ownership. Technical advancements in automation are spreading from public pilot programs and enabling the potential for radical societal change. The current vehicle ownership model needs to be updated as unused vehicles could be utilized to generate income. Private ownership will consequently become financially less lucrative than accessing vehicles through Mobility as a Service (MaaS). Moreover, shared autonomous vehicles feature high utilization and require less parking space, enabling urban structures to be redesigned in a human-centric way. And additional value could be generated by harvesting the attention of former drivers during the rides. On top of technological and social change, shared autonomous vehicles introduce influence to the governing bodies as the shared nature of autonomous vehicles will not establish itself. Negative consequences of private ownership could expand if the responsibility for shaping the usage of future vehicles from a policy perspective is neglected.

The promise of sustainability aspect of SAVs is critical as they can contribute by improving energy, space, and efficiency. They can decrease vehicle ownership by enabling multiple users to share a single vehicle. Research shows that a single SAV could replace 9 to 10 traditional vehicles, reducing congestion, parking spaces, and fleet size (Fagnant and Kockelman, 2018) (Golbabaei et

al., 2021). A study conducted in New York City found that, compared to traditional taxis, electric SAVs could cut down CO2 emissions by up to 1,100 metric tons per day (Lokhandwala, 2019). Furthermore, autonomous vehicles drive more efficiently than human drivers – fewer unnecessary acceleration, braking, idling, etc. – which can result in a 31% reduction in travel time and energy consumption (Tate et al., 2018). In terms of societal benefits, SAVs have the potential to improve road safety by reducing accidents caused by human factors, such as distracted driving, speeding, and driving under the influence, which make up the majority of road accidents today. According to research, SAVs could reduce accident rates by up to 90%, potentially saving thousands of lives each year and reducing healthcare costs (Muralidhar P et al., 2023; Rojas-Rueda et al., 2020).

Currently, legal steps towards fully automated vehicles are being taken, with an example being Germany's creation of a framework for autonomous motor vehicles in specified operating areas on public roads (Federal Ministry for Digital and Transport, 2024). These developments go hand in hand with technological advancement, making the required systems technically feasible. As new sensors and detecting systems become available, the information is processed faster and more accurately with better computing power. There is a known risk of many wasteful trips without a human in the car. However, there is also the potential for a significant reduction in vehicle ownership and ride prices compared to the current situation. The future of whether these AVs will be used in a shared system or remain primarily private will determine their effects on the transportation sector and society as a whole. If the private companies are in the lead, they could go from public agencies to the private sector, potentially affecting accessibility, affordability, and regulation. The policies relating to the AV transition can either ensure the common good or exacerbate inequalities.

However, the potential of SAVs raises serious controversy, including the worry that in a future where walking, biking, and public transit are prioritized, SAVs could contribute to urban sprawl, road congestion, and dependence on cars, ultimately a car-centric dystopian urban environment. The primary concern is that the private ownership model will persist instead of shifting to a shared vehicle model. Thus, this could lead to increased roadway capacity and hyper-commute creation. Moreover, induced demand could be amplified as the absence of a driver and the need to know how to drive would no longer be required, thus leading to a dependence on AVs and the companies behind them. This can enable companies to significantly influence transportation, access, and pricing due to the loss of personal agency in transportation. The possible increase in ownership would also require an increase in infrastructure. Thus, SAVs need to ensure that they can function sustainably, where shared vehicle models are the primary use of autonomous vehicles.

The project's scope will primarily focus on San Francisco, United States, where the primary operator of autonomous vehicles in the area is Waymo. First launching its autonomous vehicle operations in 2023, Waymo has since opened its service to the public in San Francisco. The company offers rides through its app and provides thousands of weekly rides in the city. People in San Francisco can enjoy the service 24/7 without worrying about its safety record and

technological advancements. The company has logged over 20 million miles of autonomous driving without significant incidents involving pedestrians or cyclists, which makes it expected to play a vital role in the future of autonomous urban transportation. (Waymo, 2024b)

3. Themes and Frameworks

3.1. Environmental Justice

Summeren's framework presentation has five dimensions and is a key approach to addressing past inequalities focused on implementing and enforcing environmental policies and practices:

- *Distribution Justice*: The 'who gets what' dimension focuses on distributing environmentally valuable resources. It examines unequal distributions, which historically affect marginalized/ disadvantaged communities more often. The dimension highlights the necessity of 'fair' resource distribution.
- *Participation Justice*: In the 'who gets heard' dimension, participation justice looks at the inclusivity and fairness of the decision-making process around environmental and social concerns. It is concerned with ensuring inclusive democratic processes, including transparency, equal access to information, and a formal justice system, to ensure that marginalized communities, who often feel the weight of environmental burdens, have a voice.
- *Recognition Justice*: The 'who counts' dimension highlights the diversity of those affected by environmental issues and policies. This can encompass misrecognized and unrecognized groups regarding fair distribution and participation. It seeks to counteract the historical biases that often overlook the interests of marginalized and disadvantaged communities.
- *Capabilities Justice*: This 'what matters' dimension concerns how environmental justice and individuals' ability to live their lives are intertwined. It focuses on one's ability to participate in the process and gain access to knowledge, resources, and skills. Furthermore, this dimension addresses the environmental, social, and political issues that shape environmental resources, burdens, and benefits.
- *Responsibility Justice*: The 'who does what' dimension examines who is accountable for taking action regarding environmental burdens and benefits. Integrating responsibility connects the context, vulnerabilities, and social norms to broader ethical considerations.

3.2. Participation

Main contributor: Thijs

Professor Spahn discussed participation, co-creation, and justice. Participation as a just practice is rooted in the ideals of the Enlightenment. It is founded on reason-based decision-making and believing that all voices should be heard, a core ideal in liberal democracy. Rationality in participation requires deliberation with all affected parties. This allows individuals to be heard and for rational decision-makers access to the best information on which to base their decisions. This still leaves a risk for just participation, as decision-makers are not mandated to make the fairest decision for all involved (Spahn, 2024a).

The evaluation of participation with Arnstein's ladder of citizen participation allows for clarity in power dynamics. Three categories are defined: no power, degrees of tokenism, and degrees of citizen power. These categories can be seen as gradations of citizen participation and are used to evaluate participation processes. Some so-called participation structures have a one-way flow of information and leave stakeholders powerless. This should be prevented to ensure their values are incorporated into the process. Fung has also created a framework for evaluating participation processes using three dimensions: the scope of participation, mode of communication and decision-making, and extent of authority. His framework rests on evaluating participants as a good representation of the public and informed stakeholders, the intensity and organization of participation sessions, and the impact of participation on decision-making, which can be represented graphically.

3.3. Sustainable Entrepreneurship

Professor Spahn addressed the topic of sustainable entrepreneurship, emphasizing sustainability transitions and responsible innovation, within corporation's business practices. The business ethics framework promotes a sense of moral responsibility and explicitly studies "moral problems associated with … market systems" (McMahon, 1981). Moral responsibility relates to a corporation's values, convictions, and ethics (Spahn, 2024b).

Goodpaster's writings on moral consciousness and his typology for moral development:

- Type 1—self-interest. Companies in the self-interest stage are egocentric and generally focus on their benefit without considering ethical considerations.
- Type 2—systemic variant. Divided into the invisible hand pattern and the visible hand pattern. Companies are described as being heteronomy, meaning outside forces influence their actions. This might be due to legal frameworks (visible) or market forces (invisible).
- Type 3—authoritative guide. Companies (the most developed) have an autonomous conscience, actively taking ethical actions beyond what the market or framework requires. Thus, companies are committed to pursuing sustainability transitions and responsible innovation for their merits.

Four normative avenues, which when used one can assess their alignment with social and environmental goals and identify its ethical perspective:

- Interest-based (utilitarian and consequentialist): explores the morality of actions based on consequences and focuses on maximizing happiness and satisfaction.
- Rights-based (libertarianism and contractualis): focuses on prioritizing equalizing rights protection for individuals and ensuring the fair distribution of opportunities, wealth, and rights.
- Duty-based (communitarianism): emphasizes companies' responsibilities towards the communities they impact and promotes community values.
- Virtue-based: focuses on the actor and its development of moral virtues, good character, and ethical behavior.

3.4. Responsible Research and Innovation

Höffken's presentation on responsible research and innovation (RRI) highlights the social, environmental, and ethical entanglement with the research and innovation processes, specifically within a collective responsibility understanding. Such approaches connect RRI to the AIRR framework, a future-oriented approach:

- Anticipation: ask "What if...? Questions," and enables foresight and builds resilience for the potential impacts of one's work.
- Inclusion: the importance of new/ diverse engagement, allowing for many societal values.
- Reflexivity: to be self-aware, recognizing one's assumptions and limitations and, therefore, the potential implications of such on the work.
- Responsiveness, which is adapting and responding to concerns and needs.

Beyond the framework itself, RRI focuses on the process rather than just the outcome derived from the socio-technical dynamics of the transitional process, which can create tension which highlights the dilemma that results from conflict between market economics and social responsibility practices. RRI challenges the transparent research innovation processes from government to scientific autonomy. Furthermore, second-order reflexivity enables the examination of the self and understanding how actions can influence the border socio-political structures. It challenges not only assumptions underlying innovations but also the systemic socio-technical dynamics of the system itself (Höffken, 2024).

3.5. Institutional Entrepreneurship

Professor Wieczorek addressed institutional entrepreneurship using the multilevel perspective and strategic niche management frameworks. Wieczorek examined the dynamics of stability and change within institutional entrepreneurship which are shaped by institutions and norms.

- Giddens' Structuration Theory: focuses on the duality of actors and institutions within the context of structures and the shaping of each other.
- Bijker and Law's Sociology of Technology: looks at the added context of technology and materiality by the introduction of societal actors and the seamless web of technology change requirements.
- North's Institutional Theory: introduces the institutional context as a societal building block.

In the system, there are three rules: regulative "we must comply," normative "we should comply," and cognitive "we copy others" (Wieczorek, 2024). These lead to the principles of institutionalization, which lead to the stages of habitualization, objectification, and sedimentation and create systems of barriers and resistance to change helped by institutional logic which creates stability. This creates a regime, referring to the highly institutionalized socio-technical structures, i.e. rule-setter. The rigid structures and complexity allow for change and agency.

- Embedded agency: actors who are status quo but can make a change.
- Distributed agency: actors who are dispersed in the structures and can deviate for institutional change.

This change or de-institutionalization uses entrepreneurship and institutional entrepreneurship to make deviations from some dominant rule or norms. What is called creative destruction looks for opportunities for disruption. Institutional entrepreneurship looks for ways to promote change from the bottom up (Wieczorek, 2024). Furthermore, it looks for intervention points and the past to understand how to create new paths and support alternative niches.

Institutional entrepreneurship uses the Strategic Niche Management (SNM), which supports alternative niches within the currently established structures. This happens through formation/ shielding, growth/ nurturing, competition/ empowerment, and stabilization/ embedding. The goal is to change the regime through these destabilization strategies, using direct indirect, social movements or experimentation to disrupt the system. Furthermore, the 2nd deep transition contextualizes this socio-technical change and its power. Overall, it is an understanding of the influence of innovative change on an institutional system.

4. Topic Selection for In-Depth Analysis

4.1. Institutional Entrepreneurship

Institutional Entrepreneurship provides several different lenses to evaluate the fundamental alternations of institutions that will be introduced through and are a prerequisite for shared autonomous vehicles. The previous discussion in the two-pager emphasized the normative shifts required for embracing shared mobility; it is essential to expand the analysis to include cognitive and regulatory dimensions. In the U.S., car ownership is deeply embedded in cognitive frameworks that promote it as a societal standard, shaping individual identities and influencing collective attitudes. This belief links car ownership to success and autonomy, driven by social copying and cultural stereotypes. For a transition to shared mobility, institutional entrepreneurs must address cognitive and regulatory sets of rules—such as viewing driving as a rite of passage and supporting that with subsidies—alongside normative perceptions of car ownership. The high complexity and regime stability of car ownership demands changes far beyond the boundaries of normative rules. The in-depth analysis of chapter five will provide a much deeper analysis, linking cognitive, normative and regulatory dimensions that must evolve in order to delegitimize the self-stabilizing regime of car ownership. Consequently identifying institutional entrepreneurs on all levels is indispensable to understand the requirements to drive institutional change.

4.2. Sustainable Entrepreneurship – Business Ethics

Individual mobility through automobiles influences individuals and society on many levels. The rich number and complexity of interaction points demand a deeper analysis from a business ethics perspective, especially when radical innovation could introduce substantial change. Sustainable entrepreneurship demands a thorough analysis of facts that are based on more than a single point of data. The analysis here will focus on how well viral tweets and media material, which shape public opinion, represent Waymo's business activities. The novelty of the technology and the recent public deployment attract a lot of media interest, especially in malfunctions under extraordinary circumstances. Technology errors causing disturbing consequences for individuals and society are highlighted. Are those cases single exceptions or do they represent ethical misconduct? The following chapter will use Goodpaster's typology together, extended by the 4 avenues, to assess whether Waymo's business conduct resembles conscience as an authoritative source.

5. In-depth Analysis concerning SAVs

5.1. Institutional Entrepreneurship – Car Ownership

5.1.1. Introduction

Institutional entrepreneurship is the process by which individuals or groups drive significant changes in established institutions' structures, norms, and practices. Unlike traditional entrepreneurship focused on new ventures, it reshapes socio-technical systems to overcome resistance and foster innovation, especially in sustainability transitions. Working within constraints, or 'embedded agency', institutional entrepreneurs push for reforms aligning industries with sustainability goals (Garud, Hardy, & Maguire, 2007). In sustainability focused sectors like energy, water, and transport, transitions require dismantling of longstanding socio-technical regimes. These need to be replaced by systems that meet modern environmental and societal needs. According to Fuenfschilling, this shift entails a profound reorganization, moving from stability to change through a complex interplay between policy, technology, business models, and cultural norms. Institutional entrepreneurs play a critical role in navigating these dynamics by advocating for sustainable innovations, influencing public opinion, and mobilizing resources to transform traditional industry practice (Fuenfschilling, 2020).

5.1.2. Cognitive Dimension

Institutional entrepreneurship refers to how individuals or organizations work to create, change, or disrupt established norms, or "rules," within a given social or organizational context. In the U.S., car ownership has become deeply embedded in cultural norms through cognitive structures—unconscious, shared beliefs, and mental models that influence behaviors that uphold car ownership as a societal standard. Take producer Joe Roth, who has produced many Fast and Furious movies. Through their films, car ownership is normalized and created as an aspiration. Now, if SAVs are praised in the same light through the films, it would highlight a future of transportation where social and environmental responsibility is critical. To shift society away from these cognitive rules, particularly for a transition toward shared autonomous vehicles (SAVs), we must understand the cognitive rules that reinforce car ownership.

Car ownership in the U.S. is a deeply ingrained part of social identity, often perpetuated by social copying behaviors. This concept means that people are influenced by what others in their communities and peer groups do, especially when it comes to major life decisions like owning a vehicle. For example, the stereotype that everyone drives a car reinforces a sense of normalcy around car ownership. In some regions, not having a car is associated with a lack of success or independence, reinforcing the desire to own one simply because everyone else does. (Steg, L. 2005). This stereotypical belief that car ownership is necessary to fit in socially acts as a cognitive rule that entrenches the car ownership norm.

In the U.S., obtaining a driver's license is a major rite of passage, and nearly every adult either owns or has access to a vehicle. This universal familiarity with driving and car ownership further solidifies it as the default mode of transportation. People who do not own a car or lack a driver's license often find themselves limited in terms of mobility and even judged socially, reinforcing the cognitive norm that car ownership is essential for adulthood. (Delbosc, A., & Currie, G., 2013). Institutional entrepreneurship aiming to shift away from car ownership norms would need to address this wide-reaching exposure to driving as a milestone and necessity.

Car ownership is reinforced by the geographic layout of suburban America, where homes, workplaces, and amenities are often far apart. Since the 1950s, suburbanization has normalized long-distance commuting, and with it, the car has become the primary means of transportation to traverse these distances. Consequently, many Americans perceive the car as essential for accessing distant places, an assumption that would need to be reframed for SAVs to gain widespread acceptance (Jackson, K. T., 1985). This cognitive rule is challenging to shift because it is deeply embedded in daily life, where people equate owning a car with freedom and the ability to reach remote destinations effortlessly.

Safety is another critical factor that reinforces car ownership in the U.S. American roads are filled with large vehicles, and there is a prevalent belief that driving a larger vehicle, like an SUV or truck, is safer in the event of a collision (Crandall, J. R., & Gilkey, D. P., 2000). This leads to a form of "car arms race," where people buy larger vehicles to match those of their neighbors, creating a cycle where bigger is perceived as better. For instance, owning a Ford F-150 or similar truck might feel like a safety measure, especially when alternative transportation options, such as bicycles or public transit, are perceived as comparatively unsafe. This cognitive rule not only drives up vehicle size and ownership but also makes the transition to shared, smaller SAVs seem less safe by comparison, presenting a challenge to institutional change.

Finally, public transportation and other alternatives to personal cars suffer from a poor image in many parts of the U.S. Public transit is often perceived as unreliable, slow, or unsafe, while bicycles are seen as impractical for daily commuting, especially across long distances common in suburban areas (Pucher & Buehler, 2012). This negative image of alternatives makes car ownership seem not only convenient but also superior in terms of status and reliability. The institutional entrepreneur aiming to reshape car ownership norms would need to lead by example, providing new social habits that others desire to copy. This could be achieved through social movements around the access to education systems, and marketing alternative mobility modes for others to copy. Reframing public perception about what's considered a wide-spread habit would improve the image of SAVs and other transportation options so they can be seen as legitimate, safe, and desirable alternatives to personal cars. This will undoubtedly take decades to achieve.

5.1.3. Regulatory Dimension

Disrupting and destabilizing existing regulatory infrastructure can be difficult for any startup. Still, it is often the most fundamental element, as these governmental bodies can prove nearly impossible to move in a positive direction. Unsurprisingly, Waymo and, subsequently, Alphabet, Google's holding company, are the leading institutional entrepreneurs who play a role here. However, they aren't the only players; almost every major tech company has some driverless car or taxi program. Funded by large tech companies include but are not limited to Uber/Aurora Innovation, Baidu/Apollo, General Motors/Cruise, Amazon/Zoox. All these companies have two things in common: they are wholly either technically separate companies owned by the leading tech company or one of their many divisions. All of these companies aim for the same general goal: to initiate the destabilization of entrenched regimes. However, the scale of what these companies need to accomplish is rather demanding as they have decades upon decades of policy to shift into something more SAV-friendly.

Parking minimums arguably play the most significant role in the United States car-centric design. By requiring all developments, including things like bars and clubs, to build parking, car ownership is heavily encouraged, as finding a place to put your car wherever you want to go is always going to be an option. Governments are, in turn, encouraged to maintain this status quo as the reduction of parking becomes politically unpopular (Shoup, 2017). In theory, Waymo and other SAV services would significantly reduce the need for parking as their SAV's would constantly drive around instead of sitting in a lot all day.

Another major factor is the amount of fuel subsidies the US relies on and the lack of environmental regulations regarding specific types of vehicles. While it can be hard to calculate the exact number, on average, the US subsidizes the fuel price via subsidies given to fossil fuel companies to $757 billion in 2022. (Brind'Amour, 2024) This, in turn, keeps fuel prices artificially low and allows more people to afford to fill up their tanks without giving any direct subsidies to people experiencing poverty. Fuel taxes also contribute directly to road maintenance in every state. In some states, it is mixed in to help pay for transit, but most money often goes to keep roadways expanding. (Feigenbaum, Hillman, 2020) However, the gas tax is facing a crisis as electric vehicles come into the market and remove that source of cash flow for the states. SAVs will likely accelerate this trend as many states are considering annual fees or charging per Mile instead. (Adam, 2024) Regarding environmental rules, some vehicles, such as trucks and SUVs, are exempt from the most stringent regulations. This increases their popularity as manufacturers can extract a much higher profit margin and thus be incentivized to push them over smaller vehicles (Zipper, 2024). At the end of this lax regulation, there can even be tax incentives for heavy, long-distance trucking, which provides far worse returns than rail (Cortright, 2015). This increases the demand for large amounts of space for cars, even more space than if people were driving smaller cars or just driving less. At least in the case of SUVs, Waymo presents a more affordable alternative that also aligns with consumer preferences for larger vehicles (Winston and Yan, 2021). Waymo's all-electric fleet can

meet the demand for size and space in a sustainable way, making it a viable replacement for both traditional trucks and large personal vehicles.

Ultimately, like with other issues, it comes down to legislation dictating policies like extending and expanding highways, overcompensating for bottlenecks, and, in general, feeding into the vicious circle of induced demand. As populations increase, so does the number of cars on the road; thus, so does the traffic. Voters get upset with local politicians who then push for wider roads. Those wider roads make it easier to drive your car, so now there are more cars on the road, and traffic is worse than before. This then prompts voters to get upset with politicians who push for wider roads, continuing the cycle until the city is more tarmac than the city; this is the law of induced demand. (Mann, 2014) This system has been so normalized within the United States that these roadway expansions go on without much resistance, and their funding is secured by toll roads, gas taxes, and political unwillingness to disturb the status quo. (Wolfgang, 2016) Assuming Waymo delivers on its promises, it could significantly disrupt the cycle of induced demand, instead offering a hopeful solution to the problem. The World Economic Forum has explored the potential impact of SAVs on urban traffic. Their research highlighted that while autonomous, zero-emission SAVs could offer convenient and personalized transport, they might also increase congestion due to the convenience of taxi trips and empty collecting trips. The key factors determining whether SAVs alleviate or worsen congestion are traffic rules and the proportion of autonomous versus human-driven vehicles. This suggests that significant regulatory changes and adaptations are necessary to maximize the benefits of SAVs and avoid increased congestion. (Klaus, 2020) Where Waymo fits in would be by accepting these regulatory frameworks that, while constraining, ultimately benefit Waymo's long-term goals of sustainability.

For these alternative institutions to gain traction, a bottom-up approach is needed to handle complicated government regulations. Most of the effort so far has been focused on preventing any rules from being created. After significant lobbying in California, these companies are escaping local regulation due to a legal quirk. This places control over their deployment and operations in the hands of state agencies, such as the California Public Utilities Commission and the Department of Motor Vehicles. This centralized control means local governments lack the authority to regulate or fine SAVs for traffic violations. Some local officials and residents are concerned about public safety and need more localized control, but the rules remain unchanged. (Ethan, 2024) However, that hasn't stopped places like China from regulating robotaxis with new national laws starting to take effect. Meanwhile, SAV companies in China face many of the same challenges as in the US, such as rebuilding public trust after incidents and finding a viable business model. (Zeyi, 2024) That said, not everyone can play by what US regulators set few rules out. Unsurprisingly, Tesla, which recently unveiled its take on SAVs, has not yet contacted regulators about its plans to launch in major US cities, despite CEO Elon Musk's insistence that they will be on the roadway soon. Regulatory bodies in California, Arizona, and Nevada confirmed that Tesla has not applied for driverless car service permits. While this doesn't reflect on the entire industry, this lack of communication raises questions about the timeline for Tesla's SAV rollout. (Ingram, 2024)

5.1.4. Summary

The system of automobility has continued to create the requirements for its own expansion and stabilization. Changing the institution of car ownership to an access based model enabled by shared autonomous vehicles like Waymo's requires fundamental dedication from institutional entrepreneurs on all levels. Continuous commitment to creating a new rationale on a cognitive, normative and regulatory dimension is of utmost importance to boost the institutional niche over the upcoming years. A strong common vision needs to be established for governing bodies to design transit policies that enable the desired improvements of these new mobility access models. As governing bodies are set up for stability instead of driving innovation in general, social movements from Hollywood to neighborhood communities need to create a strong demand first. The road to change will be a long one in this case, however focusing on early adopters in technology-progressive markets might be able to establish first small changes in the real world.

5.2. Sustainable entrepreneurship – Business ethics

5.2.1. Ethical challenges of automating road transport

Waymo's regular operational business conduct follows the highest level of Goodpaster's typology, indicated by proactive policy establishing and safety advancing business practices. Waymo's industry leading role has been layed out in the two-pager and can be found in appendix C. Waymo's core business model lies upon automating a highly complex system without system boundaries. This lack of system boundaries inherently proposes ethical questions about edge cases, which may not be numerous, at least currently, but pose significant challenges and dilemmas regarding ethical business conduct. Accidents caused by robots differ from accidents caused by human error, as machines would potentially have to decide to violate human rights and regulations. The societal importance of ensuring those robots take the right decision raises media attention when things go wrong. Furthermore, edge cases in road transport constitute an issue for automation because of their unpredictability. According to data from the U.S. Department of Energy (2024), in total, US drivers spent 3.19 trillion miles on the road annually. For simplicity, let's assume that 10 fatal accidents caused by self-driving vehicles are highly likely to threaten the business model Waymo has set itself up for. These rare circumstances, happening every, 3.19 trillion miles or every, or one million years of continuous driving, cannot be reliably tested for. While it is difficult to point to specific vetted cases of these ethical dilemmas, social media provides several morally dubious events where the lack of a human driver and the effect that has on the public. What actions have self-driving vehicles taken so far, and how would they be classified? These early edge cases are highly relevant for society's trust and technology acceptance. The following paragraphs will elaborate on three edge cases that happened within the last 12 months.

5.2.2. Case 1: Vandalize

One social media post from X shows a man in the passenger seat while the car is stopped due to multiple people approaching the vehicle and then proceeding to vandalize it as illustrated in Figure 1. The car, programmed not to harm anyone, cannot move until the people get out of the way. Unless the police show up, the passenger cannot alleviate the situation. They seem to be caught and exposed to other's actions. While this is relatively harmless overall, Waymo only needs to clean; it highlights how easy it can be to stop one of these cars in the middle of the street. The Waymo vehicle focuses on the virtue of caution and safety to prevent unsafe situations with respect to the pedestrians, consequently following the virtues society expect from a road user. The self-driving vehicle has also respected its responsibility for communities, preventing physical harm within its duty to provide safe transportation. From society's point of view, no rights were violated, however from a utilitarian perspective of the passenger, the vehicle has exposed the human to the transport impeding actions of others. Given the similarity of Waymo's actions to those of competent human drivers, we contend its ethical behavior to be sound despite the arguments that can be voiced from a utilitarian view from the passengers' perspective. The Waymo could start recording and connect their camera view with law enforcement to deter future disturbances.

Figure 1: Pedestrians vandalizing Waymo (Boldaji, 2023)

5.2.3. Case 2: Harassment

Figure 2: Passenger harassment by pedestrians (Amina, 2023)

Another social media post highlights the same issue with more sinister consequences. A woman is stopped in a Waymo by two men stepping in front of it as shown in Figure 2. They then demand her phone number in exchange for letting the Waymo car continue its way. While the situation resolved itself as the man eventually moved, it still shows how easy it can be to stop one of these vehicles for potentially safety-threatening reasons. The decision of allowing for potential threats of some to alleviate risk of harming physical integrity of others requires a delicate analysis of the situation. The vehicle's behavior heavily influences the interest avenue as well as the rights avenue. The vehicle's focus on safety for pedestrians potentially affects the passenger's right of physical integrity as well as their interest in agency during threatening situations. The Waymo vehicle does not per se harm the physical integrity of passengers, however it promotes situations during which the physical integrity of passengers is threatened. The loss of control of vehicle guidance negates the use of the car to escape the harassment. This heavily restricts passenger's agency in life threatening situations.

Emulating a human driver's behavior of exiting the situation by accelerating and putting one's own safety over the self-inflicted potential risk of others, would raise ethical issues of leaving that decision to a machine. However, even within the limited opportunities of remaining stationary, there is considerable leeway in actions to be taken. The vehicle could feature a panic button for passengers, which immediately connects with law enforcement and shares access to the live camera footage of the AV. Furthermore, the vehicle could play a message to the pedestrians clearly communicating that the police will arrive shortly and that their actions are being recorded. Waymo currently fails to apply effective deterrent measures to safeguard the rights and interest of its

passengers. We deem this neglect of safety measures as unethical regarding corporate conscience, and would classify Waymo's behavior in this specific edge-case scenario as corporate self-interest of Type 1 in Goodpaster's typology. If the situation would have caused physical harm, Waymo would not have not conducted what could have reasonably been expected and therefore also disqualifies for law-based thinking. This situation would need to be interpreted by the legal system. Waymo's behavior in this edge case requires further improvements to match their regular ethical business conduct.

5.2.4. Case 3: Manual Takeover

Figure 3: Law enforcement engaging manual mode in a Waymo (ABC7, 2023)

The third case highlights the issue of manual takeover of stranded vehicles in edge case scenarios. Waymo vehicles failed to correctly assess last-minute traffic diversions necessary for transporting the Vice President of the United States around the city. Figure 3 shows the vehicle having stopped in the middle of the road, severely impacting traffic operations. Dealing with unexpected route changes require additional communication between law enforcement and all vehicles. City officials had to call Waymo to enable manual driving mode on all these cars, which introduced an ethical dilemma. Should government officials be required to call in before handing down manual control, or should the government be given complete control whenever needed?

One option insulates the private company from direct government control, while the other option would theoretically allow for far smoother operations when the unexpected happens. Waymo's actions impact their duty for promoting community interest, and potentially further avenues in a cascade of misconduct. Waymo's current behavior is self-centered and safety oriented due to decision uncertainty of the vehicle's guidance system. This way Waymo neglects their lawful duty to comply in due time with instructions from law enforcement. While Waymo eventually allowed law enforcement to interfere, it caused considerable disturbance, likely unacceptable if caused by a human driver. Due to the safety risk of misconduct for enabling manual takeover, and a potential

future lack of steering wheels, Waymo should initiate a digital interference opportunity for law enforcement. A digital law enforcement interface could potentially mandate the vehicle's guidance system to avoid certain areas or turn around. Mutual communication between self-driving vehicles and law enforcement would then happen digitally and just as effectively as mutual human communication. A proactive approach of collaboration between Waymo and law enforcement would reinstate their ethical conduct to go beyond the law and the market.

5.2.5. Summary

All three cases introduce ethical challenges for automating road transport. They do show the importance of ethical consideration of all edge cases. While those can never be fully anticipated, Waymo should dedicate considerable effort to solving them for future driving after having occurred once. Governmental standards like a digital communication interface will alleviate the behavior uncertainty that is currently experienced. Given the early stages of technology deployment, these early issues could probably not have been avoided. Nevertheless, Waymo's general focus on highly ethical behavior needs to actively extend to edge cases. Furthermore, to increase public trust and acceptance, Waymo could provide documentation on how to avoid repeating the undesired mistakes in their future operations. The challenge of automation road transportation without system boundaries is bound to cause ethical dilemmas. This highlights the importance of aligning on how to deal with such situations as a society. The centralization of control over driving styles and road behavior via the deployment of the Waymo service mandates an open discussion with governing bodies and citizens to ensure a democratic participatory decision process on how to handle road behavior in edge cases. Given Waymo's industry leading role, we expect significant progress with further technology deployment.

6. New theme-framework combination

The new combination between framework and theme will elaborate on where environmental justice stands in the innovation process, using the multi-level perspective. Fair transitions are a necessity for Waymo from an instrumental standpoint: this will contribute to much needed societal acceptance and perhaps political support. A debate exists on whether innovation should be slowed down by justice concerns, since in some cases the challenge is too urgent to wait. In this situation the entire mobility regime could change due to the implementation of SAV's. Such a transition is impactful for the whole society, so here the time should be taken to discuss the justice implications of the innovation and action taken to form a just new regime.

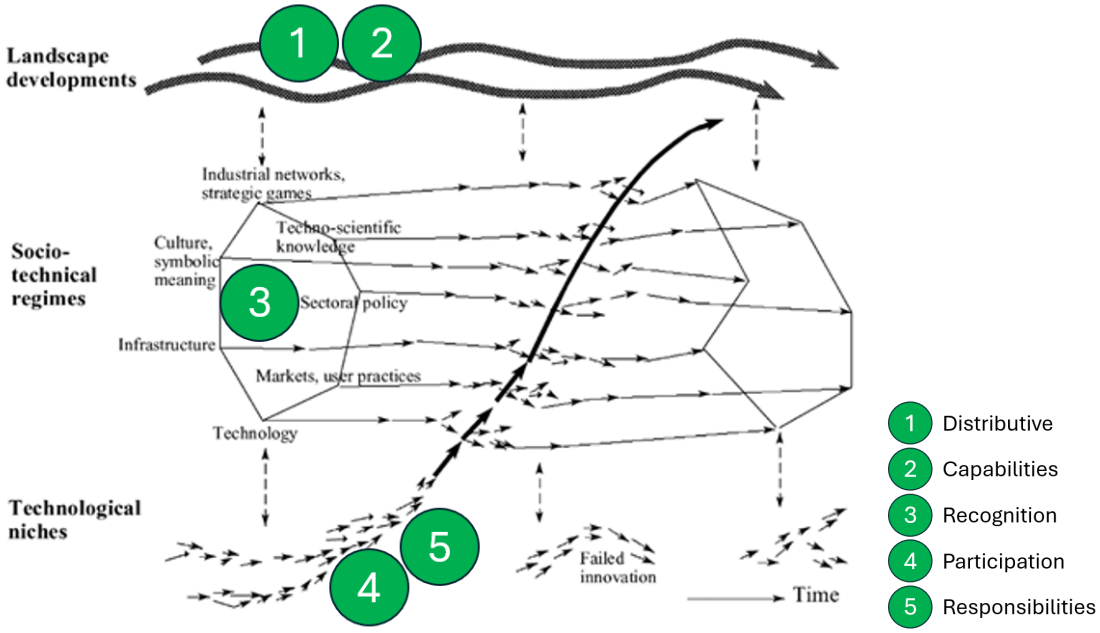

Figure 4: Environmental justice applications in the multi level perspective framework (Harbinger Consultants, 2021)

There are five main categories discussed on environmental justice: distributive, capabilities, recognition, participation, and responsibilities justice (Davoudi and Brooks, 2014). These all have their own place in the innovation process, shown in figure 4. Justice starts as a demand from society: an equitable distribution of resources and capabilities is desired, which puts pressure on the current regime from the landscape. To assess the current situation, the active regime can be evaluated from the perspective of recognition justice. With this step it will be possible to discover who is currently affected, and also who would be relevant stakeholders for the next process: participation. This element, like responsibility justice, belongs to the region of niches: Waymo's current situation. Just participation processes and responsibilities are crucial for the development

of an equitable product and process. These two factors must be considered early, before an innovation settles into a new regime: from that point changes will be late and less influential.

Distributive justice is aimed at an equitable distribution of benefits and burdens. The perspective most suitable to the case of Waymo is based on utilitarian theories. In the mobility sector an egalitarian distribution would not fit: people have differing demands, fitting the distribution to their needs will create a more efficient mobility regime. Libertarian theories are also less applicable: basing what people receive on their contributions to society is both too complicated and will create situations where needs are not met. The suitable utilitarian theories suggest that what people receive should be based on their needs: this fits well for a just and efficient mobility landscape.

Waymo already provides a just service according to utilitarian theories of distributive justice. They have a plethora of partners with whom they collaborate to provide services befitting the needs of people with mobility impairments. These groups include the Arizona Blind Coalition, United Cerebral Palsy, and Self-help for the elderly. The direct results of these collaborations can be seen in the cars operating currently. These can be controlled by voice for blind users, have ramps and lifts for wheelchair users, automated doors, interfaces with Braïlle, and have extra aid available through the app if it is still required (Waymo, 2022c).

The capabilities aspect of justice is another pressure from the landscape level. This aims at an equal distribution of capabilities concerning the ability to lead a life of one's own design. Important for this element is that the same resources do not always generate the same opportunities: humans have a unique set of skills and limitations.

In the case of Waymo, the service is not yet just according to the capabilities approach. There are some situations where marginalized groups are allowed to participate in trials, and internally there are initiatives like the employee resource group Black@Waymo (Waymo, 2021b), but this situation is far from equitable. The prices of the service are simply too high for poorer communities. This results in very little participation from their part, and a development process and product almost solely aimed at rich privileged users. This issue of a representative sample will also be discussed in the justice element of participation.

At the regime level, which represents the dominant, stable systems in place – current infrastructure, regulatory frameworks, cultural norms, etc. (Geels, 2002) – recognition justice is particularly relevant, for it emphasizes inclusivity and acknowledgement of marginalized groups within said systems. Currently, the SAV industry, and the transportation system in general, inadvertently or otherwise, does not recognise all demographics equally. Children, the elderly, and individuals with disabilities often encounter considerable barriers in accessing transportation. A study on US children with disabilities found that they face greater transportation access difficulties than their non-disabled peers due to mobility challenges, even though buses are a primary mode for school

travel (Wheeler et al., 2009). Similarly, older adults with mobility disabilities face challenges such as accessibility issues and demeaning societal attitudes (Remillard et al., 2022).

Moreover, there are little to no federal or industry guidelines specifically for SAV accessibility. Instead, accessible SAV design relies on interpreting existing standards from the Department of Transportation (DOT), the National Highway Traffic Safety Administration (NHTSA), and the US Access Board for conventional buses and vans (Tabattanon et al., 2020). Studies have identified the pressing need for research to establish inclusive design requirements for SAV, and methods to evaluate the usability thereof (Bayless et al., 2019; Claypool et al., 2017; Henderson and Golden, 2015), the latter of which is also wanting in the human factors literature (Tabattanon et al., 2019). In the case of Waymo, while the company has announced several features to enhance accessibility for passengers with disabilities, such as a unique chime and a rooftop light dome with the rider's initials to help visually impaired passengers locate the correct vehicle (Hawkins, 2022), there is no evidence to suggest that efforts to address more fundamental challenges – for example, guidelines specific to SAVs – have been made.

Another potentially contentious issue related to recognition justice within the current SAV regime concerns the safety of children on the streets. Pedestrians, particularly children, may exhibit unpredictable behaviours, which AVs must account for to prevent accidents (Millard-Ball, 2018). Research shows that children rely more heavily on AV's external communication signals than adults when determining their safety, which could lead to higher risk-taking behaviour in children when interacting with AVs in public spaces (Deb et al., 2020). While, in theory, Waymo's extensive sensor suites and redundant collision detection and avoidance system are designed to detect and respond to the unpredictable behaviours of all pedestrians (Waymo, 2021a), including children, the current safety measures do not explicitly address the unique communication needs and interactions that children require.

As previously mentioned, capability justice can be considered to operate as pressure from the landscape, for it aligns with evolving global societal values that place increasingly larger emphasis on demands for fairness. Currently, Waymo's services are only available in a few affluent urban areas, neglecting rural communities that already face limited transportation options. The reliance on smartphone apps could also widen the gap between the technology literates and those who might not be so comfortable, trusting of, or have access to modern technology. While there is some excitement – or at least, curiosity – about the prospect of Waymo expanding its operations to suburban regions (Lee, 2021), upon further investigation, we found little information to suggest that our theorized landscape pressure exists to any significant degree. Even the high-cost argument is no longer so applicable in recent years, as Waymo's pricing has become comparable – and sometimes even more affordable – to other ride-hailing services like Uber and Lyft (although such services are still quite expensive for lower-income individuals) (Velazco et al., 2024).

It follows that Waymo's priority should lie in addressing recognition justice within the regime. The company should develop comprehensive accessibility guidelines tailored specifically for SAVs and implement inclusive design features that address the unique needs of all user groups; for example, the company could benefit from collaborating with child safety experts to better understand and mitigate the risks associated with children's interactions with AVs. Expanding on the necessity to address recognition justice, Waymo should also prioritize participation and responsibility to ensure a just transition within the SAV regime – and mobility at large.

Waymo should actively involve diverse stakeholders in the decision-making process to foster inclusivity and transparency. The company should engage with communities that are most affected by their SAV deployment, such as individuals with disabilities and families with children, to ensure that their voices are heard. Additionally, to address participation justice, Waymo must ensure that information about their services is accessible to all, addressing barriers such as digital literacy to facilitate meaningful participation from vulnerable and/or marginalized groups. Meanwhile, responsibility justice requires Waymo to acknowledge and address the broader social and environmental impacts of their technology. This may include, for example, conducting regular impact assessments to evaluate how SAVs affect different communities and committing to ethical practices that prevent worsening existing inequalities. Furthermore, Waymo should continue to invest in affordable access to their services, potentially through subsidies or partnerships, to ensure that low-income populations can also benefit from and participate in shaping the new SAV regime.

7. Reflection

As among the most innovative sustainable innovations of the 21st century, SAV's existence is an awaited technology people can dream of. This technology was commonly portrayed in popular cultures, creating a paradox of a utopian future where cars drive themselves, integrated seamlessly into daily life. However, what seemed like an imaginary dream that lives relentlessly in people's heads became a reality. With Waymo entering the market in the United States, the arrival of this technology can surprise people who live around it, raising the question of whether society is ready for it to become available and change their lives, for better or worse. These questions highlight the importance of managing the shift to autonomous transportation responsibly and ethically, ensuring sustainable transitions for future generations. We can delve deeper into the topic using the frameworks we learned in class and evaluate whether such innovations are responsible and sustainable.

The class covers five frameworks: environmental justice, participation, sustainable entrepreneurship, responsible research, and institutional entrepreneurship. Environmental justice emphasizes fair access and accountability for marginalized groups. Participation frameworks assess inclusivity and stakeholder empowerment. Sustainable entrepreneurship emphasizes ethical business impacts. Responsible research views innovation as a societal duty. Institutional entrepreneurship explores how technology drives societal change. Moreover, the teaching method in the class involved writing two pagers weekly. The 2-pagers encouraged us to go beyond the framework as a comprehensive approach to determine the pros and cons of shared autonomous vehicle existence. This enables us to thoroughly assess whether SAV will positively contribute to society and the environment and whether this transition is just and equitable.

Reflecting on the journey of understanding autonomous vehicles through various lenses of sustainability and the discussed ethics frameworks has broadened our perspective on what it means to responsibly introduce a new transformative technology to society. Using the lens of environmental justice, we mentioned that Waymo has put some effort into being just for society but still has a big room for improvement. Through the participation lens, we explored Waymo's session of participation, which is seen more as education than an open discussion, creating little active involvement of the participants. In contrast, Goodpaster's typology of sustainable entrepreneurship classified Waymo as type 3: Conscious as an authority, showing Waymo works well for sustainability and society. Waymo is also considered a complex system with significant societal implications, according to Stilgoe et al. 's framework, but it still aligns with Owen and Pansera's view of responsible innovation. Lastly, through the lens of institutional entrepreneurship, Waymo can potentially advance the shifting paradigm of the American dream for freedom, with many institutional entrepreneurs collaborating in the modern era.

In the exploration process of delving deeper into responsible and sustainable innovation, we found that Waymo has fulfilled almost all the frameworks for responsible innovation, although there is room for improvement. The sustainable entrepreneurship framework that we utilized as a lens works well for discussing Waymo as a sustainable innovation. However, if we reflect on the participation process, Waymo could have done better to provide space for society to be heard and considered in its system's improvement, making it more acceptable as a responsible innovation. With this understanding, we realized that shared autonomous vehicles are complex systems involving many frameworks used to discuss whether or not the technology is responsible. Therefore, to write this portfolio, we decided to discuss institutional entrepreneurship and entrepreneurship–business ethics in-depth and reflect on what we have learned in class with a new combination as a new lens for further discussion.

On the one hand, institutional entrepreneurship involves reshaping established socio-technical systems to foster sustainability, particularly within sectors like energy, water, and transport. This complex process requires changes in rooted norms, policies, and infrastructures to move toward environmentally and socially responsible practices. That is why institutional entrepreneurship is a powerful lens for understanding how autonomous vehicles could reshape the car ownership culture in the United States. Cultural beliefs and cognitive rules reinforce car ownership as essential for social identity, independence, and mobility. With this framework, we can understand better the scale of change needed to motivate sustainable transitions. Moving forward, we also see the need for autonomous vehicle companies, specifically Waymo, to collaborate with policymakers to adjust the regulatory frameworks to address the barriers Waymo may create.

On the other hand, our exploration of autonomous vehicles using sustainable entrepreneurship–business ethics has been fascinating. It brings SAV into public discussion by highlighting the need for ethical considerations in their deployment, especially regarding complex, unforeseen cases. We understood that Waymo must proactively address these ethical issues to build trust and gain acceptance for the technology in society. To address this issue, Waymo must practice ethical business, requiring companies to anticipate and transparently manage the potential risks and uncertainties that arise in real-world scenarios, even if these cannot be fully anticipated beforehand. By documenting their learning processes from incidents, improvement feedback, and responses, Waymo can demonstrate a commitment to responsible innovation. Finally, through this lens, it is safe to say that, for Waymo to be truly impactful for society, they must move beyond profit-driven goals, embedding ethical practices to contribute to solving real-world problems.

Furthermore, we identified a new combination of two frameworks, where we positioned the environmental justice dimensions using the multi-level perspective, identifying their location in the framework, thus being applicable to enhance the view of how autonomous vehicles interact with societal values, ethics, and justice across multiple system levels. MLP assists us in recognizing further implications of autonomous vehicle deployment, especially as shared vehicles, by delving into car-centric infrastructures, regulations, and cultural norms that influence current

mobility dynamics. The categories, like distributive, capabilities, recognition, participation, and responsibility justice, introduced in environmental justice are also helpful in deepening this analysis of how SAVs impact marginalized communities, such as those with disabilities or limited incomes. This new combination is mainly useful for improving the innovation process. It helps us ensure that new technology entering society has fair access, affordability, and inclusiveness, which are understood as responsible innovation.

This reflection has enlightened our understanding of autonomous vehicles as an emerging transformative innovation that demands careful consideration of sustainability, ethics, and social inclusivity. By integrating frameworks like institutional entrepreneurship and sustainable entrepreneurship – business ethics, we acknowledge further the existence of autonomous vehicles. While they are promising, they still require responsible deployment strategies. Furthermore, the combination of environmental justice and the multi-level perspective offered further insights, enabling us to see how the system deployment intersects with societal values, cultural norms, and infrastructure needs. Environmental justice categories—distributive, recognition, and participation justice—emphasize that autonomous vehicles must serve marginalized communities equitably, ensuring fair access, affordability, and inclusivity. This framework encouraged us to consider the broader social responsibilities of SAV companies and the need for proactive engagement with all stakeholders. SAVs hold the potential to become a sustainable innovation for future generations, developed with attention to justice and inclusivity across multiple system levels, fostering a transportation ecosystem that benefits all.

Waymo has the potential to redefine mobility by actively embedding ethical considerations and collaborating with policymakers to create a sustainable and equitable future. Such a responsible approach is essential for gaining societal acceptance and positioning SAVs as a positive force that aligns with public values and meets diverse community needs. SAVs could potentially provide on-demand transportation, enhancing mobility options and offering flexibility without the financial burden of ownership. However, to be more financially inclusive, better prices should be imposed to reach more users. This shift can create sustainable, human-centric urban spaces and improve urban living conditions through reduced carbon emissions. This reflection has strengthened our belief that, despite the complexity of autonomous vehicles and all the systems around them, autonomous vehicles can be a sustainable innovation equipped with accurate attention to societal benefit, ethical accountability, and collaborative governance. A utopian future well-depicted by popular culture has been reachable, and society should be ready if any changes happen shortly.

I. Appendices

Appendix A: Environmental Justice: Shared Autonomous Vehicles

Waymo, among other companies like Cruise, is leading the testing and public deployment of fully autonomous ride-hailing services in San Francisco. Waymo, a Google company, started offering fully autonomous rides (without a human driver) here in 2023. The California Public Utilities Commission (CPUC) granted the company permission to collect fares for its driverless vehicles (Davis Wright Tremaine LLP, 2023). The experiment in San Francisco builds on the success of Waymo's previous operations in Phoenix, Arizona, where it has been providing similar services since 2017. Waymo's goal is to make fully autonomous ride-hailing available city-wide. On a conceptual level, Waymo frees existing car owners from needing to purchase cars while offering car service for those who never had a car in the first place. Both promote the freedom to pursue valued sustainability goals by reducing the dependence on vehicles while providing them when needed. The trials of Waymo service are being monitored closely for their impact on safety, passenger accessibility, and interactions with city traffic (Davis Wright Tremaine LLP, 2023). This push for autonomous ride-hailing services is a major experiment in transitioning from manually driven to shared autonomous transportation systems in urban settings.

It begins with recognition that asks us to consider who is counted in implementing shared autonomous vehicles. Understanding and acknowledging the people affected directly and indirectly by Waymo is crucial. Ranging in demographics, socioeconomic status, and capabilities, from commuters to people with disabilities to workers in the gig economy, SAVs are both creating positive and negative effects. Steven Aquino shares Waymo's priority on ensuring those with accessibility needs are prioritized in the Waymo system (Aquino, 2024). On the other hand, the existence of self-driving cars can also potentially marginalize low-income communities (Creger, 2019). This potential issue remains as an important note in the capitalistic world. Although the innovation of SAV has benefits for the demographics, it shows that the public transportation for society is inadequate, in which most of the marginalized communities in San Francisco use everyday to commute. Lin supports in her article that San Francisco's marginalized communities are facing continuous transportation inequality before and now during the SAV's innovation (Lin, 2019).

In regards to participation, the company leads the conversation, paired with government representatives and tech enthusiasts (Waymo, 2024a). Those who need a voice often need more presentation in critical discussions, i.e., marginalized communities. Currently, Waymo in San Francisco has just opened up its services to everyone; however, it uses a waitlist system in other cities. In the waitlist system, users could sign up and express their desire and reasoning behind their desire to use Waymo (Waymo, 2024a). Not only is a waitlist and any app-driven innovation self-selective in who knows how to participate, but it also gives corporations the power to

determine who can participate. In assessing community participation at Waymo, their goal should be actively informed to the public using the narratives to shape policy and the future.

Waymo offers a lot of value to those capable of using it: driving is not required anymore. This frees up a lot of time, making daily commutes a useful segment of the day again. The implementation of SAV's will also make roads safer for pedestrians and cyclists, with studies showing an 85% lower incident rate compared to the human benchmark (Kusano et al., 2024). However, concerns regarding reliability (Valdes-Dapena, 2024) and data privacy issues (Love, 2023) pose possible negatives for the users. These concerns arise in the digital era where the company asks for user data, including personal address, phone number, and any other personal information. Most of the time, tech companies use the data for marketing purposes. Although companies claim their data protection complies with the regulation, data breach phenomenon is not uncommon in this case. Another case happened with Waymo vehicles that have been reported to interfere with first responder operations (Jarrett, 2023; Kerr, 2023), this could seriously interfere with citizens' health. Additionally, while Waymo is currently more expensive than regular rideshare services, its future potential to displace jobs such as Uber drivers raises concerns (Claburn, 2024). One of the concerns is about the economy plummeting because people are losing jobs replaced by AI. More transparency around safety standards and measures taken could increase the communities trust in Waymo, with it increasing the technology's acceptability. The responsibility for Waymo's environmental burdens lies first with the company, but also with authorities. They are responsible for the emissions of the transport sector, which includes Waymo. End-users carry no safety responsibility whilst using this service.

Participation is currently limited to San Francisco and Phoenix. However, the long-term plans for the service aim to be in every major American city (Waymo, 2024b). This, unfortunately, would likely leave out the vast suburban, exurban, and rural population that covers America but would, in theory, still have a positive effect by reducing the overall need for cars. To use the Waymo service, everything is handled through the Waymo One app, which works similarly to ride-hailing apps such as Uber or Lyft. The app establishes service costs based on the most direct route, with the pricing only changing afterward if additional stops are added. In-vehicle communication is handled through screens and audible prompts.

Waymo has shown to put some effort into applying environmentally just methods. Community involvement should be extended to include low-income neighborhoods for large scale implementation. The company has put significant efforts to include diverse stakeholders from many areas, however they mostly focus on early adopters. Unfortunately, Waymo only gathers feedback from riders that are mostly tech-savvy frontrunners, neglecting all other citizens who do not use the service but are also affected by its operation. All in all, the safety benefits of using SAVs should be extended to all groups of society. Waymo should stand up to their responsibility in occupying road capacity, and make sure to offer rides for everybody, potentially applying price discrimination to enable all citizens to use them. In the end, Waymo should increase accessibility

for people without internet access and physical impairments. Lastly, the communities affected by mining for vehicle batteries should be recognized and compensated for their burden.

Appendix B: Participation: Shared Autonomous Vehicles

Participation in the decision-making process considers all the parties impacted by a new technological development and transition towards implementation, being one of the dimensional lenses of environmental justice by Davoudi and Brooks (2014). Waymo has led the conversation with local communities, paired with government representatives and tech enthusiasts (Waymo, 2024a). Following the conversations, Waymo created its own community, partnering with organizations based in San Francisco, the company's most significant area of operation. For instance, Waymo collaborates with small businesses to provide mobility independence for people with autism (Waymo, 2023a). Moreover, Waymo's website provides feedback opportunities, especially in public concerns. Despite the options on the website, Waymo should be more involved in active participation with wider societal reach to achieve environmental justice. Therefore, we will discuss in detail the public perception towards its operations, including the accessibility, pricing, and availability risks.

Public perception and safety are critical dimensions, as they directly affect the trust required for societal acceptance for the adoption of SAVs. Studies have shown that trust is a significant predictor of SAV adoption (Paddeu et al., 2020), which, in the context of autonomous vehicle technology in general, is largely influenced by perceived safety risk (Zhang et al., 2019). Public skepticism about SAV safety is pervasive, with trust in autonomous vehicles varying considerably across different demographics. Masculinity, education, and affluence are associated with optimism about AV technologies (Moody et al., 2020). Many expressed concerns about potential for technological failures, and how autonomous vehicles handle unexpected situations (Araujo et al., 2019). Such concerns are not without merit, for recent incidents in San Francisco have highlighted the very real risks associated with the technology (Agatie, 2024; Hawkins, 2024).

Waymo's engagement with the public appears to fall under the 'consultation' stage of Arnstein's Ladder of Citizen Participation (Arnstein, 1969). While they provide data on public road safety and incidents, as seen in their safety performance reports (Waymo, 2024c), there is a lack of evidence of active collaboration or decision-making involving the public. Waymo does solicit rider feedback via the mobile application, and has reportedly used it to improve their service (Waymo, 2020), but otherwise, the flow of information seems to be primarily one way. This may result in feelings of tokenism, as the public's role is reduced to only appear to participate. Given this lack of deeper engagement, we can reasonably assume that most of the decision-making processes happen privately, involving primarily technical experts and internal stakeholders. This approach may exclude vulnerable populations such as those who may be disproportionately affected by the deployment of SAVs. Fung (2006) emphasized the importance of engaging a wide range of stakeholders, which is not fully realized in Waymo's current approach. Moreover, Waymo

heavily relies on digital platforms for communication, which poses challenges in terms of accessibility. Digital literacy is a potential barrier, as people with lower technological skills may not be able to fully engage in the feedback processes or comprehend safety reports. Self driving cabs will have an impact on job security, as the value provided by ride-hailing providers will be provided by Waymo, essentially Google. The livelihood of many rather unskilled or underpaid workers would be transferred to rich companies. This seemingly unjust action of transferring wealth, will not be offset by the amount of jobs created by the robo taxi industry, for example service and maintenance. The potential gentrification of ride-hailing service provision demands participatory approaches to ensure a just transition. Governmental bodies, with the support of Waymo, should at times of large scale deployment, provide educational retraining offers, designed together with former drivers.

SAV's environmental benefits potential will only apply if social acceptance is met with large scale deployment. The service can provide significant benefits in this area, but only if people are fully convinced to forgo private vehicle ownership. Lowered ownership levels will unlock the promised improvements of lower pollution, safer streets, less congestion, and a healthier population (Mjk, 2024). This is not possible yet, as in the current situation, pricing levels for Waymo are still close to those from Uber and Lyft (San Francisco Chronicle, 2024). That may mean that a Waymo robotaxi is cheaper than a taxi in some situations, but not yet compared to owning a private vehicle (Rocket Money, 2024). Therefore for possible environmental benefits to become significant, prices need to fall drastically. Cost and availability of an SAV must be so competitive that private car ownership stops being a necessity. Another consequence of the current high prices is that lower income groups do not use the service. Since they are not able to afford it, they do not have the app, and with it the opportunity to give their feedback and recommendations on the service. Waymo's pricing does not correlate to the reduced operation cost derived from the lack of a driver. High upfront R&D investments and a lack of economy of scale due to limited ridership constitute the economic reasons behind their pricing. While affordability and thus increased accessibility will improve over time, mainly because of high ridership numbers, government subsidies would evoke those positive effects earlier. The investment of public money, similar to subsidies given to public transit entities, would only be partially justifiable from our perspective. The desired increase in safety and location accessibility needs to be evaluated against the lack of space efficiency. Subsidies should not introduce more negative externalities than they solve. For example, subsidies could be paid to people who share rides, and use the service in a combination with other public transit or biking. The design of the subsidies should be determined in a citizen empowering way, giving those who are affected the power to benefit from the service.

It is concluded that the participation process currently lacks to involve all groups of people involved, that the methods are not using the right communication, and that participants have too little active involvement. To improve this, several factors must be considered. Firstly the participation process in existence must become accessible to more people, become open self-selection, and allow all to voice their opinions and provide feedback. Higher accessibility could

be accomplished by government support for commuters, like the system in place for public transport, however policy design must focus on improving the transport system as a whole. The communication methods need to change from 1-way to conversational involvement. This can happen with group discussions and workshops, giving citizens the opportunity to voice their opinion on the innovation. Finally the authority and power in the participation process needs to increase, with real advice and consultation having an influence on the running of Waymo. This can take the shape of public hearings.

Appendix C: Sustainable Entrepreneurship: SAVs

Waymo is a leading developer of shared autonomous vehicles (SAVs). In 2023, the company launched its driverless ride-hailing service in San Francisco, establishing itself as a significant stakeholder in the city's transportation ecosystem; since then, it has provided thousands of rides to the public every week. This essay analyses the company's moral development, public image, and corporate responsibility using the typology described by Goodpaster (2007) and McMahon (1981).

Waymo presents itself as 'the world's most experienced driver' with a mission to make transportation 'safer, more accessible, and more sustainable' (waymo.com). The company underscores its commitment to reducing traffic accidents caused by human error, highlighting that over 1.3 million people die around the world every year due to vehicle crashes (Waymo, 2021a). Waymo promotes its services as enabling mobility for all, including those who cannot drive due to age or disability. Testimonials on their website feature customers who appreciate and value the independence Waymo's services provide (Waymo, 2022a, 2023b). Furthermore, Waymo highlights its efforts in sustainability by utilizing electric vehicles, optimizing routes to reduce emissions, and even developing its own methodology to accurately quantify emissions prevented by their service – 100,000 EV trips are taken weekly, resulting over 135 tons of CO_2 emissions averted (Waymo, 2024d, 2024e).

Regarding ethical leadership, Waymo's code of conduct details commitments to human rights, environmental stewardship, and ethical business practices (Waymo, 2018). The company also appears to actively build public trust through community engagement, as seen from its extensive portfolio of CSR activities: delivering donations to San Francisco family resource centres (Waymo, 2022b), organizing a visit to aimed at inspiring young girls to consider careers in STEM and feel included in the future of mobility (Waymo, 2024f), and partnering with various disability advocates to improve equitable access to mobility – for instance, in October this year, the company launched an initiative to help blind veterans with commuting independently – to name a few.

Stakeholder perceptions of Waymo are mixed. Media reviews note the service's ease of use and comfort (Magary, 2024); many riders appreciate the convenience and novelty of autonomous rides, but non-users sometimes find the still-in-development software ill-equipped for specific scenarios (Hawkins, 2023). Residents in certain neighbourhoods reported disturbances caused by Waymo

vehicles honking excessively at all hours, supposedly caused by software glitches; but despite Waymo deploying software fixes to address the problem, residents have complained that the issue persists (Davis, 2024; Larson and Gooden, 2024).

Additionally, Waymo vehicles have faced challenges in dealing with unpredictable pedestrian behaviour. There have been incidents where pedestrians deliberately obstruct the vehicles (e.g. by putting traffic cones on the hoods of vehicles, triggering shutdown mode and disabling the vehicle until a manual reset), causing them to stop in the middle of the road and leading to a traffic congestion (Kelly, 2024; Kerr, 2023). Moreover, Waymo's vehicles have had difficulties navigating emergency situations. Last year, the San Francisco Fire Department documented over 50 instances in which Waymo vehicles interfered with its operations, causing delays and complications which could have put people's lives in jeopardy (Jarrett, 2023). These incidents raise the question of how much we can trust Waymo's vehicles to behave appropriately in complex scenarios that require human judgement and adaptability.

Applying Goodpaster's (2007) typology, we classify Waymo as Type 3: Conscience as an Authoritative Source. This classification describes organizations that internalize ethical principles and integrate them into their core decision-making processes, going beyond perfunctory compliance with laws or market pressures. Waymo demonstrates this through its proactive approach to shaping ethical standards within the AV industry. For instance, Waymo actively advocates for a regulatory approach based on a comprehensive safety case; it is working on publishing a paper detailing a blueprint for building a reliable case for safety for use by any company working on fully autonomous vehicles (Favarò et al., 2023; Waymo, 2023c). This shows that the company is willing to contribute its expertise in a way that exceeds mere legal requirements.

Furthermore, Waymo emphasizes transparency in its operations. The company regularly publishes detailed reports on its safety practices, collision data, and the performance of its vehicles (Waymo, 2024b, 2024c, 2021). By openly sharing this information, Waymo promotes a culture of accountability in the industry, encouraging other players (e.g. Cruise) to follow suit. The company embodies three key virtues: *ambition* for the highest road safety standards, *caution* in building public trust, and *responsibility* as an ethical leader and technological pioneer. These virtues underscore Waymo's mission to be 'the world's most experienced driver'.

In conclusion, Waymo provides safe, convenient, hands-free transportation, enhancing mobility for those with limited options, including the elderly and disabled. By actively shaping regulatory frameworks and setting new ethical and safety standards, Waymo goes beyond merely adhering to traffic laws, demonstrating a commitment to public welfare characteristic of a Type 3 company. Despite operational challenges, Waymo's commitment to enhancing safety, accessibility, and ethical standards in autonomous driving shows a genuine dedication to welfare, positioning it as a moral leader in the evolving field of SAVs.

Appendix D: Responsible Research and Innovation: SAVs

Have you ever wondered what the future would be like if science fiction became a reality? Take the example of movies like *I, Robot* and series like *Upload*. Those examples envisioned a future where cars drive themselves, integrated seamlessly into daily life. In *Upload*, for example, characters roam around easily in self-driving cars, engaging in conversation, and even attending online meetings without a second thought about navigation. This fictional story depicts well what it is going to look like if the technology becomes available, departing from the sparks of our imagination about the role autonomous vehicles could take a critical part in transforming society of a future driven by artificial intelligence and robotics. However, what seemed like imaginary fiction is now becoming reality, with companies like Waymo currently on the market for autonomous vehicle taxi operators in the United States. Waymo's entrance to the market as an upcoming technology raises a question whether this innovation is responsible enough to create a better environment in the future.

Stilgoe et al. (2013) argue that the goal of Responsible Research and Innovation, RRI, is to reach (ethical) acceptability, sustainability and societal desirability in the innovation process and for their products. For this, deliberation through the lens of Responsible Research and Innovation needs to be the primary discussion for new advanced technology that impacts not only human life but also the environment surrounding it. This discussion is not limited only to Waymo and how their technology can benefit more lives, but also the stakeholders that are impacted by the new regime of autonomous technology introduction both directly and indirectly.

In anticipation of its new technology, Waymo has showcased its benefits to society. While the Waymo Driver has already been shown to perform more safely than human drivers (Kusano et al., 2024; Waymo, 2023d), new risks associated with this rapidly evolving technology should not be overlooked. The latest iteration of the autonomous system includes 13 cameras, 4 lidar, 6 radar, and external audio receivers (EARs) (Jeyachandran, 2024). This extensive sensor suite aims to enhance safety, but more interconnected systems can lead to unexpected failure propagation, where minor issues escalate into major failures (Macrae, 2022). For example, lidar struggles with adverse weather conditions like heavy rain or fog, leading to degraded performance (Kim et al., 2023) Although Waymo has put many efforts into creating a safe self-driving system, constant monitoring is crucial to anticipating risks, which, in this context, could be a matter of life and death.

Inclusivity is another key RRI lens for responsible innovation. Participation is commonly used as a process towards an inclusive regime. However, big companies, not limited to Waymo, gain critique on this process because they use this session to legitimize their business as “Inclusive” business, whereas the neglect of people's voices are visible as the technology continues arising in the market and media’s attention. In this case the sessions do not have an impact on the company, creating an uneven power dynamic like in a tyrannical technocracy (Stilgoe et al., 2013).

In Waymo's situation this is the case. There are many partnerships, all with good values, helping people with impaired mobility (BVA, 2024), socially threatened groups (LAUL, 2024), and local communities (Waymo, 2024a). However, the way in which these collaborations work is not what participation means. There are three main qualifiers for participation sessions: intensity, openness, and quality. Since Waymo is always in charge of the conversation, many sessions are more educational than participatory. Due to this structure and style, stakeholders have very little input, and their impact on the product and the process is negligible, reducing the intensity and the quality of the sessions. Moreover, this session is also only targeting the bodies or organizations to make Waymo look inclusive and understand their needs by using their technology rather than inviting all the non-user stakeholders affected by the existence of the technology. This issue is also seen in their community website where they are only showcasing the benefits of using Waymo technology rather than telling the information what the company learns from the communities. Nevertheless, the innovation of Waymo still benefits many people, however it could have been better if the input mechanisms were more versatile and hybrid to allow for the views of stakeholders to be heard and later implemented, making Waymo more reflexive in their operation and responsible in their innovation.

Talking about reflexivity in Waymo's operations, it's essential to consider how the company's focus on high-demand urban areas may widen the accessibility gap between urban and rural regions. It is important to remember that Waymo is a business that needs to be profitable, deployment of vehicles in rural areas may not be feasible for them to do. However, rural areas are at risk being left behind in this technological shift, potentially increasing the mobility divide. To address this imbalance issue, for instance, Waymo could initiate trials for SAVs in rural settings, modifying the technology for lower-density infrastructure and more varied road conditions. In addition, policy incentives to encourage SAV deployment in rural regions, along with partnerships with local governments, could help foster a more inclusive innovation approach (Brown & Gonder, 2022). Such efforts would allow Waymo to become more responsive in any setting to play a role in bridging the accessibility gap, ensuring that autonomous vehicle technology enhances mobility for all communities, not just urban ones.

Viewed through the RRI lens, Waymo embodies a transformative yet complex shift in transportation with significant societal implications. A new perspective by Owen and Pansera (2019) on RRI highlights that innovation need not fit a single framework but can still achieve responsible outcomes in different ways. Historically, innovation emerged from an "ivory tower" separate from society, but it now must serve a clear purpose, contributing both economically and socially. Although Waymo's innovation began as a business pursuit, its products benefit partners and communities, demonstrating a positive societal contribution. In this sense, Waymo's approach to RRI might diverge from Stilgoe et al.'s framework but still aligns with Owen and Pansera's view of responsible innovation. Waymo's unique path shows that, even when following alternative frameworks, a responsible approach can yield meaningful societal value.

Appendix E: Institutional Entrepreneurship: Shared Autonomous Vehicles

The American Dream embodies freedom. The ethos of the United States. Opportunity. It defines the United States. It is the concept that anyone can achieve success through arduous work. From its origins in the 17th century with the Declaration of Independence to 19th-century manifest destiny, the American Dream has been a staple of belief while taking a new shape in what it entails. The post-World War Two era shaped the American Dream and became intertwined with home and car ownership. Thanks in part to the GI Bill and the creation of the suburban 'Levittown,' the intersection of technology advancements, economic ability, and enabled consumerism informed what the American Dream was.

Owning a car in the United States is deeply connected to one's identity and autonomy. From your car model and color to how you decorate it inside and out, the car has become an extension of oneself. People even name ‘he’ or ‘she’ respectively. This is ever the case in the 21st century, as traditional homeownership possibilities have become unrealistic because of economic inequality. The normative societal prescribed right and privileges of car ownership is the 21st century and millennial/gen-z symbol of success. While some argue that this could be a cognitive rule, people own a car because others own cars, car ownership is a value and expectation that makes people feel like they should own cars to meet the societal and the American Dream expectations. The narrative of this normative rule is ever pushed through media outlets, influences, and peers alike, showing society that car ownership makes one happy and should be seen as a privilege.

The success of shared autonomous vehicles mandates a normative rule change related to the societal concept of personal car ownership. Waymo’s business model hinges on the ownership shift to shared mobility, a change in public perception of the American Dream. In this new world, easy access to safe mobility is critical. After continuous reproduction of the normative rule of car ownership over the last 70 years, altering the process faces strong opposition through established legitimacy of the ownership model by the majority of the currently living population. Today, the socio-technical shift from personal car ownership is only in the niche phase. At the niche level, innovations and the new socio-technical transition are emerging and starting to fill the growing demand. Companies like Waymo only put slight pressure on the existing dominant regime of car ownership. The reorganization required for the sustainability transitions depends on the normative change of altering the access mode from ownership to on-demand. Media, architects, city planners, and policy designers emphasize the need for the diversity of normative alterations. For context, when diving into the socio-technical transition, there is the assumption that shared autonomous vehicle companies, like Waymo, can meet the demand and scale required for the normative rule change.

Media outlets, led by Hollywood movie production, are eminent to institutional change. Manually driven personal vehicles have become normative role models on screens for society. A Hollywood movie directed by Joseph Kosinski, director of “Tron:Legacy”, who is experienced in weaving in

futuristic technology into capturing story lines, could introduce a new narrative of vehicle access on demand. Collaborating with popular actors with an eco-conscious mindset, like Will Smith and Zoe Saldana, could translate technological advancements into attractive story lines. Their passion for sustainable living and integrating sustainability into film has the potential to legitimize the alternative niche institution. The film industry has shaped the current regime tremendously and thus understands the complexity of the role of the car in its current embeddings. This unique position allows Hollywood actors to create legitimacy and lead as institutional entrepreneurs.

Architects and city planners have designed the built environment to represent and favor the car ownership norm. Suburban houses with driveways and garages treat cars as meaningful defining items of everyday life. Fourteen percent of the ground-level urban space is dedicated to parking in LA (Chester et al., 2015). Alternative usage for such space needs to be planned for and designed in a human-centric way. A park around a stadium instead of parking lots or garden concepts replacing garages will pose examples to de-legitimize the predominant regime. Residents and restaurants could open curbsides on city streets. Better space utilization emphasizes the benefits of the emerging institution of shared AVs. This supporting factor requires a top-down approach to destabilize the norm. Parking mandates in most US cities render these improvements regarding space allocation illegal. Furthermore, fuel subsidies currently over-proportionally benefit unsustainable vehicle ownership. Local communities ought to be allowed to decide themselves on parking mandates. The stability of the regime will otherwise remain intact. Further significant actors in the normative shift include public transport agencies, which need to co-provide better alternatives to car ownership, and insurance companies, which need to adjust their business model.

The high institutional complexity and stability demand actions from the actors above to enable the normative switch to forgoing vehicle ownership for access to SAVs. Changes by architects and city planners legally require policy changes, which in turn require a shared vision to design. Hollywood producers should initiate the new narrative first. Policy windows opened by advancement in environmental protection and societal acceptance of the sharing economy also contribute. Only then could other actors start to follow and support the succeeding institutional regime.

The shift from personal car ownership to shared autonomous vehicles (SAVs) presents moral implications regarding economic displacement. Traditional car insurance companies will face declining businesses as fewer individuals own and crash cars, forcing them to adapt their models or risk job losses. Similarly, independent auto repair shops, car washes, and small businesses tied to personal vehicle maintenance may struggle as demand for their services decreases. This could disproportionately impact small-scale companies, raising concerns about social justice and the need for reskilling programs to help displaced workers. Automobile manufacturers may also experience financial losses, particularly those reliant on personal vehicle sales, further disrupting supply chains and jobs. On the other hand, Waymo stands to benefit significantly from this shift as they capture new markets and scale their operations. By shifting to an access-based model, users

would gain greater freedom from the responsibilities tied to car ownership, such as maintenance, insurance, and parking. This would allow them more monetary flexibility, as they would no longer need to cover the significant costs of purchasing and maintaining a personal vehicle. SAVs could offer on-demand transportation without the long-term financial burden, providing users with more mobility options and flexibility in travel. Architects and urban planners will have new opportunities to design more sustainable, human-centric urban spaces. Finally, the public and environmental advocates will benefit from reduced carbon emissions, better air quality, and improved urban living conditions. Overall, the shift to shared autonomous vehicles has the potential to advance the American Dream for the modern era if enough institutional entrepreneurs collaborate. As home and car ownership once symbolized freedom and success, access-based mobility could boost flexibility and financial freedom.

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