New Traffic for Future Cities

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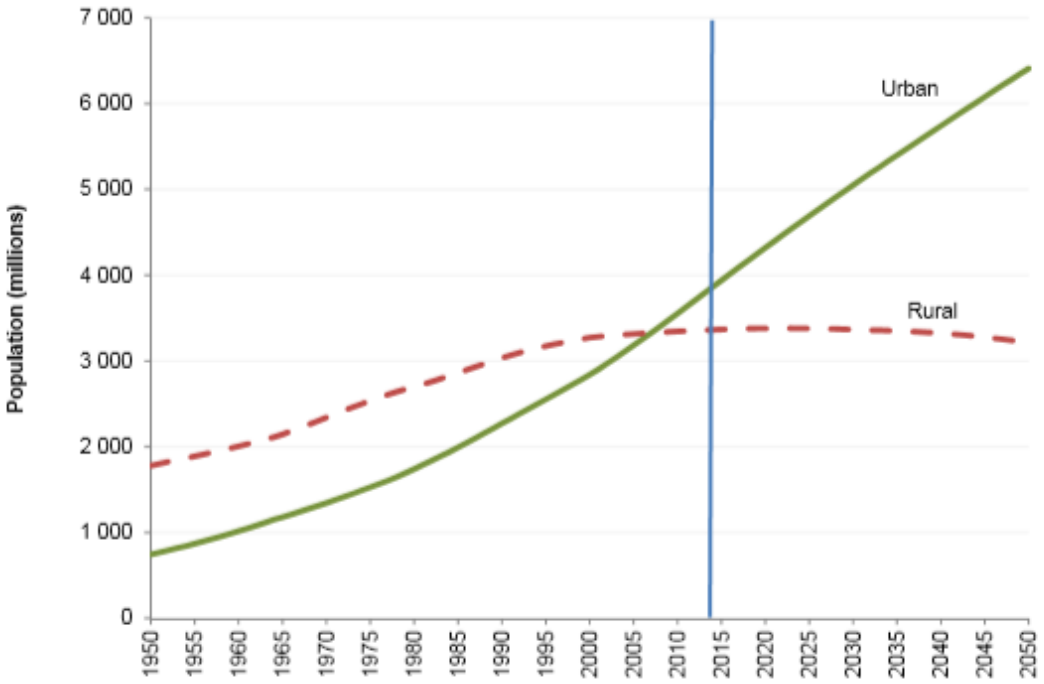
1. Introduction

The world's population is increasing and the percentage of people living in cities[1] is also increasing. In 2014, 54% of people lived in cities (United Nations 2014). In 1950, it was 30% and it is expected that it will become 66% by 2050 (United Nations 2014). Now the biggest city in the world is Tokyo with a population of 38 million. After that comes Delhi, Shanghai, Mexico City, Mumbai, and São Paulo. By 2030 Tokyo will have a population of 37 million and will still be the biggest city in the world, but Delhi will have an estimated 36 million population (United Nations 2014). In 2014 there were 28 cities which had a population of more than 10 million around the world and in 2030 this will become 41 cities (United Nations 2014). In the future there needs to be more cities in developing countries and more development in developed countries because they are aging societies with fewer children. Many of the big cities today developed in an era of mass consumption. This has brought about many problems such as global warming. Our planet will reach its limit if more cities like these are made in developing countries. There are consequently many plans for future cities which are low-carbon and smart being developed in many countries. Some of them have already began development. The focus of this research is traffic in smart, future cities. City traffic itself only access a small proportion of GDP for the whole economy's GDP (Cabinet office, government of Japan n.d.), but it will affect other economic actions. It may stop the distribution of goods and the movement of people. How can smooth traffic be managed in future cities and fit into a low-carbon society?

Table 1: the world's urban and rural population, 1950-2050 (United Nations 2014)



[1] A city is defined by UN (2014): as a municipality which satisfies the following conditions (1) 50,000 or more inhabitants (2) 60 percent or more of the houses located in the main built-up areas (3) 60 percent or more of the population (including their dependents) engaged in manufacturing, trade or other urban types of business.

Table 2: Population urban and rural in the United States and India (United Nations

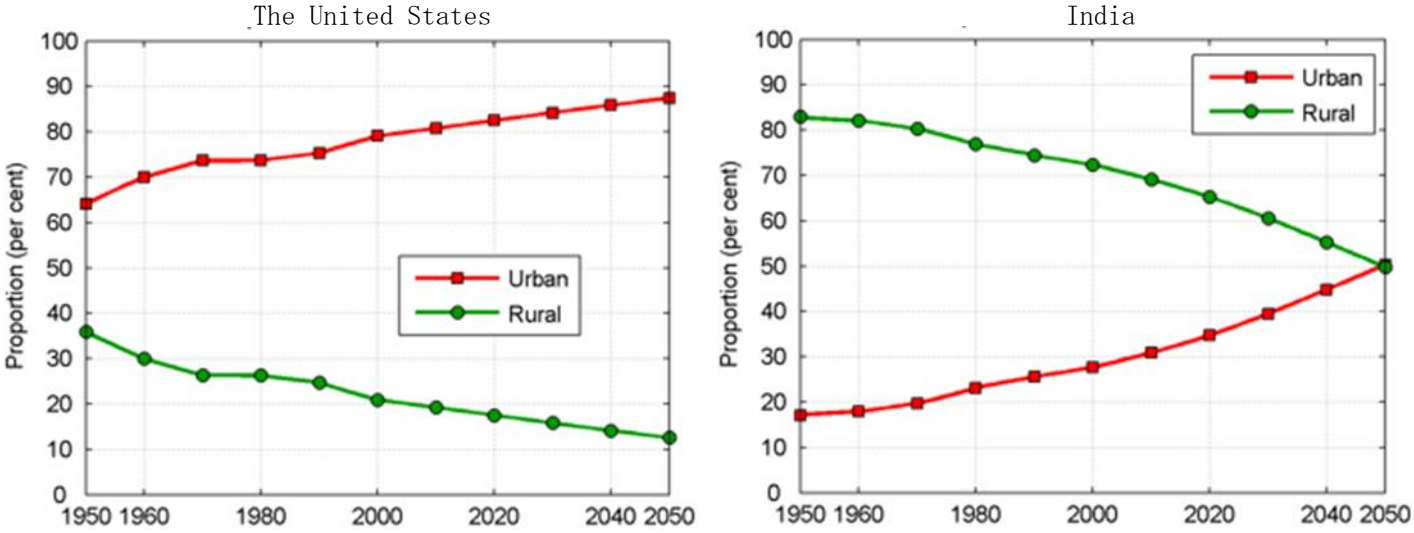


Figure 1: Paris smart city 2050 (VINCENT 2014-2015)

2. Literature Review

2.1: Traffic problems

Most traffic today is cars, which has three problems: accidents, pollution and jams.

2.1.1: Traffic accidents

Road traffic injuries were the main cause of death among people aged 15-29 in 2012 (WHO 2015). The number of people who died because of traffic accidents was 1.25 million in 2013 and it increased from 2007 because the population and number of cars around the world had grown (WHO 2015). The rate of increase is gentle or almost leveled off in-line with the population increase. However over 3,400 people die every day all over the world and tens of millions of people are injured or disabled every year. Children, pedestrians, cyclists, and older people are among the most vulnerable road users. Nearly half of all deaths are people in these group.

Table 3: Top 10 causes of death among people of 15-29 years old in 2012 (WHO

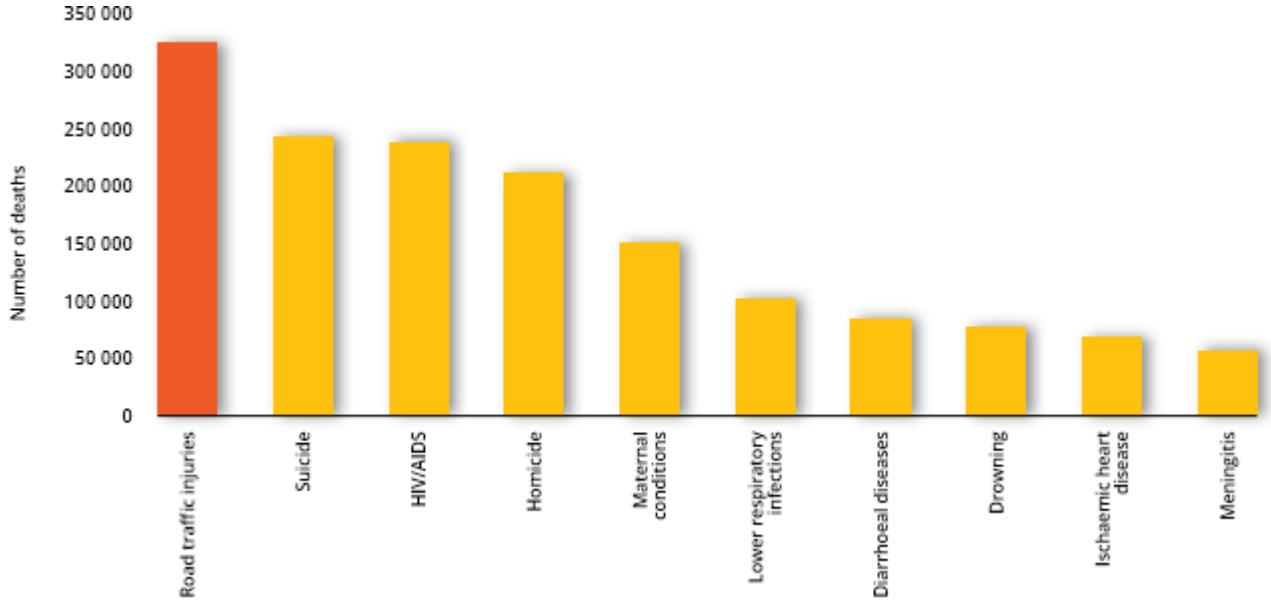


Table 4: The number of people died by traffic accident worldwide (WHO

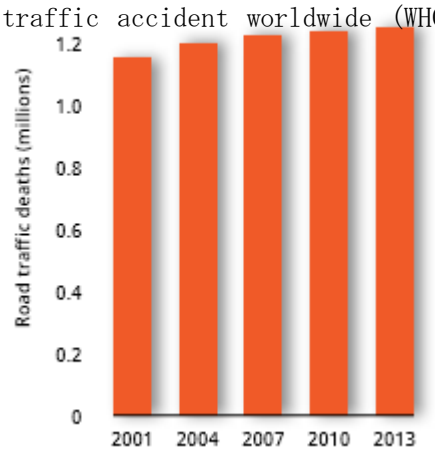


Table 5: Road traffic fatality rate per 100000 in 2013 (WHO 2015)

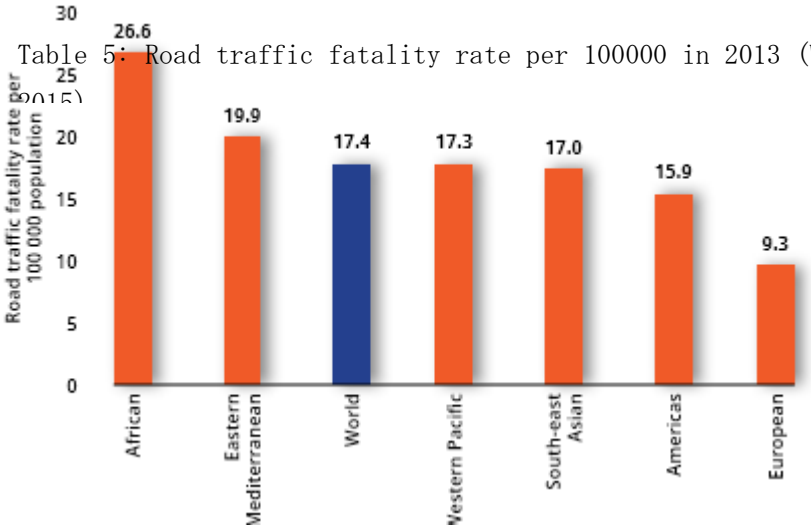
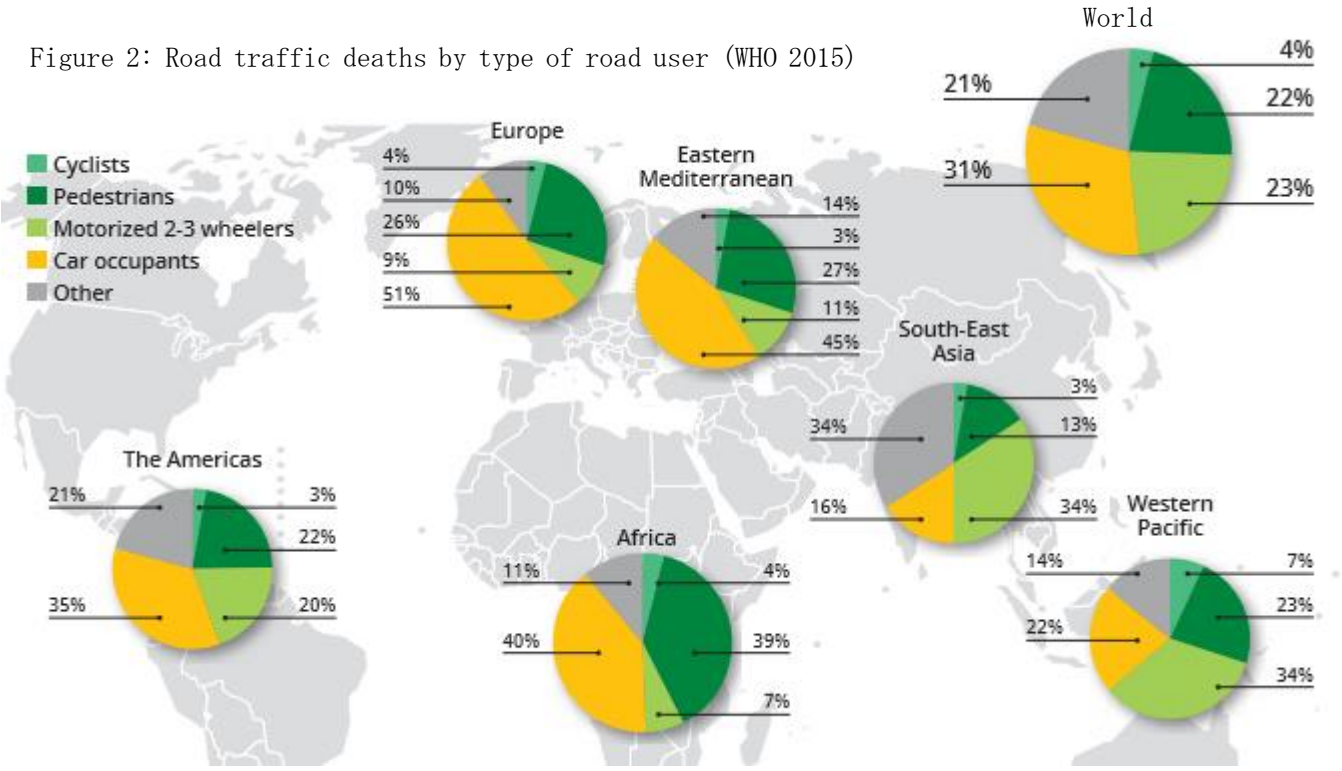


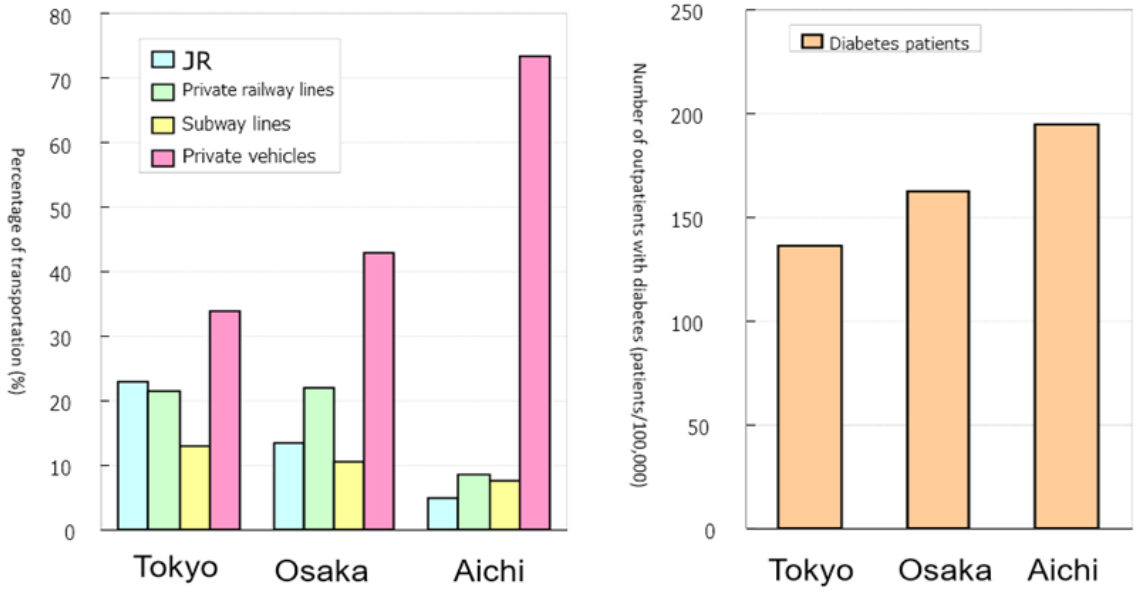
Figure 2: Road traffic deaths by type of road user (WHO 2015)



2.1.2: Traffic pollution

When the number of cars increases, there are related environmental problems such as exhaust gas, vibration, noise and pollution caused by nitrogen, carbon monoxide and hydrocarbons. They cause health hazards and many problems like global warming. It makes for a heat island, 'an urban area or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities' (Wikipedia) and is a serious problem think decreases habitability (Urban heat islands group 2016). Heat islands are very serious, especially in downtown areas and traffic pollution is not good for personal health. There is research on the relationship between traffic structure and diabetes patients (Shinya 2013). This says that areas which use more cars have more diabetes patients. Table 6 shows that Aichi has the most cars and the most diabetes. Aichi has the biggest radio of private vehicles. We do not act when we use private vehicles than when we use other transportation. Therefore people live in areas which have large radio of private vehicles are easy to become diabetes patients.

Table 6: Relationship between traffic structure and diabetes patients (Shinya



2.1.3:

Traffic Jams

Nearly 30 billion hours were spent in traffic in the United States alone in 2014 (Kabbaj 2016). People living in cities in the United States waste in 6.9 billion hours, 3.1 billion gallons of oil and 160 billion USD because of traffic jams (David 2015). Until now, the method to decrease traffic jams was building new roads or expanding existing roads. The best example of this method being used successfully is in Paris. Traditional buildings were destroyed and 137 kilometers of transportation-friendly boulevards were built. Still now this method is used in most developing countries, but it has become not viable in most developed countries. The largest cities in developed countries have so many buildings and it is much too expensive for public finance to afford such construction (Kabbaj 2016). Traffic jams have a negatire influence on the economy and environment of cities and the methods used today cannot solve these problems. There needs to be a new method to decrease traffic jams.

Table 7: Congestion growth trend-hours of delay per auto commuter (David

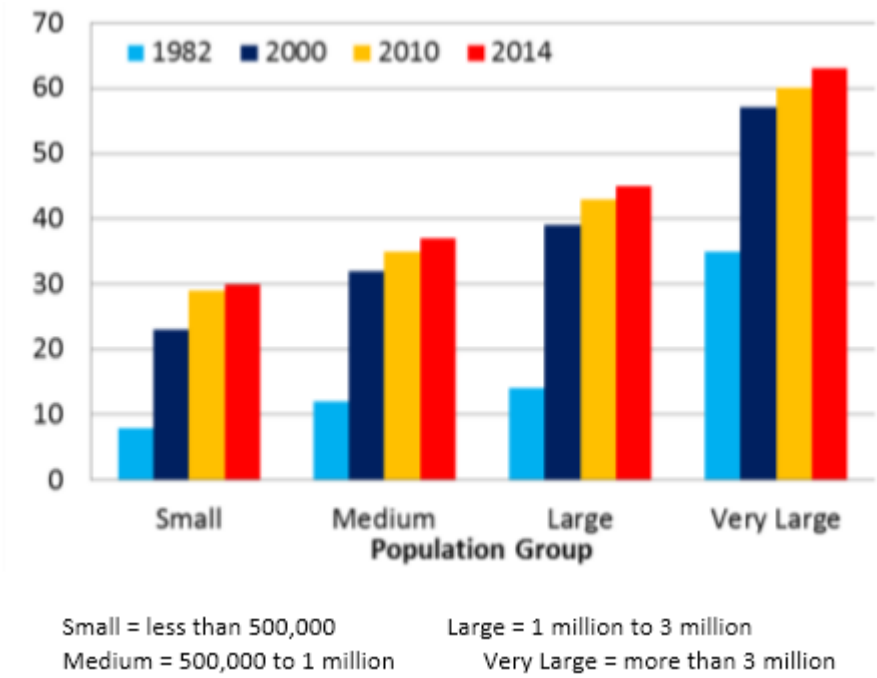


Table 8: Percent of delay for each day (David

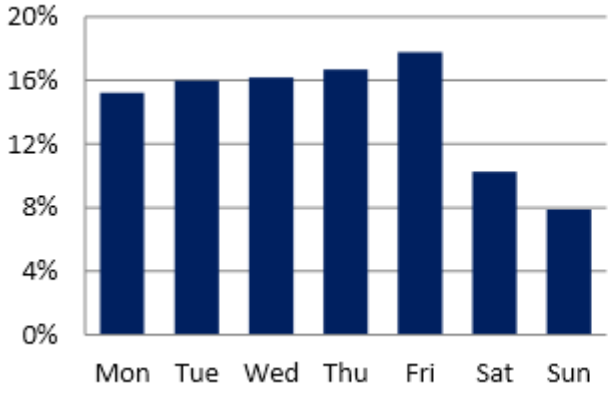
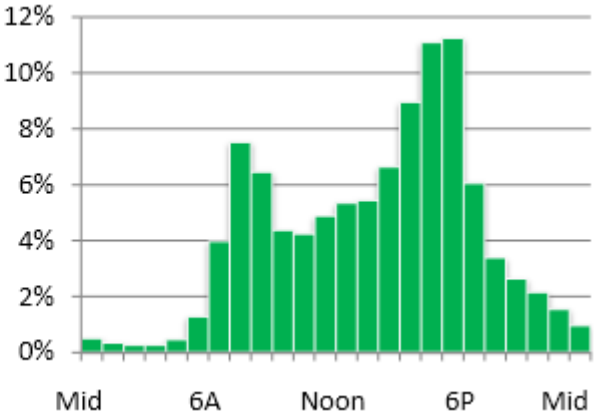


Table 9: Percent of delay for hours of day (David



2.2: How to solve these problems?

The future model of traffic is smooth flowing and kind to the environment while helping provide excellent economic development. To solve the problems of car traffic today and realize this future we need to decrease dependence on cars, in other words decrease the number of cars, improve public transportation and make the city more walkable. To make a walkable city, four factors are needed: a proper reason to walk, a safe environment to walk, comfortable walking and interesting sights (Jeff 2017). An impersonal and sterile city will not be walkable. Disorderly land development and area like ordinary suburbs will not be walkable either. A walkable city brings many benefits that not only reduces traffic jams and has a good effect on the environment, but also leads to economic revitalization. In a car society like America, many people live in suburbs and some people even spend more money on transport than housing (Jeff 2013). If they lived in a walkable city, they could spend more money on amusement or entertainment. This is good for the economy and walkable cities should be introduced all around the world.

Figure 3: Making city more walkable (Jeff 2017)

3. Separating traffic by speed

3.1: Trade-off between cars and pedestrians for city block size

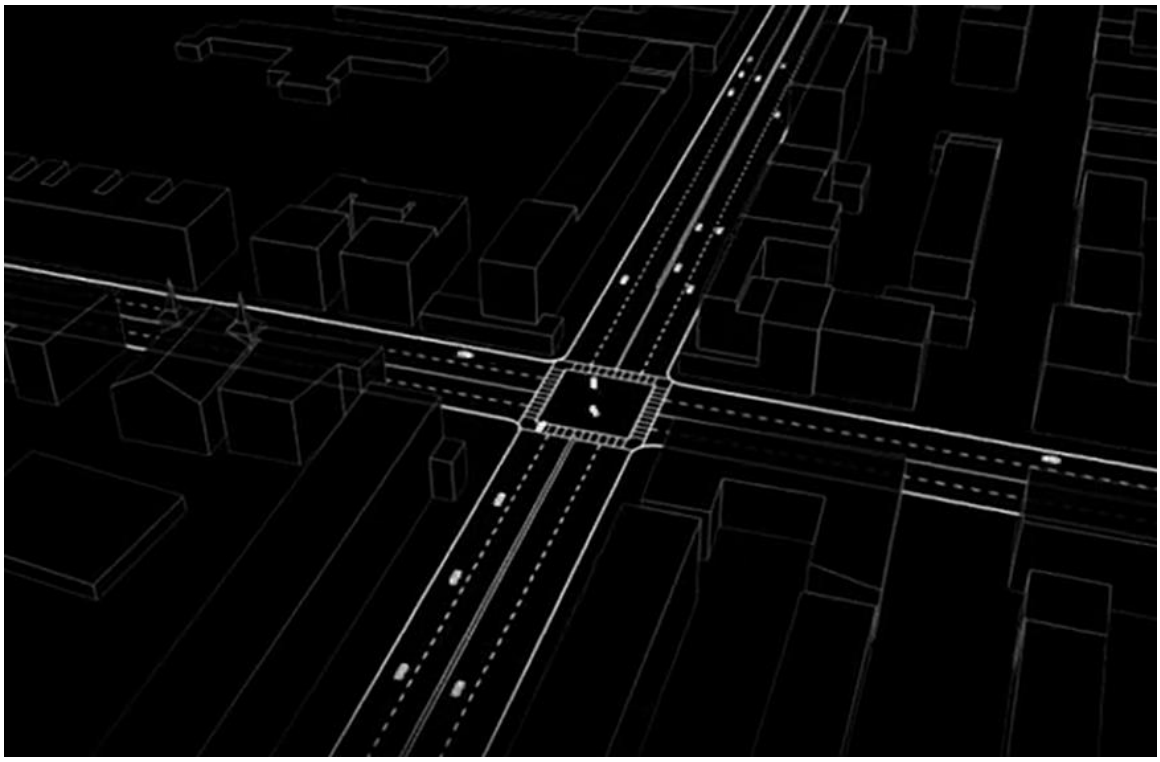
One important aspect of city traffic is how long the city blocks are. Blocks sizes that benefit cars and those that help pedestrians are not compatible. For cars, a large block size is good because there are few traffic lights or cross roads. It means there is a lower probability of traffic accidents and traffic jams and decreases traffic pollution. On the other hand, for pedestrians, a small block size is good (Jeff 2017). It means pedestrians have many streets to use and walking becomes fun and convenient. There is a car-pedestrian trade-off.

3.2: Auto-driving system

There have been many advances in car technology since the 20th century. One of these is the auto-driving system. Thanks to this, in the future, people may not have to drive cars. It means the number of traffic accidents and traffic jams will decrease. and traffic lights at cross roads will not be

needed (MIT 2016 & Wanis 2016). Auto-driving systems use more energy than conventional cars because they use many sensors and computers. Despite this, there will reduce wasted energy because auto-driving cars will not stop as often and will not start and stop suddenly. They can use energy efficiently. In addition, with systems that generate electricity from motion they can use energy more efficiently. The problem of traffic pollution can be solved, and it becomes a problem of energy efficiency. Therefore, the big three problems of traffic can be solved, however government must spend a lot of money on traffic and this is a large burden for the economy in the medium-term. Furthermore, even with auto-driving, traffic jams will happen with too many cars, after all people must decrease their dependence on cars. In addition, when there are no traffic lights due to auto-driving systems, how can pedestrians cross the road? It is impossible because there is no break between cars and even if a pedestrian bridge was made at all cross roads, people would not want to walk in such a situation.

Figure 4: Future cross road with no traffic lights (MIT 2016)



3.3: Car road and park road

Traffic needs to be separated by speed. Future cities should introduce two types of road, one is the car road and the other is the park road. The car road is for high speed transportation such as cars and Bus Rapid Transit (hereafter BRT). Park road is for slow transportation such as pedestrians, bicycles and Light Rail Transit (hereafter LRT). A car road is like a normal road today with a BRT lane. With using auto-driving system cars and no traffic lights, even in downtown area of the biggest cities, only two lanes of roadway for cars would be needed at most because there are only cars in car roads and they can move as fast a speed over as short a distance as possible with auto-driving systems. As a result, traffic volume per lane can increase. Thanks to the close flow of cars, vibration power generation may be introduced in car roads. A park road is like an urban park continuing around the city with sidewalks, bicycle lanes, LRT lanes and public facilities. This is not just for transport but will also be a part of citizens daily lives. Park roadways should have greenery, ponds and facilities built into and around the park road. In addition, pedestrians will be safe from car traffic

accidents because cars are separate from park roads. Car roads and park roads will be separated when they cross with car roads elevated or underground. More space for traffic is needed than today to introduce this system but the vertical design will allow for more space in future cities. To make cities more walkable, the functions of a city must be brought together in downtown to make the city physically closer. This means the use of more high and underground spaces. Technology for buildings is developing rapidly like Building Information Modeling or BIM, allowing skyscrapers to be constructed with little cost and time (AUTODESK. n.d.). This allows more space for traffic.

Introducing such a system would be positive for not only smooth and comfortable traffic but also a city's economy. Smooth traffic with no traffic jams makes distribution of goods and people smooth. This means that the city's economy works well. Thanks to introducing park roads and more skyscrapers, land value will become higher in downtown and around the park road. It is usual for land value near a park to be higher than other areas because more greenery makes the environment better and people feel happier. In addition, park roads will improve the environment of both residences and work places. The quality of city life will improve. Wellington Webb, an American politician, said that the 21st century has been called the century of cities and most GDP all over the world will be made from cities because most workers live in cities. This system will bring huge economic development.

Table 10: Structure of car road and park road

BRT	bicycle LRT

Figure 5: Images of park road (Adobe Stock)

Figure 6: Dr Evenhurs

4. Interview to Dr Evenhurs

I met Dr Evenhurs from the Department of Geography of the University of Cambridge and discussed the idea to separate traffic by speed. He also thinks we need to have separate traffic systems for different transport methods. His idea is more advanced in that we should pack the car road underground. He said we should use all three -dimensions for traffic. Too huge a road or train line makes it more difficult to cross the road. When cities make big roads, they should be above or below the pedestrians. If car roads can be removed from ground level, there are only park roads on the ground. It is the ultimate walkable city. Packing roads underground is easier on man-made islands and reclaimed land. He also said that in the future cars may not need to be owned due to compact city designs and close city traffic because of new car technology. There will also be more self-driving taxis and car shares. This is one of the ways that park and ride can be used when it is difficult to build the car road below ground. When all cars become self-driving, lane and traffic lights are not needed. If this is realized, pedestrians and other slow traffic cannot cross the car road. This is also a reason why slow and high speed traffic must be separated.

Figure 7: Above, showing visualization of a car road located underground. Below showing cross-section of multiple underground layers (Country Garden n.d.)

5. Conclusion

The most important point is separating traffic by its speed and making cities more walkable. The problem of traffic today, such as traffic accidents, traffic pollution and traffic jams, can be solved with separating traffic by speed. This makes city traffic more smooth flow, walkable, comfortable and will develop a city’s economy. Public transportation, car roads and park roads can cover all traffic. Car roads underground allow park roads to be built as large and as together close as possible to make foot traffic more safe and comfortable. This is also good for the environment. Such road traffic will help the cities’ economy. As a research area for the future, the process of making such a city and self-driving cars is important. In this situation the traffic will be more complicated. It is difficult to coexist and make traffic which fits both self-driving and normal cars. Another area of concern is the car market. If people do not need to own cars in the future because of self-driving taxis and car shares, then the market for cars will reduce. It may weaken traditional manufacturing economies, like Japan and South Korea. The economy should be changed over from mass-consumption to a smart society.

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