The Future Integrated Traffic Management System to Optimize the Automobile Traffic

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ABSTRACT—Automobiles have developed rapidly at this time, where Europe, the US, and China are the largest markets for automobile production and sales. However, traffic congestion is not only the main problem, environmental deterioration, energy exhaustion, and atmospheric pollution also occur in line with the growing of automobiles. Therefore, it requires adequate infrastructure and steps on how to optimize traffic to increase productivity, safety and satisfaction of road users. This research aimed to determine how a developed country like the US controls its infrastructure system, how the development of automobiles is in line with the increasing level of road congestion, and how modern traffic management solutions optimize congestion. In collecting data in this study, the author uses descriptive methods with literature study. Data will be collected through journals, books, research in the same field, electronic documents, statistical data, etc. The research shows that to optimize the automobile traffic, a country and automobile companies should manage the traffic with computational framework, using algorithms, future interaction and signals connected cars, and using the central control center. The future integrated traffic management will allow a new transport standard that will benefit the road users in fuel saving, ridesharing, creating high quality worldwide route and traffic light optimization, and avoid them from time wasting.

1. INTRODUCTION
In most developed countries, various transport infrastructures were constructed a few years ago to provide the specific amounts of traffic expected at the time. With the increasing demand for a more comfortable lifestyle, people are buying more vehicles than ever before. Thus, the increase in the number of cars leads to urban traffic links. There are a lot of advances over the past 200 years in vehicle technology, transportation advancement systems, and traffic networks, while the mobility is still increasing. The development in vehicle technology occurs not frequently because of the technological developments as well as the development of trends and human mind-sets.

Automobiles have developed rapidly at this time, where Europe, the United States, and China are the largest markets for automobile production and sales. This automobile development is due to the fact that it is the most comfortable and popular transportation for passenger transportation. This development is also supported by developments in technology, so it is not surprising that today's cars have internet connection and several vehicles connected to the power grid. The current automobile industry is vast.

The United States is the largest single manufacturing country in total product value, manufacture value, and the amount of wage earners hired. The six American businesses are dependent on the manufacture, distribution, service, and the use of motor vehicles, which are more than a fifth of the...
nation's extensive business and more than a quarter of its retail trade that comes from automobile businesses' sales and revenues. For other countries, this proportion is rather slighter, where Japan, South Korea, and Western European countries have quickly moved toward the United States level [1].

From the background above, then the critical question arises, are developed countries like America good at managing their infrastructure? How the impact of this infrastructure in influencing traffic in the increasing use of automobiles and the emergence of hi-tech cars? How is a modern and future integrated traffic optimization that can be implemented by both the state in improving infrastructure, and car makers in creating smart cars? From this research, the author will describe and answer these critical questions based on the collected statistical data. Therefore, the author raises this problem in a research entitled "The Future Integrated Traffic Management System to Optimize the Automobile Traffic".

2. AUTOMOBILES IN THE US

As shown in fig.1, the United States has 273.6 million registered vehicles reported in 2018. These are cars, motorbikes, trucks, buses, and other vehicles.

![Figure 1. Numbers of vehicles in the United States from 1990 to 2018. Source: Statista (2020)](image1)

Besides, in 2016, there were 6.3 million sold cars reported in the United States. After China, the United States is the largest car sales market in the world, with around 17.2 million new light vehicles reported in 2018 [11]. In 2019, The United States spent $29 billion on infrastructure and $67 billion were transferred to states as additional in infrastructure [14].

![Figure 2. The change of infrastructure spending in the United states from 1980 to 2015.. Source: USAFacts (2020)](image2)
According to USAFacts, traffic jams in 2017 slowed vehicle passengers by an average of 54 hours a year.

For the United States, infrastructure is very important for a functioning economy because infrastructure enables countries to be productive, enjoy a certain quality of life and achieve economic progress by stimulating growth, creating jobs and improving productivity, quality of life and efficiency.

In 2020, the United States faced an economic crisis caused by the COVID-19 that affected the nation’s infrastructure to face major shortfalls in transportation, water and other systems. The United States infrastructure conditions were The American Society of Civil Engineers has reported that in 2017, the nation’s infrastructure conditions were poor, with high risk of failure [7]. The United States is facing a blatant problem in funding improvements to the highway system due to the increasing of the amount of the fuel efficient or electric vehicles on the United States [12]. The funding problem that America is today is the fuel tax. Modern cars are getting better at increasing mileage, this results in less taxes being collected due to fewer gallons of gasoline. Because of the tax problem, electric vehicles do not need gasoline, so there is no need to pay fuel tax.

3. THE IMPORTANCE OF THE OPTIMIZATION OF TRAFFIC INFRASTRUCTURE

3.1 The US Infrastructure
The United States will be able to have a great economy if its transportation infrastructure is running properly. According to USAFacts, the US spent $29 billion on infrastructure in 2019, and the US has channeled $67 billion for development in states.

Around $20 trillion, The United States economy in 2020 is derived from the massive network of functional transport infrastructure, for example, bridges and highways (McBride and Moss, 2020). Many infrastructure assets - from major roads to public transport and passenger rail systems - are out of service and need to be repaired, reconstructed or replaced. For example, transit agencies around the county had a backlog of deferred maintenance of $98 billion [13].

The road remains congested - about 42 percent fall into this category. This is detrimental to the economy of about $101 billion in time and fuel wasted each year, The Federal Highway Administration said it would cost about $170 billion annually to make significant improvements. And without a strong structural bridge, highway traffic is getting slow. Today, about one in nine of the country's more than 600,000 bridges are classified as structurally imperfect. To deliver goods in bulk, some The United States, manufacturing sectors still dependent on inland waterways, but the system has not been updated since the 1950s. It wastes valuable time and money for the producers behind this plumbing system. And because 95 percent of international trade is shipped by water, The United States...
ports must be prepared to handle ever-increasing volumes. For port upgrades, federal funding has refused to place most of the burden on state port authorities and private investors. The number of Americans using the public transportation system continues to increase, and is not expected to slow down any time soon. As investment rises in travel, deteriorating fleets and facilities cost the economy tens of billions of dollars [4].

3.2 The Importance of Infrastructure
Infrastructure is a vital factor for productivity, safety, and satisfaction in a country. The costs are often high to build and maintain roads for the government, even though the roads are used every day by road users for various purposes and purposes. Poor road quality can also lead to potential accidents and carelessness. The government must not only divide the territory appropriately, but it is also important that these roads are highly efficient to enable passengers to reach their preferred destinations with as little trouble as possible. This is particularly important in large countries, where cities are further spread out from one another.

3.3 Road Traffic in the US
Road traffic is a common problem that can make worry among drivers. Besides, it also has impact on pollution and money and time wasting. There is about 213 billion miles that America's motor vehicle fleet travelled within May 2020. But there is an increase of traffic about 45 billion vehicle miles in April. Amid January and July 2019, the traffic volume total is reached about 3.3 trillion miles of vehicle trips [11]. The traffic can be maintained by speed optimization, so the highways and traffic can move, where the maximum speed limit is resolute by the best speed for detailed real-time traffic situations. With enhancement learning methods that simulate the best speed at any certain moment, this solution can be reached [2]. In the United States, 30% of energy is used to transport people and goods. This has an impact on air pollution, including nitrogen oxide emissions, and black carbon, all due to energy consumption. Therefore, applying machine learning-based technology to transport and the environment is a new idea that could have significant benefits for energy and environmental health [6].

In summary, infrastructure is a vital factor for productivity, safety, and satisfaction in a country. The costs are often high to build and maintain roads for the government, even though the roads are used every day by road users for various purposes and purposes. Poor road quality can also lead to potential accidents and carelessness. The government must not only divide the territory appropriately, but it is also important that these roads are highly efficient to enable passengers to reach their preferred destinations with as little trouble as possible. This is particularly important in large countries, where cities are further spread out from one another.

4. Data Analysis and Discussion
Based on the information stated in section II and III, the author stated that the increase of the use of automobiles will make the traffic situations be changed significantly, especially by the present of smart and hi-tech automobiles. A big amount of self-driving cars is about to happen soon. These cars let the passengers to not be involved in direction planning. This innovation will deliver a good opportunity to manage the traffic schemes to collaborate and obtain the effective traffic controlling. This idea of innovation sees a progressively unified system to optimize routes and traffic lights in order to minimize travel time by knowing passengers' source-destination pairs. With the optimal preparation of transport times and traffic lights timing, the system can also be responsible for simultaneous emergency access strip for high priority vehicles such as police cars or ambulances if necessary [8].

Both human and mechanical, concern above congestion has directed to large road construction and traffic control improvement. Traffic signs and lights, the presence of traffic police, the reminder of separate from pedestrians’ path, and distance between vehicles from vehicles are permanent part of the city's infrastructure [10].
This problematic situation makes the author identify and will state the right solution so that traffic can be optimized.

4.1 Alternative solutions
The following is the alternative solutions that the government and automobile company can take for optimizing the traffic management system.

4.1.1 Improving access.
To say abolishing congestion is the incorrect objective, even if congestion does have a negative effect. However, congestion can also be a sign that an area is a busy place, where there may be signs of a successful and vibrant economy there. Therefore, the solution that can be applied by the US government focuses on providing and improving access. This means that the government can try to widen and build roads.

4.1.2 Algorithms.
A few years ago, there might not have been any interconnected cars, and no such advanced algorithm existed at the moment. But in the future, cars will become more connected. European regulators are likely to force automakers to build cars with emergency dialing technology in 2018. In Europe, parliament wants vehicles to automatically dial the emergency number 112 in the event of an accident. Then the car will provide GPS location to the operator to deal with the accident immediately. Thus, all cars are expected to have their SIM cards and cellular networks in it.

The rapid development of technology, both hardware and software, makes it easier for people to solve existing problems. As in the present time, the number of vehicle users is increasing. This resulted in several large cities experiencing traffic jams. Therefore, the government can try to apply a traffic light system based on Fuzzy logic that is designed that can regulate traffic lights based on the number of vehicles. There are many trials and researches that presented the effectiveness of this Fuzzy logic algorithm. This system is an image processing algorithm development to control traffic density at a two-way intersection based on Fuzzy logic. The software used for image processing and Fuzzy processing is MATLAB R2009b. From the vehicle detection algorithm that has been made, the success rate for vehicle detection is 100%, for vehicles 3, 4, 7, 8, and 9, 80%, for vehicles 5 and 6, 90%, and for vehicles amounting to 10 by 70%. So that the success rate of vehicle detection from all experiments is 85% and error is 15% with error detection +1. The success rate of detection is influenced by the background, light intensity, vehicle colour, irregular vehicle position, and the non-adaptive threshold value. The length of time to turn on the traffic lights depends on the conditions made based on the defuzzification output.

4.2 Computational framework by automobiles interaction.
A way that is also quite good in optimizing automobile traffic is by reducing travel time and fuel consumption by making vehicles communicate with each other and with traffic lights. Location, speed and destination must be transferred with traffic controllers and other road users to create instructions for the driver. This solution could eliminate stop-and-go driving, but researchers are still looking at ways to do this.

Future connected cars will tell the driver the optimal speed, the best path to drive, or the best route to take [9].

Fortunately, this solution is going to happen soon. Authorities in the United States will soon approve new standards to allow vehicles to communicate with each other, in the hope that this new technology will reduce traffic accidents. In less than three years, automakers may be obliged to equip all new cars with vehicle-to-vehicle communications.

This V2V system will allow the cars to calculate the danger risks in 300 meters in front of the cars, and let the drivers know to avoid the hit. This system estimates the 80 percent accidents reduced.
The recent advancement, it is reported that the world-famous car manufacturers such as Honda, Volkswagen, Ford, and BMW are testing the technologies by which cars and traffic can communicate to each other due to congestion reduction, safety improvement, and also emissions reduction. In early October 2018, Volkswagen collaborated with Siemens in testing a smart light system in Germany, Wolfsburg. This experiment is conducted by preparing 10 roads with 10 traffic signal systems and will send information about the light phase of these lights. This experiment allows the system to notify the driver when to use the green light wave to make this concept work on a variety of cars.

On a BMW, for example, this car will count down to green seconds, and on Mercedes, if the driver is driving between 32 and 52 kilometers per hour, the driver will get a green signal. To produce more accurate position data than GPS, the Network uses Wi-Fi technology and sensors. With this system, the car will be assisted in avoiding unnecessary stopping and starting to reduce the amount of gas emitted by the car, as it is known that the car produces more emissions while stop than moving. Besides, increased safety will be achieved with this technology as the car sends information about traffic conditions directly to the driver [5].

4.3 The author’s recommendation to better traffic management system.

4.3.1 Effective navigation route controlling.
The government can use traffic signal controllers which is a device installed at an intersection that functions to control the sequence of lights, this tool is moved together with computers, communication equipment, traffic counters and gauges detection device [3]. The management will obtain a great traffic optimization opportunity by determine the navigation route of passengers. However, it also poses a considerable challenge to cope with this data competently to make new passengers can access routes with that data. A big amount of navigation routes has to be retained in an organized method that is easy to access by an integrated traffic management system. Greatly effective data collection and mining approaches will be essential to learn about systematic travel patterns of chronological navigation routes in order to get a summary of traffic conditions of the recent navigation route in real-time.

4.3.2 Direct time and multiple routes optimization.
To seize most optimization chances to make passengers able to arrive at their endpoint on-time with high probability, the unified system of traffic management should be competent in real-time routes assigning. The system should be able to route non-urgent vehicles to make transport time spaces for urgency vehicles like police. Incentives should be presented to increase booking to ease the hassle of real-time routing. There should be a transport fee scheme that allows for lower transport costs (price or time) for passengers with bookings or ridesharing. Furthermore, confidentiality will be a challenge to answer how to achieve a correct route determination with an estimated passenger location. Besides, the company should considerate about cars and pedestrians who cannot drive alone. They may transport on their way but changing paths may still need control. A routing algorithm that needs the optimization standards into justification will need a non-trivial work to improve.

4.3.3 Large scale traffic optimization.
Accessibility is another issue. A modern urban highway network can have 100 traffic lights, while 1000 cars need to be navigated. Thus, the management should find the best scheduling time for cars and traffic lights to make the traffic become effective and optimized. Discover ideal car arrangement and traffic lights. An accurate algorithm for calculating the best result is infeasible in big road systems, in this case, the government can try the Fuzzy algorithm as stated in the previous section, which many researchers have researched the effectiveness of the Fuzzy algorithm. One of the researches of the use of Fuzzy algorithm, which from the vehicle detection algorithm that has been made, the success rate for vehicle detection is 100%, for vehicles amounting to 3, 4, 7, 8, and 9 of 80%, for 90% of vehicles are 5 and 6, and for 10 vehicles, 70%, these results are obtained from the use of the Fuzzy algorithm [15]. Partition techniques and graph summaries to create overlapping road system barriers where each barrier
could be improved autonomously and best navigation and traffic light arrangement could be concluded awaiting examination.

5. CONCLUSION
The future integrated traffic management system allows a new transport standard that will prominently benefit in travel time reduction, fuel saving, ridesharing, qualifying world-wide route and traffic light optimization, this system will be more regulate the transport time approximation and fast redirecting.

The future integrated traffic management system means that government and Automobiles companies should be open to the technology advancement and take all the possibilities and changes related to technology. Therefore, the improvement and advancement in automobiles is required, while in other hand the government should take part in infrastructure improvement remembering that the level of automobile use is getting higher in accordance with the technology advancement. People will always look at developments in technology, and this means, the government as a road provider must pay attention to all aspects of safety, comfort for road users, and to achieve that points, the use of technology in traffic management system contributes greatly, and should be considered.

ACKNOWLEDGMENT
In completing this research, the author would like to thank Statista, U.S. Department of Transportation, and USAFacts which have provided valid and complete data sources in accordance with the author's writing requirement. This writing also would not be completed without previous studies, articles and reports related to this study; all research sources will be mentioned in the references section.

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