Group ID: 10-40

Future Trends Report

Community / Organisation Studied: Commuters

STEP 1. Identify Challenges

Our team derived the challenges from our primary findings which are based on 100 survey responses as well as through secondary research findings. Our respondents are all commuters who use buses and we picked groups of commuters at different age ranges to get different opinions.

Many of the problems that Autonomous Buses will face are similar to what Autonomous Vehicles will face. Hence we have also highlighted some of the problems that AVs will face.

Challenge #1: Lack of trust over System Reliability

60% of our survey respondents chose the reliability of the Autonomous Buses as a potential key concern. They believe that in the case of a power outage, equipment like GPS, sensors and cameras would not work. They think that the Autonomous Buses are not safe and reliable. This results in lower acceptance rate of Autonomous Buses.

"Lack of trust is one of the biggest obstacles to the adoption of automated vehicles. But trust is a relationship — a shared acknowledgement of risk. So it's important for both cars and drivers to understand one another's skills and limitations." (Muller, J., 2019)

It was also mentioned in a white paper by INTEL, that "Too often, tech companies focuses more on created trusted technologies (like trusted execution environments) than on how technologies might be received by people. Confusing designs and interactions can make embracing new technologies difficult. When it comes to AVs, the stakes are even higher as we can face injury or even death". Therefore "Trust interactions will promote confidence, control and a sense of safety for the people operating AVs." (INTEL, 2016)

Thus, we can tell that lack of trust is indeed an obstacle to allow increased adoption of Autonomous vehicles and thus Autonomous buses. This could have been a result of the lack of information on Autonomous Buses. Without good knowledge of how it works, one does

not feel safe and confident and thus is unable to trust the machine to totally take charge and navigate by itself while sharing road use with other human road users. So, we need to work on this problem. The greater the trust the people have in AVs, the more confidence people would have in the AV Systems, therefore this would help in a greater adoption rate of Autonomous Buses.

Challenge #2: Need for Good Data Management Infrastructure

Telefonica and Intel, 2 data companies, estimate that just 1 autonomous vehicle will consume 4 terabytes (TB) of information per day, with just 1 hour of driving! This comprises of technical data (new driving scenario) and crowdsourced data (road or traffic conditions).

This 4TB of data per car, can be exponentially increased. It becomes a challenge when we need to make sense of that data, to turn it into actionable insight that lets cars think, learn and act without human intervention. Data that lets cars do the driving so that 90% of the accidents caused by human error may be over.

According to a product review on Autonomous EZ 10 minibus with 5G capabilities, "AV will rely heavily on 5G and cloud communication for tasks like image recognition." "Data hungry cars will need 5G to support advanced services. Cameras would be drawing 20 to 40 MB per second, LIDAR up to 70 MB, GPS around 50 Ks, and sonar and radar about 100 KB per second. Specialized 5G networks need to be available to enable vehicles to talk to each other and points like traffic lights." (Mechanical Engineering, 2018)

Thus, an enormous amount of computing and cloud capacity is required to process, analyze, share and store such huge data sets. And it is not possible to tackle these data challenges by just one company. Government and companies may need to "work together across the industry to develop secure state-of-the-art platforms and to share safety-related information. We should work towards a shared vision of a world without accidents and with mobility for all, industry collaboration will accelerate the ability to deliver". (Winter, 2017)

Challenge #3: Safety of Passengers not ensured

According to our survey, 57% of the respondents are concerned about accidents and crashes involving autonomous buses.

NUS transport researcher Lee Der Horng (2016) commented that “machines can never fully replace drivers” and “Without the driver, you must find a way to monitor the passengers' behavior, including their intentions.” Hence, more carefully thought through safety measures and road preparation should be added into the Autonomous Bus Systems.

With the absence of a safety driver, passengers are naturally concerned about safety since human intervention is absent and autonomous buses are subject to various external factors such as road and weather conditions, other road users etc. Human beings can sometimes do better judgement than machines as they can sense and react accordingly through sight, sound and instinct. Thus, safety of passengers remain a key concern before they adopt autonomous buses with open arms.

Challenge #4: Legal responsibility

As AV technology is still not mature, accidents are “not to be unexpected” during trials. Legal responsibility thus remains a grey area in many aspects.

Who would be liable when an Autonomous Bus hit another car driven by a human or a pedestrian? Would the person(s) in the AV at the time of the accident be liable? What happens if there is no one in the AV when the accident occurs? Who is to be blame when accidents involving Autonomous Buses occur due to heavy downpours or flash floods?

Singapore has amended the Road Traffic Act to better regulate trials of AVs. But as the AV technology is emerging, new rules and existing regulations would have to be continuously added or amended to adapt to the changing environment.

Challenge #5: Lack of a Robust Data Collection and Communication Mechanism

As Challenge 3 suggested, safety remains a key concern for commuters and the general public. This inevitably leads us to the next challenge – is there a robust data collection and communication mechanism in place now? How can accurate real-time data about the road and weather conditions be collected and shared among key parties, eg. Autonomous Bus companies, LTA as well as commuters so that the commuters feel safer on the road? This calls for the need for a Robust Data Collection and Communication Mechanism. With huge data collected and shared, then massive machine learning can happen. But how and from where do we collect such data?

STEP 2. Craft the Underlying Problem

Using the challenges listed in Step 1, identify a problem of major importance to the chosen community / organization in the future. Write your Underlying Problem making sure your question clearly explains the action that will be taken and the desired results/goal of that action.

Incorporating Challenge(s) # 1, 3 and 5

Underlying Problem:

Given that there are large numbers of commuters who are concerned about the safety and reliability of autonomous bus systems, how could we improve the infrastructure of autonomous bus systems so as to raise the commuters' confidence in autonomous buses when they are rolled out in Singapore by 2030?

STEP 3. Produce Solution Ideas

Solution #1: Conduct multiple tests and trials for Autonomous Buses

Some of our survey respondents replied that conducting multiple tests and trials, learning from these trials and fine-tuning these infrastructure and autonomous bus system can improve the safety and reliability factor and thus commuter's confidence in Autonomous Buses.

Autonomous shuttles are already currently on trial in Nanyang Technological University's (NTU) as well as National University Singapore (NUS) within their campus grounds.

NTU and Volvo have launched a 12m-long autonomous electric bus- the world's first. The bus can fit up to 80 people and has gone through multiple tests at NTU for safety. The bus is equipped with edge-cutting technologies to ensure the safety of the passengers like the GPS

antennas, Light Detection and Ranging Sensors (LIDARS) and a stereo-vision camera that record a 3-D view of the surroundings.

NTU's Energy Research Institute (ERI@N) will build on its experience of running self-driving electric shuttles. The autonomous driving software will be tested against different road scenarios. This could involve motorcycles cutting into lanes or motorists changing lanes without signaling. Further research like the above has to be done to help to encourage more passengers to board autonomous buses.

In June 2019, National University of Singapore (NUS) has also launched a year-long trial of the EasyMile EZ10 autonomous shuttle to gauge the commercial viability of such a service. The key purpose of the road test is to 'map' the route through the collection of data for the vehicle's navigation systems, hence increasing the accuracy of the routes and thereby improving the infrastructure, allowing the Autonomous Buses to be deployed more safely.

Solution #2: Constantly upgrade and improve equipment to increase safety factor

It is absolutely necessary to constantly upgrade and improve equipment and infrastructure in order to maintain and improve the safety factor of Autonomous Buses.

We should learn from SMRT flooding incident that happened back in October 2017. SMRT maintenance team had not performed maintenance works and this led to the malfunctioning of the water pumping system at Bishan MRT station that caused a massive 20-hour disruption to the train system. Similarly, constant monitoring, upgrade and improvement of the equipment and infrastructure such as the wireless monitoring system, various sensors, charging platform infrastructure is crucial.

Solution #3: Educate the public about the benefits of having a good infrastructure of autonomous buses and how it can reduce the chances of accidents.

To reduce accidents, it is paramount to have a well-supported infrastructure behind the Autonomous Bus system. Educate the public that with a strong system supported by the government and relevant authorities and 3rd party transport and automobile companies, it allows for data aggregation, machine learning as well as sharing of relevant data with selected stakeholders.

Also, 90% of car accidents happen because of mis-judgement by drivers, inexperience, fatigue, reckless driving, negligence, slow reaction time, etc. With aggregated machine learning in place backed by solid system, autonomous vehicles can operate under a much safer environment, as compared to a vehicle driven by a driver.

Therefore, through educating the public about the huge amounts of resources (time and money) and efforts put into the testing of the Autonomous Buses, the public would learn about the work contributed by scientists, engineers and professionals from the transport industry, thus they would be more likely to accept what is to be rolled out in a few years' time. We will be able to spread awareness of the Autonomous Buses and increase the commuters' confidence in the Autonomous Buses.

Solution #4: Programme multiple different scenarios into the autonomous system such that the bus knows how to respond to different circumstances

Autonomous system have to be programmed to handle different scenarios in times of emergency or uncertainties. This method includes the use of Machine Learning. As the Autonomous Bus goes about its' daily route, it will learn from specific events which happened throughout the day. If similar events happen again, the bus will then react accordingly, after learning from its' previous encounter. Safety should be the core focus when designing these programme configurations. For example, when the bus met a fallen tree, it could quickly react and brake before it crashes into the tree. Also, this could be further enhanced by the data collection method which is being explained later. Data could be transmitted to other buses and thus, could avoid accidents.

Solution #5: Come up with a Robust Data Collection and Communication Mechanism

A solution to the Underlying Problem is to come up with a robust Data Collection and Communication Mechanism. We need to collect accurate real-time data about the road and weather conditions in specific areas and share these information among key parties, eg. Autonomous Buses in the network, LTA as well as commuters. Commuters, once they understand and are made aware that road conditions, autonomous vehicles etc., are all well monitored and a plan B is always in place in case of emergency, they will be more confident and assured that Autonomous Buses are safe to take. Thus, this calls for the need for a Robust Data Collection and Communication Mechanism. With huge data collected and shared, it will facilitate more massive machine learning to take place.

However, it is critical that the collection of such data needs to come from a reliable source, preferably a network which has island-wide coverage, for example traffic lights, bus stops or lamp posts, since the data and trends will lead to further development of the autonomous buses. For a better experience for the commuters, the improvements have to be appropriate and precise. The data collected needs to be accurate & transmitted securely to keep the data private and to work on the information quickly to enhance fast machine learning and quick data analysis as well as response.

STEP 4a. Select Criteria

Criterion #1: Difficulty to execute

Criterion #2: Impact to commuters once implemented

Criterion #3: Cost of implementation

Criterion #4: Time taken for implementation

Criterion #5: Commuters' Acceptance

STEP 4b. Apply Criteria

List the solution ideas from Step 3 on the grid. Use each criterion to rank the solutions on a scale from 1 (poorest) to 5 (best). The weighting for one important criterion may be doubled if necessary.

Step 3 Sol'n #	**Solution Idea**	**Criteria (weightage)**					**Total**
		1(1)	**2(2)**	**3(1)**	**4(1)**	**5(1)**	
#1	Conduct multiple tests and trials for Autonomous Buses	2	4	3	4	3	20
#2	Constantly upgrade and improve equipment to increase safety factor	3	**3**	**1**	2	4	16
#3	Educate the public about the benefits of having a good infrastructure of autonomous buses and how it can reduce the chances of accidents.	5	**1**	**5**	3	1	16
#4	Programme multiple different scenarios into the autonomous system such that the bus knows how to respond to different circumstances	1	**2**	**4**	1	2	12
#5	Come up with a Robust Data Collection and Communication Mechanism	3	**5**	**2**	4	5	24

STEP 5. Develop an Action Plan and Evaluate its Feasibility

Action Plan derived from Solution #5

Solution #5: Come up with a Robust Data Collection and Communication Mechanism

A good Data Collection mechanism is required to better manage Autonomous Buses, control the Autonomous Buses and set the routes of the Autonomous Buses to arrive at their destination on time and to avoid taking any undesired routes or meet any unforeseen circumstances. Through the Data Collection Mechanism, data such as real–time traffic conditions, images and videos of accidents & roadworks will be collected & analysed.

The Data Collection Mechanism can be executed through the use of Smart Lamp Posts. Smart Lamp Posts, are already in The Smart Nation and digital government office (SNDGO)'s plans. Refer to Figure 1 below.

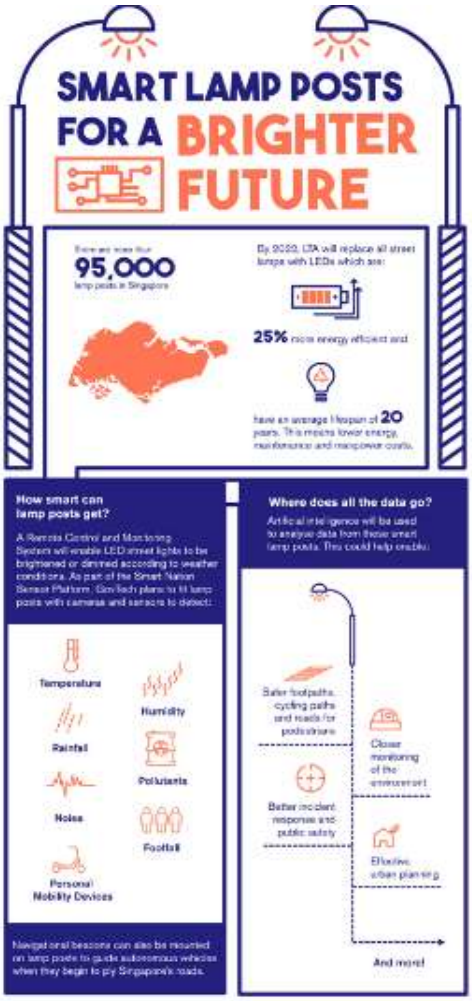

Figure 1. Smart Lamp Post Information by GovTECH.

"Laap", or "Lamp post as a platform" is a project which aims to host sensors on lamp posts. The Smart Nation and digital government office (SNDGO) and government technology agency trials will be started in Geylang and one-north to equip the lamp posts with various capabilities to improve urban planning. The aim is to turn all of Singapore's over 100,000 lamp posts into smart platforms.

The initial plan by SNDGO of the Smart Lamp Post is used more for urban planning. However our design on the SMART Lamp Post can be deployed as an infrastructure solution for the autonomous bus system. We can incorporate high resolution cameras, speed sensors, video cameras and advanced communications protocol onto these smart lamp posts, which are linked to all the Autonomous Buses through the cloud, will be able to show and record real-time footage of current traffic conditions, any accidents which occur or any road closures as well as weather conditions, ie. factors that might impact the functioning of Autonomous Buses.

These data will then be processed and stored in Cloud Data Storage. Through Artificial Intelligence and AI recognition Software, massive machine learning will take place. As more data gets collected, more accurate interpretations of the information can be achieved thereby resulting in better autonomous vehicle management.

These data are sent to the other Autonomous Buses which are currently on the road as well, especially those Autonomous Buses that are en route to the reported incidents/areas. Once the Autonomous Buses are notified, they will react accordingly to the data which it has received.

For example, if the Autonomous Bus receives information that an accident has occurred on the expressway which it plans to take to reach its destination, resulting in slow traffic and many blocked lanes, the Autonomous Bus will immediately calculate the next fastest route towards its location which has smooth-moving traffic. This would allow the Autonomous Buses to arrive at its destination in time and would not get caught in heavy traffic jam. Thus, this example of the use of the Data collection Mechanism through the Smart Lamp posts shows that this method is reliable, convenient, allows the Autonomous Buses to be punctual and fast, as well as being able to raise the commuters' confidence in Autonomous Buses and the Autonomous Bus Systems. Passengers waiting for buses in the affected routes will be alerted via their transport applications, that buses have been re-routed and they can be advised to either change their mode of transportation, wait for another bus or go to the next nearest bus stop.

These Smart Lamp posts require uninterrupted power supply to keep it functioning 24/7. We proposed that the Smart Lamp posts can be powered by solar energy and stored in an in-built battery within the lamp posts. The cameras and sensors will also rely on the Lamp post's stored power to operate. The Smart Lamp posts, together with the entire Data collection mechanism, will be implemented all over Singapore.

Currently, prototypes are being tested to determine the kinds of technological capabilities that can be incorporated. The trial will use crowd analytics and environmental sensors to measure air quality, rainfall and water level. Some examples of the technological capabilities include: Environmental Sensors, Speed Traps, Cameras and Sound Sensors. The Speed Trap is able to detect fast-moving vehicles such as Cars on the road or Personal Mobility Devices (also known

as PMDs) which are going above the speed limit. The cameras will be equipped with Facial Recognition. The sound sensors will be able to detect unusually loud sounds, such as someone screaming or the sound of a car crash. The smart Lamp posts have many functions, thus, not only will they help to increase Autonomous Bus Systems and improve the commuters' confidence in Autonomous Buses, but it can also lead to safer streets and roads for everyone.

Implementation Timeline for Smart Lamp Posts:

2020: Attract more engineering firms to tender for Smart Lamp Post Projects.
2020-2021: Lab tests and development to be conducted
2022: Final prototype to be constructed
2023: Evaluation trials to be in township like Punggol and Jurong Innovation District together with Autonomous Bus system
2025: Design Changes and Improvement
2026: Tender for Mass Production
2027-2030: Roll out to the various township in various phrases with completion in 2030

We noted that ST Engineering has already won an S$7.5 million contract for the trial of a smart lamp-post project in Singapore, but having more players in this field can increase competitiveness and allow for more learning within the industry. According to Professor Archan Misra from the Singapore Management University's School of Information Systems (SMU), he believes the smart lamp post is still at least four years away from reaching a level where its capabilities will match its intent. Second Minister for Transport Ng Chee Meng also mentioned in 2017 it would take about 10 to 15 years before AV technology could be deployed widely. Transport Minister Khaw Boon Wan also announced that Punggol, Tengah and the Jurong Innovation District will be the first areas in Singapore to have self-driving buses and shuttles plying the roads from 2022.

Hence the above timeline provides feasible and more realistic implementation actions for the Smart Lamp Posts to be carried out.

Potential Resistors/ Obstacles:

Intrusion of Privacy

Our research has discovered that some commuters have concerns regarding the possible invasion of their privacy with such data collection and monitoring via the Smart Lamp Posts in public places. They worry that with the use of cameras and Facial Recognition software, these could be used to find out about their whereabouts and intrude their privacy.

Regarding these concerns, Prime Minister's Office Smart Nation and Digital Government Office (SNDGO) Deputy Secretary responded, "We have no plans to use it to probe into how people live their lives." "The whole point of the sensor platform is to look at improving services, look at how to run the city and operate the city better and how to plan the city better. We have no plans to do moral policing or things like that." (Tan Kok Yam, 2018).

Cybersecurity threats

Another concern is cybersecurity and data leaks threats.
One of the reasons for this fear is probably due to the nation's worst cyber attack that happened in June 2018, where 1.5 million SingHealth patients had their personal particulars accessed and copied, including our Prime Minister Lee Hsien Loong.

Professor Archan Misra warned that cybersecurity threats such as hacking and data leaks could be bigger dangers as compared to infringement of privacy issues. "Some of the things I've heard is that there is potential that a lot of the communication infrastructure is based on things such as Wi-Fi. These are unlicensed spectrum, meaning they are sort of more vulnerable to threats, because anybody can bring a laptop and start messing around with these," "So you (have) got to have a higher level of security for some of those." (Khan, 2018)

How to resolve such issues:

Better education of the public about such systems and open disclosure is probably the best solution to such concerns.

Professor Archan Misra mentioned, “You want the public agencies to be more upfront about what they’re using them for and to highlight the positive use cases. Admittedly there will be a very tiny sliver of cases, when you’re tracking a person of interest, criminal on the run, and you’re going to be using all this infrastructure to monitor those and track them. But that’s going on already, there’s no surprise and there’s high public acceptance of that.”(Khan, 2018)

Secondly, have measures in place to ensure that only people who are authorized to access are allowed to do so.
SNDGO says that the data collected will be safe, and there will be measures to prevent misuse. “Internally we have access controls to make sure that those accessing any kind of sensor or personal data have a purpose, are allowed to do so," said Mr Tan. "We will be able to track whoever who accesses the data in a matter that is not relevant, that does not gel with what the officer is supposed to do. As for those who misuse or abuse the access to personal data, they will be penalised." (Tan Kok Yam, 2018)

Potential Assistors:

Some of the potential assistors could be the Smart Nation and Digital Government Office (SNDGO), Enterprise Singapore (ESG), Land Transport Authority (LTA), Autonomous Vehicle developer ST Engineering and Committee on Autonomous Road Transport for Singapore (CARTS).

SNDGO is under the Prime Minister’s Office. It plans and prioritises key Smart Nation projects, drives the digital transformation of government, builds long-term capabilities for the public sector, and promotes adoption and participation from the public and industry, to take a collective approach in building a Smart Nation. (Smart Nation Singapore, 2019) SNDGO has started a Smart Nation Sensor Platform (SNSP) which is an integrated nation-wide sensor platform to improve municipal services, city level operations, planning and security. Lamp

posts as a platform (Laap) is one of the projects. It can use Artificial Intelligence (AI) to help with the autonomous transportation systems.

Enterprise Singapore can provide grants to potential companies with a good knowledge of such technology to set up companies and participate in the Autonomous Buses initiative. LTA and the Government will definitely be involved to set the rules for the use of Autonomous Vehicles and determine how the Autonomous Vehicles should interact with other vehicles on the road. LTA address issues like who has right of way during a situation between a human driver and an autonomous system. They will address issues like who has right of way during a situation between a human driver and an autonomous system.

Survey conducted to solicit feedback on our action plan:

With our proposal of data collection via Smart Lamp Post, we solicited feedback from the commuters by conducting a second survey.

A total of 42 respondents participated in our survey, out of which 88.1% of the respondents replied that Smart Lamp Post designed with advanced features will help to improve the reliability and safety of Autonomous Buses. Refer to Figure 2 below.

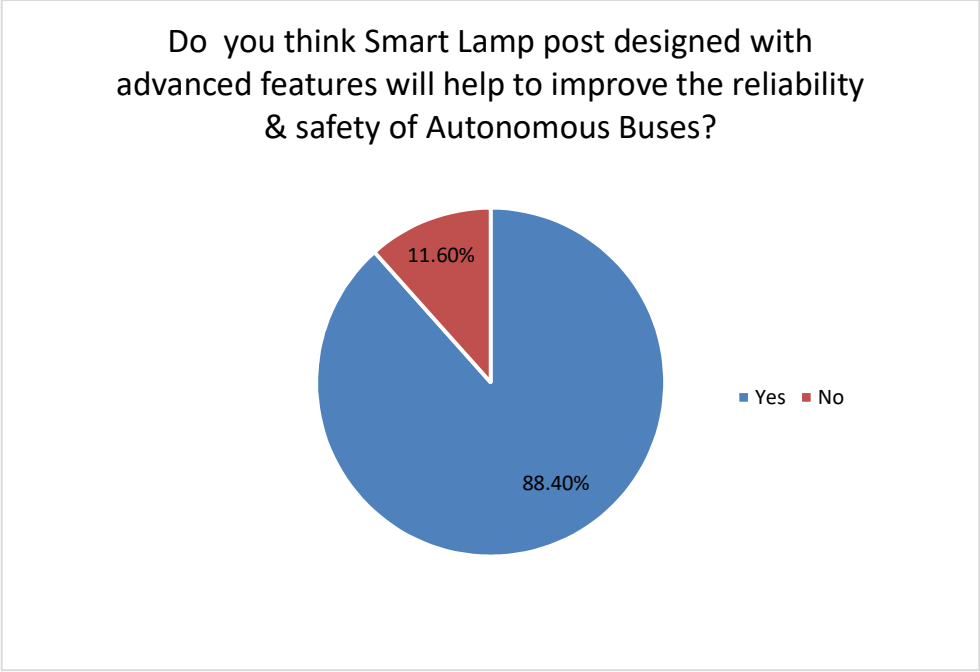

Figure 2. Survey question on whether Autonomous Bus system will help to improve the reliability and safety of Autonomous Buses.

Next, consistent with our proposal, majority of the respondents agreed that the following features are to be incorporated into this Smart Lamp Post system. Please refer to Figure 3 below.

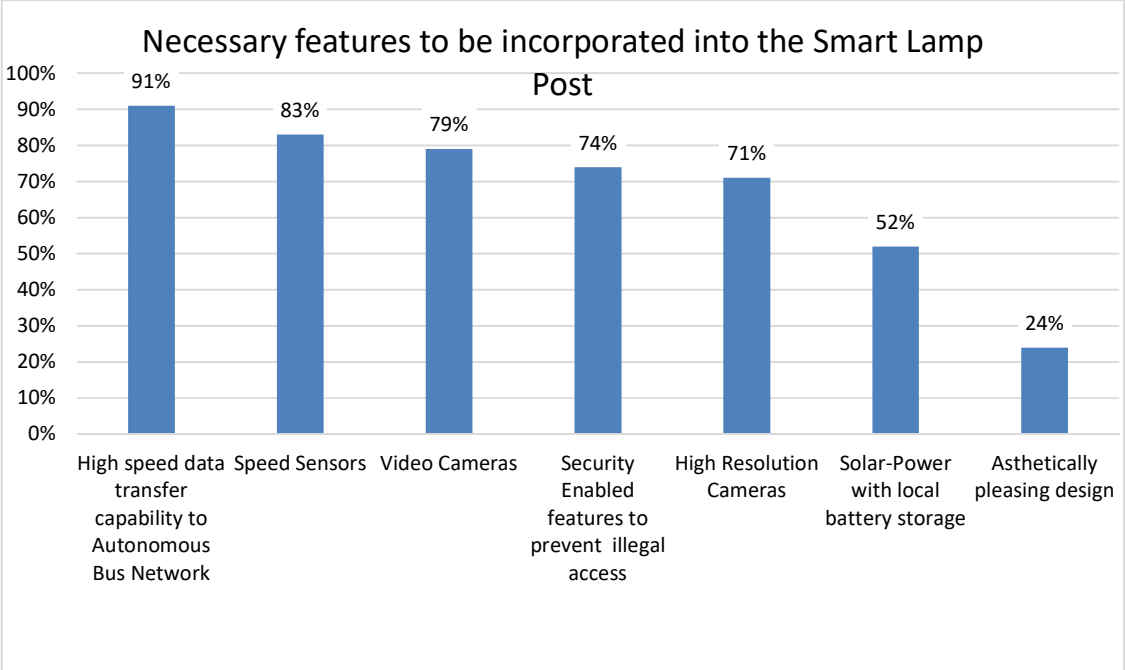

Figure 3: Responses on features to be incorporated into the Smart Lamp Post

According to our survey, 69% our respondents are concerned about cybersecurity threats such as hacking and data leaks of the information collected.

To ally commuters' cyber security concerns, the government and relevant parties must provide adequate security against illegal access and data breach.

67.4% of the respondents feel that one of the safety measures can be through strictly restricting the access of the lamp post video footage and data to only authorized personnel, the Police and Land Transport Authorities (LTA) as well as the companies running the Autonomous Public Transportation. With this in mind, we further proposed that such data should only be stored and owned by the Government and be placed behind the firewall. Access control of such data must be authorized by the Government agencies before 3rd parties can access such. There must be regular audits that no data breaches occur.

48.8% of the respondents feel that we must implement new legal regulations to protect the use of such data and impose strict punishments against the offenders. Currently, those who are found to be in breach of the Personal Data Protection Act in Singapore could be fined up to S$1 million.

Conclusion

Hence with the feedback solicited from the commuters, we are confident that our proposed solution of improving data collection infrastructure of autonomous bus systems through the use of smart lamp post along with our suggested action plan will best raise the commuters' confidence in autonomous buses and hence increase the adoption rate when they are rolled out in Singapore by 2030.

Bibliography

List of References:

Muller, J. (2019). Building trust in automated vehicles is a two-way street. *AXIOS* Retrieved from https://www.axios.com/trust-in-avs-human-driver-car-technology-12f8d55a-bae5-46f2-bab1-3a81ed419ce5.html on July 1, 2019.

Jack Weast et al., INTEL (2016). *A matter of trust: How smart design can accelerate automated vehicle adoption.* Retrieved from https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/trust-autonomous-white-paper-secure.pdf on July 1, 2019

5G MINI-BUS (2018), *Mechanical Engineering* Vol. 140 Issue 9, p27.

Driverless buses in 2018: Rigorous trials before self-driving buses hit the road. (Oct 20, 2016*) The Straits Times* Available: https://www.straitstimes.com/singapore/rigorous-trials-before-self-driving-buses-hit-the-road

Jeff McMahon. (2018) *7 Ideas To Pave The Way For Autonomous Vehicles* [On-Line]. Available: https://www.forbes.com/sites/jeffmcmahon/2018/04/09/7-ways-the-roads-can-get-ready-for-autonomous-vehicles/#ca15b5643dd6 Retrieved July 1, 2019

New rules for autonomous vehicles (Feb 8, 2017) *The Straits Times.* Available: https://www.straitstimes.com/singapore/new-rules-for-autonomous-vehicles

Singapore university embarks on autonomous trial. (Jun 3, 2019). *SmartCitiesWorld* https://www.smartcitiesworld.net/news/news/singapore-university-embarks-on-autonomous-trial-4236

Self-Driving Cars Might Kill Auto Insurance as We Know It. (Feb 19, 2019). *Bloomberg* Available: https://www.bloomberg.com/news/articles/2019-02-19/autonomous-vehicles-may-one-day-kill-car-insurance-as-we-know-it

Kathy Winter (2017) For Self-Driving Cars, There's Big Meaning Behind One Big Number: 4 Terabytes Available: https://newsroom.intel.com/editorials/self-driving-cars-big-meaning-behind-one-number-4-terabytes/#gs.tnrpha

Ahmad Khan, 'Smart lamp posts' in Singapore won't shine light into people's lives (May 13, 2018) *Channel News Asia.* Available: https://www.channelnewsasia.com/news/singapore/smart-lampposts-singapore-wont-shine-light-peoples-lives-10229804

ST Engineering wins contract to test smart lamp-posts. (Oct 2018) *Channel News Asia.* Available: https://www.channelnewsasia.com/news/business/st-engineering-wins-contract-to-test-smart-lamp-posts-10823710

Smart Nation and Digital Government Office, Singapore (2019) *Smart Nation Singapore*, Available: https://www.smartnation.sg/why-Smart-Nation/sndgg Retrieved August 4, 2019.

Kevin Kwang, (2018, June 6) Singapore relooking road rules to allow for self-driving vehicles. *Channel News Asia.* Available: https://www.channelnewsasia.com/news/singapore/self-driving-cars-road-rules-singapore-mot-10397586

Straits Times, Toh Ting Wei (2019) *NTU and Volvo launch world's first full-sized driverless electric bus for trial.* Available: https://www.straitstimes.com/singapore/transport/ntu-and-volvo-launch-worlds-first-full-sized-autonomous-electric-bus-for-trial

5G MINI-BUS (Sep2018) Military & Government Collection Mechanical Engineering. Vol. 140 Issue 9, p27-27. 1/3p

Straits Times, Adrian Lim (2016) *Driverless buses in 2018: Rigorous trials before self-driving buses hit the road* Available: https://www.straitstimes.com/singapore/rigorous-trials-before-self-driving-buses-hit-the-road

Forbes, Jeff McMahon (2018) *7 Ideas To Pave The Way For Autonomous Vehicles* Available: https://www.forbes.com/sites/jeffmcmahon/2018/04/09/7-ways-the-roads-can-get-ready-for-autonomous-vehicles/#7252743b43dd

Smart Nation Singapore (2019) Autonomous Vehicles Available: https://www.smartnation.sg/what-is-smart-nation/initiatives/Transport/autonomous-vehicles

Land Transport Guru (2017) *Autonomous Buses in Singapore* Available: https://landtransportguru.net/autonomous-buses-in-singapore/

Today Online (2016) *Self-driving buses easier to implement than cars but concerns remain: Experts* Available: https://www.todayonline.com/singapore/self-driving-buses-easier-implement-cars-concerns-remain-experts