

Project Work Written Report

Group 10-30

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Driverless vehicles

Levels of autonomy in cars

There are six levels of autonomy in driverless cars, with Level zero meaning no autonomy and Level five signifying complete autonomy. In level zero, all aspects of the driving are controlled by the driver and there are no computers in the car with built-in capabilities to operate the vehicle by itself. Some functions such as steering are assisted by a computer. **Most vehicles presently are at this level with two or more** automated functions work together to relieve the driver of control. Examples include Tesla Autopilot. Level three vehicles have a system with both adaptive cruise control and automatic emergency braking and the automobile can perform all aspects of the driving task under some circumstances. In level four, the car can do all the driving and no human driver required. Human drivers can interfere when needed. **Level five vehicles can perform all driving functions under all conditions and is the top level of autonomy.**

Development progress of driverless car

Locally

The National University of Singapore, the Singapore-MIT Alliance for Research and Technology , A*STAR's Institute for Infocomm Research and nuTonomy are some driverless car projects that have been approved to conduct trials on the streets of Singapore, especially on the streets of one-north, Singapore's business park.

In Foreign countries

Germany:

Volkswagen has started to use five highly automated versions of its compact Golf cars on the streets in Hamburg. Hamburg has allowed Volkswagen to test their driverless cars on a nearly two-mile stretch of road.

USA:

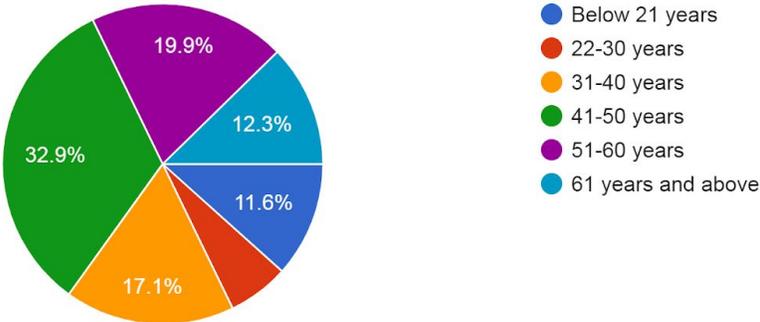
The US postal service has started a pilot program involving using driverless trucks to deliver mail to three southwestern states. It includes five round trips, totalling to more than 3,380 km, or a 45 minute drive. TuSimple, the designing company of the trucks, said that they aimed to eliminate the problem of driver shortage due to an aging workforce. Waymo, a driverless car company founded by Google, is now owned by a company called Alphabet. Waymo currently operates in Chandler, Tempe, Gilbert and Mesa.

Aim: To investigate if Singapore is ready to adopt driverless cars

Interview survey results

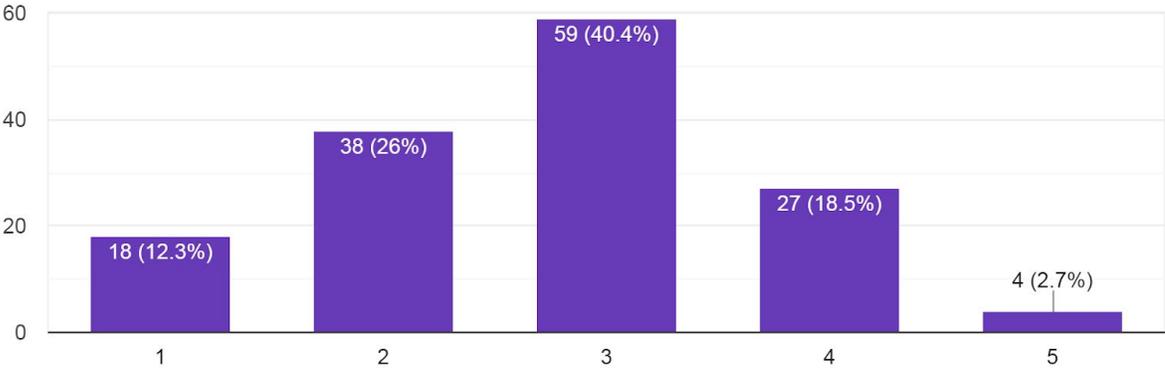
What is your age group?

146 responses



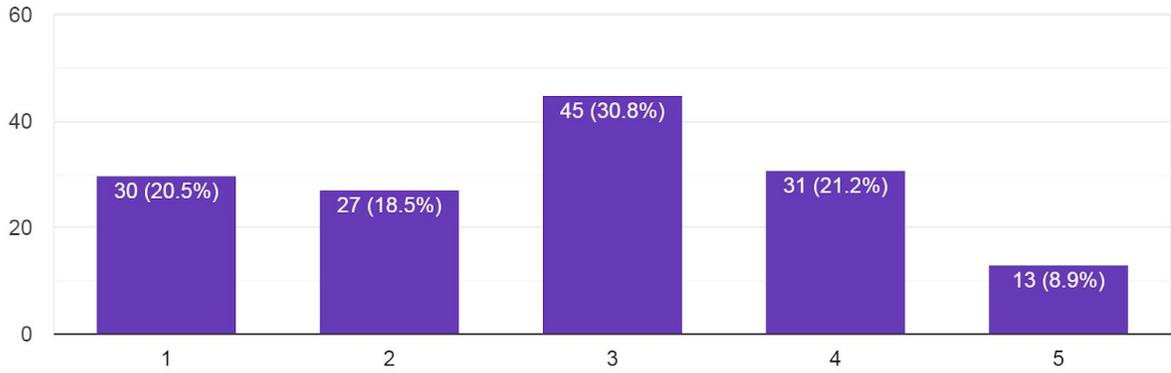
On a scale of 1 to 5, with 1 being the least and 5 being the most, rate how much you know about driverless vehicles.

146 responses



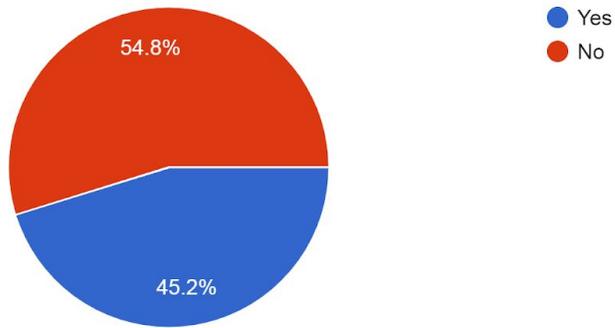
On a scale of 1 to 5 , with 1 being the least and 5 being the most, rate how much you feel driverless vehicles benefit you?

146 responses



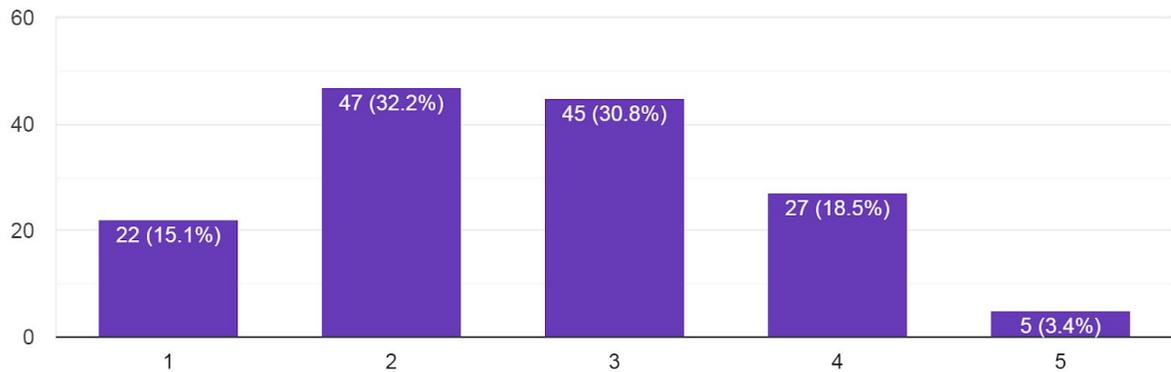
Do you feel that driverless vehicles will take over normal cars?

146 responses



On a scale of 1 to 5, with 1 being the least and 5 being the most, rate how confident you are about the safety of a driverless vehicle.

146 responses



Potential challenges

Colour indicator for challenges:

- Red: challenge
- Blue: research
- Green: Observation

Challenge one: (Safety Concerns)

In our survey, 47.3% of our respondents compared to 21.9% were not confident about the safety of driverless cars with some adding in their answers that **having no control over the car seems dangerous** and hence they would not want to ride driverless cars. **This could be because the safety of users might be breached as no matter how high tech the system/computers are, there is still a risk of computer failure and the passenger could end up being killed.** There was a recent car accident where an autonomous Uber car killed a woman in Tempe, Arizona in the US. In the wake of that accident, John M Simpson, privacy and technology project director with Consumer Watchdog said that “the robot cars cannot accurately predict human behavior, and the real problem comes in the interaction between humans and the robot vehicles”. In a fatal self-driving car accident in 2016 which caused one death and involved a self-driving car, it was found out that against a bright spring sky, the car’s sensors system failed to distinguish a large white 18-wheel truck and trailer crossing the highway, Tesla said. The car attempted to drive full speed under the trailer, “with the bottom of the trailer impacting the windshield of the Model S”, Tesla said in a blogpost. **This accident shows that driverless cars are still unreliable under certain conditions, and hence still unsuitable for commercial use.**

Challenge two (concerns of liability in the event of an accident)

In our survey, many of our respondents expressed their concerns over the legal question of who is responsible for a car crash, with many adults between 30 and 50 hinting that they would rather drive their own car because of this legal issue. There is a question of who is liable in a self-driving car accident as it is the software that controls the car and which caused the accident, creating a moral dilemma whether the person in the front seat is liable of footing the damages. Even a car that technically functions perfectly according to road laws and mechanical performance could still perform an operation that causes negative results. State and federal laws in the united states where most of the test-driving of driverless cars occur, largely fail to specify who will be held liable for accidents caused by such vehicles.

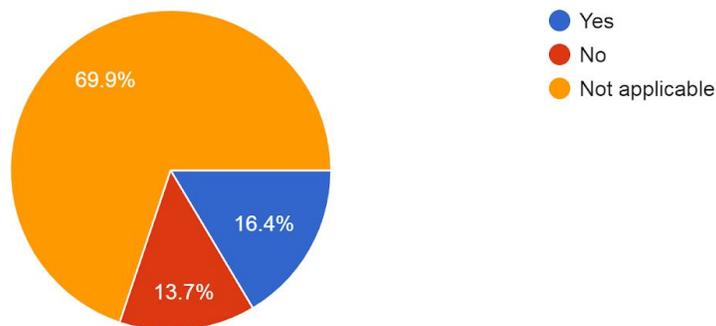
Challenge three (Cyber security concerns)

In our survey, we observed 30.5% of our respondents said that the computer systems operating driverless cars could be hacked. There is a possibility of the system used to drive autonomous vehicles being hacked. A cyber breach by a data center would in the worst case scenario would result in data being lost. However, if hackers manage to interfere with the driverless car network, lives would be lost and the damage to repair those affected autonomous vehicles will cost thousands. The cyber attack could potentially hinder the transport network in the affected country by causing jams for unaffected vehicles. (research) There was a recent cyber attack on singhealth where data of 1.5 million patients were stolen including a few prominent people such as Prime Minister Lee Hsien Loong. Almost all organisations and businesses polled in a survey suffered close to four cyber attacks in 2018. There were also more than four million threats detected and blocked in 2018 according to cyber security firm Kaspersky Lab. According to Forbes, two years ago, a team of experts easily penetrated the car area network of a semi-autonomous Jeep Cherokee and killed its transmission. These recent events clearly show that cyber attacks is a serious threat that must be countered before the introduction of driverless cars.

Challenge four (Loss of jobs)

If you are working in the transport industry, do you feel that driverless vehicles will take over your job?

146 responses



Out of 30.1% of respondents working in the transport industry, 16.4% of respondents said that they could lose their jobs to autonomous vehicles while only 13.7% did. Uber, one of the top private-hire car companies in the world, has resumed testing of self-driving cars, in a bid to save manpower costs, meaning that jobs could be lost globally as Uber is an international company that hires drivers from all over the world. Other taxi and private-hire companies could also follow suit. According to Fortune.com, an AI expert, Kai Fu Lee says that 40% of the world's jobs will be replaced by robots capable of automating tasks. He said that both blue collar (manual labour) and white collar (works in a professional environment) professions will be affected, but he believes those who drive for a living could be most affected. "Chauffeurs, truck drivers, anyone who does driving for a living—their jobs will be disrupted more in the 15-25 year time frame," he said in an interview. According to www.thebalance.com, one of the reasons for unemployment is that computers or robots could replace humans when technology advances too quickly. Hence, taxi drivers and private hire drivers could find themselves being replaced by autonomous vehicles. Many of these workers may be unable to find jobs in other sectors. This could cause unemployment in many parts of the world.

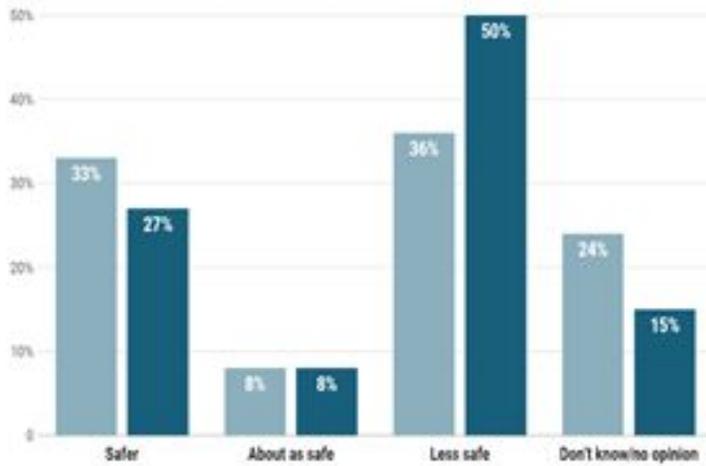
Challenge five (Low public confidence)

In our survey, when we asked how confident they were about driverless cars, we found out 45.3% of our respondents out of a scale of one to five, with one being the least confident and five being the most confident, choose either number 1 or 2, showing the clear lack of assurance the general public has as a whole about the safety of driverless cars. In an alarming trend, in 2014 while only 20% of US drivers said they will not buy a driverless car, a more recent survey found out that 50% of US adults whose trust had been damaged by accidents by autonomous vehicles, said that they found driverless cars unsafe. **Based on these observations, the public may not be willing to adopt driverless cars as they could think that they are unsafe or do not have a good impression of driverless cars.** According to the New York Times, driverless cars in Arizona owned by Waymo were attacked at least 21 times during test runs. One man even slashed a tyre of the car to stop it from moving. Driverless cars in Arizona owned by Waymo were attacked during test runs. A man even pointed a gun at a driver who was testing the driverless car. Another stood in front of a driverless car so that it could not continue moving. When the police asked him why he did it, he said that he “was sick and tired of the Waymo vehicles driving in his neighborhood” and thought that it was the best way to resolve the problem. These incidents shows the public’s annoyance and distrust with driverless cars. According to www.iii.org, a survey conducted in May 2016, found that 55 percent of consumers say that they would not ride in a fully autonomous vehicle. Similarly, another survey of 2,000 people from the UK, by enterprise information management company OpenText, revealed falling public support for autonomous driving technology. The survey focused on the extent to which the UK public believes driverless cars will play a part in their lives over the next 15 years. While 60 percent of UK citizens believe that driverless or autonomous cars will one day outnumber conventional vehicles, over half (52 percent) said they would never consider buying or renting a driverless car, even at the same price as a ‘normal’ alternative. Also, only 19 percent of people felt that they would be comfortable being a passenger in a driverless car, clearly showing that public confidence in the safety of driverless cars is low. The graphs below shows that people mostly do not feel assured to use self-driving Cars. **All these recent events show that the public has little trust in driverless cars.**

Fatal accidents damage trust in autonomous driving

■ January 11-16 ■ March 29-April 1

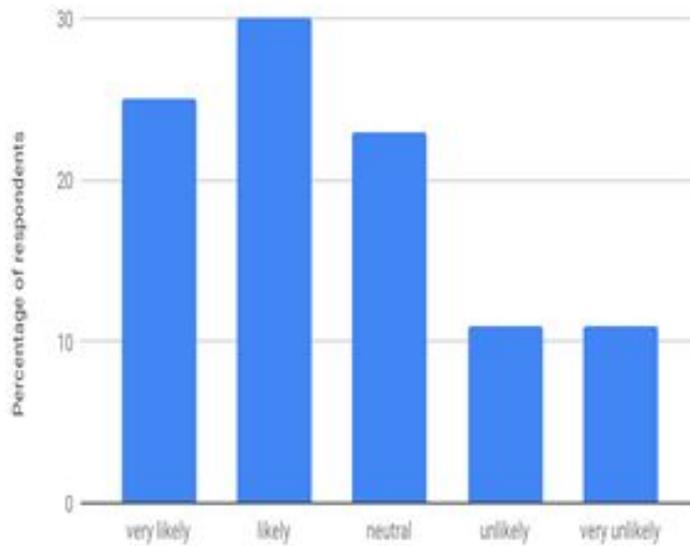
Based on two polls asking, "Would you say that self-driving cars are more or less safe than vehicles driven by humans?" among roughly 2,000 US adults, each with a margin of error of +/-2%



Source: Morning Consult

statista | BUSINESS INSIDER

Percentage of U.S. car drivers who are likely to buy a partially autonomous car, as of 2014



Underlying problem

Given that driverless cars are bound to revolutionise the transport industry in the future, with the potential of improving traffic conditions and reducing carbon emissions, however, the public's confidence in the use of driverless cars is low as evident from our interviews and survey results (condition phrase), how might we increase the public's confidence to adopt driverless cars (key verb phrase) so that driverless cars can be successfully implemented in Singapore (purpose) in 2030 and beyond? (future scene parameters)

Solutions to the underlying problem

Solution 1: Campaign to inform the public

The land transport authority and the ministry of communications and information could do a **collaboration to set up campaigns through newspapers, social media and even on television**. The Mass media and all media in general have a heavy influence and impact on individuals and society, as many people rely on the media as a source of information without even thinking whether it is true or not. Currently, when the government introduces an initiative, they ensure it has good publicity (Sanaa Latiff, 31 Dec 2015). The newspapers could have **advertisements on driverless cars and use graphics to convey the information about driverless cars** in a more interesting way. For example, the Straits Time did two interactive graphics on Budget 2019. One of them was an interactive budget calculator where subscribers could calculate the amount of tax they have to foot this year. Another one was a game where subscribers could see how they were at planning the budget for 2019. These interactive graphics allowed subscribers to better understand Budget 2019. The ministry of communications and information could also get Mediacorp to get its actors to **act out the potential benefits of driverless cars, including safety features, rigour of research for safety and security** allowing the public to get a visual sense of what will happen when driverless cars are introduced and assuring the public that driverless cars are safe and secure. Singapore could also **publish documents or videos on how they test the driverless cars**. These will help the public to have more information about driverless cars and realise that driverless cars are indeed beneficial and safe. **The LTA could harness the power of social media to inform the public about driverless cars. With many of our skeptical respondents using social media platforms, having campaigns on social media platforms will mean that skeptics could be more easily persuaded.**

Solution 2: Collaboration between research agencies

Research agencies such as Smart nation could pair up with universities such as NTU which is already testing driverless vehicles and NUS, car manufacturers who have an interest in driverless cars and the Land Transport Authority to help research, test and monitor driverless cars. This will allow better research and advances in driverless cars. The LTA could act as an assurance to the public that the driverless cars are safe and even arrange for a wider distance to test driverless cars. Research papers and news articles could then be published regarding this testing of driverless cars, not only clocking up the kilometres driverless cars have driven but prove to the public that driverless cars are safe and change their perception of driverless cars. There could be holographic displays where infographics and real time tracking of driverless cars are displayed at the click of a button on the holographic projector. A laser pointer could be used to move to other sections of the live information report . In the driverless car, the driver-cum-passenger could receive real time holographic displays communicating messages from the control center, allowing the driver to make real time changes to the route of the driverless car.

Solution 3: Boosting infrastructure

Infrastructure could be improved to support driverless cars. The ministry of national development could coordinate with LTA to have driverless car parking lots and even automated electric combined and autonomous car charging points where the charging point helps to do everything with a touch of a button, significantly reducing carbon emissions. The government could also set up autonomous car centres to conduct regular inspections on driverless cars to check for any irregularities and problems. To facilitate vehicle traffic, Radio transmitters could be placed at traffic junctions among traffic lights to allow the computer in the driverless car to maximise driving time.. There could also be higher-capacity mobile and wireless data networks handling both vehicle-to-vehicle and vehicle-to-infrastructure communication, and roadside units providing real-time data on weather, traffic, and other conditions allowing driverless cars to navigate efficiently. For example, to attract people to live in punggol which was an unpopular place, the government built amenities and attractions there. Now, there are many people living in punggol. The government could do it to attract people to buy driverless cars.

Solution 4: Public test-drive driverless cars

People with doubts can experience the testing of the driverless cars organised by authorised car dealers and hence increase confidence over them. Simulation booths, possibly holographic, can be set up so that potential buyers of cars, who having test-driven the driverless cars already, can decide after being informed by the possibly holographic booths and having experienced benefits driverless cars can bring. The car dealers could also have driverless car simulators to help the test-drivers familiarise with the driverless cars before they actually test driverless cars. According to The Lindenberger Group, benefits of simulations include no risk, which means it would be safe, which could attract the public and they may eventually buy a driverless car.

Solution 5: (Policy-making)

The singapore government could introduce initiatives to help encourage people to get driverless cars. They could have introduced a driverless car bonus and reduce road taxes on driverless cars, hence making driverless cars cheaper and encouraging people to buy them. In a parallel to hybrid cars, close to one-fifth of Singapore's taxi fleet is made up of petrol-electric hybrid models - up from zero just 10 years ago when the government introduced an emissions-based taxation scheme which offered \$30,000 and \$45,000 in rebates for hybrid cars and taxis, respectively, showing that if the government did the same to driverless cars, the sales of driverless cars will also increase.

Decision-making matrix

Criteria:

Criteria 1: Which solution would take the least time to implement?

Criteria 2: Which one could be the most effective in changing the impression of the public?

Criteria 3: Which one would negatively affect the public the least/positively affect the most?

Criteria 4: Which solution would need the least cost?

Criteria 5: Which solution is most easily adapted?

1 is the worst while 5 is the best and the solution with the highest score is the best solution.

	Criterion 1: Which solution takes the least time to implement ?	Criterion 2: Which one could be the most effective in changing the public's impression of driverless cars	Criterion 3: Which one would negatively affect the public the least?	Criterion 4: Which one is the cheapest to implement?	Criterion 5: Which solution is most easily adapted?	Total: (Max 20)
Solution 1: Campaign to inform the public	3	2	2	4	5	16
Solution 2: Collaboration between research agencies	4	4	5	5	4	22
Solution 3: boasting infrastructure	1	3	3	3	1	15
Solution 4: Public test-drive driverless cars	5	1	3	2	3	14
Solution 5: Policy-making	2	5	4	1	2	14

Best solution: Solution 2

Collaboration between research agencies.

Action Plan

We, the Land Transport Authority of Singapore(LTA), would propose in 2020 to **research agencies such as Smart nation could pair up with universities such as NTU which is already testing driverless vehicles, NUS, car manufacturers who have an interest in driverless cars or the Land Transport Authority to help research, test and monitor driverless cars to prove their effectiveness and assure the public.** This will allow better research and advances in driverless cars.

We could assure the public that driverless cars are safe by arranging for a wider distance to test driverless cars. To do so, public roads could be used late at night to test the driverless car under real traffic conditions. Gradually, the testing could be extended to busy major roads. A control center could be set up to help enable better communication between drivers once the testing of driverless cars take to the roads. In the driverless car, the driver-cum-passenger could receive real time holographic displays communicating messages from the control center, which allows the driver to make real time changes to the route of the driverless car based on notifications on traffic. This will enable drivers to test driverless cars in different circumstances such as jams. There could also be holographic displays where infographics and real time tracking of driverless cars are displayed at the click of a button on the holographic projector. A laser pointer could be used to move to other sections of the live information report. Further progress in software for driverless cars could be made, allowing the cars to become more efficient and at the same time prove to the public that they are safe.

Professors specializing in transport research could be brought from overseas to help facilitate the testing of driverless cars. Academia could even collaborate with computer companies in Singapore to design a new computer chip specially suited for gathering topographical information of the area so that the cars will know what route to take.

Lastly, to ensure the public is aware of such research efforts and given that the government has control over the media, multimedia could be taken advantage of to promote the research progress of driverless cars in Singapore. Newspapers having interactive graphics allowing subscribers to better understand the benefits of driverless cars and they could also quote from research papers to further prove that driverless cars are safe as it is proven by research. To cater to the youth, the research efforts could be promoted on social media platforms such as Facebook and Instagram. The Straits Times is also currently holding a Big Read talk where editors of the newspaper can talk about driverless cars in greater detail with experts in driverless cars on hand to explain. With more knowledge about driverless cars, the public may be convinced that driverless cars are safe, and hence consider buying one.

Evaluation of action plan

Considering that the only 44% of Singaporeans read books, high multimedia coverage of the successful research efforts will allow the public to be eventually swayed and be confident in the safety of driverless cars. An article in Quora (Sanna Latiff) notes that media is a very powerful weapon that can change people's perspectives and beliefs in a few minutes. Hence I find this action plan to be feasible.

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Extra supporting material

Car insurance

Car insurance will help you and those affected by the accident if you cause an accident. The auto liability coverage required on your car insurance policy helps pay for the other party's medical bills and property damage. It also helps pay your legal fees, if you're taken to court over the accident.