

Group Title: Future Problem Solvers

Group Number: 10-44

Written Report

The Fourth Industrial Revolution is a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before. The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century.

The notion of a fourth industrial revolution was introduced by Klaus Schwab, founder and Executive Chairman of the World Economic Forum, and it is viewed as fundamentally different from the previous four revolutions. During the first industrial revolution, steam power was introduced, and as a result many tasks could be carried out more efficiently using machines instead of animals and humans. Factories were built and production increased greatly. With the invention of the steam engine, transportation also made a great leap as steam locomotives, steam powered boats and ships came into play, helping to transport people and goods more efficiently and quicker than before. ("Industrial Revolution", 2019)

Further on the second industrial revolution arrived. This time steel replaced iron in railroads, and it was further put to use in industrial machines, ships and construction, due to better methods of producing steel. Steel was able to be used to produce railroads at a competitive price. It was also durable and stronger than Iron, which had been used in the past, and Rails could now support heavier loads, be laid more easily and became much more productive. Electricity also became widely used and available with advancements on how to produce and harness it, and its uses increased with inventions like the incandescent light bulb. Light bulbs were much safer than gas lamps, and provided better working conditions. Many manufacturing machines were also invented, improving production. Petroleum also came into use as people learnt how to refine and separate it. Gasoline from petroleum was used for powering internal combustion engines, which were much more efficient than steam ones and improved transport greatly. (“Second Industrial Revolution”)

Finally, the third industrial revolution saw the rise of computers, with the use of digital logic circuits thanks to the invention of transistors. Computers can process data quickly and use little space to do so, and with the later invention of the internet computers provided people with countless services, like video games, data processing, ATMs, electronic music and CGI in movies and television. Mobile phones were invented as well, and communication was much easier. Digital cameras were also introduced, which were much easier to use. (“Third Industrial Revolution”)

The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions.(Flores, Canare, Francisco, Caboverde, 2018)

However, Schwab also has grave concerns: that organizations might be unable to adapt; governments could fail to employ and regulate new technologies to capture their benefits; shifting power will create important new security concerns; inequality may grow; and societies fragment. The 4th IR also has the potential to destroy many jobs, because automation and computers can readily take over them due to their greater efficiency.(Flores, Canare, Francisco, Caboverde, 2018)

Schwab puts the most recent changes into historical context, outlines the key technologies driving this revolution, discusses the major impacts on governments, businesses, civil society and individuals, and suggests ways to respond. At the heart of his analysis is the conviction that the Fourth Industrial Revolution is within the control of all of us as long as we are able to collaborate across geographies, sectors and disciplines to grasp the opportunities it presents.

In particular, Schwab calls for leaders and citizens to “together shape a future that works for all by putting people first, empowering them and constantly reminding ourselves that all of these new technologies are first and foremost tools made by people for people.”(World Economic Forum)

Learning how humankind can benefit from this revolution while addressing its challenges is also the central aim of the World Economic Forum Annual Meeting 2016, which is being held under the theme “Mastering the Fourth Industrial Revolution”.

Crowdsourcing ideas, insights and wisdom from the World Economic Forum’s global network of top leaders from business, government and civil society and young leaders, this new book by Klaus Schwab titled “The Fourth Industrial Revolution” looks deeply at the future that is unfolding today and how we might take collective responsibility to ensure it is a positive one for all of us.

The **transportation industry** is one area which will be **greatly affected** by the fourth industrial revolution. In this fast-paced, interconnected world, transport is something everyone will be involved in, and will influence it. With the rise of the fourth industrial revolution, people’s attitudes, habits are changing; for example in areas of privacy, ownership, consumption patterns and interactions; and these may well impact how people get around. New technology also offers opportunities to those in the transportation industry, for example the use of automated vehicles. At the

same time, jobs and people required may change as certain jobs are no longer needed while new ones arise.

How does this impact transportation in the future? We have done a sample survey targeted at students and their parents on their opinion of transportation in Singapore and we have received 45 responses. Our survey findings show that people frequently walk and take public transport such as buses and the MRT/LRT. 52.4% of the respondents also feel that there are problems with the way they travel and that there is space for improvement compared to the 47.6% minority. (fig. 1)

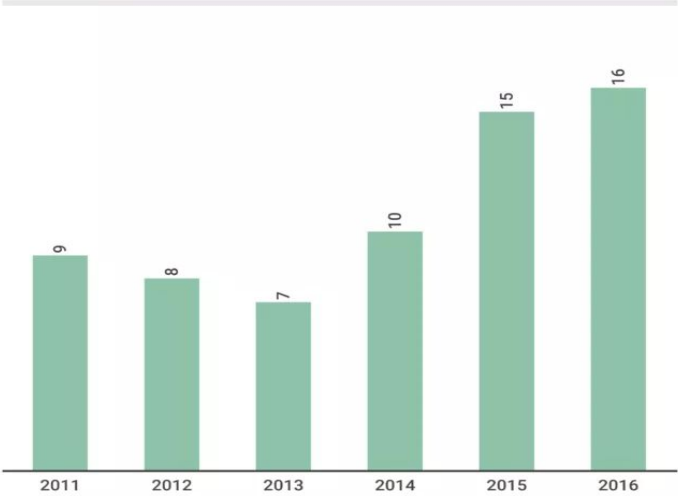
Thus, our group has come up with 5 problems that the population in Singapore is facing right now and 5 solutions to these problems.

Firstly, we have observed that more than 30 of our survey respondents take public transportation and many have complained about traffic congestion. This is mainly caused by heavy traffic especially during peak hours and lunch hour, causing vehicles on roads to travel at a very slow speed which may delay the time taken to arrive at a person's intended destination. Traffic congestion is thus a serious problem which we have identified through our survey; it has a great impact as it affects the economy (Hartman,2017), harms the environment by causing more carbon dioxide emissions and air pollution (Beggs,2018;Hartman,2017), impacts the health of people and causes stress, frustration and inconvenience for commuters(Hartman,2017). We also have done some research and found out that the current speed of vehicles during peak hours on expressways is

only around 63km/h. (“Road Traffic Conditions during Peak Hours”, 2016), confirming that traffic congestion is indeed a problem in Singapore.

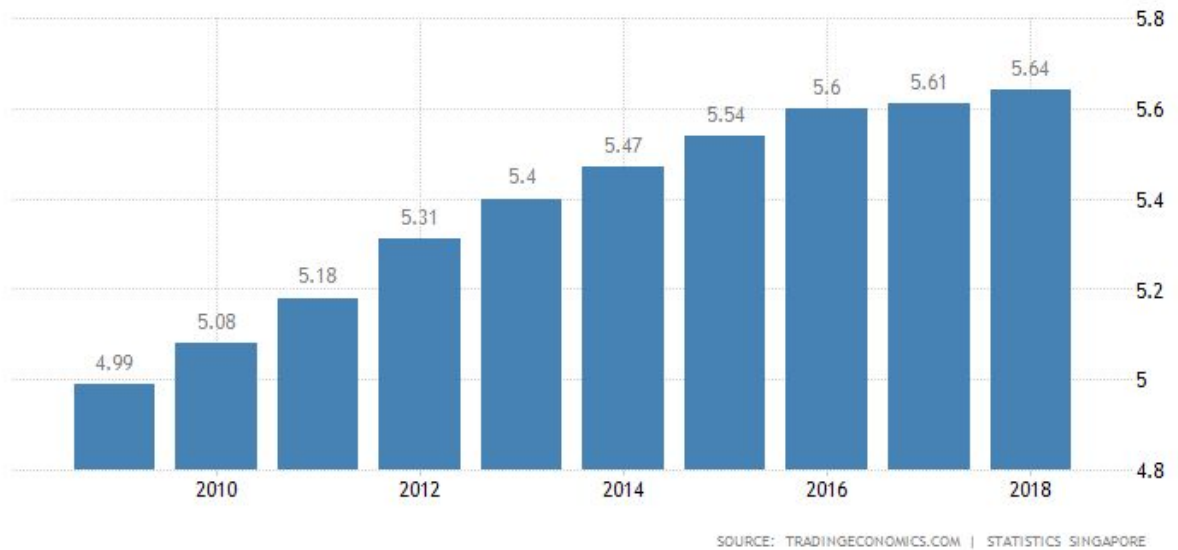


Number of MRT delays >30 minutes



Source: LTA

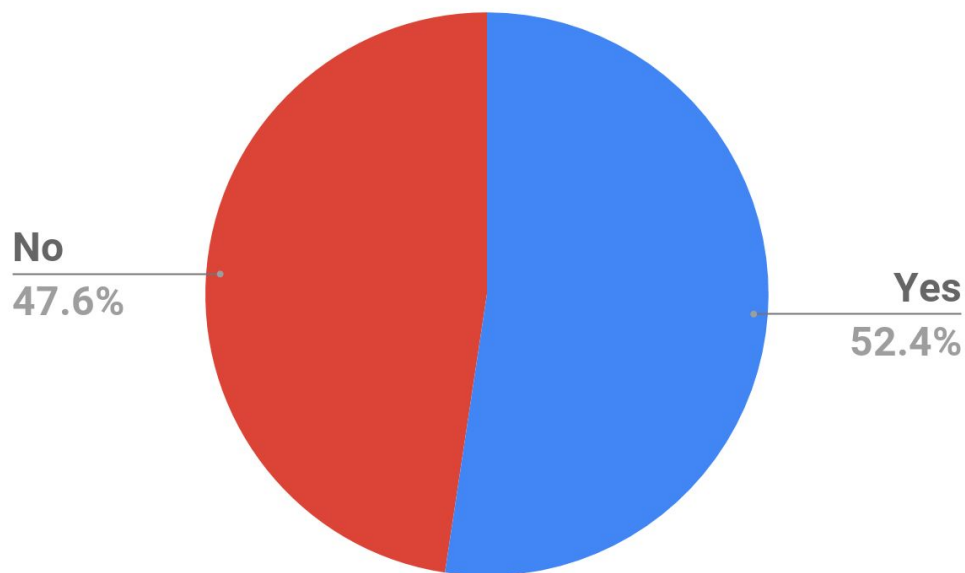




A **second problem** we have identified is that public transport in Singapore can get very crowded during peak periods. 10 out of 40 of our survey respondents have raised this issue. We have done some research, and public transport ridership in Singapore for buses and the MRT has been increasing. (“Public Transport Utilisation - Average Daily Public Transport Ridership”, 2018) This issue could result in longer waiting time for commuters and as a result negatively impact the economy and also cause frustration, stress and inconvenience to people.

Thirdly, some of our survey respondents have complained about MRT breakdowns. These can negatively impact people by causing serious delays, disrupting work and school and once again frustrating and stressing

them. Economy will also be affected when people have difficulty getting to work on time and less precious time is spent doing productive things. As MRT helps to reduce traffic congestion and take some of the strain off buses and taxis, MRT breakdowns can increase traffic congestion seriously and result in the negative impacts mentioned earlier (Hao, 2018). MRT breakdowns may also reduce people's trust in the system and cause them to turn to other transport options like private cars and further contribute to traffic congestion. Our research has shown that while train reliability in Singapore has improved recently, serious disruptions do still occur (Tan,2019)



The **fourth** problem which we have found from our survey is that public buses in Singapore tend to arrive infrequently, increasing waiting time and travel time for commuters. This could potentially affect the economy, inconvenience people and there is a chance it could lead to

decreased trust in Singapore's public transportation systems and result in people turning to less efficient and environmentally friendly transport options like private cars. This may also worsen the previously stated problem of traffic congestion.

The **fifth** problem we have found is that people tend to drop others off at inappropriate places for their convenience, such as bus stops or roadsides. However, this may cause problems because dropping others at unsuitable places would make them hold up traffic, causing traffic jams especially during peak hours and if many people do so, serious traffic congestion can result and people take a longer time to get to get to their destinations.

Our **Underlying Problem** is:

How could we increase the efficiency of our transportation systems, decrease congestion (people and vehicles) and decrease waiting time so that Singaporeans can get around quicker, in more comfort and with greater ease.

Below are the five possible solutions we have come up with.

Firstly, the government can gradually reduce the maximum number of new private cars which can be bought every year. This way, congestion on the roads may improve and people will reach their destinations faster. It will also help reduce carbon emissions and free up parking space for other

purposes. This is based on our research, which shows that one of the causes for traffic congestion is too many cars on the road. (Rosen,2013)

Secondly, the government can increase the number of public buses available and schedule them to arrive at bus stops more frequently so as to reduce waiting time, increase space for passengers on the bus and help people reach their destinations faster. Trust in public transport can also be increased and congestion, global warming and pollution can be improved. (Yang, J., and J. F. Coughlin, 2014)

Thirdly, the government could slowly phase out normal, non automated vehicles and replace them with shared, automated(self-driving) ones (both private cars and public transport). Most road accidents are actually caused by human error(Singh, S. 2015), a problem which would obviously not be present in automated vehicles. These automated vehicles would also be able to drive more quickly and more closely packed together without compromising safety than human driven vehicles, reducing traffic congestion and increasing the transportation system's efficiency. They being shared will also help reduce the number of vehicles on the road(Lim,2017) and help traffic congestion.

Fourthly, the government can work to expand roads so that it could have a larger vehicle capacity. Congestion occurs when demand for road space exceeds the supply, hence, with wider roads, the occurrences of traffic jams on roads will decrease especially during the peak hours and lunch hour so vehicles will be thus able to move smoothly on the roads

without any inconvenience. This will also help to ensure that in the case of a car accident, there is still enough space for the vehicles behind to pass and reduce the impact of any accidents on the traffic flow.

Fifthly, the government could **set up more cameras** near bus stops throughout the entire island and **impose fines** and other **serious punishment** on those who are caught stopping vehicles at bus stops or roadsides for invalid reasons and are blocking the path of incoming buses and other vehicles. These actions cause commuters waiting at the following bus stops and vehicle drivers to be delayed, inconveniencing the bus drivers and the commuters as this might lengthen commuters' time to reach their desired destinations. These actions can also contribute to traffic congestion and reduce commuter's trust in public transport, causing traffic congestion as explained above. Therefore by discouraging people from committing such acts, we can reduce traffic congestion and help people get around quicker.

Our criterias for choosing the solution are **Cost, Appeal, Feasibility, Low Accident Occurrence Rate**, and **Efficiency in solving underlying problem**. Cost was chosen as the price a government has to pay to put in effect a policy can greatly influence if they are willing or not and even if they are able to. Although in reality it does not really affect how well the solution works, a solution should possess sufficient appeal so people will accept it more easily and there would be less opposition to it. A solution must be

feasible so it can be put in place without too much difficulty. The very aim of a solution is to solve the underlying problem, therefore its ability to do so must be assessed.

Our **Decision-Making Matrix** is shown below:

Possible solutions/factors	Weighting (larger the more important)	Possible solution 1	Possible solution 2	Possible solution 3	Possible solution 4	Possible solution 5
Cost	3	5	3	1	2	1
Appeal	1	1	2	3	4	5
Feasibility	4	5	3	2	1	4
Low Accident Occurrence Rate	2	1	2	5	3	4
Efficiency in solving underlying problem	5	2	1	5	4	3

Total Score		48	32	49	40	47
--------------------	--	----	----	----	----	----

Through our **Decision-Making Matrix**, our selected solution is **Solution 3, Implementation of autonomous vehicles and a smart personal steering wheel.**

Description of our action plan

All vehicles are replaced with autonomous ones and are all either a part of public transport, or are shared cars. For shared cars, each person who wants to participate in it have a gadget called a personal steering wheel, with which they can “call” a car to them and carry them where they want to go. All these will be implemented gradually, with the slow phasing out of HDV public buses and slow limitation of sale and importation of private HDVs.

Feasibility of solution

Our group has done some research on companies that are also having similar ideas as us. We have found a company, Jaguar Land Rovers, having a similar idea as us. They had an idea of creating a voice-intelligent steering wheel, which they named “Saver”, to revolutionize the way that drivers drive, by allowing the steering wheel to have mobile phone-like functions like reading the news and making reservations etc. The steering

wheel can summon an autonomous car with the ability to “communicate” with the pedestrians to ensure road safety.

Possible disadvantages and challenges

1. Our solution may be opposed by many people because they are uncomfortable with riding autonomous vehicles and doubt their safety. (Kyriakidis, Winter, Happee.2015)

2. AVs are a lot more expensive than HDVs due to their advanced technology and it may hence be difficult for the government to fund the replacement of HDV buses with AV ones.

3. AVs do not need a driver, so bus drivers and cab drivers will end up losing their jobs.

4. AVs have no driver, so it can be very difficult to tell whose fault it was during an accident, liability is an issue.

Solutions to these problems

For problem 1: Talks, posters, emails, leaflets and visits can be used to explain to people how comparatively AVs are safer than HDVs using statistics and logical explanation about lack of human error.

For problem 2: Although these AVs cost more to produce and buy, they

use less fuel, take up less space and overall save money so the monetary problem is not actually so serious. Replacement is done slowly and can be slowed down even more so as to make sure funding is sufficient.

For problem 3 and 4: AVs will cause more job opportunities to exist, such as software developers and wireless network engineers. A new kind of job where people investigate case by case AV accidents (which are difficult for computers to analyse) can be implemented, helping with employment and liability at the same time.

Action Plan

From our solution, we have created an action plan. This action plan is proposed for the government to solve our underlying problem. Firstly, the government starts off by inviting car companies to come to Singapore and run the AV shared car scheme here. Arrangements are also made for AV buses to be bought for public transport. Then, the car companies collaborate with each other to create, test and improve on the personal steering wheel for a few years. After they are confirmed to be safe and efficient, the government can introduce the car sharing to the people, promote it and explain its benefits to people, allowing the citizens to slowly give in to usage of this technology. The same can be done for the buses, with only a small number of 30 buses around the country being introduced. Jobs such as the investigator profession can be introduced after this product is used by the people. Gradually, improvements can be made based on data collected on the way, and AV buses can be made to replace

HDV ones and the AV car sharing can be expanded while importation and sale of private HDVs are limited more and more. Finally, the end goal of having all AV buses and all the cars on the road to be shared AVs can be reached.

References:

1. Land transport authority (last updated June 6 2017) Road traffic conditions during peak hours (retrieved from https://data.gov.sg/dataset/road-traffic-conditions?resource_id=bdfdb0b5-c3a4-4dc9-8a9a-ec130ba9fd0f)
2. Harrison Beggs(19 January 2018)How Traffic Congestion Affects The Environment(retrieved from <http://soulfest.com.au/blog/how-traffic-congestion-affects-the-environment/>)
3. Dennis Hartman(Updated 5 October 2017)The Effects of Traffic Congestion(retrieved from <https://getawaytips.azcentral.com/the-effects-of-traffic-congestion-12304680.html>)
4. Land transport authority (last updated March 15 2018) Public transport utilisation-average daily public transport ridership (retrieved from <https://data.gov.sg/dataset/public-transport-utilisation-average-public-transport-ridership>)
5. Wong Wen Hao(7 February 2018)Train disruptions and their impacts on the economy (retrieved from <http://simecons.com/train-disruptions-and-their-impacts-on-the-economy/>)

6. Christopher Tan(12 February 2019)MRT network sets new high in reliability(retrieved from <https://www.straitstimes.com/singapore/transport/mrt-network-sets-new-high-in-reliability>)
7. Allan Rosen(8 July 2013)What Really Causes Traffic Congestion?(retrieved from <https://bklyner.com/what-really-causes-traffic-congestion-sheepshead-bay/>)
8. Flores, Stephanie & Canare, Tristan & Francisco, Jamil Paolo & Ed Caboverde, Christopher. (2018). Mapping the 4IR At-Risk Workers in the Philippines. SSRN Electronic Journal. 10.2139/ssrn.3298550.
9. History.com editors.(1 July 2019)Industrial Revolution(retrieved from <https://www.history.com/topics/industrial-revolution/industrial-revolution>)
10. Second Industrial Revolution (retrieved from https://en.wikipedia.org/wiki/Second_Industrial_Revolution)
11. Yang, J., and J. F. Coughlin. "In-Vehicle Technology for Self-Driving Cars: Advantages and Challenges for Aging Drivers." International Journal of Automotive Technology 15.2 (2014): 333–340.
12. Brock Bontrager(15 January 2018)The Race to Fully Autonomous Cars. (Retrieved from <https://medium.com/swlh/the-race-to-fully-autonomous-cars-8212ff73aad>)
13. Adrian Lim, 15 May 2017. Self-driving cars can free up space. Retrieved from:<https://www.straitstimes.com/singapore/transport/self-driving-cars-can-free-up-space>

14. M. Kyriakidis, R. Happee, J.C.F. de Winter.(29 Jan 2015)Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. Traffic Psychology and Behaviour. <http://dx.doi.org/10.1016/j.trf.2015.04.014>

Charts and data

Figure 1 (responses from question: “Think carefully. Are there are any problems with the way you travel and the facilities provided?”):

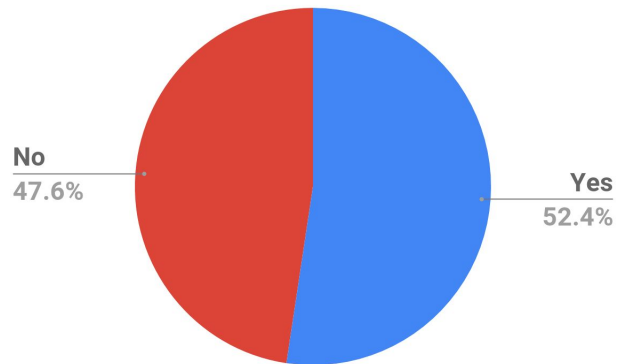


Figure 2:

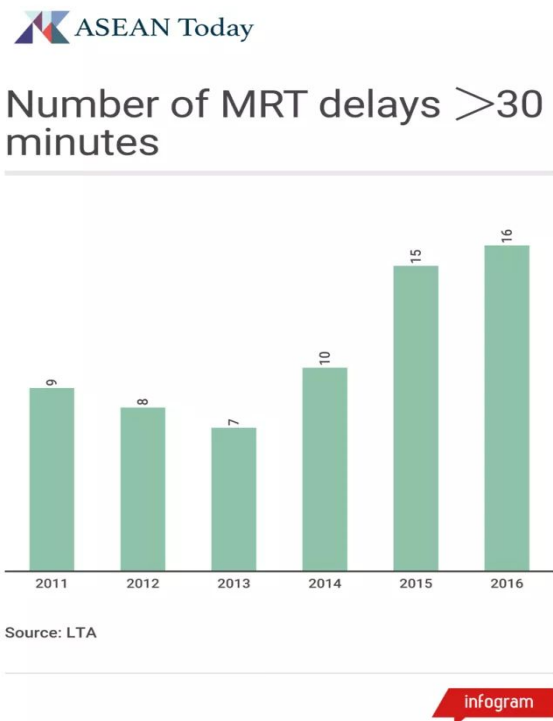
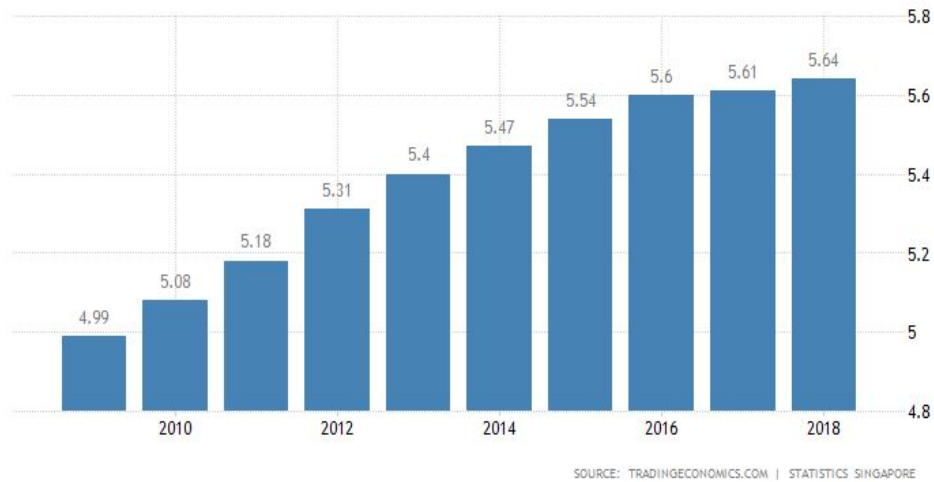


Figure 3:

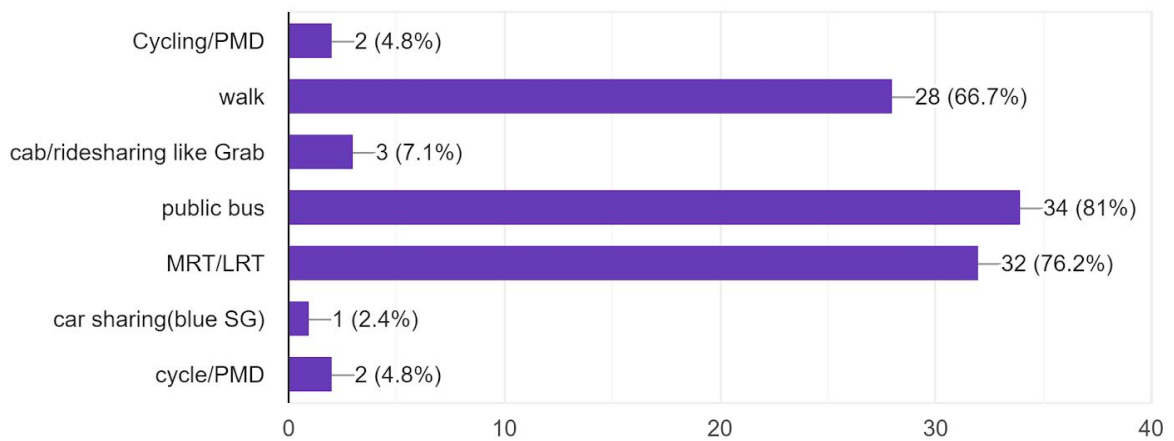


(number of cars)

Figure 4.

How do you normally travel?

42 responses



Done by: **Lim Mu Quan, How Tai Xi, Jack Zhong Lin Xuan (leader) and Dai Zhuoyang**

Mentored by **Mr Mervin Cohen**