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Transforming Current Transportation Paradigm

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Abstract: It has been a long discussion that the current transportation paradigm is getting more negative in people's lives. Many people have complained about the traffic jams, air pollution, and over-use of natural resources. This study aims to analyze the problems of the current transportation paradigm and try to come up with specific solutions to form a new transportation paradigm. Does the question include the main issues that cause the current paradigm to become less effective and damaging? What new technology can help to change the old paradigm? What can economy type be helpful for the new paradigm? It is essential to tell people how serious the issue is and what they can do to improve it.

Keywords: transportation paradigm, traffic congestion, global warming, emissions, environment, driverless car, new energy vehicles, parking lots

1. Introduction

The current transportation paradigm has many problems that should be focused on and solved. There are four aspects of problems that will be discussed. Each affects people's living qualities from different perspectives, and there should be specific solutions to handle them.

First of all, traffic congestion is a severe problem that is related to and affect people's daily life. That is to say; traffic congestion means that more vehicles are attempting to use a road facility than the facility can handle without causing more than acceptable levels of delay or inconvenience [1]. When too many motor vehicles occupy the same road system, traffic slows down and may stop altogether. In industrialized countries, roads leading to cities become congested as more people own cars. For example, in the United Kingdom, highway traffic doubled between 1983 and 1993 [2]. Regardless of the level of development, traffic congestion is a growing problem worldwide, and everything indicates that it will continue to worsen, which is undoubtedly a threat to the quality of urban life. Its main manifestations are longer journey times, more significant uncertainty in arrival times, increased fuel consumption, other operating costs, and pollution compared to uninterrupted traffic flows [3]. According to the data from the US department of transportation, in the United States, from 1982 to 2003, the duration of congestion increased from 4.5 hours to 7.0 hours per day, and congestion intensity increased from 33% to 67% of highway trips. Over the past 20 years, congestion intensity, measured by the average delay penalty (additional travel time per day due to congestion), has increased

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from 13% to 37% [4]. Thus, it turns out that congestion will continue to worsen without decisive policy changes. Traffic congestion is a critical issue because it brings a lot of adverse effects on people's lives, including economic growth, which means the increased transportation costs due to traffic congestion often increase the cost of goods and services produced within the city, resulting in a loss of competitiveness in international markets, deterioration of quality of life, detrimental effect on environmental quality in particular air quality and noise pollution, anti-social behavior and so forth. Therefore, people need some new ways to travel mode to change the above situation.

Second, warming has been a severe phenomenon in recent years, and global warming is closely related to greenhouse gas (GHG) emissions, especially carbon dioxide. Unlike regional air pollution from car exhaust, greenhouse gas emissions from cars cause global warming. These greenhouse gases could absorb radiation from the sun and heat the ground causing global warming. Carbon dioxide emissions strongly relate to traffic, especially private cars.

Ground transportation is a large emitter of GHGs, and CO2 emissions (6.31 $GtCO_2$), which account for almost 20% of worldwide GHG emissions (35.49 $GtCO_2$) in 2021, and automobiles account for approximately 65% of greenhouse gas releases in total transportation [5]. A study shows that from 2020 to 2021, GHG emissions from ground transportation are the largest emitter and increase by 8.9% (513 MtCO2) compared to power and industry by 5.0% (657 MtCO2) and 2.6% (256 MtCO2), respectively [6]. Globally, there has been a large increase in CO2 emissions over the last decade from 30 GtCO2 to 35 GtCO2 [7]. Taking London and New York as examples, it 2020 to 2021, their vehicle's CO2 emissions increased by 10.6% and 7.5%, respectively [6]. Firstly, there is a growing demand for private cars, which increased almost nine times from 1950 to 1990, and secondly, basically, 80% of private cars are used for personal transport [8]. The number of private cars has increased because people think they can facilitate their daily life, for example, going to work or school without transport. This is one of the reasons why CO2 emissions are high and increasing. In addition, the excessive number of private cars can lead to traffic congestion and an increase in the number of parking spaces required.

Excessive CO2 emissions contribute mainly to climate change such as global warming. The warming of the Earth's climate brings many problems; one of the most talked about is rising sea levels. Both sea level rise and warming will lead to glacier melt, which will lead to sea level rise [9]. Some marine life is also affected by the acidification of seawater due to the rise in temperature and the dissolution of carbon dioxide in the water, for example, many corals die as a result, and the destruction of coral, which provides a habitat for many fish, can also have a significant impact on fish [9]. In addition, many natural hazards, like floods, droughts, heat waves, and worse environmental problems, may increase with higher temperatures in both regions and globally [10].

Furthermore, Nowadays, environmental problems all over the world are becoming increasingly severe. Although many countries appeal to cut down carbon emissions, greenhouse gas emissions are still extremely high. This will lead to serious environmental problems such as global warming. Roser states, "The world faces two energy problems: most of our energy production still produces greenhouse gas emissions, and hundreds of millions lack access to energy entirely" [11]. In contemporary times, people pay overwhelming attention to energy efficiency and significantly ignore the later consequences of energies like fossil fuels. As a result, the world now has great difficulties transforming energy from fossil fuels to safe, low-carbon, cheap large-scale energy.

Moreover, the energy problem is also closely related to greenhouse emissions. Based on the scientific result, "It is the production of energy that is responsible for 87% of global greenhouse gas emissions" [11]. Besides, most of the carbon emissions are emitted in developed countries. From the graph below, we know that those highly developing or developed should pay more attention to decreasing carbon emissions.

Moreover, in some poor regions all around the world, those countries even lack access to energy.

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Because of a lack of access to modern energy and technology, people in these areas still cannot fully use electricity and live a simple life. Besides, as people in these regions generally use solid-fuel cars, it is hazardous for them to utilize them because indoor air pollution can have a detrimental effect on people's health.

The last problem of the current transportation paradigm, the parking lot, should be a significant problem to be focused on. The market for cars is becoming larger nowadays. In China, America, and many other countries, many families have one to two or even three private cars. The increasing number of cars means more parking lots are required in both residential and public spaces. The research should study how many parking lots there are in a particular area and the use rate. In addition, what effect dies it brings? The article "Why California Has Too Much Parking and How It is Making Climate Change and the Housing Crisis Worse" by Seitelman introduces some findings: "There are too many parking lots that remain unused. For example, 42% of parking spaces in San Francisco and 27% of spaces in Santa Clara County are unused. This brings two troubles. First, the government needs much money to manage these parking lots, and second, it occupies lots of areas that would have been used for residential houses." [12].

In another article, "Are We Tired of Doing Parking Lots Dumb Yet?", the author Beuerlein introduces another finding: "Most parking lots are just grey and ugly without any plants such as grass or trees. Maybe we should consider building more trees at the parking lots." [13]. All these findings reveal problems related to the over-supply of parking lots.

Each of these four problems is very important that should not be ignored. They affect transportation, the natural environment, residence, and even the national economy. Solutions for them may include both circular economy, such as auto recycling, and sharing economy, such as sharing parking lots.

This paper discusses the unsustainable problems of the current transportation paradigm globally and assesses the role those different new technologies can play in transforming current systems into more sustainable forms.

For the new paradigm to be reconsidered, people may choose new energy sch as electricity, to substitute gasoline. It can protect the environment and even be more convenient. In addition, driverless cars can also help people to save time driving and solve traffic congestion. Parking lots can also be decreased, and prices reset to make more land for the natural environment. The core difference between the old and new paradigms is that new transportation aims to make transportation more effective and save the natural environment positively. Therefore, the solutions will include four perspectives: Parking lot problem solution, solving emission of large amounts of GHGs, Global energy solutions, and Solutions to traffic congestion. Each sector includes both the benefit and the problem that is to be confronted currently.

2. Literature Review

2.1. Problems of Current Transportation Paradigm

In recent years, greenhouse gas emissions have gradually become a severe environmental problem. The greenhouse gases (GHGs) consist of ‘carbon dioxide (CO2), methane (CH4), ozone (O3), water vapor, nitrous oxide (N2O), and other gases, with carbon dioxide (CO2) and methane (CH4) being the leading gases in GHGs [14]. These greenhouse gases could absorb radiation from the sun and heat the ground causing global warming.

In general, ‘China, the United States, and European countries are the largest emitters of GHGs, accounting for half of the world's GHGs. And each year, emissions are increasing; for example, in '2019, the increment is 0.9% of 2018'. In addition, the most significant increase was in transport, with worldwide transport emissions increasing by 'almost 80% in 2019 compared to 1990' and Europe by

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'almost 20% in 2019 compared to 1990'. Transport is the only factor in Europe where carbon emissions are still increasing [15]. In the past, Europe has accumulated the most significant amount of carbon dioxide emissions, which are not easily degradable and require a global effort to reduce greenhouse gas emissions.

CO2 emissions can be divided into five factors: energy, industry, buildings, transport, and agriculture [16]. Fossil fuels are now the leading cause of global warming due to CO2 emissions, and conventional cars are currently mainly powered by the combustion of fossil fuels [17]. On a global scale, transportation is a vast sector of global greenhouse gas emissions, accounting for almost 20%, and road transport accounts for approximately 65% of greenhouse gas releases [18]. In Europe, electricity generation and transport are the two primary sources of CO2 emissions, with transport accounting for 70% of the content and rising every year. The majority of these 70% emissions come from cars [19].

As we can see, transport is a large emitter of GHGs, and CO2 emissions increase annually. Unlike other areas, there is a need to find the exact way to reduce CO2 emissions in this transport area. Private cars now dominate the roads and the number of private cars is still growing [20].

3. Driverless Cars

In contemporary times, due to the significant amount of carbon emission, the environmental problem such as global warming has become increasingly severe. As a result, people started to pay increasingly more attention to reducing carbon emissions. As the primary carbon emission source, fuel cars must be changed to new modalities.

Among all those new modalities of driving cars, self-driving is one of the most effective solutions to change situations. However, a few obstacles to the driverless car becoming a reality exist. Firstly, from a technological perspective, according to Gupta, there are mainly five obstacles, road conditions, weather conditions, traffic conditions, accident liability, and radar interference [21]. Road conditions, weather, and traffic conditions are unpredictable. There can be millions of different conditions, making self-driving cars extremely difficult to work successfully without any problems. Although these problems are relatively complex, people have already solved the problem with artificial intelligence.

Nowadays, the obstacles to self-driving are something other than technology. From the market, state, and civic sectors, there are separately several problems from each perspective. Firstly, according to the state sector, there are no proper legislations for self-driving cars. Generally, Gupta talks about the problems of accident liability. “The most important aspect of autonomous cars is accident liability. Who is liable for accidents caused by a self-driving car?” [21]. Neither the people who provide driverless cars with software to rely on nor the people who design physical parts of the car undertake full responsibility for car accidents. Moreover, some industries would be disrupted from the market sector after the entry of self-driving cars. A researcher points out, "Short-haul flights may see a drop in demand. Perhaps we no longer require overnight-stay hotels on the highway” [22]. Consequently, the development of the self-driving industry can lead to several industries' decline, making self-driving cars harder to achieve. The decline of several industries means the rise of several industries. Due to Bindra, "The entertainment industry will need to evolve and learn how to amuse millions of people in their cars as they move from place to place" [22]. These changes in entertainment have to keep pace with the rapid development of self-driving cars. Last but not least, there are still some civic difficulties. There are quite a large amount of people who enjoy driving cars. Some people propose that "While many people dislike driving, much more love driving and won't be willing to give up their favorite pastime easily” [23]. Self-driving cars make them lose the opportunity to drive cars. Hence, people cannot adapt to self-driving cars in a short time. Besides, people are getting used to driving fuel cars. It is difficult for them to change to driverless cars because they may concern about car accidents. Besides, self-driving cars need to gather a variety of information about personal

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information, which may violate some privacy policy

4. New Energy Vehicles

Compared with fuel vehicles, new energy vehicles have the advantage of energy saving and emission reduction, so they are widely accepted. However, battery electric vehicles face significant challenges. With the cost of battery technology and vehicle charging issues, the development of new energy vehicles has increased at a decreasing rate.

The first challenge of the new energy car is the high battery cost. Batteries in electric cars need to be able to hold massive amounts of charge to make the cars practical for most drivers [24]. So the batteries used in new energy vehicles need to be made of expensive materials, which, combined with the scarcity of these materials, results in high costs and high selling prices. As a result, some consumers are reluctant to buy new energy vehicles because they cost more than gasoline. If electric car makers could ramp up production volume and use economies of scale, electric cars could be less expensive. However, consumers will only buy them if the price is lower [24].

The second issue is that people are concerned about how far they can drive in an electric car before the battery runs out because the country's charging infrastructure does not meet expectations [25]. Most production electric cars about to hit the market can only go about 100 miles on a single charge. Moreover, getting a full charge takes around eight hours unless you have access to a specialized charging station [24]. Charging vehicles is a big problem; the number of charging stations is in short supply, and charging efficiency is low. During National Day, many new energy car owners encountered the problem of highway charging. Some owners said that in order to queue for charging on the highway, they did not even dare to go to the toilet, fearing that it would take a few more hours to go to the toilet. Another owner said he was afraid to turn on the air conditioner because he was afraid of running out of power and almost getting heat stroke. Charging posts are even tighter, especially during holidays, and suggest people's concerns about battery capacity and range time [25].

5. Changing Parking Lots

For the new transportation paradigm, one important sector is the parking lots. In the article "Why California Has Too Much Parking and How It is Making Climate Change and the Housing Crisis Worse," the author introduces that "currently there are lots of parking lots that are unused in America such as Los Angeles. The cost of managing these areas is expensive. In addition. It occupies many areas that would originally be for parks and trees." [26]. According to this description, the significant number of parking lots in America, and maybe even many other countries, is a severe issue.

The second concern related to the oversupply of the parking lot is that it causes traffic jams. Still, in the article written by Seitelman, he explains that: “Once there are free or low-cost parking lots around, especially near the hot places such as shopping centers, most people will choose private cars to go there. For those places, the cost of parking is prohibitive. People will choose buses or subways to go. The cost is an important factor affecting the parking lot and the number of cars." [26]. Therefore, traffic jam exists. This description reveals another problem related to parking lots which is the low cost. It is the origin that stimulates people to drive private cars and cause trouble for traffic.

6. Parking Problem Solutions

In order to handle the problem of over-supply parking lots, different countries and companies are acting with their solutions. The article "Reducing Parking Spaces Helps Cities Cut Auto Emissions," written by Stecker, mentions how the European countries try to solve this: "In Germany, it comes up with two solutions. The first one is to control the number of parking lots. Once a new one is built, an old one will be rebuilt as a park or something else. The second is encouraging public transportation

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by prioritizing access to public transit users." [27]. These two solutions can be classified into two categories: circular economy and sharing economy. The second solution can be regarded as using the sharing economy. The government tries to push people to use public transportation like subways and buses. People can share a transit tool together. Thus, fewer private cars will be in the parking lots, and the extra ones can be reduced.

However, these two solutions still have their problems separately. For the first one, it might be hard to decide which parking lot should be changed. This is because there are different users for every parking lot. Even if the ones with fewer users are circulated, there would be one day when a new parking lot is built; no old one can be circulated as everyone has many users. For the second solution, encouraging people to take public transportation is a good approach, but it is not convincing enough to prioritize access to those who take public transportation.

In another article “Lots to lose how cities around the world are eliminating car parks," the author gives a solution that might fix these problems: "the data shows that free or low-cost parking lots urge people to drive private cars and cause traffic jams. Therefore, San Francisco decides to increase the cost of certain parking lots, especially for those easily accessible or people who spend less time arriving there. The result is that researchers show that a 10% increase in parking price can reduce the demand between 3-10%." [28]. This decreases a lot relative to the situation before. The trend is that private cars on the road will decrease as parking fee increases. Parking limits cause the disincentives to drive.

This perfect approach can be complementary to the first two solutions. Increasing parking costs can prevent people from using the parking lots and driving private cars. However, more work still needs to be done to convince the public of the increasing parking cost, and for some companies, decreasing parking lots might affect their business. An excellent solution to this may be that the government can increase the price level of cars. This is an idea to rethink the problem in another way. If the prices of car increase, which would be more persuasive than a parking lot, fewer people would buy and drive private cars. Then, for those who insist on buying private cars, the more expensive parking fee may be acceptable.

7. How to Solve the Emission of Large Amounts of GHGs

One of the most effective options for reducing GHGs emissions is the development, and use of renewable energy vehicles, especially electric vehicles are seen as the most likely to "have a promising potential and environmental economic effect" [29]. An electric vehicle is a vehicle that uses electricity as its primary energy source, which can be powered by a “collector system, batteries” [30].

One of the benefits of electric vehicles is that there are "no significant emissions of GHGs" from their use, although the "manufacture of batteries may produce CO2" [31]. The first step in generating power for electric vehicles is to produce electricity, which can be generated from non-fossil sources such as renewable energy sources like solar and wind. This generated electricity can then be transported via wires to the battery charger where it is stored. The electricity from the battery charger recharges the car's battery, and finally, the car's electricity is converted into kinetic energy [32]. Petrol cars usually use a spark-ignited internal combustion engine, where fuel is injected into the combustion chamber and combined with air. A spark from a spark plug ignites the air and fuel mixture. If electric vehicles were to replace conventional cars in large numbers, the demand for fossil fuels would fall, and GHG emissions would be much less. The second significant advantage of electric vehicles is the support they receive from many governments. Many countries offer consumer "subsidies or tax reductions" in order to stimulate consumers to use these low-emissions vehicles, for example, "the UK's plug-in car subsidies, the US's clean car rebate program, and Japan and China's green car purchase incentives" [33].

Charging infrastructure is currently being promoted by governments in many countries. In many

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cities with a high number of electric vehicles, charging stations are being manufactured by governments, with investment from car manufacturers. In Asia, for example, in the major cities of “China, such as Beijing, Shanghai, and Shenzhen," charging stations are being built in large numbers. These cities target “one charging station for every eight electric vehicles” and are looking to build high-density charging networks in the city center areas [29]. In many countries, governments have supported the construction of charging stations economically and politically to recommend them.

One of the drawbacks of electric vehicles is the high market price, which is probably one of the main deterrents to people buying an electric vehicle. This is because the high price of an electric car can come from "the high purchase price, the high cost of batteries, the cost of fuel, and the price of maintenance” [34]. However, the fuel cost of electric vehicles is usually lower than that of fuel vehicles. However, people do not compare and analyze the price of fuel when it comes to purchasing decisions. Moreover, "price is an indicator for many people buying a car," so they will not choose a more expensive electric car [35].

Another issue regarding electric vehicles that may hinder the widespread use of electric vehicles is the range issue. She et al. (2017) suggest in their article that Some people expressed concerns about "how far they could drive an electric car." In practice, in this article, the authors show that with home charging and existing public charging infrastructure, "45.5% of taxis have an optimal battery range of 100 ~ 200 miles, while 40% of private cars have an optimal battery range of fewer than 50 miles", and that a proportion of petrol cars can now be replaced by electric vehicles. "Approximately 78% of private cars and taxis have an optimal battery range of fewer than 300 miles, a condition that can be met by the existing purely electric vehicle models on the market. On the other hand, a higher proportion of 17.3% of private cars requires a battery range of more than 500 miles", as most of these vehicles are parked in suburban areas and lack the support of charging infrastructure [36].

In addition to some of the reasons mentioned above, the “safety of electric vehicles and the environmental friendliness” of the batteries are also factors of concern [29]. Suppose people want electric cars to be widely available. There are several suggestions here; firstly, there is a need to continue developing electric vehicles, and when the technology is advanced enough to solve some of the above problems, more people will want to use electric vehicles. Secondly, the government needs to give some subsidies and tax breaks to consumers when they buy an electric car, and some funding could be given to research institutes for electric cars.

8. Solutions to Traffic Congestion

We need a range of actions on all aspects of the urban transportation system designed to influence supply and demand to rationalize road use in congestion-prone areas and times [3]. First, we want to circulate to those who only contribute to congestion to a lesser extent. So this means primarily providing clear and unobstructed routes for public transportation and giving public transportation priority in its exercise compared to other vehicles on the road, including segregating bus lanes where appropriate so that public transportation is not impeded by congestion [3]. In addition, additional incentives are needed to reduce the use of automobiles in more crowded places and at times of the day. Finally, it is essential to recognize that using private car-based personal travel is unsustainable in the long run, although this does not necessarily require it be banned. This is because private cars have many uses and make urban life easier, such as facilitating social life, shopping, or traveling to faraway places. However, using them every day to get to work or school in congested areas is another matter.

Also, getting self-driving cars to scale could ease congestion. While self-driving cars will not necessarily reduce the number of cars on the road, they may reduce congestion and collisions due to driver error. These vehicles use sensors and software to control, navigate and drive the vehicle. If all roads on the vehicle were autonomous, the vehicle would then be able to accelerate and decelerate and merge on and off the highway without human intervention, thus creating a smoother driving

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pattern [37].

The most obvious "common sense" solution when traffic exceeds supply is expanding capacity. That is what we do with most things if we can. If our house is too small, we will make it bigger. If the Internet is too slow, we will add capacity. On the roads, that means adding some lanes to existing roads. The problem with this solution is that it is expensive and also, taking them brings different socio-political dynamics because people do not like to be moved. In addition, if capacity is expanded, demand will respond [38].

9. Conclusion

In order to cope with the problem of the global energy crisis， people and governments all over the world have been looking for practical solutions. Unfortunately, because of a few obstacles mentioned before, it is not easy to solve the problem of global energy. However, there are a few possible solutions.

Nowadays, a variety of countries still largely depend on non-renewable resources. In different countries worldwide, the government usually pays most of its attention to energy efficiency but dramatically ignores the later consequences of utilizing it. Consequently, the government should appeal to move towards renewable resources. "The best possible solution is to reduce the world's dependence on non-renewable resources and to improve overall conservation efforts”[39]. This way, we can significantly reduce the pollution caused by non-renewable energies like gas or oil and transform them into clean energy such as steam, the solar, wind, or nuclear energy. As gasoline prices have become increasingly high since the pandemic, according to the truth that "Gas was now more expensive than solar or wind, Mendiluce argued." Consequently, we know that non-renewable energy like gasoline cannot only pollute the environment substantially but is not that cost-efficient. Hence, transforming into non-renewable energy that is cost competitive and environmentally friendly is a trend worldwide.

Among all these non-renewable resources, nuclear is one of the energies that possess the most significant potential. Based on Hal Hodson's saying, "Nuclear energy is deficient carbon as solar panels and wind farms. It is safer than all fossil fuels because it does not emit particulate pollution, which causes respiratory disease" [40]. By giving all these advantages, we can realize the immense value of utilizing nuclear power. Moreover, nuclear power is a power that does not change much. Unlike solar and wind power, which greatly depend on the weather each season, nuclear power is always very constant.

Nonetheless, this solution is not perfect; there are still some obstacles. "In the west, at least in countries like the United Kingdom, in America, France, basically we lost the ability to build them; we have not built them for such a long time" [40]. Western countries used to utilize those non-renewable resources and would not want to waste money and time on the "painful" process of building nuclear energy stations.

Besides, nuclear waste is also a problem that needs to be solved. It is certain that this nuclear waste turns out to be highly radioactive. Because of this, people and governments in various areas are still concerned about the safety of using nuclear power. However, stringent regulations have been made worldwide to ensure the proper use of nuclear power. According to Hodson, "All the nuclear waste that the planet has produced so far in 50 or 60 years is enough to fill in one football field by about six feet” [40]. Compared to the waste caused by coal, gas or oil, it is substantially tiny. Hence, this can transform into another advantage of using nuclear power.

In conclusion, the four solutions discussed related to the new transportation paradigm in this study are all being developed and have their problems to overcome. However, it is still good that people have realized these problems and are trying to solve them instead of simply ignore. For the technology

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issue, scientists still need to explore new knowledge. For the economic approach, the government must set and implement policies that the public can accept. Finally, people need to have confidence and patience that transportation will meet a revolution in the future.

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