WRITTEN REPORT
AUTOMOBILES
4TH INDUSTRIAL REVOLUTION
AIDAN NG

Challenges that community face in 2030
- Interview with 10 drivers and passengers, aged 25-65 consisting of professionals, delivery men, Housewives , and Grab drivers)
Questions asked:
What is your occupation, age?
Given that the autonomous vehicles are fast changing the roads , what are your views on this?
Do you think AV vehicles can reduce road accidents?
Would you be interested in driverless cars?
Do you think the 4th IR of automobile will affect your job?
Recorded Interview:
https://drive.google.com/open?id=1Gs-gyUT1__K_R8CzaXldI5l9YNAvdPWq

Elderly struggling with technology

Observation:
All three elderly people interviewed expressed that technology has taken over many aspects of their life and that they are at a loss when it comes to using services such as i-banking, e-payments and car-sharing apps. Many respond to technological change with scepticism and being intimidated. Most of the elderly did not have the opportunity to receive a proper education during the tumultuous and less affluent pre-independence era. Given this lack of foundational knowledge, it has been tremendously challenging for many seniors to acquire information technology skills, let alone adjust to the age of automation and digital interaction.

Problem:
With the Internet of Things being a key aspect of the Fourth Industrial Revolution, mobile apps would be a key platform to gain access to 4IR Technologies. Many elderly are strangers to ride-hailing apps such as Uber and Grab. It is a challenge for them to acquire IT skills. Most of them mainly use public transport as it is cheaper and they are so used to it. They need assistance in learning to use handheld devices and digital services When the need arises, many rely on their children or others to help them book a ride using the apps.They cannot understand how the apps function and are not confident to use them for fear of errors that will result in monetary loss.   They are most vulnerable to cyber crime as they are generally not as technically savvy and may not be as comfortable in the online environment. Cyber scams may sometimes go unreported by older victims because they may not know who to report them to, are ashamed at having been scammed, or do not even realise they have been scammed.They will likely be left behind, unable to enjoy the convenience of the shared mobility or car on demand service.

Singapore, at present, has over 487,600 citizens over the age of 65. With the Internet of Things being a key aspect of the Fourth Industrial Revolution, mobile apps would be a key platform to gain access to 4IR Technologies. According to the Infocomm Development Authority (IDA) Annual Survey on Infocomm Usage in Households 2014 people aged 50 and above registered the highest year-on-year increase in Internet use across age groups.The growing trend among older Singaporeans in the use of smartphones and Internet simultaneously increases their exposure to cyber predation.

COSTLY CAR OWNERSHIP

Observation

9 out of 10 of the car owners interviewed are concerned with the higher cost of car ownership in the future.

Problem:

Affects families which require cars to transport the sick, young and aged or wheelchair bound.

The high expenses (interest, road tax, car insurance, parking, ERP, petrol and servicing) and the higher cost of car price will make it hard for the average citizen to own a car.

The costs of autonomous cars is likely to be astronomical at first. There are some estimates that costs could be upwards of $100-300,000. Fully autonomous tech could add at least $100,000 to the price of a vehicle, while even semi-autonomous features like Tesla's Autopilot and Cadillac's Super Cruise already add $5,000 and$10,000, respectively, to the base vehicle cost. It will likely be some time before the technology has developed enough to become available for the average Singaporean. According to a recent study, "Emerging Technologies: Autonomous Cars—Not If, But When," IHS Automotive forecasts that the price for the self-driving technology will add between $7,000 and $10,000 to a car's sticker price in 2025, a figure that will drop to around $5,000 in 2030 and about $3,000 in 2035, the year when the report says most self-driving vehicles will be operated completely independent from a human occupant's control.The first generation of truly autonomous cars could cost $300,000 to $400,000 apiece, Austin Russell, CEO of Silicon Valley startup Luminar, said in a recent interview.

TRAFFIC CONGESTION

Observation

All, except 2 working in the transportation industry, like the idea of driverless driving. No more driving fatigue, getting lost and distracted driving. No more difficult maneuvering and parking.. Difficult maneuvering and parking would be less stressful as no special skills are needed when the car could just drop you off and then go park itself.

Problem:The popularity of driverless vehicles could increase the number of vehicles on the road resulting in traffic congestion. People who have difficulties driving—such as disabled people, older citizens, and children may suddenly start buying cars leading to busier roads.

A report released by the World Economic Forum and Boston Consulting Group used simulations to examine how traffic flows would change around the city of Boston as more robotic cars hit the roads. They found that self-driving cars could lead to a 5.5 percent increase in traffic in the city's downtown as commuters will likely choose the new vehicles over public transportation. A new study by UC Santa Cruz Professor Adam Millard-Ball in the Journal of Transportation Policy makes a convincing case that self-driving cars will dramatically increase traffic further. Millard-Ball forecasts that the number of cars on the street could grow exponentially as more people are able to take their hands off the steering wheel and just sit back and ride.Furthermore, when not in use, autonomous vehicles need to go somewhere. There are three options: go back home, park somewhere, or circle around. Most likely, these cars will endlessly circle the streets rather than parking and paying fees.

RISK OF COMPUTER CRASHES OR GLTCHES

Observation: 4 out of 10 interviewed, expressed doubts and do not have complete trust in the technology in autonomous cars. Problem: Like all computer systems, autonomous cars would be programmed to run a certain way, but with all automated systems there is always a risk of the computer being hacked or crashing due to a glitch or error. No system is infallible and if a hacker was able to get into the car's software, they could potentially reprogram the car to do any number of things. Hackers getting into the vehicle's software and controlling or affecting its operation would be a major concern. A computer malfunction—even just a minor glitch—could easily cause a far worse accident than anything human error might typically incur. Maintenance would have to be overseen. Some process of governmental oversight would have to be installed to make sure every driverless car is mechanically sound and up-to-date. According to data from the University of Michigan's Transportation Research Institute's report, which compared all the available data on all collisions of self-driving cars with statistics involving human-driven ones, driverless vehicles get into more crashes, but those crashes are less serious than those caused by conventional vehicles.

JOB LOSS FROM AI

Observation:

From our interviews with the 2 taxi/Grab drivers, they drive 10-14 hours daily so that they can earn enough to offset their petrol and rental expenses. They feel that the job market is bad and even though they only earn an average of $2000 per month, other than driving, they have limited choices.

Problem:

Replacing human controlled driving due to 4IR will see these people in need of new employment. It is projected that globally there will be wide-scale redundancies among drivers in the trucking, taxi, ride-share, courier, and food-delivering industries. Many of their livelihood will be impacted by the coming changes.

It is estimated that autonomous cars could eliminate 300,000 driving jobs a year, according to a May 2017 report from Goldman Sachs. But that won't happen right away; the report estimated that from 2025 to 2030, autonomous cars will be 20 percent of car sales.

In the US, the Department of Commerce estimates that one in nine workers are currently in occupations that will be affected by the introduction of AVs

Given that AV (autonomous vehicles) is fast changing the roads in Singapore , how can we enhance the ability of people involved in the automobile industry to deal with the Fourth Industrial Revolution in the year 2030 and beyond, so that our people can travel safely,

	Criteria 1: Ease of travel	Criteria 2: Cost of travel	Criteria 3: Efficiency of travel	Criteria 4: Comfort of travel	Criteria 5: Ease of implement -ation	Total:
Upgraded AV transport	3	5	4	3	4	19
AV shared mobility	3	3	5	4	3	18
Encouragi -ng walking and	1	5	2	1	4	13

cycling						
Driverless cars	5	1	5	4	1	16
Flying cars	2	1	4	3	1	12

Promotes use of upgraded public transport

We recommend building and operating a public transport system that provides a high level of connectivity, speed and comfort, that Singaporeans will feel less of a desire to drive.Hence we need to invest heavily in the public transport system. **Many improvements to our train, bus and taxi services have been implemented or are underway, and the government have plans to build several more new MRT lines.**

AV promises a more efficient transportation solution and lower environmental footprint by optimising road usage. In Singapore, the North-East and Downtown MRT lines, and LRT already use driverless technology to improve the punctuality of our mass transport and overcome our manpower constraints. AV-enabled mobility could be a central feature in our future town-planning, enabling commuters to get around effortlessly by offering first- and last-mile connectivity within neighbourhoods. With mobile technology and smart algorithms, on-demand public transportation is fast becoming a reality. Through a smartphone, a commuter will indicate where he wants to be picked up and dropped off within a town area. The bus operator will use an algorithm to aggregate these demands and determine the number of buses to deploy and the routes they will take. The bus operator can thus avoid plying routes without commuters. Commuters will benefit from shorter waiting times and usually a more direct path to their destination.

AV shared mobility

We recommend car sharing as it will reduce the number of vehicles on the roads and increase convenience to commuters. Sharing concepts become economically viable with the introduction of autonomous vehicles.

It will no longer be necessary to search for a shared vehicle in the surrounding area: instead it will be possible to order vehicles to wherever the user happens to be via a convenient "on demand" service. Urban areas similar to Boston can prevent more gridlock by encouraging sharing of self-driving vehicles and

continued use of mass transit. To do this, we recommend lowering prices for autonomous carpoolers, converting parking lots into pick-up and drop-off zones, and creating self-driving-only lanes. Consumers are less invested in the concept of owning a car, due to difficulty reconciling the practicalities of ownership with things like parking costs, maintenance costs, and environmental impact. Car-sharing services work across multiple industries—transportation, technology, insurance, finance. In the process, they are disrupting the notion of car ownership.

Driverless cars

While a self-driving car may not be perfect, driverless vehicles have the potential to provide significant road safety, economic, environmental and social benefits, including improved social inclusion.

This could lead to a massive reduction in traffic accidents, injuries, and deaths. This technology will make driving easier and safer, allow people to be more productive and offer greater mobility to a wider range of people than ever before, reduce emissions, and ease congestion.

In Singapore, A*STAR's self-driving vehicle was the first to be approved for public road testing at one-north in July 2015.It has ferried several dignitaries such as our Prime Minister Lee Hsien Loong, Minister S. Iswaran, Minister Vivian Balakrishnan, and several Ministers from other countries.

Walking and cycling

Walking and cycling are the other healthy alternative for getting around. Some might fear cycling, however, a 2017 study of more than 250,000 people in the UK showed cycling to work reduced your risk of death from all causes by around 40%.

This study involved tracking people for around five years to look at the relationship between how they commute and a number of health outcomes.It took into account their age, sex, socioeconomic status, ethnicity, smoking, BMI, diet and other types of physical activity. This estimate also took into account risks cyclists often worry about, such as having an accident and exposure to pollution. So when you cycle, the health benefits that reduce your risk of dying far exceed your actual chance of dying on the road.

The same UK study as above showed walking reduced the risk of heart disease

by 27%, and the risk of dying due to heart disease by around 36%. However, one appears to need to walk at least 10 km each week to see this benefit.

Flying Cars

SINGAPORE: Trials for air taxis will take off in Singapore in the second half of 2019, with German company Volocopter to conduct flight tests.
The company announced this at the Autonomy and the Urban Mobility Summit in Paris on Thursday (Oct 18).

Flying is safer than driving.The flying car is a type of personal air vehicle or roadable aircraft that offers door-to-door transportation by both ground & air. Flying car should be capable of safe, reliable and environmentally-friendly operation both on public roads and in the air. The flying car requires much smaller parking space than the plane & it is more convenient than the car, especially when it comes to maneuvering traffic jams. Flying cars run on a minimal amount of fuel hence they are quite-fuel efficient,

However, it is costly to build and qualified aircraft pilot and road driver is needed to operate it. If the people face inclement weather conditions and fail to control the car in the air, they are more likely to crash, There would be more rules for flying cars, more strict rules and control to ensure a safe ride, otherwise accident rates would drastically increase and when the flying car crashes into another, they wouldn't survive that easily, They would fall to the ground killing pedestrians or the other people compounding the devastation of accident.

The airplanes are directed by the air traffic control, They are given explicit instructions when to take off, where to fly, and how to land but if too many people use flying cars, it would be nearly impossible to control who lands, when and where, and it would be chaos.

Associate Professor (Adjunct) Neo Kok Beng, the chief executive and founder of Neo Aeronautics, said that when it is fully operational, it will be able to fly above double-decker buses and expressways, and accommodate the weight of the average American or Singaporean. However, the company plans to launch the vehicle, once ready, in the United States only, he said, because Singapore regulations do not allow for personal aerial vehicles to be operated in the open.

ACTION PLAN AND TIMELINE

There are three primary ways in which our transportation system can be improved :
(1) the implementation of autonomous forms of public transport (e.g., trains and buses),
(2) ride-share companies are developing autonomous fleets, and
(3) individuals are purchasing personal vehicles with autonomous features (e.g., lane keeping systems, adaptive cruise control, parking assistance, automatic braking while skidding, and blind spot and collision warning systems).

These implementation scenarios can emerge in combination. The ultimate scenario is that in the long term 'mobility as a service' (MaaS) will evolve to provide seamless door-to-door conveyance involving multiple forms of transport that are bundled together in the form of personalised mobility packages.
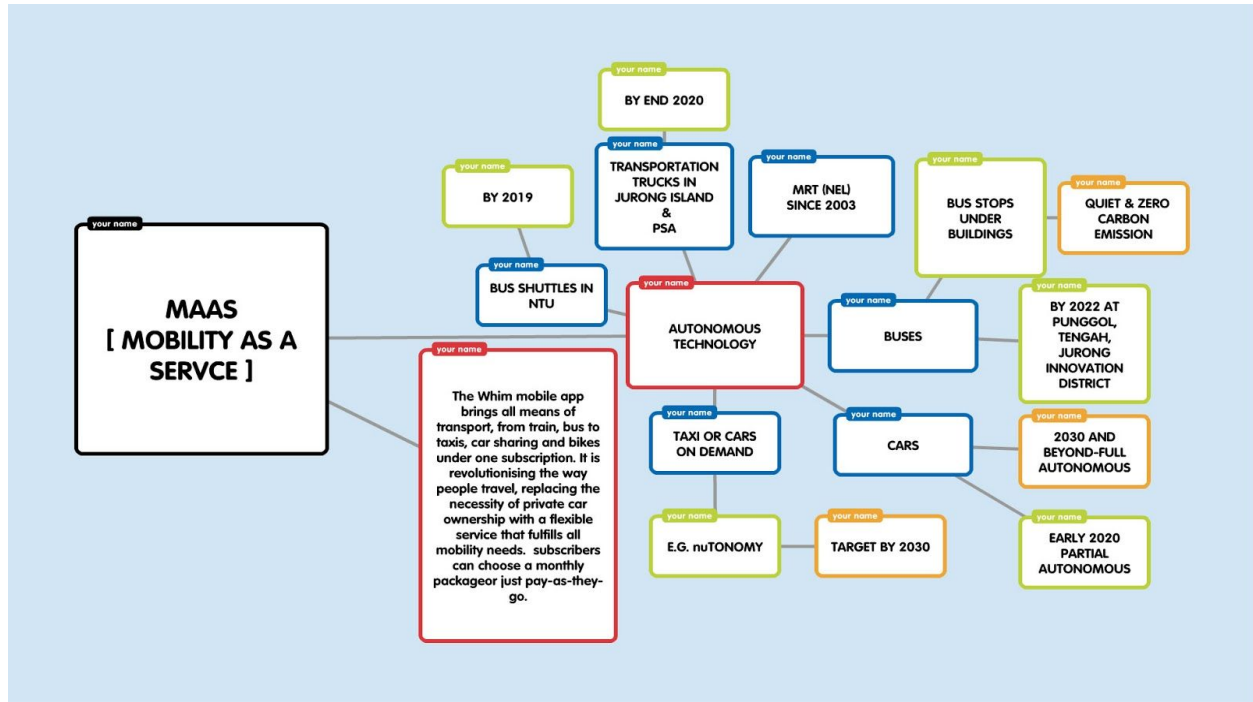
A peek into the future

10 to 15 years down the road, an AV might take your children to school, before bringing you to work. Rather than being left unused at the carpark, it could then be routed to drop your parents off at the market. Such an automated system could enable car-sharing in a wider sense, with a potential to reduce passenger vehicles to a third of current numbers, according to a 2011 MIT study in Singapore.

Even freight transport can be transformed. As a major air and shipping hub, Singapore has much to gain from developments in this area. With automated transport, we could be less reliant on manpower, and see improvements in safety and productivity. Optimised routes and schedules will boost performance and help keep our country at the top of the trade.

A "Smart Nation"

Efficient, environmentally friendly, time-saving and stress free, AVs could transform our lifestyles.They may not only reduce the need for parking spaces, they also bring with them the potential to free up road space that can be redesigned for other uses such as walkways, bicycle lanes and more green spaces.In Singapore, urban and transport planners are expanding the rail network, aiming for 8 out of 10 households to be within a 10-minute walk of a MRT station by 2030. For those living outside this range, or do not have the desire or means to walk, cycle or scoot, robo-taxis can provide the missing link. The price of a robo-taxi ride is also expected to be lower than a conventional taxi ride, with labour costs removed.

For car owners who make this switch, the overall cost of transportation will be lower compared to car ownership, which includes the cost of parking and vehicle maintenance. The primary goal in congested cities is to reduce reliance on private vehicles, and encourage the use of public transport. Singaporeans care about public transport and will continue to use it if transit options are convenient, cost-effective and

Reliable.
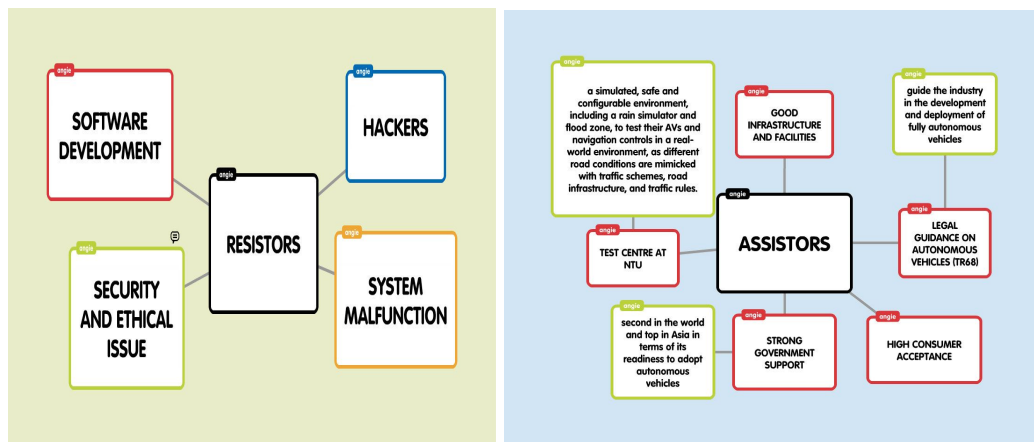
Feedback from community:

Interviewed **10** people. All welcomed the idea of autonomous vehicles and all like the convenience, environmentally friendly and the stress-free transportation system. Bus stops can be located below buildings, (Maas system) allows full access to and tracking of all modes of public transport. Driverless cars ready to ferry the disabled and seniors at all time. However, in times of emergency, they will still travel by non-driverless cars as there is speed limit 30km/h for autonomous cars for now.

Driverless car legislation TR68

Singapore has been an early champion of the technology and was last year ranked first among 20 countries for policy and legislation regarding self-driving vehicles in KPMG's Autonomous Vehicles Readiness Index .Most recently, in early 2019,the country's Land Transport Authority (LTA) published a new set of documents called to guide the industry in the development and deployment of fully autonomous **Technical Reference 68 (TR68) that offer provisional national standards vehicles that do not require human monitoring or intervention.** It spells out expectations such as how fast such vehicles should travel and the space between them on the road and covers areas such as vehicle behaviour and safety as well as cyber security, is intended for fully autonomous vehicles Currently, the ones being tested here, in places such as the one-north business district, all **need a safety driver**, who takes control of the vehicle if necessary. It helps to ensure a smooth transition as autonomous vehicles move from the development stage to real-world use. Issues like who has right of way during a situation between a human driver and an autonomous system need time to be addressed.

AUTONOMOUS VEHICLES –TRIALS IN SINGAPORE

A*STAR's Institute for Infocomm Research (I2R)

- ○ A*STAR's <u>self-driving vehicle</u> was the first to be approved for public road testing at one-north in July 2015.
- ○ It has ferried several dignitaries such as our Prime Minister Lee Hsien Loong, Minister S. Iswaran, Minister Vivian Balakrishnan, and several Ministers from other countries.

nuTonomy, an MIT / SMART spin-off

- **A developer of autonomous vehicle technology with focus on launching a commercial autonomous mobility-on-demand service in Singapore, nuTonomy's software has been tested in the US, Singapore, and Europe.**
- **nuTonomy was the first private company - and the third applicant - to obtain approval for public road testing at one-north as of April 2016.**

NANYANG TECHNOLOGICAL UNIVERSITY (NTU)

- **Driverless shuttle bus now travels a 500m route connecting student halls with the main academic areas, ferrying up to 300 passengers a day.**
- **The vehicle will eventually travel across the entire campus, and is expected to connect NTU to the neighbouring Cleantech Park.**

LTA AND ST KINETICS

- ST Kinetics will develop and integrate autonomous vehicle (AV) technologies onto two 40-seater electric buses. These buses will use a satellite-based Global Positioning System (GPS) and a suite of sensors to scan and determine their location and immediate surroundings. Radars and sonars will also detect other vehicles and pedestrians up to 200m ahead.
- The three-and-a-half year project will also look into improving autonomous buses' ability to navigate in heavier rain conditions, up from the current 10mm/h to 30mm/h.
- The autonomous buses will be tested in various locations, scenarios and environments, which can potentially include Jurong Island and NUS campus.

THE SELF-DRIVING CARS TIMELINE- PREDICTIONS BY TOP AUTOMAKERS

Ford – True Self-Driving by 2021

Honda – Self-Driving on the Highway by 2020

Toyota – Self-Driving on the Highway by 2020

Renault-Nissan – 2020 for Autonomous Cars in Urban

Conditions, 2025 for Truly Driverless Cars

Volvo – Self-Driving on the Highway by 2021

Hyundai – Highway 2020, Urban Driving 2030

Daimler – Nearly Fully Autonomous by Early 2020's

Fiat-Chrysler – CEO expects there to be some self driving on the road by 2021

Reasons for companies to be overly optimistic on prediction of full autonomy:

To generating national or company pride,

To earn media attention,

To boost engineer recruiting efforts, and

To appeal to investors.

Dr Park Byung Joon, an SIM University senior lecturer in urban transport management thinks that we may be too optimistic in thinking autonomous vehicles will soon be a common sight on the roads. **"It's at least a decade or two away.**

Hiccups in driverless technology

In January 2018, Uber CEO Dara Khosrowshahi said he wanted to have self-driving taxis picking up passengers by 2019, and that 20% or more of Uber's fleet could be driverless.

However, Uber's self-driving car ambitions have hit a major roadblock, when an

autonomous Uber car killed a woman in the street in Arizona, in what appears to be the first reported fatal crash involving a self-driving vehicle and a pedestrian in the US.Uber eventually announced the closure of its self-driving car program in Arizona on May 23. Its program remains suspended elsewhere in the country.

Mr James Tan, the principal engineer of Sensors & IoT at Government Technology Agency (GovTech), shared about the experience of deploying autonomous wheelchairs at Changi Hospital - (a collaboration between the SMART, MIT and NUS).

Two autonomous wheelchairs were deployed at a taxi

stand at the hospital to help ferry patients and the designated distance was 200m. While the distance was short, human traffic was heavy, and that the algorithm had a rule that said the wheelchair must give way to humans. In the end, it took nine minutes to travel the 200m, which was not acceptable, the GovTech official said, raising that as an example of how traffic rules for AVs can be complex and need to be carefully thought through.

18 OCT , 2016 nuTonomyself-driving car and a lorry collided yesterday morning, in what is believed to be the first accident in Singapore involving an autonomous vehicle. No one was injured when the car knocked into the lorry while changing lanes in Biopolis Drive at one-north at around 9.30am.The self-driving car, which was on a test drive, was travelling at a "slow speed", had two engineers on board and one of them was behind the wheel as a safety driver, nuTonomy said.

Dr Park Byung Joon, an SIM University senior lecturer in urban transport management, said the accidents do not come as a surprise. "Humans don't always behave the way they should on the roads. And technology is not

advanced enough to pre-empt how humans would behave," he said.

CHALLENGES AND RISKS IN THE EVOLUTION TO FULL AUTONOMY

Many years of validating and tuning of systems needed to expose systems to a significant number of uncommon situations, to expand to broader use cases and geographies.

Engineers also need to achieve and guarantee reliability and safety targets. The systems need time to improve, to make complex decisions. Building a system that can operate in unrestricted environments will therefore require dramatically more effort, given the exponentially increased number of use cases that engineers must cover and test. In the absence of lane markings or on unpaved roads, for example, the system must be able to guess which areas are appropriate for moving vehicles.Most tests with AVs around the world have been done in closed-circuits and not public roads and lack of real-life unexpected situations.

Risk of hackers interfering with the system and wreaking havoc.If managed to infiltrate into the system, hackers could not only mess with your iTunes playlist but also disable safety features such as airbags and ABS or even steal the vehicle entirely.The main stumbling block is the development of the

required software. While hardware innovations will deliver the required computational power, and prices (especially for sensors) appear likely to go on falling, software will remain a critical bottleneck (infographic).

Governmental or legislative efforts.. Autonomous vehicles require both the right legal and technological frameworks. There is serious <u>liability concerns</u> when machines operate themselves in a potentially dangerous environment. There must be good infastrusture to support the implementation to allow the vehicle to be legally driven.

Careful considerations of ethical and safety implications needed before any large-scale implementation takes place.

Timeline of events:

June 2003:Opening of the third line in the Singapore MRT system, It is the first MRT line in the network to use **<u>fully automated and driverless</u> trains**. However,SBS Transit and SMRT have started deploying drivers on their driverless MRT trains in order to improve reliability on the North-East, Downtown and Circle lines.

2016: **nuTonomy, an MIT / SMART spin-off** which focus

on launching a commercial autonomous mobility-on-demand service in Singapore, obtained approval for public road testing at one-north as of April 2016. Operated through the Grab app, the company took their autonomous taxis onto a designated 2.6 sq mile area of Singaporean streets. Since then, the company has expanded its route and now has permission to operate in a number of areas in Singapore.

2017:**Launch of the Centre of Excellence for Testing & Research of Autonomous Vehicles at Nanyang Technological University as a test town for driverless vehicles.**The facility offers companies and developers a simulated, safe and configurable environment, including a rain simulator and flood zone, to test their AVs and navigation controls in a real-world environment, as different road conditions are mimicked with traffic schemes, road infrastructure, and traffic rules.

Jan 24 2019: Driverless car legislation: With the amendment to the Road Traffic Act, the Singaporean law now recognises that motor vehicles don't require human drivers, making it the **first world country to widely adopt autonomous driving.**

February 2019: Singapore is **second in the world and top in Asia in terms of its readiness to adopt**

autonomous vehicles (AVs) on the strength of its government, infrastructure and consumer acceptance, according to a report by KPMG. It reflected the Singapore government's efforts to position the country as a centre for autonomous vehicles,

MooVita recently launched MooAV, best described as a huge robotic bug self-driving vehicle. MooAV is considered the car of the future.*This new automated form of transportation will not need a physical driver enabling the elderly and disabled to get around easily*

LTA published a new set of documents called Technical Reference 68 (TR68) that offer provisional national standards to guide the industry in the development and deployment of fully autonomous vehicles.Operators are required to have a qualified safety driver who will be able to take control of the vehicle in an emergency and to minimise the occurrence of accidents

Mar 2019: **Nanyang Technological University (NTU) and Volvo Buses on Tuesday (Mar 5) launched a 12-metre autonomous electric bus in what they said was a world first**.The launch comes as part of a development programme between the two, under NTU's partnership with the Land Transport Authority (LTA) to develop and conduct autonomous vehicle bus trials for

fixed routes and scheduled services. The electric buses, with a capacity close to 80 passengers, will soon begin driving at the campus of Nanyang Technological University in Singapore, before trials are extended to public roads.https://www.channelnewsasia.com/news/singapore/driverless-electric-bus-launched-by-ntu-and-volvo-in-world-first-11311838

MaaS Global (mobility as a service) will start piloting Whim service this year in Singapore and the commercial launch is planned in Q1 2019. The world's first Maas operator MaaS Global from Finland is starting operations in Singapore, and will be partnering with ComfortDelGro, one of the world's largest land transport companies. Other partners who will be announced soon include major car rental companies, car sharing, bike share and scooter share operators as well as public transport in Singapore.

The Whim mobile app brings all means of transport, from train, bus to taxis, car sharing and bikes under one subscription. **It is revolutionising the way people travel, replacing the necessity of private car ownership with a flexible service that fulfills all mobility needs. Our subscribers can choose a monthly package, which suits their needs to cover all their daily journeys, or**

just pay-as-they-go.

By 2019: **Fully automated Group Rapid Transit would operate a minibus service route that connects the halls of residence with the main academic areas in NTU.**

2022: The Singapore Government said it will **introduce self-driving buses and shuttles in Punggol, Tengah and the Jurong Innovation District** from 2022 for off-peak and on-demand commuting. The Ministry of Transport had also said it is relooking how road rules can be extended to such self-driving vehicles in the future https://www.channelnewsasia.com/news/technology/singapore-driverless-vehicle-autonomous-national-standards-11190498

Early 2020's: An increase in number of cars with some self-driving capacity on the road, mostly being luxury cars or part of commercial fleets.

2030 and beyond:Driverless cars on public roads. Associate Professor Marcelo Ang, director of the National University of Singapore's Advanced Robotics Centre, said it is difficult to say how long it will take for **fully autonomous vehicles to be commonplace on roads**

here.