

# *The New Transportation Paradigm: The Sharing Economy*

Zi Wang<sup>1,a</sup>, Zilong Ji<sup>2,b</sup>, Guangyu Ma<sup>3,c</sup>, Ziang Qu<sup>4,d</sup>, Yuchen Lin<sup>5,e,\*</sup>

<sup>1</sup>*H.S. Senior, The Governor's Academy, 01922*

<sup>2</sup>*Economics major, the State University of New York at Buffalo, 14226*

<sup>3</sup>*H.S. Senior, Beijing Xin Fuxue International Academy, 101399*

<sup>4</sup>*Sociology major, University of Alberta, T6G 2R3, Canada*

<sup>5</sup>*Economy major, Pennsylvania State University, 16802*

*a. brendan.wang@govsacademy.org, b. 1611450571@qq.com, c. garyma18700866916@gmail.com*

*d. zqu@ualberta.ca, e. ypl5596@psu.edu*

*\*corresponding author*

**Abstract:** The idea of a new transportation paradigm consisting of shared, multi-passenger vehicles has emerged along with the introduction of partly autonomous automobiles. As such a transformative but untested idea, the amount of existing research regarding this topic is limited. However, there are certainly discussions focused on individual elements of this topic and testing on a small scale: Driverless cars, shared vehicles, multi-passenger travel, etc. From these scattered papers, our team was able to compile the main problems with the current transportation paradigm and the potential benefits of the new sharing paradigm that we are advocating for. In this paper, we addressed four problems with the current paradigm and devised solutions for each problem via the benefits of the new sharing paradigm. Although we were unable to collect tentative data due to technological limitations, we gathered any research we could to simulate a world where the sharing transportation paradigm is adopted at a large scale, demonstrating the efficacy of the new paradigm in solving current pressing issues with a concentration on improving the environment both in cities and in general.

**Keywords:** shared mobility, current transportation paradigm, shared vehicles, autonomous vehicles, traffic congestion, external energy production, urban transformation

## 1. Introduction

Sharing economy, as a new concept, is becoming increasingly popular. From sharing cars to bedrooms, the advent of the internet has changed how people borrow by using social platforms such as Airbnb, Uber, and Craigslist. Consumers can use sharing modalities to increase the efficiency and convenience of life. The world has witnessed a steep rise and penetration of the sharing economy facilitated by the growing digital platform and the willingness of consumers to try mobile apps that facilitate peer-to-peer business models, shared entrepreneurial enterprises, etc [1].

In various sharing economy modalities, sharing transportation draws much attention. However, most people still use their cars to commute or travel. Even with the emergence of many cars rental or sharing services, customers still prefer to own private cars. Right now, urban area transportation

is divided into two parts, public transportation, such as buses, subway, and taxis; most private transportation relies on vehicles. The emerging one is gradually getting on the stage and becoming more and more popular in some level of sharing private cars like Uber and Lyft. However, public transportation requires people to go to stations that might be far away from home and cannot be reached at any time. Uber and Lyft can be available anytime, but this modality wastes lots of resources. Moreover, it does not decrease the number of cars on the road since many people choose to use Uber as a full-time job which loses the purpose of using current resources.

With the acceleration of urbanization, the current transportation paradigm in big cities faces plenty of problems. The most significant aspects are limited resources for production, parking space shortage, traffic congestion, increasing expenditure, and air pollution from automobile exhaust.

To begin with, the automobile industry requires several raw materials like steel, rubber, plastics, and aluminum to produce cars and auto parts. At the FT Future of the Car 2022 conference, Carlos Tavares (Stellantis CEO, the world's fourth largest carmaker) said that the automotive industry is facing a shortage of raw materials and a supply problem. Based on Bank of America's global research report, the high inflation has led to the highest raw material cost. Moreover, "In the past year, the raw material cost in an average U.S. vehicle has been steadily rising, increasing ~87% from a low point of approximately \$2,200/unit in Apr '20 to roughly \$4,125/unit in May '21" [2]. The traditional auto industry has been affected, and the electric vehicle industry has also been affected. Tesla CEO Elon Musk talked about the price of lithium going insane, which caused the factory to accelerate mining speed. In addition, it is easy to be affected by other factors like pandemics, war, or some shipping accidents. Geopolitical risks like the disputes between Ukraine and Russia cause the price of crude oil keeps rising and are hard to achieve. In 2021, Suez Canal obstruction also caused the oil price to rise more than 3% [3].

Second, congestion also is a severe issue in significant urban areas. "Americans lost an average of 97 hours a year due to congestion, costing them nearly \$87 billion in 2018, an average of \$1,348 per driver." [4]. The INRIX transportation analyst Trevor Reed noticed that "Congestion costs Americans billions of dollars each year. It will continue to have serious consequences for national and local economies, businesses, and citizens in the years to come". The congestion report shows that widening roads cannot solve congestion, instead "expanding road capacity creates major financial liabilities." [5].

Third, the increasing fee to maintain a car is also a big issue for consumers. Maintaining a car includes the cost of car insurance, the cost of gas, cost of maintenance. The total costs are around \$10800 to \$12000 per year to own a car [6]. Due to this high cost and time spent, it is difficult for small businesses and job seekers to afford a personal vehicle and run their businesses. Carsharing provides an excellent opportunity to fill this demand. Moreover, carsharing is an efficient and flexible approach for idle cars [7]. Compared with car sharing, public transportation is not convenient in several ways. Many people take buses or subways to avoid congestion in urban areas; however, the study shows that in both off-peak and peak periods, the average running speed of the route is below average. Public transportation relies on load rate, service reliability, average dwell time, and running speed [8-11]. However, all the crucial factors that affect public transportation are not under the control of consumers. Moreover, public transportation requires consumers to wait in specific locations, which might be far from consumers' current location.

Fourth, too much space is taken by parking lots. Shared mobility options can help address the problem of excessive space taken up by parking lots while not causing any additional problems in turn. Parking space is needed when people drive their vehicles to a location and then need to leave their vehicles somewhere in the vicinity of that location. At the same time, they take care of their affairs before driving their vehicles back to their homes. In principle, whether a person is in a shared vehicle or their own personal vehicle, they will spend the same amount of time in that

vehicle since they are only in the vehicle for their commute. In a shared vehicle, however, that person will not need to park the car since the car will then be at the service of the next person who needs to commute to a location. The proliferation of shared mobility options could thus result in a significant drop in the space required for parked cars, primarily if urban infrastructure supports such options and encourages widespread access to those options. For example, city governments could establish special lanes on roads that are reserved for shared mobility users and incentivize commutes with multiple passengers.

For these reasons, the priority objective is to develop of new connection of sharing economy on transportation to solve those current transportation paradigm issues. Therefore, the proposed approach focuses on the benefit of sharing transportation and expands the scale of sharing transportation.

## 2. Literature Review

The impacts of ridesharing services on traffic congestion should vary with urban spatial features. [1]

Raw materials take up almost half of the price for cars [9]. Steel takes up almost half of the vehicle, making it the most needed material [9].

The prices of steel/iron have gradually increased since the 1900s as mining sites are becoming less convenient [10].

The scarcity of metals such as steel and aluminum is not the primary problem in the present as they are relatively abundant. However, the process of forging these metals from rocks is pretty costly [11].

Mining minerals and metals are becoming costlier as it consumes excessive resources such as water, oil, energy, etc [12].

More and more car manufacturers are using aluminum to replace steel in cars [13]. This is caused by the price increase of steel and the better qualities of aluminum, even though aluminum is more expensive than steel [13].

This study provides a robust framework for decision-makers across the US for further analysis on the subject [14].

The connection between traffic congestion and economic development [15].

In the present report, the results of two focus groups conducted in Malaga and Madrid were presented in order to define and evaluate the barriers and potential consequences of autonomous driving [16].

The paper raises questions about the role urban planning can play in the rollout of AVs in order to anticipate and mediate unwanted built environment and socio-spatial impacts, as well as reconcile the ambition of transport innovation with the public purpose of planning [17].

The increasing development of society has also pushed the automotive industry forward, with different maintenance measures for electric cars than for cars that rely on oil as an energy source [18]. Electric vehicles are usually driven by electricity, and an electric vehicle's charging life depends on battery usage. Charging patterns at different pressures are different. Usually, the high voltage will reduce the battery life [19].

There has been a recent trend in shared mobility, and this alternative to private car ownership not only provides some benefits to riders but can also benefit the environment and society in general. Taking into consideration that privately owned vehicles are parked approximately 95% of the time and that increasing numbers of private vehicle owners correlate with environmental concerns, especially in urban regions, researchers are interested in examining how shared mobility can create solutions to both environmental and social problems with a focus on how to shift demand from private vehicles ownership to shared mobility services [20, 21].

Machado investigates shared mobility with an emphasis on urban areas with a literature review of the existing research on this topic [21]. The authors conclude that the rising trend of shared mobility options can make travel more efficient, reduce environmental pollution, and lower personal costs associated with private vehicle ownership and maintenance [21]. However, the researchers found that while shared mobility can help create solutions to a wide range of issues, these options alone will not be able to solve broader urban transportation problems connected with rising motorization rates without the correct policy and strategies in place [21].

Rising motorization rates may stem from biased consumer perceptions that do not fully realize the actual costs of private vehicle ownership [22]. Moody's 2021 study found that non-use value stemming from the convenience and social status connected to vehicle ownership, however, must also be taken into account to ensure that shared mobility options have non-use value which can ultimately lead to wider spread adoption of shared modes of transportation [22]. Additionally, Kamargianni notes that understanding how to optimize shared mobility services requires an examination of riders' preferences and needs [23]. The researchers conducted a literature review to investigate how services with higher mobility integration appeal to riders and increase demand for these shared services. Overall, the authors conclude that factors such as integrating payment and ticket services and using a single application can be more appealing and convenient to riders [23]. As society becomes more engaged with taking action on environmental concerns and the social and economic issues of urban deterioration and high costs increase, researchers find that shared mobility options can offer solutions to complex challenges if the correct policies, technology, and strategies are implemented.

Economic thinking and planning have shifted increasingly in recent decades toward the concept of sustainability, leading to the sharing economy (SE) concept. [24] Sustainability considers the impact of historical consumption practices, noting that they have promoted environmentally harmful effects that are destructive to the planet. One of the critical obstacles identified as problematic in current economic and consumption patterns relates to individual ownership and access; the SE concept is therefore understood to address issues of access and ownership as a step toward sustainability [24].

While research into the area of SE is growing, there are many gaps, particularly in having concise and precise definitions within academia of what the SE is in detail [25]. There are implications for the government, policymakers, businesspeople, and entrepreneurs [26]. Research is increasingly focusing on the meaning of SE in these different sectors, primarily through the development of role-specific definitions [27].

Role-specific definitions are critical for the SE concept; without them, it is difficult to develop robust business plans that allow SE practices to flourish [28]. The business model notion becomes even more complex in considering the massive growth in the digital economy [29].

### **3. What Are the Benefits of the Sharing Paradigm?**

#### **3.1. Sharing Economy on Vehicles on a Big Scale Would Conserve Energy and Materials**

First, sharing vehicles can help decrease the usage of raw materials and less the effect of accidents. According to the data, 47% of the cost of a vehicle is contributed by raw materials [9]. You might ask: "Why do these raw materials still so much marginally when we have all these mass-producing, efficiency-maximized factories?" Well, 47% of the average car is composed of steel, a resource businesses have grown to compete for in the past few years [9]. Then, you might think: "Why are steel prices so high? Isn't iron one of the most abundant metals on Earth?" Yes, iron is abundant, but it is not just the scarcity of the metal that makes up the majority of its price but the process of producing it.

To better understand why the price of steel has been steadily rising since the 1900s, the process of steel production needs to be addressed [10]. The first step involves blowing up "Taconite," a rugged rock that contains iron, into small pieces [11]. This requires an immense number of explosives to be effective. The second step is transporting the pieces of taconite via "giant dump trucks as big as a house [11]." As you might imagine, these trucks consume fuel like drinking a bottle of water in a desert. The third step is crushing the taconite into marble-sized powder and mixed with water until it becomes "as fine as powder [11]." The last three steps involve separating the iron ore from the taconite, rolling the taconite into pellets, and then transporting these pellets to steel-making factories to be melted into steel [11]. This process includes the extensive use of explosives, gas, water, and lots of electricity. These resources added that "about three times as much material needs to be moved for the same ore extraction as a century ago," all contribute to the gradual rise in steel price (ignoring the price spike of steel during the pandemic) [12]. As steel prices continue to rise with inflation, automotive companies are switching to another metal: Aluminum [13]. Although this metal is known to be the most abundant metal in the world, the cost of forging pure Aluminum with mining sites becoming more and more challenging to excavate on will inevitably raise costs.

Since the unavoidable production costs for each vehicle are here to stay, and essential resources such as petroleum and electricity continue to rise, shared vehicles have to make an appearance on a big scale. As you can imagine, the full adoption of sharing vehicles will reduce the total number of cars both on roads and in total. Because people will not need to own a car to hastily travel to where they desire, a single car will replace dozens of family cars as they are just as convenient. Furthermore, once the production of total automobiles decreases due to the decreasing demand, these raw materials, including steel, oil, and energy, can be incorporated into products outside the automotive industry. This will decrease the cost of commodities, benefiting consumers individually. Furthermore, because we are advocating for private companies such as 'Apple' to manufacture vehicles via mass production, they can cooperate with other companies to distribute raw materials to achieve an even higher production efficiency as the vehicles are essentially homogeneous. All this will allow raw materials to remain relatively constant in price and more cost-effective use of those materials in the production of automobiles.

### **3.2. Sharing Economy Would Decrease Congestion by Using Advanced Technology and Algorithm**

With the continuous improvement of people's quality of life, most travel modes are dominated mainly by private cars because it is more convenient. However, with the continuous development and marketing of automobile enterprises and the continuous increase of people's demand for cars, the saturation degree of cars in the city is constantly increasing. Some more busy cities, such as New York, Los Angeles, and Boston, are stuck in traffic. "Manhattan's daytime population (area of 22.96 square miles) is approximately 3.94 million people and consists of approximately 41% daily commuters, 37% residents, 10% out-of-town visitors, 9% local day-trip visitors, and 3% hospital patients and students [14]." Traffic congestion in New York City has long been a defining feature and ranks the city as the second-worst in the United States and the third-worst worldwide

Traffic flow will naturally increase in relatively developed areas, and relatively remote areas will rarely see traffic jams. "Understanding the link between congestion and the economy is critical to improving the leveraging of transport and land use policy to support more fundamental social objectives [15]." Traffic jams and regional economic development are closely linked. The number of cars in some crowded places will also increase with it. "Large regional economies lead to more congestion, while congestion may impede economic activities by degrading mobility services [15]." The number of cars does not decrease as demand increases. For consumer goods such as

automobiles, we need to take corresponding measures to manage them, because if traffic jams occur constantly, they will also cause great trouble in our daily lives. The efficiency of people traveling can be improved if the traffic is no longer crowded in the future.

The sharing economy will help us solve related problems. Usually, we travel if everyone drives a car, then everyone's vehicles together will change a lot. However, if one more car is used, such as a bus or a shared bike, the overall number of cars will be less, and the frequency of people using cars will also decline. "Empirically, the entry of on-demand ridesharing services can impact traffic congestion through two countervailing effects. On the one hand, providing more convenient, less expensive services and on-demand ridesharing creates a demand-inducing effect by diverting non-driving trips, like public transit, to a driving mode. Hence, on-demand ridesharing could induce additional traffic volume, thus increasing traffic congestion. On the other hand, on-demand ridesharing could reduce traffic via an efficiency enhancing effect [1]." The article shows that if people use ridesharing or choose to take public transportation, the problem of traffic congestion will be significantly improved.

Shared vehicles are already in view, but traffic congestion can be solved by advanced technology and algorithm because it can be an essential factor driving human development. In the future, we can use driverless technology to share our cars. Since then, people's travel efficiency has been dramatically improved because they do not have to drive by themselves and do not park after using their vehicles, thus increasing the utilization rate of the land because the parking lot is no longer in use. Imagine a big city like San Francisco in the future. When driverless cars controlled by an advanced algorithm become mainstream, there will be less congestion and accidents on the road and highways because of unified planning and data collection of the system. An intelligent transportation system (ITS) with a platform for consumers and providers is created to control and allocate all the cars on the road. It would collect all the street data to consider the best way to the destination when those technology companies cooperate with local governments to develop the infrastructure, providing high-speed highways only for driverless sharing cars. Driven by saving more time and money, consumers are more willing to consider new vehicle ideas.

"The development of autonomous vehicles holds a high potential for improving security, reducing congestion, increasing fuel efficiency, and saving time. Various studies on the implementation of AVs predict that fully autonomous vehicles will be available for the public in the 2020s [16]." Driverless cars are likely to be a critical development project in the future of urban planning. If technology is added, people may not use traditional public transportation but brand-new driverless shared cars.

"Autonomous vehicles technology and associated new smart technology platforms intend to disrupt urban mobility patterns. The potential impact of such change on transport networks and the public and private entities shaping these networks raises important questions for transport planning and policy [17]." Perhaps in the future, the technology will be soon, people's life efficiency and traffic jams will be improved.

### **3.3. Sharing Economy Helps Decrease the Expensive Cost and Time Spent on Maintaining Private Vehicles**

In addition to congestion, another severe issue that current transportation contains is spending more time and money on maintenance and inspection. As people's quality of life and needs are improving, more vehicles are appearing in the city. Buying a car does not mean a little awareness of all the problems; we need to do regular maintenance to the vehicle to keep them in everyday use. However, the maintenance measures for electric vehicles and cars that use oil as an energy source are also different. For electric vehicles, electric drives that have been developed for industrial applications are fundamentally different from those for electric propulsion [18]. In essence, EV

drives need high torque and power densities, high efficiency over broad torque and speed ranges, good control ability, high reliability, and free from maintenance. For cars that rely on gasoline, maintenance on gasoline vehicles increases with fuel and time of life. The difference between electric and gasoline cars is that aside from the difficulty of planning routes that include visits to charging stations, the charging decisions made by these stations to introduce further complications. Unlike gasoline refueling, which occurs at the same rate regardless of how complete the vehicle's tank is, battery recharging occurs at different rates depending on the initial state of charge. The charging rate is typically highest when the battery's state of charge is low, decreasing gradually until the battery is fully charged. The longevity of an EV's battery also depends on the charging pattern, including the types of charging stations visited and the extent to which the battery is charged. Fast-charging stations that operate at higher voltages can greatly diminish battery life, as they can perpetually maintain a high state of charge in the battery [19].

The emergence of car sharing is an excellent solution to the problem of people who cannot afford a car or not having the money to pay for expensive maintenance. For instance, a person who cannot afford a car is eager to find a decent job, or a small company requires employees to visit their potential consumers more often. It can benefit from sharing transportation without worrying about expensive fees. We can imagine that when car sharing becomes mainstream, people will no longer have to worry about car maintenance. A particular company will service each car, and we do not have to pay any extra fees. Those companies can do regular inspections and maintenance and collect damaged vehicles. This is because private companies can request funding from the government as they are not receiving any revenue from consumers. The government can use this to show people that they are putting the tax from citizens to good use. At the same time, people will be more willing to pay taxes during trips on shared vehicles if needed. This is just like our shared cars today, where shared cars are maintained by retrieving and repairing them at a specific time each week based on the damage people provide to their vehicles. We pay a tiny percentage of the cost.

For example, each vehicle is equipped with a locator in Changchun, China's Mojitrans car-sharing service. When the car breaks down, or a passenger needs assistance, a person called a car-sharing operator is available to provide timely service. They are assigned several people in each region to perform maintenance and repairs for different situations. In addition, they clean the cars every day. These services and platforms have been created to solve the problem of car maintenance. Sharing services will save consumers time and money on owning and maintaining vehicles. Imagine a future where we have a shared car through the sharing economy, where we can go out and see a shared car, and with only simple program software and steps, we can drive a shared car. We would only have to pay a small percentage of the cost. The shared cars will have fixed parking spots at each location, and someone will check on the cars daily to ensure the passengers' driving experience. People no longer have to worry about maintenance costs and save time on maintenance. We can use shared cars anytime, anywhere to meet our travel needs.

### **3.4. Sharing Economy Helps Improve the City's Infrastructure, Especially the Shortage of Parking Lots**

Besides the high maintenance and long time consumption, another problem that makes a living in big cities heady is the shortage of parking lots. Parking lots take up much space because most people do not use their cars throughout the day. For example, Morris writes that cars are generally parked for 95 percent of the day [20]. This statistic is logical if one considers that on most days, most people use their cars primarily to commute to work and then drive back home. If one assumes that a person's regular commute is 30 minutes each way, that person will use their car for 60 minutes a day, or 1 hour out of every 24 hours. This figure would amount to using one's car 4.2 percent of the time every day, with the car being parked either in one's garage or near one's place of

work for the remaining 95.8 percent of the time. Of course, people may occasionally drive to other places, such as the grocery store or special trips. However, this general car usage is nevertheless accurate for most people on most days. All these parked cars constitute a significant inefficiency insofar as they represent resources not being used to produce value.

Moreover, parking lots take up excessive space precisely because people generally use their cars for less than 5 percent of a typical day, with the car remaining parked in one location or another for the remainder of the time.

Shared mobility options can help address this issue. A key implication of the presence of such options is that they could lead to a significant decrease in rates of private vehicle ownership [21]. Many people may own their vehicles primarily because they need to commute to a few places in their lives for a brief period and would not be able to do so without having reliable access to a car. As such, private car ownership is, to some extent, determined by infrastructure and the transportation options that are or are not available within the context of that infrastructure. This insight is congruent with Moody's finding that car ownership means more to people when the alternative consists of public transportation options that are inconvenient, unreliable, and connotative of low social status [22]. However, one also has reason to believe that people would be more inclined to use shared mobility options if convenient and socially favorable options were available. To address the problem of excessive space taken up by parking lots, it is necessary to develop transportation options that can satisfy people's needs to the point that they believe using those options outweighs the benefits of having their cars. For instance, the government could build a speed-up highway especially for sharing vehicles, which can also solve congestion since the total number of cars will decrease. Some of the benefits of private vehicle ownership are material or practical, with the sense of freedom and the possibility of having one's vehicle being very important for people even if, in practice, they leave their vehicles idle and parked for more than 90 percent of the time [22].

Shared mobility options could help tip the scales toward people shifting away from private car ownership. These options would undoubtedly assist with reducing the need for parking space since this model would result in more vehicles being active for more of the time during any given day. For example, under a shared mobility scheme, a person might wake up in the morning and find a parked car (not their own) on their block. They may then drive the car to work and park for the day, at which point someone else could use that vehicle to run their errands and pursue their affairs. Then, when the first person finishes their workday, they would commute back to their home in a different vehicle from the one they drove in the morning, potentially with other commuters who are also going in the same direction. This type of system would help address the problem of parking lots requiring excessive space since the system would help keep more cars mobile for more significant parts of the day. As such, the system would minimize the need for parking space, which could allow for the development of smaller parking lots calibrated in size to reduce parking demand.

For this type of system to be successful, however, governments at both the municipal level and higher may need to invest resources in developing adequate infrastructure. Shared mobility options are affected by network effects. They become more valuable as more people use the options and as urban environments are developed, assuming that shared mobility options rather than individual car ownership will be the norm [23]. Reducing the need for parking space will require congruence between both public-level investments and individual-level decisions. However, technological features may help facilitate more efficient parking solutions in urban areas. Energy, time, and money are wasted with inefficient parking systems. It benefits all involved to find viable solutions to these joint problems.

Additionally, the increase in private car ownership leads to congestion by increasing the number



of cars traveling on the roads or streets at any given moment, which produces more traffic jams [24]. Shared mobility can help solve this problem by reducing the number of cars on the roads and streets, making traffic flow more smoothly and quickly. Private car ownership exacerbates environmental pollution by producing more carbon emissions and smog due to the higher number of cars [24]. Shared mobility can help solve this problem by reducing the number of cars that are being operated, thereby reducing the total amount of carbon emissions collectively emitted. Encouraging the shared mobility trend through driverless electric vehicles, which take up less space, can also be important. Driverless electric vehicles can help individuals explore and transport themselves through large cities. Significant companies like Lyft are participating in facilitating this trend and expanding it through more cities [25]. Thus, it is a trend that can revolutionize transportation by reducing or eliminating the pollution caused by private car ownership.

### **3.5. What Would a Future with Sharing Economy Look Like: A Transformed City**

From a technical standpoint, the shared vehicles we are trying to advocate for are driverless, electric vehicles that can accommodate multiple passengers simultaneously. So we are looking at a society with most, if not all, vehicles available for sharing with a network of calculations between individual vehicles.

In this world, people travel around the cities every day efficiently and are surrounded by a pollution-free atmosphere (or at least one in which pollution is minimized). This efficiency is due to the algorithms that allow vehicles to roam around the city without traffic lights. In addition, the clean environment is bolstered by the separation of fuel production (from internally produced energy in the car using gasoline to externally generated electricity from distant locations) and the reduced heat production from fewer cars on the road.

This new world will have thinner roads and fewer parking lots in terms of public infrastructure. The width reduction for roads can be tolerated as driverless cars do not require space to make up for potential mistakes (sudden braking from the car in front or sudden change of lanes from a car on the side). The total number of parking lots can also be reduced as driverless cars allow for more compact storage of vehicles when unused. The middle lane of a typical parking lot would become unnecessary as the cars will drive themselves to the passengers instead of the other way around.

Regarding the ownership of these shared vehicles, they do not have to be owned by just a few private companies; individual households can also own them. Imagine a middle-class household where they would not be able to own a luxury SUV in the current paradigm. They would, however, be able to own one in this new society of shared vehicles due to the automatic revenue generation from sharing their vehicle during weekdays. Additionally, they could travel on weekends in their SUV instead of renting one expensively. Of course, they must take care of their vehicle every day in terms of cleaning and fueling it, but owning the ever more popular personal solar panels for charging at night would eliminate the need to pay for electricity. Besides, the weekly revenue generated would most likely cover the cost of hiring a professional cleaner to take care of the hygienic aspect of the vehicle.

In short, the broad adoption of these shared vehicles will provide for a cleaner urban environment, a more incredible speed for traveling in the city, more space for parks because of thinner roads and more compact parking lots, and last but not least, the exclusive ability to own a revenue-generating luxurious vehicle for those who still want to own a car for themselves.

## **4. Conclusion**

You might ask: "Why haven't we adopted this new transportation paradigm?" There are two answers to that question. The first answer is that we are simply not technologically advanced

enough to create "fully autonomous" vehicles. Several companies have achieved outstanding results regarding the vehicles' ability to recognize objects in a fraction of the time during high-speed driving. However, once conventional references such as lines on the road are taken away, such vehicles struggle to drive safely and smoothly. The other answer is about the psychology of the human mind. Many of us still want to own a private sports car or simply travel alone without others in the same car. Although this thinking is not wrong by any means, it is undoubtedly an obstacle we have to overcome when considering both the environmental and societal benefits that the sharing transportation paradigm can bring.

In the present, we should continue to develop better versions of "autonomous" vehicles until we truly get to "fully autonomous", and people around the world should start to consider this new paradigm of shared transportation as a real possibility shortly.

## Acknowledgment

Yuchen Lin, Zi Wang, Guangyu Ma, Zilong Ji, Ziang Qu contributed equally to this work and should be considered co-first authors.

## References

- [1] Li, Z., Liang, C., Hong, Y. and Zhang, Z., 2021. How Do On-demand Ridesharing Services Affect Traffic Congestion? The Moderating Role of Urban Compactness. *Production and Operations Management*, 31(1), pp.239-258.
- [2] Ihsaan Fanusie (2021) Raw material costs rising for automotive industry: BofA report. <https://finance.yahoo.com/news/raw-material-costs-rising-for-automotive-industry-bof-a-report-172812315.html>.
- [3] ABC News, March 26, 2021, Suez Canal blockage sends shipping, oil rates surging as oil and gas tankers diverted. <https://www.abc.net.au/news/2021-03-27/suez-canal-ever-given-blockage-sets-shipping-rates-surging/100032888>.
- [4] INRIX (2019) Congestion Costs Each American 97 hours, \$1348 A Year. <https://inrix.com/press-releases/scorecard-2018-us/>.
- [5] Transportation for America. (2020) The Congestion: How more lanes and more money equals more traffic. <https://t4america.org/wp-content/uploads/2020/03/Congestion-Report-2020-FINAL.pdf>.
- [6] Emily Delbridge (2021) What Is the True Cost of Owning a car? From the balance <https://www.thebalance.com/true-car-ownership-costs-4165784>.
- [7] Litman Todd (2000) Evaluating Carsharing Benefits *Transportation Research Record Journal of the Transportation Research Board* 1702(1):31-35 DOI:10.3141/1702-04.
- [8] Jiabin Li, Xumei Chen, Xin Li, Xiucheng Guo (2013) Evaluation of Public Transportation Operation based on Data Envelopment Analysis *Procedia - Social and Behavioral Sciences*, Volume96,2013,Pages148-155,ISSN1877-0428.
- [9] Yahoo! (n.d.). Raw materials – the biggest cost driver in the auto industry. Yahoo! Finance. Retrieved August 18, 2022, from <https://finance.yahoo.com/news/raw-materials-biggest-cost-driver-180628123.html>.
- [10] Iron Ore - Historical Statistics (Data Series 140) U.S. Geological Survey. (n.d.). Retrieved August 18, 2022, from <https://www.usgs.gov/media/files/iron-ore-historical-statistics-data-series-140>.
- [11] Iron Mining Process. Minnesota Iron. (2018, January 31). Retrieved August 18, 2022, from <https://minnesotairon.org/education/iron-mining-process/>.
- [12] Guardian News and Media. (2014, October 24). Iron ore and rare earth metals mining: An industry under siege? *The Guardian*. Retrieved August 18, 2022, from <https://www.theguardian.com/sustainable-business/2014/oct/24/iron-ore-rare-earth-metals-mining>.
- [13] Maverick, J. B. (2022, July 13). What raw materials do auto manufacturers use? *Investopedia*. Retrieved August 18, 2022, from <https://www.investopedia.com/ask/answers/062315/what-types-raw-materials-would-be-used-auto-manufacturer.asp>.
- [14] Baghestani, A., Tayarani, M., Allahviranloo, M. and Gao, H., 2020. Evaluating the Traffic and Emissions Impacts of Congestion Pricing in New York City. *Sustainability*, 12(9), p.3655.
- [15] Sweet, M., 2013. Traffic Congestion's Economic Impacts: Evidence from US Metropolitan Regions. *Urban Studies*, 51(10), pp.2088-2110.

- [16] López-Lambas, M. and Alonso, A., 2019. *The Driverless Bus: An Analysis of Public Perceptions and Acceptability*. *Sustainability*, 11(18), p.4986.
- [17] Legacy, C., Ashmore, D., Scheurer, J., Stone, J. and Curtis, C., 2018. *Planning the driverless city*. *Transport Reviews*, 39(1), pp.84-102.
- [18] Zhu, Z. Q. and Howe, D. (2007) 'Electrical machines and drives for electric, hybrid, and fuel cell vehicles', *Proceedings of IEEE*, 95, 746–765 (DOI: 10.1109/JPROC.2006.892482).
- [19] Klabjan, D. (2014, May 25). *Finding Minimum-Cost Paths for Electric Vehicles*. Klabjan. [https://www.academia.edu/4621733/Finding\\_Minimum\\_Cost\\_Paths\\_for\\_Electric\\_Vehicle](https://www.academia.edu/4621733/Finding_Minimum_Cost_Paths_for_Electric_Vehicle).
- [20] Morris, D. Z. (2016, March 13). *Today's cars are parked 95% of the time*. *Fortune*. <https://fortune.com/2016/03/13/cars-parked-95-percent-of-time/>.
- [21] Machado, C. A. S., de Salles Hue, N. P. M., Bessaneti, F. T., & Quintanilha, J. A. (2018). *An overview of shared mobility*. *Sustainability*, 10. <https://10.3390/su101243242>.
- [22] Moody, J., Farr, E., Papagelis, M., & Keith, D. R. (2021). *The value of car ownership and use in the United States*. *Nature Sustainability*, 4, 769-774. <https://www.nature.com/articles/s41893-021-00731-5>.
- [23] Kamargianni, M., Li, W., Matyas, M., & Schäfer, A. (2016). *A critical review of new mobility services for urban transport*. *Transportation Research Procedia*, 14, 3294-3303. <http://doi:10.1016/j.trpro.2016.05.277>.
- [24] Dizikes, P. (2021, June 8). *Trying to put the brakes on car ownership*. *MIT News*. <https://news.mit.edu/2021/car-ownership-china-0608>.
- [25] Guzman, J. (2022, August 16). *Lyft, Motional roll out new fleet of driverless electric vehicles in Las Vegas*. *The Hill*. <https://thehill.com/changing-america/resilience/smart-cities/3604194-lyft-motional-roll-out-new-fleet-of-driverless-electric-vehicles-in-las-vegas/>.
- [26] Curtis, S. K., & Lehner, M. (2019). *Defining the sharing economy for sustainability*. *Sustainability*, 11(3), 567.
- [27] Ritter, M., & Schanz, H. (2019). *The sharing economy: A comprehensive business model framework*. *Journal of Cleaner Production*, 213, 320-331.
- [28] Sutherland, W., & Jarrahi, M. H. (2018). *The sharing economy and digital platforms: A review and research agenda*. *International Journal of Information Management*, 43, 328-341.