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Study on the Failure of Autonomous Mobility in World Network Cities

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Abstract

Globalized cities are currently showing changes due to autonomous driving (AD). It is also maximizing globalization connections in cities where autonomous mobility is as complex as AD. The purpose of this study is to reveal that cities that realize AD and mobility will grow into globalized cities. Several cities, including New York and Shanghai, have attempted and are in progress, but failed cities are increasing. Although the technology of AD and the trust of citizens are prioritized, the city that has built the city's infrastructure is expected to be a city that has succeeded in AD. This is because commercialized cities or AVs will become hubs for mobility globalization, excluding rapid climate change or AV companies, and empirical analysis has been conducted that if AVs fail in metropolitan New York due to urban complexity (population density), urban economy size (GRDP), patents, number of consumers, infrastructure public EV chargers, and road quality. It examines whether the realization of AD by region and country affects overall national innovation. As a result, even if AV succeeds in large cities such as New York, Seoul, which has a higher population density (complexity), has a negative meaning, and a more similar Tokyo has a positive meaning. It can be seen that regional research on AV should also be prioritized in large cities such as Shanghai. This means that in order for AV to be realized in each city, the construction of AI infrastructure data must be actively changed to establish globalization of cities for economic growth as autonomous mobility.

Keywords: *Reliability, Safety, AV, Mobility, AI, Globalization, AV-City*

1. Introduction

Currently, New York is one of the most important cities in the world in terms of international networks and mobility globalization. Both large cities are a collection of people of various cultures and languages, making it an ideal place for international business and cultural exchange. In addition, all large cities have excellent transportation systems, making it very convenient to travel inside and outside the city. Traffic congestion is currently a problem, and an AV (autonomous driving vehicle) system can be installed and meta-analysis at the same time connected to escape it [1]. Still, AV safety and unexpected accidents occur in the process of realizing AV completely. But there are also some important differences between cities. In a way, New York is an older city than Shanghai in Asia, and is the financial and cultural center of the United States. New York, founded by the Dutch in 1624, has a history dating back about 100 years before Shanghai, which was established by the

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Qing Dynasty in 1700. New York played a pivotal role as a European arrival point in North America and later served as the capital of the United States, becoming a significant political and economic hub. Over time, it evolved into a diverse international city, embracing various cultures and languages. Similarly, Shanghai held importance as a major port even prior to its formal establishment. Situated at the confluence of the Yangtze River and the Yellow River, Shanghai served as a crucial link between inland China and the sea. With fertile land and abundant resources, it was already prosperous. Following its opening in the late 19th century, Shanghai underwent rapid development, emerging as a vital center for China's economy and politics. Its growth continued, transforming it into a prominent global trade hub by the 18th century. New York City is a good city to live in, although it is complicated and difficult in many ways when looking at the conditions of course of mobility urbanization. In New York, various cultures and people can gather to share new experiences. Also, since New York is the center of the global economy, there are many jobs and many opportunities. After living in New York, it has a charm that is incomparable to other cities. Large cities aim to globalize mobility in third spaces. The paper can look at the central cities of New York and Shanghai in G2 countries. Due to the construction of canals and railroads in the past, international cities such as New York and Shanghai have grown through connections outside the city. However, the establishment of AVs and mobility is used as a third space (mobility house) in the city through connection inside and outside the city. It will also realize hyper-connectivity by moving goods between cities and cities through AD. This is because cities where autonomous-driving vehicles commercialized mobility will be hubs for globalization [2], major companies studying autonomous-driving are Tesla (US), Cruise LLC (US), Uber Technology (US), Lift (US), Waymo (US), Aptiv (Ireland), Baidu (China), Diddy Chuxing (US), Germany (US), AutoX (US), Pony.ai Germany (US), AutoX. In the future, cities will pursue globalized cities by supplying large amounts of energy and establishing AV mobility technologies in preparation for the rapid expansion of users with electricity obtained from various regenerations using hydrogen.

2. Prior Research

2.1 Methodological Modeling

Existing studies deal with changes caused by AD in globalized cities, but the need for this study is that autonomous mobility in complex cities maximizes globalization connections. As of 2023, the number of cities where Tesla's Full Self-Driving (FSD) is used as AVs (autonomous driving vehicles) is the United States (129), Canada (3), Australia (1), Germany (1), Belgium (1), and unidentified regions (2). Existing studies have focused on the importance of social science research aspects related to autonomous vehicles, and aimed to provide the research community with a foundation for further research that can effectively combine neuroscience with traditional investigative methods. To this end, it is important for companies that develop autonomous-driving vehicles to innovate in consideration of potential passenger needs, desires, and fears. In addition, social support essential for the absorption of AD technology cannot be achieved without understanding potential consumer attitudes toward new technologies. Accordingly, before the test run, the functional aspect of the vehicle was mainly more predictive of the intention to use, while emotional factors became dominant after the test run. Therefore, it is essential to consider an individual's actual experience based on becoming a passenger in an autonomous vehicle. Also, creating policies without personal experience can be easily misleading. Finally, since field emotions are difficult to evaluate, neuron-scientific measurements were conducted by complementing existing methods [3].

AV can be seen in demanding driving environments such as New York, Seoul, and Tokyo in Asia. Consider a situation that is important for communication with blind spots in the city. To identify such a situation, we first simulate a multi-agent perspective on a real-world self-driving dataset, and secondly propose a way to find difficult scenarios for isolated agents and thirdly reinforce the scenarios with adversarial obstacles. This means that bandwidth-efficient and uncertainty-aware methods reduce the collision rate by up to 62.5% compared to a single agent baseline [4]. Another study applies a classical central city model to consider three key topics related to the widespread adoption of autonomous-driving vehicles: sprawl, energy consumption, and housing economics, AVs have been modeled to reduce marginal commuting costs and, in some cases, demand for urban and residential parking. This leads to sprawl in some models and creates opposition forces that increase density in others. These research models pointed to increased welfare but pointed to increased energy consumption due to longer commuting, greater traffic congestion, and higher productivity, raising questions about autonomous-driving vehicles saving energy. In most models, AVs make outer areas accessible quickly and lead to greater housing economics by reclaiming land previously used for parking. The impact of AV on cities is significant and depends on how this new technology is implemented [5]. In order for existing research to be possible, autonomous mobility must be realized. However, as of 2023, complete AD is failing. However, it is believed that it is partially by 2030. The following prior research evaluated the social and economic extended life cycle of the aforementioned vehicle types to identify, classify, and systematize the possible negative effects of automobile driving technologies in regional (urban logistics) and global (world ecosphere) environments. It was confirmed that there was a difference in the regional and global induced negative effects of the new driving technology. The rebound effect considering the local urban logistics environment and global impact was mostly based on energy consumption. In our previous work, we have identified and analyzed the indirect recoil effects from the impending adoption of AVs related to urban logistics development or global environmental systems [6]. Although AD is being developed and implemented using numerous AIs, Microsoft's open-chat GPT and Google's bad still have problems applying them to autonomous mobility in the problem of providing answers even if they are false information. In response, the paper can look at the research that occurs when complex cities and logistics proceed autonomously through AI systems. Advances in sensor technology, mobile network technology, and artificial intelligence have broadened the boundaries of various vertical fields such as eHealth and AD. Planning and decision-making techniques in AD become much more challenging due to the diversity of dynamic environments in which vehicles operate, uncertainty in sensor information, and complex interactions with other road participants. Methods to deal with high-level decision-making in complex and uncertain urban environments are relatively less explored areas. Autonomous-driving vehicles are comprehensive intelligent systems that incorporate technologies for environmental understanding, route planning, decision making, and motion control. AV's decision-making system plays an important role in performing safe and efficient maneuvers [7]. As of May 25, 2023, there were a total of 10 accidents in the Shanghai AI autonomous driving service. Of these, seven were minor accidents, and three were serious accidents. Minor accidents were mainly car-to-passenger contact accidents. All of the serious injuries were accidents involving cars and bicycles. Shanghai AI self-driving service started in October 2021. A total of 1 million passengers have boarded since the service began. The accident rate is very low at 0.01% per 1 million passengers. The city of Shanghai is still in its early stages of development. As this service continues to develop, the accident rate is expected to decrease further. A safe AV is possible if you don't get hurt in the event of an accident. However, a fully secure AV is practically impossible. AV still consists of software and hardware and cannot prevent all accidents. In addition, AVs, like human drivers, can be affected by the behavior of other drivers. However, AVs can recognize and react to the surrounding environment faster than human drivers, reducing accidents. In addition, AVs can reduce accidents, alleviate traffic congestion, and increase energy efficiency in a more accurate and predictable way than human drivers. However, there are still many challenges for AV to be commercialized safely. To this end, it is essential to build urban mobility and to build a platform infrastructure through AI for anyone in a place where hydrogen or electricity is charged and preserved in the region. Existing papers have designed a simple empirical rule.

2.2 Prior Case Analysis

Table 1 predicts an increase in AV test cities by 2030 as the size of the global AD market increases. By 2030, from 68 cities in 2021, it will be 10 times larger to 672 cities.

Table 1. Global AVs Market Size & AV testing cities (Statista, 2023[9] &author)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
sizee($bil)	106	148	206	288	403	565	793	1116	1572	2218
AV cities	68	85	100	137	175	226	293	384	507	672

1) Research Hypothesis

H1: Improvements in urban transportation infrastructure will have a positive impact on the realization of autonomous mobility. H2: Strengthening control is necessary to increase the safety and efficiency of AV technology. H3: Privacy needs to be guaranteed for urban residents to accommodate the AV of AI decision making.

2) Research Base

For an autonomous city to succeed, research is based on H1 of the above three hypotheses. These hypotheses are essential for urban globalization by connecting urban and urban logistics through AD. If AVs are not reliable and safe, people will not use AVs. If AVs are not efficient, self-driving cities will fail due to traffic congestion and increased fuel costs. If AVs are not cheap, self-driving cities are not attractive to the public. Self-driving cities are in their early stages, but their development potential is significant, and if they succeed, they will revolutionize transportation, the environment, and the economy.

3. Globalization of AV Connectivity and Mobility

3.1 Urban Case of AV Failure

Tesla has been developing self-driving car (AV) since 2016, but they have yet to be commercialized. Tesla's AVs are being tested in several cities, including the United States, Europe, and China, but they are still not perfect. The cities where Tesla's AV failed are as follows. San Francisco and Pittsburgh, USA: San Francisco is the first city where Tesla's self-driving car was tested. However, San Francisco and Pittsburgh also suffered from Tesla's AVs due to complicated terrain and weather. China's Shanghai Tesla is working with a local company to test AVs in Shanghai, China. However, like San Francisco and Pittsburgh, Shanghai suffered from Tesla's AVs due to complicated terrain and weather. The reason why Tesla's AV failed was that Tesla's AV was still in the early stages of development. Tesla's AVs are not suitable for complex terrain and weather. Tesla's AVs have difficulty recognizing various means of transportation in the city, including pedestrians, kickboards, skateboarders, bicycles, and electric motorcycles. Tesla's AVs did not grasp the city's ability to cope with unexpected situations such as road construction, construction sites, and events. In order for Tesla's self-driving car to succeed, these challenges must be solved. San Jose, California, USA, one of the cities where Tesla's self-driving vehicles failed the most, is the city where Tesla's self-driving vehicles have been tested the most, but at the same time, it is the city where self-driving cars (AVs) have caused the most accidents. From

2019 to 2021, there were a total of 12 accidents caused by Tesla's self-driving car in San Jose, which killed two people and injured 13. Another city where Tesla's self-driving car failed is Austin, Texas, USA. Austin is the city where Tesla's self-driving cars (AVs) were tested the second most, but like San Jose, it is the city where AVs caused accidents. From 2019 to 2021, there were a total of nine accidents caused by Tesla's self-driving car in Austin, which killed one person and injured 10 others. What this failed city has in common is that it has a lot of traffic, a variety of weather conditions, and a lot of pedestrians and cyclists. These cities are very complex for AVs to drive, and many technological advances are still needed to enable AVs to cope with all situations. Other self-driving developers test to solve unexpected problems, but they are predicting and giving up in the distant future if they are to be commercialized.

3.2 New York, AV City

From the mathematical analysis of the above policy, it can be seen that autonomous mobility expansion and smart cities can be affected. Mobileye (Intel's self-driving subsidiary) has expanded its global AV test program to New York City, the U.S. Starting with Israel, which is based in 2018, Mobileye is conducting a test program for AVs in Munich, Germany, in 2020, and has expanded to Detroit, Shanghai, Tokyo, and Paris, starting with New York in the U.S. The test vehicle is equipped with a 5th generation integrated semiconductor called EyeQ5 and has 8 driving and 4 parking cameras. It is a system similar to Tesla's camera vision that allows AD with only cameras without radar or lidar sensors. The Mobile Eye is currently the only self-driving vehicle in New York City that has been approved for test driving. Mobile Eye plans to start commercial robot taxi services in 2025 after sufficient testing and technology maturity. New York City is the largest city in North America and the most difficult city to drive in the world. This is because there are many complex road structures, many pedestrians, cyclists, and aggressive drivers. Mobile Eye is trying to prove its self-driving technology capabilities by testing self-driving vehicles in a challenging environment and commercialize AVs.

3.3 Analysis of AV City Construction

Is the failure of AVs in the old city center possible from the point of view of building a new autonomous mobility city? Because old cities have different characteristics from existing urban infrastructure, the introduction and operation of AVs presents challenges and considerations. Therefore, in the event of a failure or difficulty in AVs, it can be approached from the perspective of constructing a new autonomous mobility to improve and solve it. The construction of new autonomous mobility restructures and upgrades the old city's roads, transport infrastructure, communication systems and more. For example, in old downtown areas, safety and reliability can be enhanced by improving the structure and arrangement of roads and signs, strengthening communication infrastructure, and improving lane recognition and crosswalk detection systems. The construction of new self-driving mobility can help the failed operation of AVs alleviate traffic congestion and maintain efficient traffic flow. However, it is an evaluation of infrastructure construction costs, technology regulations, and citizen acceptance. From a long-term perspective, new city construction may not be desirable as companies, customers, and governments prefer AVs where AD can be done anywhere. Therefore, the development of an AV that is usable and safe in any city is a very important condition. To this end, industry, government and academia must continue to invest in the research and development of safe AVs, and develop safe AD technologies that are regulated and mitigated.

3.4 Study on the Economics of Autonomous Mobility

Shanghai Automotive introduced SAIC Mobility Robotaxi, a Level 4 AD platform, in December 2021. This data-driven initiative explores Level 4 AD technology for urban mobility with 15,000 test environments, including autonomous highway driving and 926 test roads. Robotaxi, equipped with advanced AI and AD solutions, aims to accelerate AD technology development in China and potentially reduce traffic congestion and carbon emissions [8]. It is too early to say that Robotaxi has been successfully operating since December 2022. SAIC Mobility Robotaxi's success is attributed to its early adoption of L4 autonomous driving technology, partnership with Momenta, and extensive testing.

Table 2. Regulation to the adoption of AV& Energy (McKinsey, 2021[9,10] & author own)

	N, America	Europe	Asia	Startup	Incumbent
Customer demand	19	6	18	17	12
Regulation	52	70	55	58	61
Technology	29	24	27	25	27
AV energy system	Y	Y	N	-	-

China's self-driving industry is developing rapidly, and the size of China's self-driving vehicle market will reach 100 billion yuan (approximately 16.5 trillion won by 2025). For example, Baidu is focusing on AV software development, while Xiaofeng and Nio are working on AV production. Geely Motors Zicker is collaborating with Google Waymo to develop self-driving electric vehicles for ride-sharing. In addition, Chinese companies are setting up self-driving test zones across China to test self-driving vehicles.

3.5 Corporate Perspective

The above study aims to explore the possibility by comparing cities that cannot implement AD level 4. No city has fully realized AD yet. However, in some cities, AVs are operating in limited areas. For example, in California and Nevada in the United States, AVs have been licensed to operate in certain areas. In addition, self-driving taxis operate in Shanghai, China. However, in order for AVs to be fully realized, there is a major problem to be solved. For example, AVs should be able to recognize and cope with complex traffic environments. This is because AVs must be safe and reliable. If these problems are solved, AVs can help reduce traffic congestion and improve safety. In addition, self-driving vehicles can create new business opportunities and contribute to economic growth. Over the past five years (2016-2020), a total of 664 patents have been filed with the Intellectual Property Office (IP5) in Korea, the United States, China, Europe, and Japan. The U.S. applied for 239 cases (36%), China 118 cases (17.8%), South Korea 100 cases (15.1%), Israel 89 cases (13.4%), and Japan 81 cases (12.2%). Israel's Mobile Eye (88 cases), which has major camera and artificial intelligence (AI)-based AD technology and is testing AD in New York, is the largest number of applicants. In Korea, Hyundai Motor ranked eighth (17 cases) and the Electronics and Telecommunications Research Institute and Samsung (9 cases each) ranked 15th. As a result, Korea ranked third in the world in the field of self-driving precision maps.

4. Empirical Analysis and Results

4.1 Mobility Globalization Analysis

Based on literature studies on mobility and globalization above, the hypotheses in Chapter 2 may be related to each other. From this point of view, the integration of urban transportation infrastructure affects the realization of AD mobility, and it may be related that strengthening control and protecting personal information are necessary to trust in the safety and efficiency of AD mobility. Therefore, these hypotheses are related to each other and take into account various aspects of dealing with AD mobility. The introduction and main body compare New York and Shanghai because they are important cities in G2 countries, but the analysis includes Seoul and Tokyo because they are one of the representative cities actively introducing AD technology in relation to the development of AV (AD) technology. Therefore, it is possible to obtain meaningful research results to analyze the data of these cities and evaluate the possibility of AD technology.

4.2 Empirical Analysis

Based on the above AV-compared national data, the possibility of large cities (central cities) growing into autonomous mobility cities was analyzed. National policy and legislation, legislative score/4, technology and innovation companies, AV headquarters, patents, consumer acceptance, annual search volume difference: per million, infrastructure: public EV chargers, road quality /10, etc., were used in multiple regression analysis using Confused.com and OECD data. Among them, factors that are not directly related to the transition to autonomous mobility, such as national policy and legislation, legislative score /4, AV headquarters, and AV companies with investments of more than $50 million were excluded. In addition, environmental factors due to rapidly changing climate change in each city were excluded. It surveyed Korea, the United States, and Japan.

When comparing New York and Asia, the center of globalization in preparation for AV, Asia (Seoul in Korea, Taoism in Japan) was analyzed by adding urban complexity (population density) and urban economic size (living level). Data: Patents, consumer acceptance (difference in search volume per million per year: infrastructure: public EV chargers, road quality /10, included data: urban complexity (population density), urban economic scale (GRDP), etc

-Independent variables: Seoul, Tokyo, -Dependent variables: New York

United States, New York = - 1,828.1089 - 3.1885 * Korea, Seoul + 9.9620 * Japan, Tokyo (1)

Table 3. AV analysis for cities

Regression Statistics					
R	0.9990	R^2	0.9979	Adjusted R^2	0.9965
MSE	9,791,579.3076	S	3,129.1499	MAPE	253,362.5458
DW	1.1717	Log likelihood	−54.7253		
AIC	19.2418	AICc	19.9084		
BIC	19.1376	HQC	18.8250		
PRESS	1.4777E+10	PRESS RMSE	49,627.1333	Predicted R^2	−0.0541

United States, New York = − 1,828.1089 − 3.1885 * Korea, Seoul + 9.9620 * Japan, Tokyo

	Coefficients	Std Err	LCL	UCL	t Stat	p-value	H0 (5%)	VIF	TOL	Beta
Intercept	−1,828.1089	1,635.8292	−7,034.0475	3,377.8297	−1.1175	0.3452	Accepted			

Korea, Seoul	−3.1885	0.4544	−4.6346	−1.7424	−7.0170	0.0059	Rejected	19.1428	0.0522	−0.8114
Japan, Tokyo	9.9620	0.6502	7.8926	12.0314	15.3204	0.0006	Rejected	19.1428	0.0522	1.7715

Figure 1. Judging from the fact that Predict Y is biased to the upper and lower coordinates, it shows that AV mobility should be carried out in a different negative and positive relationship between Seoul and Tokyo.

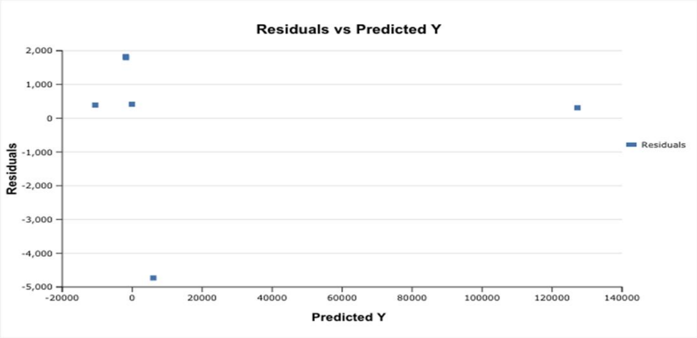

Figure 1. Residuals vs. Predicted Y

This is to evaluate the success of AV by comparing Seoul and Tokyo in Asia, and Shanghai can be compared when Chinese data are released in the future. The purpose of the analysis is simply to understand the correlation between the characteristics of Seoul and Tokyo and the probability of AV success in New York. In other words, it is intended to analyze how variables in Seoul and Tokyo affect the AV success of New York. Through this, it is possible to find out what advantages Seoul and Tokyo may have in introducing AV or whether there are areas to challenge. Therefore, it aims to show the correlation between the characteristics of Seoul and Tokyo and the probability of AV success in New York. The analysis results can provide insight into what factors Seoul and Tokyo should consider in introducing AV, such as population density (complexity). Based on the above results, the "Japan, Tokyo" independent variable has a statistically significant positive effect on the relationship with New York. This rejects the null hypothesis and accepts the alternative hypothesis. Therefore, Tokyo is more likely than New York when it comes to AV success. On the other hand, the "Korea, Seoul" independent variable has a statistically significant negative effect on the relationship with New York. This rejects the null hypothesis and receives an alternative hypothesis. Therefore, regarding the possibility of AV success, it is concluded that Seoul is less likely than New York.

4.3 Summary and Limits

Seoul and Tokyo cities will compare and analyze data to realize AD around New York to reveal that there are differences in possibilities. Based on this, the paper aims to present different feasibility of AV in other large cities such as Shanghai. The following data can be demonstrated through analysis with this data. First, accident occurrence data: Responsibility for accidents related to AVs and responsibility data for accident types (whether manufacturers, drivers, or carriers) should be transparent. This is because this data can determine the frequency and type of accidents. Second, user experience data: Data on citizens' experiences using AVs should be accumulated. This represents user satisfaction, reliability, convenience, etc. Third, traffic and road data: Data related to traffic flow, road conditions, and traffic signals are required to understand the interaction between AVs and urban transport infrastructure. This allows you to analyze the efficiency and traffic congestion of autonomous vehicles.By analyzing the above data, you can gain insights on the safety of AD, user reliability, and traffic efficiency. Various analysis methods and techniques can be used to analyze and visualize corresponding data. However, it is important for various cities to identify factors such as environment and climate and generalizing them is limited because it is difficult. However, it can be an important variable in comparing the possibilities of mobility.

5. Conclusions

This study reveals that New York's autonomous mobility urbanization affects national development and other cities. However, even if AV is successful in New York, I can prove that it is unlikely to be well realized even in other large cities such as Shanghai, just as Seoul and Tokyo showed negative and positive values. Future AV cities need to respond to changes in consumer acceptance, public EV chargers, road quality, urban complexity, urban economic scale, and infrastructure. The conclusion that autonomous vehicles are more feasible on highways than in large cities, when compared to New York, suggests that the variable for a major city like Seoul has a statistically significant negative impact on the relationship with New York. This could imply that the feasibility of autonomous vehicles in large cities, including Seoul and potentially Shanghai, may be lower compared to New York. However, it's important to conduct a specific analysis for Shanghai or any other city to confirm whether similar trends hold true for those locations. This change in the consciousness of urban citizens is also very important for the policy of AI autonomous vehicles. As the empirical results, To realize AV mobility in Korea, urban citizen acceptance should precede infrastructure investment, which can lead to urban globalization.

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