



Candidates must complete this page and then give this cover and their final version of the extended essay to their supervisor.

Candidate session number	0		0	
Candidate name				
School number		0		
School name				
Examination session (May or November)	May	Year	2015	

Diploma Programme subject in which this extended essay is registered: Design Technology  
(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: How will current and proposed technologies assist Hong Kong in its mass transportation of the growing population?

### Candidate's declaration

*This declaration must be signed by the candidate; otherwise a grade may not be issued.*

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature: \_\_\_\_\_

Date: 14.11.2014

## Supervisor's report and declaration

The supervisor must complete this report, sign the declaration and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator.

Name of supervisor (CAPITAL letters) \_\_\_\_\_

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

is a highly motivated Design Technology student and his approach to producing this essay has been one of enthusiasm and commitment. He has worked in a focused manner throughout the whole process of researching and writing this essay and he has produced a quality text .

has considered in a good degree of depth the extent to which people identify with the difficulties of mass personal transport in the significantly densely populated environs of Hong Kong. Alternative opportunities for transport are thoughtfully considered throughout this text.

has travelled widely throughout the Asia region and his experiences are evident within the text especially in relation to Japan. He found it relatively difficult to find primary data but was able to find significant and appropriate data from the HK government and the MTR corporation. This essay represents a very good attempt at satisfying the assessment criteria within Design and Technology.

*This declaration must be signed by the supervisor; otherwise a grade may not be issued.*

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent  hours with the candidate discussing the progress of the extended essay.

Supervisor's signature: \_\_\_\_\_

Date: 14/11/2014

**Assessment form (for examiner use only)**

Candidate session number	0		0	
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**Achievement level**

Criteria	Examiner 1	maximum	Examiner 2	maximum	Examiner 3
A research question	1	2		2	
B introduction	2	2		2	
C investigation	2	4		4	
D knowledge and understanding	3	4		4	
E reasoned argument	3	4		4	
F analysis and evaluation	3	4		4	
G use of subject language	2	4		4	
H conclusion	2	2		2	
I formal presentation	3	4		4	
J abstract	1	2		2	
K holistic judgment	3	4		4	
Total out of 36	25				

Name of examiner 1: \_\_\_\_\_ Examiner number: \_\_\_\_\_  
(CAPITAL letters)

Name of examiner 2: \_\_\_\_\_ Examiner number: \_\_\_\_\_  
(CAPITAL letters)

Name of examiner 3: \_\_\_\_\_ Examiner number: \_\_\_\_\_  
(CAPITAL letters)

IB Assessment Centre use only: B: \_\_\_\_\_

IB Assessment Centre use only: A: \_\_\_\_\_

**How will current and proposed technologies assist Hong Kong in its mass  
transportation of the growing population?**

**May 2015**

**Design Technology**

**Word Count: 3,287**

**Abstract Word Count: 299**

## Abstract

Hong Kong's growing demographic is troubled by its limited living space. Growing up in Hong Kong, I felt as though Hong Kong's public transportation was a great one, slowly improving over the years. But recently, due to increased tourism, especially due to Hong Kong's one-country two systems, the mass transportation of the growing population seems to be behind other countries.

As a design technology student, finding a solution to a problem is a frequent situation that I am exposed to, through the analysis of products and trying to find ways in which the certain product can be improved through its aesthetics, ergonomics, and materials. Towards the transportation system of Hong Kong, the same analytical thinking can be applied to find ways to improve the system. By looking at the transportation system as a product, I can find ways of improvement through its functionality and even provide new ideas.

Judging by the fact that technology has dramatically improved over the last decade, I believe that the transportation network will advance into a fully technologically assisted system, allowing me to come up with the question, **How will current and proposed technologies assist Hong Kong in its mass transportation of the growing population?**

By looking at the demographics of Hong Kong, it gave me a basic idea as to how tightly packed the city was, showing that the efficiency of public transport is unlike any other. Studying the two main forms of public transportation in Hong Kong

RQ

has helped me to come to conclusions and provide more environmentally friendly, space conscious decisions towards future transportation.

Apart from new idea to transport a large population, providing ideas for citizens minimize the daily use of transportation was also considered through incentives. These ideas eventually led to a conclusion as to which is more effective.

Word Count: 299

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## Investigation

Hong Kong is a densely populated city located in the southeastern area of China. With a population of approximately 7.15 million people in 2012, the whole population fits into an area of 1,104 square kilometers, with the population density results showing roughly 6,650 people per square kilometer. This makes Hong Kong one of the most densely populated cities in the world <sup>[11][12]</sup>. Due to Hong Kong's limited area, the idea of transporting the majority of the population throughout the city can be considered a challenge. With the current public transportation system considered one of the best in the world, the ever growing population would most likely put stress on the transportation network in the near future, leading to my research question focusing on how the current and proposed technologies assist Hong Kong in its mass transportation of the growing population.

Currently, transportation for Hong Kong's ever growing population is fulfilled with 11 million daily trips on public transport <sup>[10]</sup>, making it one of the most efficient cities in the world in terms of managing the movement of its population (Hong Kong Special Administrative Region Government). The rise in public transport in Hong Kong is mostly due to the limited natural land space, and therefore underground transportation and other factors contribute to the efficiency of Hong Kong's 7 million, strong population <sup>[11][12]</sup>.

Due to the limited size of Hong Kong, an increase in road transportation has in turn, increased the amount of road congestion. An abundance of private cars share the road with several public transport facilities, such as double decker buses, light buses, taxis and trams. Therefore, in order to reduce road congestion, the government has



implemented incentives to attract members of the public to make use of Hong Kong's astounding public transportation network. This includes incentives on all the road transportation mentioned above, trains, and water transportation, connecting what is considered remote parts of Hong Kong with the city.

But as Hong Kong slowly opens itself up to its mainland counterpart, China, an increase in population will unquestionably put stress on the transportation system. The growing economics of the city also adds to the increasing number of wealthy individuals, who invest in better luxuries, such as private cars and thus increasing road usage.

*RO has not been clearly stated in intro*

### Demographics

With the population roughly at 7.15 million as of 2012, Hong Kong's population is rising at annual average of 0.8%. With a low birth rate coupled with a very low death rate, Hong Kong will slowly increase in population size as the city maintains a high life expectancy level <sup>[12]</sup>. However recently, a surge of mainland Chinese immigrants have contributed to a boost in the population figure, with 2012 showing a 1.2% increase, 0.4% higher than the annual average and 0.5% higher than 2011<sup>[11][12]</sup>. By limiting the number of mainland Chinese allowed to give birth in Hong Kong, the rates will most probably rise slowly in the future.

Along with the population rise, transportation networks are constantly growing and refreshed to enable commuters to travel all over Hong Kong. With abundance in tourists as well as locals, many travelling through would also take public transportation, as there is no need to drive within the confined areas of Hong

Kong. With over 54 million travellers passing through, the transportation network has held up extremely well as 75% of tourists were from China, showing that the connecting railways at border crossings are constantly busy.

## MTR

The Mass Transit Railway, known as the MTR, is one of the most profitable railway companies in the world. It was established in 1979 as a solution implemented by the Hong Kong government to ease road congestion due to Hong Kong's growing economy. In the year 2000, it was privatized in order to maximize its profits, which in turn provided a constant improvement to customers, with service also seeing improvements made to make travels as efficient as possible <sup>[17]</sup>. In 2007, the MTR acquired the Kowloon Canton Railway, or KCR, through a merger of a 50-year service concession, making the MTR the railway monopoly in Hong Kong, while providing an annual payment to the KCR.

The entire MTR route length is 174.7 kilometers with 82 stations, spanning over 9 commuter lines in Hong Kong, Kowloon and the New Territories. A light rail track with 68 stops also serves local communities in the North Western part of the New Territories. The network carries about 4.4 million passengers per day as of April 2014 – accounting for 40% of trips made on public transport in Hong Kong each day <sup>[14][17]</sup>.

The MTR has invested in several rail extensions to provide an increased convenience in access to its trains from around Hong Kong, with several lines aiming

to reduce travel time from Hong Kong's new territories to its central business district, and even beyond that towards China <sup>[14]</sup>.

Until recently, the MTR has had a history of running smoothly but because of aging hardware and slow improvements to their rolling stock, the MTR has halted services from a couple of minutes to hours, with incidents becoming more frequent. With the increase in commuters, the quality of service of the MTR has reduced due to frequent malfunctions and customer disputes.

Apart from operations in Hong Kong, the MTR also runs train systems across the world, with an example being London's Overground Franchise, and recently one of four companies to be short-listed to run London's new crossrail project <sup>[2][4]</sup>.

The MTR's ever expanding railway is due to the huge amount of profits earned annually. The profits are earned through property, with the unique genius of transporting customers to one of the MTR owned malls, which in turn increases business for store owners within them. The MTR usually acquires properties that are within walking distance to a station, and by owning the transportation and the living area of the customer; the MTR turns in a profit of about USD 2 billion <sup>[15]</sup>.

With the newest MTR map showed below, it clearly marks the areas of which Hong Kong can be easily reached, something that could not previously be done within a short period of time. By expanding the areas the MTR can reach, travellers can choose to have home further away from the expensive areas of the city, while being able to travel there with ease.

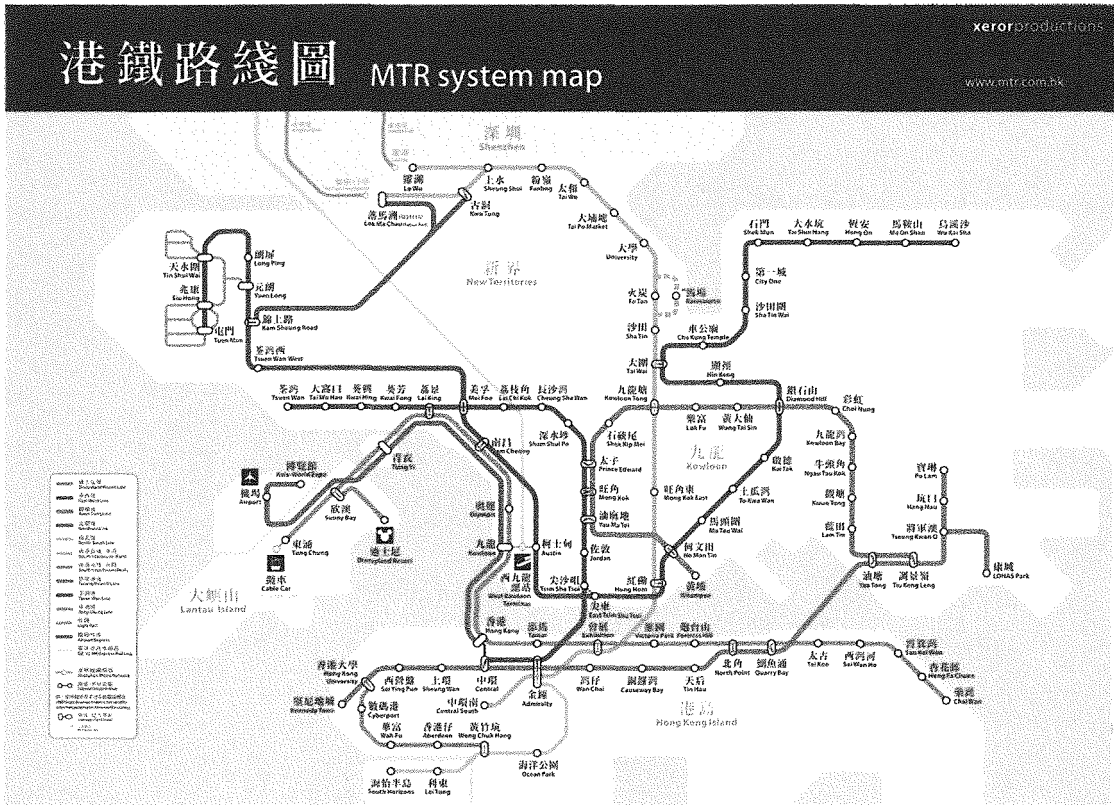


Figure 1. An updated map of the Hong Kong MTR system

## Buses

5 companies provide Hong Kong with franchised bus services <sup>[17]</sup>, the earliest one being the Kowloon Motor Bus Company. The Kowloon Motor Bus Company, or KMB, was founded in 1933. Based on figures from the end of 2013, KMB operates 312 bus routes in Kowloon and the New Territories and 60 cross-harbour routes. With a fleet of 3,777 buses, mostly double-deckers, the KMB is one of the largest road passenger transport operators in the Southeast Asia. The total licensed fleet carries about 2.59 million passengers a day <sup>[10]</sup>.

Non-franchised buses <sup>[17]</sup> also provide Hong Kong with a public light bus network, which is run by several private companies. Public light buses are minibuses with no more than 16 seats. Only 4,350 public light buses are allowed to run due to road regulations to reduce congestion. Two types of public light buses exist in Hong Kong; green-capped minibuses are used for scheduled services while red-capped minibuses are used for non-scheduled services. With data from the end of 2013, 1,263 red minibuses are in operation and are allowed to operate anywhere, except where special prohibitions apply, without fixed routes or fares. 3,807 green minibuses operate only on fixed routes with fixed fares, with 71 main green minibus routes on Hong Kong Island, 78 in Kowloon and 197 in the New Territories. Red minibuses carry about 348,200 passengers a day, while green minibuses carry about 1.5 million passengers daily <sup>[10]</sup>.

The increase in franchised buses and non-franchised buses have caused many road congestions, as private cars and taxis share the road as well. But as a cap on non-

franchised buses help to stop the problem from increasing, franchised buses are increasing, with companies such as KMB importing a wider variety of newer buses to improve its quality of service.

Another main problem from the buses is pollution, with many companies still running aging fleets. Although companies are introducing newer bus models and experimenting with hybrid and electric technologies, many buses that are still running are over 15 years old, which has a higher chance of breaking down on Hong Kong's already congested roads, which affects traffic as a whole. The older diesel engines in the aging fleet also contribute to a large percentage of Hong Kong's environmental pollution, which can be greatly reduced if newer buses were introduced.

A trail run of electric buses was conducted by KMB, hoping to transport a large amount of people in a cleaner fashion. This trial proved to impact Hong Kong greatly, with a positive reception in terms of environmentalists. The only downside was that the batteries would not last long enough due to the product only being in the trial stage, and because of the lack of electric vehicle charging points through out Hong Kong, let alone for buses, the infrastructure needed to maintain this modern technology would need to be greatly supported by the government in terms of subsidies and infrastructural materials.

## Proposed Mass Transportation ideas:

### Trains

Many countries are starting to implement the use of driverless trains[5], operating by the means of automation to improve timing precision and reduce human errors. This fully automated, electrified rail system can already be found at many airports, for example Hong Kong's International Airport and Singapore's Changi Airport. The trains serve as a connection between airport terminals. The automated systems can provide efficient and accurate transportation in terms of time and energy as driver errors are eliminated due to the trains being electric. But as the trains are all electric, more attention is needed to watch over the smooth running of the trains, to make sure there is no fault and watch for delays.

Maglev Trains <sup>[5][16]</sup> connecting cities are also being considered, especially in Japan through developing their bullet train fleet, the "Shinkansen"<sup>[16]</sup>. Currently there are only two examples of maglevs used for commercial operations, one being Shanghai's "Transrapid" system and the other, and Japan's "Linimo" line near the city of Nagoya.

Maglevs, unlike conventional trains, use a magnetic force to levitate above a guided track, and can travel at a running speed of 500 kilometers per hour. The "phenomenon of superconductivity" describes the loss of all electrical resistance in certain types of metals and alloy oxides below a certain temperature. As an electrical current is passed through, the coils used to propel the Maglev become a strong magnet as the current is forever flowing. The attractive and repulsive forces propel the maglev between the magnets installed on the maglev body and coils on the ground –

essentially an electromagnet moving a magnet with push and pull forces. Apart from the frictionless motion, Maglevs achieve their super speed through their aerodynamic design, allowing for low maintenance as there are no moving parts to wear out <sup>[5][16]</sup>.

This existing technology, already present in Japan and Shanghai shows that cities can utilize this high-speed transportation to manage a growing population and economy. In terms of Hong Kong, using a superconducting maglev between Hong Kong and its mainland counterpart could increase business ties between people as it would require less than 15 minutes to reach Shenzhen and would most likely need about 1 hour or less to get further to places such as Shanghai.

If the technology was implemented in Hong Kong, people who cannot afford the astronomical price of living but work in Hong Kong have the incentive to live further away, something that is currently considered to be a burden among workers. The introduction of high-speed transportation between cities can also provide an incentive for people who want to find work within China's financial gateway to the west. This economic incentive would definitely prove to be a benefit towards companies and their employees – this could also encourage a lower wage as living out of Hong Kong does not require an extremely high standard of living.



### Driverless cars:

The development of driverless cars has allowed technology to take an individual around. With its efficiency and advancement, it marks the beginning of a new stage in technology. The ease of transport provided has nothing in comparison and is built around the mindset of safety. The uses of driverless cars appeal most to those who find it hard to drive, or are unable to due to disabilities or age. As certain types of public transportation can be a burden, the use of driverless cars could potentially be a means of transportation for millions, if not, billions of people.

Driverless cars are another way in which road congestion can be alleviated as the reduction of human error can contribute to smoother traffic. If the technology was implemented to transport a large population in a small area, like Hong Kong, it could boast beneficial results due to Hong Kong being one of the most congested cities in the world, with strong competition between road users as the city is constantly busy.

Tech giant Google's study into autonomous cars<sup>[18]</sup> has prompted auto manufacturers to study the idea of autonomous cars, with luxury companies such as Mercedes Benz and Audi already testing models with certain semi autonomous features. Volvo, another brand known for innovative safety – including the 3-point seat belt – has also invested in self-driving cars with the aim to reduce road casualties to almost 0 by 2020. Economically, the idea of self-driving cars will potentially introduce itself to a huge market as there are individuals who would like to purchase cars, but don't have the means to due to their disability or other factors.

Although driverless cars are beginning to show up on public roads <sup>[6]</sup>, members of the public cannot yet buy the product, as there are still many flaws to the car. A few of them include not being able to work in heavy rain or snow, not being able to stop for police roadblocks, not being able to sense potholes in the road, and not knowing 99% of roads, while the 1% of roads all belong to roads in America <sup>[1]</sup>. This shows that the idea of driverless cars cannot be available worldwide at this moment.

Since the current times are times of technology, the fear of cars being accessible to hackers is a prominent threat, with many cars on the road with high tech electronic systems being accessed already.

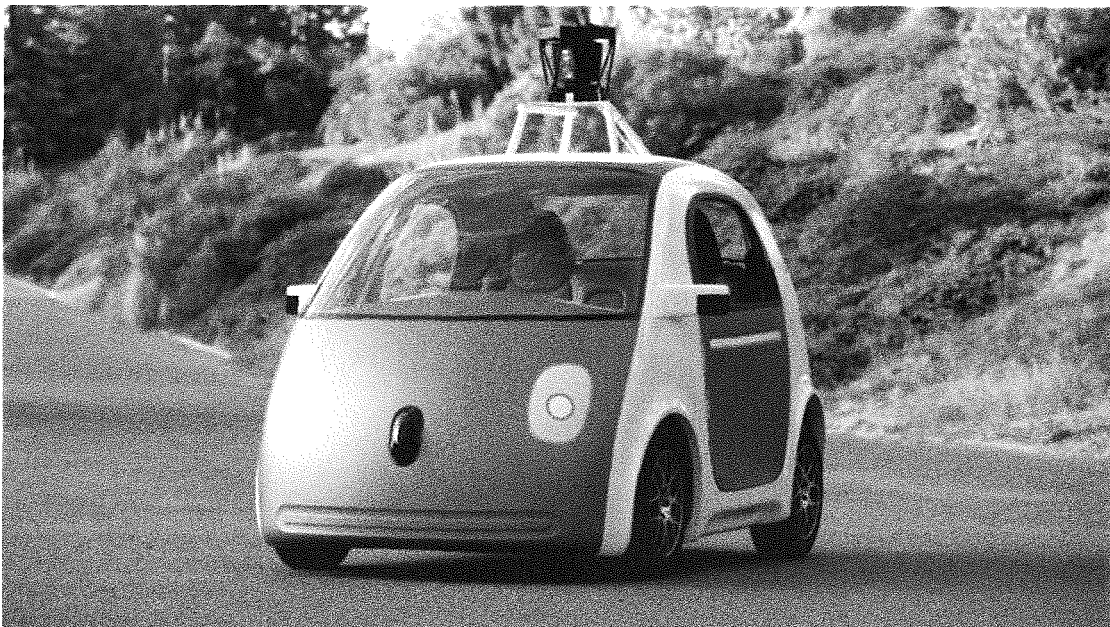


Figure 2. Google's fully autonomous car <sup>[18]</sup>.

### Incentives to sustain growing population

As an incentive to attract commuters to travel on the train before peak hours, Singapore's Land Transport Authority (LTA) has introduced a free travel scheme before the rush hour to reduce congestion at its stations. By exiting before 7:45am at one of Singapore's 18 heavily used stations, commuters can enjoy a free ride, while a 50% discount is offered if the time edges closer to peak travel time. Due to the success in this program, the LTA have decided to extend the free pre-peak travel program, prompting commuters to save while reducing congestion. Data of commuters show that about 7 per cent of commuters have shifted out of the morning peak period since the introduction of the free travel scheme <sup>[19]</sup>. This results in a greater distribution between times in which people commute.

In a survey conducted by the LTA in Sep 2013, most commuters who shifted their travel to the pre-peak period did so because of the free travel or discounted fare. 95% of them said they would continue travelling early. Mostly those who took the regular train at peak hour were those who did not have flexible working hours, which amounts to a large number <sup>[19]</sup>.

Hong Kong, on the other hand, can take Singapore's example to create a more user friendly and less congested area during the peak travelling hour, as Hong Kong's MTR system is constantly full with workers travelling to and from work, and tourists exploring the city through the MTR's convenience.

### Elderly Incentives:

Back in Hong Kong, our own MTR system has introduced an incentive, used to encourage and enable elderly and disabled members of Hong Kong to travel on the MTR, franchised buses and ferries at any time at a concessionary fare of \$2 per trip <sup>[13]</sup>. The Scheme aims to help build a caring and inclusive society by encouraging these groups to achieve a more social life as an easy access to public transport can allow for more travel, thus more interaction with other members of the public.

The scheme was introduced in the year 2012 with aims to increase travel among the aging population of Hong Kong and to provide them with easier access to other areas of the city <sup>[13]</sup>.

### Work from home

Technology in the recent years has allowed for many employed members of the public to work from home <sup>[7]</sup>, or commute less to work due to flexible arrangements. This change from the past can have an effect on a transport system, such as Hong Kong's.

Many individuals from the tertiary sector currently work in office buildings throughout Hong Kong, but because employers want to cut back on costs, many employees have the option to work from home, thus reducing the amount of energy used at the office. And because of this, workers do not need to commute to and from work, which cuts down on the stress on travelling and the stress on public transportation. Studies from the Harvard Business Review show that workers who

worked in telecommunications answered 13.5% more calls from home than in the office, almost an extra days worth of work <sup>[3]</sup>.

But with the increase in productivity, there is also an increase in income, which enables an employee to travel more and thus, take more transportation. If this were the case, the use of public transport facilities would be under a heave load due to transporting more tourist-like consumers.

## Conclusion

To conclude the investigation, I believe that if Hong Kong does not improve its public transportation network greatly, the whole system will come under heavy burden, making the public choose private forms of transport to get from point A to point B.

If newer technologies were to be implemented, the movement of the population would flow more smoothly compared to the current situation, which would provide a great source of revenue to the economy. The environmental impact could also be greatly reduced due to newer technologies incorporating a certain degree of environmental consideration. Technologies such as the maglev would also require less energy to operate, using only electricity to operate the electromagnets. Even as trains use electricity, the use of electricity in an electromagnet would be considerably less than that of a conventional train, and in turn burns less fossil fuels to run, if renewable energy was not used to produce the electricity.

Current forms of road transport, such as franchised buses, non-franchised buses, ferries, and taxis can help transport the population, but would cause traffic congestion to increase at an exponential rate. As well as road congestion, the environmental impact of a large amount of idling cars would contribute to an unhealthy environment for people and the planet. The amount of pollution created would be close to Beijing's current situation, where breathing in the air is equivalent to smoking a pack of cigarettes a day.

The increase in the standard of living within the city of Hong Kong, due to being a financial hub, also allows its people to access luxury goods. With new luxury cars on the market, I believe a majority of the wealthier population would invest in private luxuries rather than publicly accessed facilities.

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