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Is India Ready for the Autonomous Vehicles?

Shravani Sharma*, Shivanand Swamy†

Shravani Sharma, New Delhi, 110065, India, Shivanand Swamy, CEPT University, Ahmedabad India 380009

Abstract

Is India ready to accept the arrival of new technologies? This is an existential research question for transport agencies and operators, but is the subject of scant academic enquiry thus far. This paper will take a theoretically-driven research approach. Methods will include: reviews of existing evidence including the growing literature on likely consumer response to Future of mobility (Autonomous Vehicles) capture their perceptions, pre-positioning and likely responses to the same; and, applied analysis of the possible impacts of new technologies on local transport operations, along with policy prescriptions to maximize benefits for the populace. The intent is to help industry partners, including transit agencies in India and abroad, to situate themselves to best meet the transport and accessibility needs of their populations.

This paper aims to capture various aspects of perception analysis both qualitative and quantitative based on various surveys techniques on the simple question that "Is India ready for Autonomous Vehicles", and to understand their point of view for as to what they think could be the barriers to the penetration for the Autonomous Vehicles in the current Market. In the end it also tries to understand if India is good for autonomous vehicles for private cars or public transport.

* Shravani Sharma. Tel.: +919365175695
  E-mail address: shravanishq@gmail.com
* Shivanand Swamy. Tel.: +919825407505
  E-mail address: shivanand.swamy@gmail.com

Introduction

The emerging trends of new Mobility in India are breathtakingly increasing in a rapid manner. The emergence of shared economy, shared mobility, on demand services in terms of transportation, mobility as a service etc. have seen a rapid change. Now, the latest trend is to talk about the carbon emission reduction via various means to control congestion and with the emergence of new technology such as electric vehicles or autonomous vehicles, there would be efforts to take care of the same.

Although, the government is taking so many steps for the electrification of vehicles in India, with regards to infrastructure, economic incentives and policies, it can be seen that not many steps have been taken to do the same for the autonomous vehicles. The autonomous vehicles might seem far away, but India is getting more and more fascinated towards the electronic and automatic features in vehicles. It might be simple steps like the basic level of automation, but still, people are using them, and the automobile industries are quite intrigued to make it more and more user friendly and acceptable in the market.

This paper explores user's perception about the use of autonomous or self-driving vehicles in India. The focus of the study is to analyse the factors of awareness, reliability, safety, convenience, perception of the autonomous vehicle system in the user's point of view to see if they feel that these are the future of India's mobility scenario by 2030-2050.

Background

What is an Autonomous Vehicle?

An autonomous vehicle can drive itself from Point A to Point B with no manual input from the driver. The vehicle uses a combination of cameras, radar systems, sensors, and global positioning system (GPS) receivers to determine its surroundings and uses artificial intelligence to determine the quickest and safest path to its destination. Mechatronic units and actuators allow the "brain" of the car to accelerate, brake, and steer as necessary.

History of the autonomous car

Much like electric vehicles, autonomous cars may seem like a very recent initiative but were first developed decades ago. These included both OEM driven initiatives like the GM Futurama exhibit at the 1940 World's Fair and running autonomous prototypes from GM and Ford in the 1950s. There have also been several independent attempts to build autonomous cars over the years in the US, Japan, and Europe, in the 1960s through the 1980s. Most of the early attempts at autonomous driving needed significant help from infrastructure (like special roads with metal guide strips and radio sensors to point out the right of way to the cars), but some also used early cameras, remote sensors, and actuators to allow the cars to control themselves—in much the same way as semi-autonomous cars can today. The early "self-driving" cars were able to complete test routes but were largely untested in real world traffic conditions.

The big breakthrough that brought autonomous driving out of the fringes of "skunkworks" programs and the odd science class project was the DARPA Grand Challenge. Organized by the US Defence Department's defence Advanced Research Project Agency (DARPA), this competition brought a number of schools, OEMs, and innovators together to create the autonomous vehicle of the future—initially aimed for potential military use, but eventually with crossover to civilian applications.

The DARPA Grand Challenges were held in 2004 (open desert), 2005 (desert course), and 2007 (urban course). While the participants had varying degrees of success (the first Grand Challenge saw no participant complete the course and had no winner), the reliability and capability of the machines improved dramatically with each iteration. The first Grand Challenge winner was Stanford's Stanley vehicle in 2007—a modified Volkswagen Touareg that earned the

team the $2 million winning purse. The Grand Challenges got many of the OEMs and other participants in the autonomous vehicle field today, including Google and Cisco Systems, seriously thinking about the technology. Many members of participating teams are spearheading autonomous vehicle development at the auto OEMs and other companies today.

Table 1 Timeline of Autonomous vehicles *(Ravi Shanker, 2013)*

1970		
	1977	First truly autonomous car unveiled by S. Tsugawa at Japan's Tsukuba Mechanical Engineering Laboratory
1980	1980	Ernst Dickmanns' vision-guided Mercedes-Benz van achieves 39 mph on streets without traffic
		The US Department of Defense funds the DARPA Autonomous Land Vehicles (ALV) project
	1987	The European Commission funds the €800 million EUREKA Prometheus Project on autonomous vehicles
1990		
	1994	Dickmanns / Daimler-Benz vehicles, VaMP and Vita-2, drive more than 620 miles in Paris
	1995	Carnegie Mellon University Navlab project ("No Hands Across America") achieves 98.2% semi-autonomous driving over 3,100 miles
	1996	Alberto Broggi's ARGO Project achieves 94% fully autonomous driving on a 1,200 mile journey across Northern Italy
2000		
	2004	DARPA starts long distance competitions;
		In 2005 $2 million prize awarded to Stanford University
	2007	DARPA Urban Challenge focuses on 60-mile urban environment, Carnegie Mellon's team takes first place
	2010	Google starts their Driverless Car program using a mix of Google Maps data, radars and LIDAR

Advantages of autonomous vehicles

The main advantages come from the assumption that once artificially intelligent robots take over a formulaic and mundane task like driving, they will make fewer mistakes than human drivers. This should result in several socio-economic benefits.

Lives saved. Each year 30,000 to 40,000 people are killed on the roads in the US alone. Despite a recent decline, there were 11 mm road accidents in the US in 2009 (latest data from the US Census). Most of these accidents are caused by driver error or mechanical failure. Driver errors are, in turn, caused by lack of knowledge, failure to follow traffic rules, driver distraction, or driver incapacity (DUI or fatigue). Arguably, an autonomous car should be more capable and consistent with its computer-driven ability to determine and interpret its surrounding environment and apply traffic laws. This should result in significantly fewer accidents, especially if a high percentage of cars on the road are autonomous. This could be even more beneficial in emerging markets where limited driver experience, weakly enforced traffic laws, and poor road conditions result in a significantly higher ratio of traffic deaths to car population than in the developed world.

Gasoline saved—In the US alone, automobiles consume 143 bn gallons of oil per year use at a cost of over $500 bn. Cars that drive themselves based on predictive capability and the ability to alter the state of the car based on anticipated load conditions should be significantly more efficient than manually operated vehicles. Just using cruise control in a car of today can easily result in a 15-30% fuel economy improvement vs. manually operating the throttle. This is because the car knows what kind of load will be placed on the engine and adapts accordingly. In the future,

autonomous cars with vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2X) communication ability will have a far greater understanding of road and traffic conditions and should be able to predict even anticipated loads on the engine allowing them to operate in "cruise" mode all the time. This could result in a similar level of fuel economy savings as using cruise control all the time. Combined with a push for more fuel-efficient internal combustion engines and light electrification, corporate average fuel economy could run up to 75 mpg and above. In a utopian world where all cars are self-driving, cars can theoretically be made significantly lighter (why reinforce a car that is not going to crash?), potentially driving fuel economy north of 100 mpg.

Traffic patterns—V2V and V2X capability should enable autonomous cars to know the position of surrounding traffic and create significantly more efficient traffic flow. Every year, the existing US car park burns 3 billion gallons of gas sitting in traffic jams. Autonomous cars should be able to not only dynamically re-route themselves based on anticipated traffic conditions (similar to advanced GPS systems today), but also to avoid creating traffic jams in the first place. Car positioning based on V2V/V2X communications should allow traffic to negotiate intersections without stopping, and cars should be able to travel at higher speeds and in closer proximity to each other (the aerodynamic efficiency of this should further boost fuel economy).

Consumer productivity. One benefit of smoother traffic flow, is less time spent on the road getting from Point A to Point B, which should significantly boost commuter productivity. The bigger gains could come from not having to manually drive the car, freeing up the occupants' time spent *in* the car for other pursuits. US drivers spend an average of 75 billion hours each year on the road, which can now be put to good use. Whether people choose to spend this time eating, sleeping, watching TV, reading the newspaper, working, or simply conversing, it should result in significantly de-stressing the average commute and life in general.

Boost to the economy. Autonomous cars do end up converting commuters into consumers, the resulting enhanced consumer productivity could drive economic value creation, which could conceivably help boost the economy. More importantly, more time to consume…anything—movies, TV, books, news, food, YouTube videos… in the car, means more opportunity to buy stuff. Expect to see a massive increase in the number of billboards by the side of the road, location-based advertising (Ravi Shanker, 2013).

The fundamental reason for the autonomous vehicle having the backing of all major industry players is that it holds the key to a better and cleaner transportation ecosystem and a better human experience. Autonomous vehicles aim to achieve reduction in road congestion, improvement in road design as more cars in seamless coordination with each other can be added onto the same amount of real estate on the road, safer transportation, and increased mobility. It will also result in a hassle-free travel experience for cyclists and pedestrians as well as for the ones travelling in cars. It promises to bring about a huge cultural change as well to the point that the idea of someone driving themselves would cease to be the norm. It is also believed that autonomous vehicles shall greatly improve the safety of our roads.

Self-driving cars will reduce road accidents by as much as 90%. Automation will make for safer driving, with savings of up to $190 billion a year, mostly from reduced health care costs. Human error has been one of the biggest contributing element to road accidents; drivers distracted by their phones, drinking and driving, lack of skill, and road rage to name a few prevalent accidents- inducing errors. Driverless cars would eliminate the chance of human error while driving. According to a study by KPMG, autonomous vehicles will create an additional three hundred thousand jobs in the UK by 2030. Industries like telecom, digital, and media will also offer additional jobs as the inter-connected and autonomous vehicles open new markets (Associates, 2017)

Autonomous vehicle's Global Scenario

It is important to understand where does India stands in terms of the autonomous vehicles readiness index, and also understand what are the other countries doing in this field so far.

The Netherlands is the clear leader in this first *Autonomous Vehicles Readiness Index (AVRI)*. The AVRI is the first study of its kind, examining where countries are today in terms of progress and capacity for adapting AV technology. The Index evaluates each country according to four pillars that are integral to a country's capacity to adopt and integrate autonomous vehicles. These include: policy & legislation; technology & innovation, infrastructure and consumer acceptance. It is within the top four of each of the four pillars and ranked number one on infrastructure, most likely due to its heavily-used, well-maintained road network, rated as being among the world's best by the World Economic Forum and the World Bank. It also has by far the highest density of electrical vehicle charging points, with 26,789 publicly-available points in 2016 according to the International Energy Agency's Global EV Outlook — more than Japan has for a road network more than eight times the length. The Netherlands also has high-quality wireless networks too. As well as having great infrastructure, the country comes second only to Singapore in the consumer acceptance.

Singapore's Land Transport Authority (LTA) takes a safety-first approach with AV trials starting on lightly used roads and graduating to more congested environments only after they have demonstrated readiness. All test AVs will be required to log travel data to enable accident investigations and liability claims. On consumer acceptance, the entire city-state of Singapore is effectively a test area for AVs, meaning all residents may see the technology in development. Consumer research suggests they are more open to the technology than many other countries, including the Netherlands. The country's strong scores for infrastructure, including very high road and mobile network quality, are only undermined by a low density of charging stations for electric vehicles.

The US leads in AV innovation, and is ranked at the top of the technology and innovation pillar of this index. It scores maximum or near-maximum ratings on industry partnerships, research and development hubs, AV technology company headquarters, investment, and World Economic Forum ratings for technology availability and capacity for innovation. The country has by far the greatest number of AV companies, with 163 headquarters, with second-placed Germany having just 22, although this is adjusted by population for the index. Companies including the Detroit-based 'Big 3' auto-makers, other automotive companies, ridesharing companies such as Uber and Lyft and intermodal innovators like Hyperloop.

The UK rates in the top five for three pillars, but only tenth on infrastructure. On technology and innovation, the country has good scores on industry partnerships and research and development hubs, as well as high ratings from the World Economic Forum on both technology availability and capacity for innovation, although it has fewer AV patents than other leading nations. On consumer acceptance, it has among the highest ratings from KPMG's *Change Readiness Index* and the World Economic Forum, although lower ratings for the proportion of people living in test areas and on consumer acceptance. On policy and legislation, the UK is near the top in AV regulation, with the Department for Transport having determined that it is legal for driverless cars to operate on any public roads without permits or extra insurance and the establishment of a Centre for Connected and Autonomous Vehicles. The government wants to have driverless cars on British roads by 2021 and plans to make further changes to regulations to support this.

Germany is in the top five in the policy and legislation and the technology and innovation pillars, but is let down by mid-table rankings for infrastructure and consumer acceptance. On policy and legislation, it receives high scores on government investment in AV infrastructure and pilots, with its government legislating in 2017 to allow tests of self-driving cars on public roads,23 and it rates consistently well on other variables. In 2013, the Ministry of Transport established the Automated Driving Round Table, an advisory body linking industry, academia, associations and public administration.

New Zealand is second only to Singapore on policy and legislation, with high scores for its AV regulation and having a specific department to deal with this. The country has no specific legal requirements for cars to contain drivers, the NZ Transport Agency can provide support to those undertaking testing, and it is collaborating with Australia to minimize duplication and share knowledge. The country is perceived as having a clear, straightforward regulatory framework, with government agencies accepting the need to adapt legislation to new technology.

India is among the bottom three countries in all four pillars of the index. Its government has effectively banned AVs, with road transport and highways minister Nitin Gadkari saying in July 2017 that it would not allow driverless cars as they would take people's jobs. As a result, India has been given a score of zero in many policy and legislation categories, including those covering regulation and government investment. India has ambitions, with its Automotive Mission Plan aiming to bring its automotive industry into the top three in the world in engineering, manufacturing and export of vehicles and components. The government of India has also set an ambitious goal of achieving 100 percent electric vehicle mobility by 2030. However, it scores poorly on road safety, accounting for 10 percent of global road accidents according to the International Road Federation.

Given the overall socio-economic benefits of autonomous transport and the strong entrepreneurial ecosystem, India could become an important AV market in the long term. But at present, on technology and innovation it scores minimally for lack of patents and investments and low usage of electric cars. On infrastructure, it scores poorly for mobile network quality and in KPMG's *Change Readiness Index* technology infrastructure rating. On consumer acceptance, survey data suggests Indians are among the most accepting of AV technology — but the evidence from the rest of the data is that they are unlikely to get much chance to use it (KPMG, 2017).

The automobile is at a crossroads. Industry, government, consumers, and society as a whole face enormous challenges around safety, efficiency, and mobility. Autonomous vehicles and vehicles features have the potential to vastly improve the quality of personal and commercial transportation in each of these key areas.

Safety

Car crashes have been called a "major epidemic." Recent statistics show that 32,788 people were killed in motor vehicle traffic crashes in the United States in 2010. The number worldwide is about 1.2 million. Driver error is by far (95%) the most common factor implicated in vehicle accidents (followed by road/weather condition 2.5%, technical failure (2.5%). The broad introduction of mobile communication devices may worsen this already bad situation. A recent study shows that the risk of a crash or near-crash due to dialing on a cell phone is about three to six times higher, depending on the type of vehicle, compared to the nondistracted situation. The risk of an accident due to texting is even up to twenty-three times higher. Addressing driver error as the primary factor leading to accidents and casualties would make traffic much safer. While education, communication, and enforcement can help, direct drivers assistance may be the most promising tool. There is clear evidence that driver assistance systems and, eventually, complete vehicle autonomy, can significantly reduce property damage, injuries, and casualties.

Efficiency

Another recent and significant statistic shows that the impact of traffic congestion in the United States leads to unproductive time of about thirty-six hours for the average commuter each year. Which in addition totals in 2.8 billion gallons of fuel unnecessarily burnt and a financial loss of $87.2 billion per year in the United States in 2007. While these numbers show that traffic is an additional burden on the business schedule of the working population, it also documents a sizable (and potentially avoidable) portion of the emission problems that needs to be attributed to the transportation sector (the 2.8 billion gallons of fuel represent about 2% of the entire transportation sector in the U.S.). Autonomous driving technology can help to harmonize traffic flow by controlling individual automobiles more precisely through anticipation and inter-vehicle collaboration. Of course, coordinating traffic in this way will present challenges to privacy and autonomy. Any standard or plan must proceed carefully and take these and other factors into account. But ultimately, vehicles can be controlled most efficiently where the overall traffic situation can be examined. This usually incorporates data that an individual driver could not comprehend (e.g., platooning of multiple vehicles by means of multiple layer traffic control). Estimates show that an efficient cruise control alone could improve fuel savings by 7% in addition to the gain in travel time through a smoother traffic flow. Other experiments show that the effect of vehicle convoying/platooning can take advantage of aerodynamic drag reduction which can lead to another fuel saving in the order of 20–25%.In order to take advantage of those benefits, vehicles need to be controlled by autonomous driving/driver assistance systems, which eliminate the inefficiencies of human drivers by navigating vehicles more precisely and collaboratively in traffic.

Mobility

Yet another recent study showed that one-half of afterschool trips made by fifteen-year-olds are made by private automobile; for eighteen-year-olds, this ratio increases to three-fourths.9 U.S. adolescents are clearly dependent on the automobile for basic freedom of movement. Acquiring a driver's license is a defining moment in the life of young people as it suddenly enables them to live their lives more actively and socially, but it also leads to a higher danger in their lives due to risk of accidents. Autonomous driving technology could help tremendously with the transition between "not driving" and "driving" adolescents as when, for instance, fifteen-year-olds experience the benefits of individual and independent mobility earlier while being shuttled by an autonomous car without affecting the schedule of their guardians. Autonomous driving/driver assistance systems can also help novice drivers acquire the driving skills necessary to become a safe and experienced driver with a much lower risk of accidents.

Importantly, autonomous driving technology can help elderly or disabled citizens keep an active lifestyle such as running daily errands and maintaining their social relationships. Elderly drivers reportedly tend to avoid particular driving situations (at night, in poor weather, on highways and drive less overall. Individuals experiencing lower levels of cognitive and visual function due to disability also generally drive less. Autonomous driving technology can help those drivers master difficult traffic situations while keeping them and others safe (Beiker, 2012).

Table 2 Example mechanisms of CAV impact under different road network situations *(Atkins, 2016)*

Behaviour type	Description	Potential CAV impact on vehicle operation and network performance
Free driving	The vehicle responds only to the infrastructure (i.e. there is no other traffic)	Perfect throttle control – no oscillation around a desired speed Changed profiles of acceleration and deceleration
Vehicle following	The vehicle is following another vehicle in a single lane	Vehicles are able to travel at smaller time intervals, safely and at greater speed than currently
Lane changing	The vehicle changes lane in a multi-lane situation, either to maintain a desired speed or to prepare for a route decision	Vehicles are able to accept smaller gaps in traffic and manoeuvre safely between streams of traffic at greater speed
Merging and joining	The vehicle must join a dominant stream of traffic and avoid conflict	Vehicles cooperate to enable smooth merging of conflicting traffic streams, at higher speed and with smaller gaps
Planning and decision making	The vehicle must react to the behaviour of other vehicles, other road users or infrastructure	Better provision of data and communication between entities leads to better and more efficient decision making

This shift towards self-driving vehicles is not taking place at an equal pace around the world. India's auto sector is at a very early stage in its journey toward developing and manufacturing autonomous vehicles. Rolling out autonomous vehicles will be a complex task in India due to number of significant challenges. Reliable traffic data is scant. In India where weak infrastructure presents another major obstacle to the development of autonomous vehicles. These issues are amplified by India's notoriously bad traffic, which poses serious technical challenges when it comes to developing algorithms for operating autonomous cars. Developing adaptive machine learning algorithms based on existing driving habits and road conditions is a complex solution to this key challenge. Indian consumers are highly price sensitive, so achieving autonomous vehicles prices that are acceptable to buyers and commercially viable for automakers is perhaps

the most challenging balancing act for the sector. Local carmakers will also struggle to reduce their speed to market when compared with foreign companies that benefit from long-standing global production platforms.

There are many issues related to India such as road density, organic roads, mixed traffic, numerous individual personal vehicles, so many drivers who has no education sometimes, and are exposed to drugs and alcohol, therefore many driver errors and road fatalities and accidents.

Much of the success of autonomous vehicles in India will depend on whether automakers can earn the trust of consumers, especially regarding safety and data privacy issues. The success of Indian manufacturers will be determined by how well they prioritise investment across developing powertrains, autonomous features and safety technologies. The government needs to support the development of autonomous vehicles by expediting infrastructure development and more rigidly enforcing driving regulations. India's autonomous vehicle sector is at a nascent stage and has a very long way to go before autonomous vehicles become both a commercially viable and publicly accepted alternative to petrol and diesel vehicles, according to local to makers. Some semi-autonomous features are currently available within the high-end Indian luxury car segment, but the selection is limited and only accessible to a small, wealthy client base. While India is expected to become the world's third-largest car market by volume within 2020, the development and adoption of autonomous vehicles is expected to lag far behind, mainly due to a lack of quality traffic data and supporting infrastructure. Development of autonomous vehicles in India is being spearheaded by key local automakers, such as Mahindra & Mahindra and Tata Motors. Government support includes policies such as the Motor Vehicles (Amendment) Bill 2016, which will permit autonomous vehicle testing (Consulting, 2017).

But why act now rather than wait to see how quickly AVs are adopted? A key reason for policymakers to consider AVs now is because the spatial planning and infrastructure investment decisions that we make today will determine the development of our countries and cities for decades. If we anticipate an AV future today, we can avoid wasting taxpayers' money on investments that may soon prove obsolete, or worse frustrate the realization of AV benefits. AVs imply changes to road infrastructure, including on-road telematics, signage, crash barriers, lane widths and curbs. They may also affect business cases for public transport schemes, which will need to integrate with AVs, as well as parking schemes and multimodal transport ticketing. AVs will also affect the placement and development of homes and businesses. They could make ride-sharing and mobility as a service schemes more attractive, meaning space currently used for parking can give way to more housing and public spaces in urban areas. But by making longer commutes more attractive, they could also encourage more suburban and rural development.

AVs will also have major impacts on public policy outside of transport. For example, many professional drivers are at risk of being replaced by technology. There are also implications for government revenues. At present, taxes on fossil fuels generate billions of dollars, while electric vehicles receive subsidies in many countries. This means a shift to electric AVs would create a hole in tax revenues. Authorities need to think through urgently how to recover that lost revenue. For example, through road pricing, which might also help tackle congestion. Supporting an AV future implies myriad other public policy enablers too.

Authorities will want to ensure that AVs are safe, both mechanically and in terms of their security from cyber-attack, so vehicle licensing could change, with new controls on data security. Regulations on vehicle insurance will need to adapt, including who is responsible for a driverless vehicle's actions. Driving licenses could become redundant, although many countries use them as an identity card. Road traffic regulations, designed for use by humans, will ultimately be replaced by protocols, determining priority at junctions and giving way to emergency vehicles. The data generated by AVs will present policy challenges. Questions include the ownership of this data, whether the security of information is a public or private responsibility and what the data can be exploited for, whether that be advertising, road condition monitoring or passenger health. Different countries may come to different conclusions across these issues. Indeed, the optimal AV future of one city may differ from another nearby, depending on patterns of travel and availability of public transport alternatives. But basic standards of interoperability will need to be put in place across countries and potentially entire continents. The reality is, AVs will have far-reaching implications across numerous areas of policy-making for countries around the world. So now is the time to plan (KPMG, 2017).

Hence there is a need for the people to understand the perspectives of the potential users to be able to build up a strong market and invite investors to show interest in the India automobile scenario.

Research Gap

Although numerous studies have been done on the evolution of autonomous vehicles and the technological aspect of it, not much emphasis or importance is being thrown light upon on the consumer behavior of the acceptance of the product in developing countries like India. India is a country still struggling with many other third world problems, and the question of urban mobility in the future scenario is still a mystery in terms of research and understanding. Although it has come up with many new concepts regarding the emergence of future mobility scenarios such as car sharing, mobility as a service, encouraging Active travel and non-motorized transport, and electric mobility, people are still skeptical about brand new features such as autonomous vehicles.

Dubai's Roads and Transport Authority (RTA) launched the first tests of the world's first autonomous pods. The autonomous pods – launched in cooperation with Next Future Transportation – are designed to travel short and medium distances in dedicated lanes. They can be coupled together in as little 15 seconds or detached – depending on the riders' destination – in five seconds. Each pod is fitted with cameras and electromechanical technologies to carry out the coupling and detaching, which can be activated while the pod is in motion (Jr, 2018). According to RTA, each pod has an average speed 20 kilometres per hour, and measures 2.87 metres in length, 2.24 metres in width and 2.82 metres in height, and weighs about 1,500 kilograms – enough to carry 10 riders. The autonomous pod is fitted with a battery that supports three hours of operation, and can be charged in just six hours.

During the last few decades, India has seen a meteoric rise in the registration of private vehicles especially for cars. The data from the Statistical department, Government of India shows the numbers below and this can be interpreted as there has been a tremendous rise in the total number of vehicles all over India over the last few years. Also, the highest share of mode as of from 2013 to 2017 is of two wheelers followed by cars. Saddening fact is that the least number of vehicles for the total mode share for India is of buses. Although the government has taken major steps in the past to encourage Public transport and active travel such as walking and cycling, this fact did not change the statistics for the vehicle ownership especially for cars and two wheelers (India, 2015).

This rise in private vehicles are leading to numerous problems including air pollution, road fatalities, injuries, congestion etc. Hence Bringing of autonomous vehicles seems to be a fancy idea, however, it would be interesting to see if it should be bought in the form of Public transport rather than private vehicles, as the Indian mobility scenario is a little bit different to other countries as it is a land of heterogenous traffic which includes all modes of transport such as three wheelers, two wheelers, animals, pedestrians, cyclists al in the same designated road space. The planning and implementation part is also really lagging behind in encouraging people to cycle or walk more, or regarding advanced modes such as charging infrastructure planning etc.

When the autonomous vehicles come into the Indian mobility market, which is going to be in the near future, how are people going to react to it in terms of policies and acceptance of the product, how are the levels of automation going to be implemented in the existing infrastructure market, how are the policies going to change etc.

Survey Objectives and Design

The survey questionnaire was prepared to get public opinion on the adaptation of self-driving vehicle technology in India. The factors that were considered for preparing the survey questionnaire included were mainly based on

    (i)   The personal feelings towards the adaptation and acceptance of these autonomous vehicles in the near future.

    (ii)   The concerns of these people regarding the same and as to see the readiness in terms of acceptance on the consumer side.

The following factors mainly have been included for getting drivers' perception on the autonomous vehicle technology:

• Familiarity or awareness with the technology
• Interest
• Reliability
• Safety
• Stress
• Convenience
• Willingness to accept or reject the new form of mobility
• Roadway Safety
• Perceptions regarding AV

Additionally, the respondents were given the freedom to express their opinions on as to what they feel regarding the same.

A sample size of 200 respondents were taken for the web based survey and it was strictly mentioned that only people with Indian nationality could participate in this study. This was done entirely to understand the perception from the common mob, about fancy concepts like driverless cars in a third world country where people are still struggling with concepts regarding access to basic amenities. A random sampling survey was done, keeping an open ended, non-biased.

A stated preference survey method is being followed for the purpose of this paper, o that it can be used for future demand modelling and other such research based analysis in the prediction of AV analysis in the Indian market. Stated preference (SP) methods are widely used in travel behaviour research and practice to identify behavioural responses to choose situations which are not revealed in the market, and where the attribute levels offered by existing choices are modified to such an extent that the reliability of revealed preference models as predictors of response is brought into question. This paper reviews recent developments in the application of SP models which add to their growing relevance in demand modelling and prediction (HENSHER, 1994).

At the end of the paper, the research aims to answer if the Indian mobility scenario should go for autonomous cars or more like the Dubai pods, or public transport as they will be easier to implement keeping in mind the Indian road issues and people's perceptions impacted after various feeds from news channels regarding safety and security of the autonomous vehicle driving.

The demographics of the respondents are as follows:

Table 3 Demographics of the respondents

Demographics	Classification	Percentage
Age	18-30	86
	30-60	12
	60 and above	2
Gender	Male	60
	Female	40
Employment	Private Organisation	57
	Public Organisation	9
	Student	27
	Unemployed	7

The survey revolved around specific questions which emphasized specific questions which focused on capturing the views of the people regarding the perception of autonomous vehicles penetration in India.

The research questions were such as:

(i)   Are people aware of autonomous vehicles?
(ii)   If autonomous vehicles came into the Indian automobile market, are they going to use them and the reasons for their decisions?
(iii)   What do the respondents think that the barriers to the penetration of autonomous vehicles are in the Indian automobile market?
(iv)   Do they see the autonomous vehicles as the future of mobility in the near future?
(v)   Is it better to adopt autonomous vehicles at Public transport or private vehicles in India?

Lastly, they were asked about their views and opinions regarding the same to understand what do they think about the penetration of these autonomous vehicles in the Indian market and their expectations and aspirations. There are some interesting opinions about the concept about the autonomous vehicles coming into the Indian market any soon.

Results and Analysis

The respondents were asked certain questions which is mentioned in the previous section, and it was interesting to see how many of the respondents owned a vehicle and if that mattered their opinion regarding the perception about the autonomous vehicles. Studies in the past shows that driving is a passion for some people and they would not want it to be replaced by any artificial intelligence. Here in this study, out of the 200 respondents, majority with a 74% owned vehicle of some kind or the other which includes either two wheelers, four wheelers, etc.

Table 4 Vehicular Ownership of the Respondents

Do you own a vehicle?	
Response	**Percentage**
No	26
Yes	74
Total	100

Then before beginning to understand their perceptions about AV, it was important to see if the respondents were aware about the concept of autonomous vehicle. Surprisingly majority of the sample, had knowledge about the latest kinds of technologies. A very low percentage of the people were unaware of the AVs and this can be because most of the respondents were educated and had knowledge about the new technologies including automation in vehicles.

Table 5 AV awareness of the respondents

Are you aware of AV?	
Response	**Percentage**
No	8
Yes	92

When the whole world is talking about the future of mobility and advanced forms of intelligent forms of economy, it was interesting to see if the Indian crowd was ready to accept and use this new form of technology. 2030 and 2050 are the latest targets across the globe and everyone is setting targets to bring change either in the form of reducing carbon emissions through greener ways, or to encourage new forms of transportation of through innovative business models to encourage forms of economy. Hence, the respondents were asked if they would like to see and use these autonomous vehicles in the coming years and to capture their feelings in the later parts regarding as to why or why won't they use these kinds of technologies.

Surprisingly, there was not many people who were extremely negative abbot the idea, although they were a little skeptical regarding the implementation and safety part.

Some of the respondents have quite elaborately described their reasons to like or dislike these AVs which are described later in this paper.

Most of the people were really not sure about the AVs in India with percentage of 42% because probably they are not being able to imagine how it would be implemented in India, although they are really fascinated by the idea of it. 12% more people were negative about the idea of AVs than the positive ones.

Table 6 Vision for AV in 2030-2050 India for the respondents

Do u see AV as the future of India in 2030-2050	
Response	**Percentage**
Maybe	42
No	35
Yes	23
Total	100

It was surprising to see that even though the respondents were skeptical and doubtful about it, when asked if they would like to use these AVs if they were available in the market, the answers about "Yes" and "No" we almost the same!

Table 7 Willingness to use AV in India

If these AVs are in the market, will you use them?	
Response	**Percentage**
No	50.31
Yes	49.68
Total	100

Some of the respondents were positive about the arrival of the AVs in the Indian automobile market. These accounts up to 23% of the total sample size. They feel that it could be a possibility that AVs can turn out to be the future of the Indian Transportation system. It was interesting to see what made them feel positive about it and when asked the results were as such that majority of the people (30%) wanted to try them just because it was an exciting and new concept. This was followed by 25% of the people who felt that driving problems would be solved by this as in India there are numerous problems like breaking the traffic rule, heterogeneous traffic, infrastructure issues etc, and would give them a pleasant experience.

21% of the people think that it would be easier for them to commute via these kinds of AVs. Minimal people with a percentage of 2% each think that they are inclusive and affordable each. This is due the income disparity amongst the Indians as there is a huge gap between the rich and the poor and not many people can afford to own such fancy concepts even if they wanted to. It's a fact that the initial costs will be tremendously high and maybe later might submerge. However, it might not be affordable at the moment.

Table 6 Reasons to accept and use AV in India according to the respondents

Reasons to use AV in India	
Reasons	**Percentage**
Affordable	7

Affordable	2
Easy	21
Exciting and New	30
For saving hassles while driving. In India, driving is not a pleasant experience.	25
Inclusive	6
Safe	9
Total	100

Even if they wanted to accept and use the autonomous vehicles, there were some issues they were concerned about regarding the implementation. These might have acted as the barriers to AV in the Indian market. Majority of the people (28%) think that the existing infrastructure might be a lot of trouble to implement the functioning of AVs in the Indian roads.

This is followed by the factor of mixed traffic (22%) and there might be problems in detection and response for the artificial intelligence for the roads with such mixed traffic including animals, vehicles and humans. 15% also think that people's perceptions might be a major factor that might add on to the implementation and functioning of these AVs. These are followed by some other factors such as policy implementations and other third world problems like access to basic amenities, poverty etc. that India is currently facing right now.

Table 7 Barriers to AV penetration in India according to respondents

Perception on Barriers to AV penetration in India	
Reason	**Percentage**
Existing infrastructure	28
Heterogeneous Traffic	22
Income Structure	11
India has other issues to take care of now	12
People's Perception	15
Policy Implementation	12
Total	100

There were 50.31% of the respondents of the total sample size, who answered that they will not be using AV when it came to the Indian market. 25% of them will not use them because they assume them to be incredibly expensive. The other 25% of the respondents think that there might be extreme safety issues keeping in mind the latest media highlights about accidents by the AVs. This creates a psychological impact in making a decision of choosing an AV or not. 18% of the people were doubtful about the performance as they assume that Indian roads with such diverse traffic are not compatible enough for these AVs.

Another major factor, that people also wrote in their genuine concerns about the AVs coming into the market, 19% of the people, think that these are a threat to the human jobs, especially in a place like India where there aren't much jobs available, and there is huge competition among the people due to the massive populace. They fear that these will reduce drivers' and mechanics' jobs and the artificial intelligence will take over!

11% people of the total sample size will never use the AIs because they have the passion for driving and for cars. If they are not able to speed, or get the high which the driving provides them with, it will never going to be a replacement in the near future.

Table 8 Reasons not to accept and use AVs in India according to the respondents

Perceptions on unwillingness to use AV in India	
Reasons	**Percentage**
Doubtful about their performance	18
Expensive	25
Passion for Driving	11
Safety Issues	25
Security Issues	2
Will reduce human employment with Artificial Intelligence	19
Total	100

Quantitative analysis is a great way to see the weightage of the issue but for this paper, a little bit more than the quantitative aspect was required. People were given the freedom to express their views and opinions regarding the arrival of the AVs in the Indian automobile market.

People had some brilliant responses to the arrival of AVs and their concerns were extremely relevant and valid looking at the current Indian context.

Majority of the people were concerned about the existing infrastructure, policy implications, and data driven and implementation aspects. People also were worried about the human being's jobs being taken away by the artificial intelligence.

Also, some people made valid points like why are even cars required and to promote AVs in terms of Public Transport or combine the AV technology with Electric Mobility, which are surprisingly quite innovative ideas coming up from the common people.

Some of the brilliant responses from the respondents are as follows:

Table 8 Personal Views of respondents regarding Autonomous Vehicles penetration in Indian automobile market by 2030-2050

"The autonomous vehicles should allow me to do other tasks while travelling comfortably. Of course, how much such vehicle can be customized to Indian conditions remain a big challenge. Safety of travellers is also an issue".

"Can be useful for disable friendly people"

"I believe Autonomous vehicles would have a handsome share of the automobile market in India by 2050. Say, around 10% market share in 2030 and 40% market share by 2050".

"There are far too many loose ends to answer this question. Presently dealing with E vehicles itself is a challenge, AV seems to be a distant dream or maybe applicable in highly controlled environments which cities are not".

"Difficult but implementable"

"Let's not make everything automatic that we forget to believe that we're human".

"Autonomous vehicles might become more evident in other countries than in India. Indians are peculiar. So things that might work for other countries might not work here. Although I do see a possibility of autonomous public transportation in the country".

"Autonomous vehicles might become more evident in other countries than in India. Indians are peculiar. So things that might work for other countries might not work here. Although I do see a possibility of autonomous public transportation in the country".

"AVs in India - good thought'.

"First the roads should properly be constructed with well-drawn signals, traffic signs and road lines which isn't there for most part of the road of India. Only after these things are solved then we might see a future of AV which is obviously well beyond 2040".

"It requires very basic Accessibility to all infrastructure to be placed first in Indian market. But lack of political will to provide firstly in public transport and then to in private market is bigger Challenge I would say".

"Will change traffic conditions".

"Depends on whether our infrastructure improves and if we are able to inform, educate and train people about AVs"

"Supporting infrastructure and people perception plays the key role in the success of AV. Uninterrupted Internet and GPS facilities needs to be upgraded beforehand. Traffic flow needs to be channelized. Many more to do with.!!"

"Rather than wasting time on irrelevant subject, researchers should aim at finding alternate energy options for future vehicles that does not pollute the environment further".

"Lane Behaviour is completely absent in India. with heterogeneous traffic conditions, we can't predict that to what extent the system will be successful".

"I would not promote it".

"The infrastructure will be a problem for sure, acceptance, approach and attitude of the users must be addressed".

"Needs to be launched properly, effectively and on a large scale for it to become successful".

"Implementation of AV would definitely bring a decline in the drunk driving scenario".

"Highly unlikely"

"It is always good when we have many options to choose from".

"If we consider the chaotic state of transport in urban areas at present, it's almost impossible to even think about autonomous vehicles.
It might be a possibility if we somehow manage to leap-frog into a completely transformed urban transport in the coming decade.
On the other hand, keeping the passenger movement aside for a moment, Road based Inter-city freight movement is a sector which can provide a promising venture for such a technology.
Again, the question of institutional willingness comes into picture as we are yet to deal with some more pressing concerns of today, like shift to alternative fuels, public transport, better logistics based infrastructure, etc. etc.
These would be the priorities for at least coming 2 decades as our smaller metropolitans are also growing very rapidly".

"Hope only... Nothing more than that"

"Strict traffic rules and wide smooth road with proper sign will help to improve no hawkers no cows and no dogs on the road"

"Autonomous tech is good but will give boost to unemployment. We do not live in a country where such system is needed. Tech as a necessity and tech as a luxury are two different things. One had to understand which is to be employed when and where".

"When we look at the bracket of 2030-2050, the idea may look realistic but personally I don't see them taking shape in metros purely due to our poor traffic scene but however it might be potential in the tier 1 cities like a Ranchi or Hubli-Dharwad or Amaravati who are being built now with better planning for the future".

"In my opinion, a country like India where there are so many jobs dependant on this industry, I don't think autonomous vehicles are the right way to go. The focus of urban transport should rather be on active modes of transport which have so many other benefits".

"Recently an AV in US has met an accident and killed a person. A lot of work is needed to improve AV as of now. Can't say about 2050z".

"Not sure considering there are other issues to tackle like pollution, population, infrastructure, illiteracy, civic sense, safety, unemployment, child labour".

"Lane driving is not followed in India and infrastructure is poor. Maybe in 2030 things may change".

"If the government puts in efforts to make the whole process of setting up the required infrastructure, then surely India will be the biggest market for autonomous EV's".

"Let us try to have car less society".

"Only possible with better infrastructure and a better sense of driving".

"To get AVs to India, existing infrastructure needs to be updated and for that cities have to make huge investments in road infrastructure".

"For cities with congested traffic. I am concerned about safety of people with a AV".

"AV will definitely reduce the manpower and increase travelling comfort n safety".

"I am not sure considering the supply of transportation side and the exponential increase in demand, that if the AVs are good option to be promoted right now or moving towards sustainable transport".

"It may be big market if the infrastructure is developed enough along with people's notion towards autonomous vehicles".

"The insurance policies relating to the use and user of these vehicles will have to be devised to affix responsibility in case of any accident or mishap".

"Revolutionary yet Dangerous".

"it's good to adapt and upgraded technology but the way technology upgrading in last decades I think by 2030 - 2050 some innovation is coming in the world. or maybe everyone goes towards sustainable transport".

"It would reduce pollution".

"It would very encouraging situation if we can expect 100% AV in the whole city in entirety. But will it be possible".

"It's good initiative but considering pollution issues its should be designed such way that it's easy to use, low cost and environment friendly".

"No, bring electric vehicle first. Then we will talk of Av".

"If the way vehicles are driven in this country especially Delhi changes then surely it can be thing of future".

"With the second largest road network in the world, India strives to battle revenue loss on road transport. The second largest population comes into picture. It is not a very wise thing to put your money on at this stage, with unemployment taking its toll".

"The technology needed for AVs to run safely without killing people is still in making. They currently prioritize only the customer's safety. Other programming solutions identify any object in the way and stop for it to pass- even for rocks in the path! India has a million things on the way, that way the AVs would be stopping forever. These delays will make it slow and inconvenient. Also, there are other concerns when thinking about Infrastructure to Vehicle (I to v) and Vehicle to Infrastructure communication. For the AVs to run successfully, all information like the curb length, the sidewalk, the buildings, etc must be synced with the software. It's a huge amount of data gathering and mining and managing! Plus, India's infrastructure is very complex! I don't see AVs as our future even in the US!".

"Assuming all supportive systems in the country undergo a swift advancement and if AVs were to become a reality in India by 2030, we'd be left with a huge workforce of drivers, mechanics who would have to be placed in alternate jobs".

"I personally think if India would be able have that kind of funds in the future, we should invest it to provide housing and infrastructure for the poor. We shall also think of sustainable modes of transportation and definitely not private automobiles".

"I really don't know how India will manage from its traffic crisis as day by day roads are getting denser. India needs to get used to by efficient public transport facility which can cater the demand as we don't have enough spaces of roads in the cities like Delhi, Mumbai, Bangalore, Ahmedabad etc.".

"As in India major highway upgradation is going we are expecting a better highway in coming 10 years which is mainly rigid Pavement (PQC) which will have a good life and less maintained so AV has good chance to enter in "it as in Trucks, trailer long distances busses which run over night throughout night as it will reduce accident rates. But expecting in city area is quite difficult as traffic is not so well trained to follow rules however it can be trail in small stretch"

"While the traffic of conventional vehicles in India is not regulated (including existing infrastructure constraints), it is hard to achieve any solid results in AV technologies adoption."

"By that time there are good chances that we may have that organised traffic and infrastructure for these vehicles"

"Nope. I would be very interested to see how the process will take place".

"AVs are very good approach especially keeping in mind of the driver behaviour in India, but infrastructure has to be improved before bringing in AVs into Indian market. By 2030 or even 2050, I don't see a major change in infra to support AV!"

"Long way to go".

"India needs to develop roads that can cater to driverless cars".

"AV is absolutely the future of transportation, but it's still far away in case of our country. Possibly our grandchildren will be using AV's nearby year 2100".

"This concept will be successful only if supporting Infrastructure is facilitated which in turn results in the best performance of the technology".

"May be, would like to see them in the future"

"Why do we have to take out employment in a country like India, when there are already people without jobs" ..

"Totally against it being a part of India".

"Something to look forward to! But the infrastructure should be made such that it would welcome AV's and not serve as a hindrance to them!"

"AV is the future, but not at the moment!"

"self-driving cars will reduce instances of accidents caused by driver error, drunk driving or distracted drivers".

"I don't think AV is better option for India. Why should we use private vehicle at all ??"

"I guess let us currently focus on enhancing existing infrastructure for seamless and orderly movement of driver based vehicles in terms of reduction of incident rates. Only then can we build an environment with use of appropriate road technology for AVs".

"Artificial Intelligence and machine learning make autonomous vehicles quite feasible. The problems with regards to infrastructure and safety will be addressed over time with the entry of large private corporations, with some support from govt policy".

"It's a good effort for a heterogeneous traffic like ours and thinking of an advanced technology, as people will definitely encourage an easy and comfortable mode for the transportation. Though this system is tough to think about but its possible to make it real".

"Its possible provided we have the right infrastructure".

"India is very diverse in terms of attitude, behaviour it's highly not possible to exist AV. Example; we are used to feel food by eating with hands similarly whenever AV is on the road we are curious to always come in between the road or touch the vehicle to stop it".

"Education and enforcement can be a major barrier in India".

"According to Uber India stats, there are almost 500000 registered drivers under their hood and plus we have other players in the market. And also, India faces high rates of unemployment. So, with the introduction AV's here the unemployment rates are likely to rise, means strong opposition from that section".

"We may have such vehicles in future but they still will get struck on roads due to missing traffic sense!"

"May be viable for some part/ type of road. i.e. Express Highway, Special corridor".

"Lot of infrastructure improvement needs to be done before introduction of AV. Segregation of AV from normal manual driving".

"It will still take a lot of time for India to bring in such changes in vehicles and various other things".

"I feel that AV is future transportation anywhere in world sooner or later. To make it possible in India few changes in infrastructure is needed. However, regulations in metros and connecting highways might make this possible. By 2030 to 2050 semi-autonomous vehicles might be well operable with existing conditions".

"India should first concentrate in the Human Rights and poverty issues, I feel then on AVs"

"Yes, there is possibility in India Autonomous Vehicles can be used in 2030-2050".

"Our first target should be providing the right infrastructure and getting people to follow traffic rules. This is a major challenge which needs to be resolved before bringing any technological change like AV".

"Autonomous Vehicles are not suitable for Indian conditions. We try to simulate traffic flow models in India and nothing comes close. AV completely depends on the algorithms and predictable models. Heterogeneous traffic conditions will be a nightmare for such models and Enforcement issues will continue to be an issue which will hamper the use of AVs in India".

"Slight error in judgement could prove fatal".

"I would like to see India as a more pedestrian and Bicycle friendly country with public transport more familiar than personal cars. Better Railways and Subways are the future".

"I wish we are able to recognise planners, urban designers etc by 2030-50, and start making a change in pollution less reduced car driven roads".

"I think the biggest challenge that India might face due to introduction of AVs is irregular traffic movement, and the investment it requires to fix the basic infrastructure such as road quality and improved pedestrian infrastructure to reduce Jay walking".

Conclusion and Recommendations

The study revolved around capturing the perceptions of the people and to understand if the people of India are ready to accept the new trend of mobility in the form of Autonomous vehicles. Also, to capture their views and opinions regarding what they think to be improved in terms of policies or infrastructure to implement the functioning of the autonomous vehicles in India. There were mixed opinions regarding the arrival and acceptance of AVs.

Some people were extremely positive and gave positive feedbacks on how things could be improved. 49.68% people of the total sample size confirmed that if AVs were in the Indian market, they would use them. Some of the interesting suggestions were:

- It is the future of transport and it can be implemented through improving infrastructure and policies.
- They can be combined with electric vehicles and public transport to make it more accountable and implementable.
- AVs can help in reducing air pollution and congestion.
- AVs can be inclusive and disable friendly.
- Most of the people (30%) were excited and wanted to try them as they were a new concept and intrigued to see how it would work in an Indian market.
- 25% of the people wanted to try it to save the hassles while driving and thought that the AVs will be easy to drive and save time. They can use the same travel time to do something more productive in the travel time.

50.31% people out of the total respondents were quite reluctant to use them and surprisingly the percentage for the people who said will use the AVs were almost equal to these. The major reasons why people think that it is not a very good idea to use AVs in India are as follows:

- 25% of the respondents of the total sample size were reluctant to use the AVs as they think that AVs are expensive, 25% thought that they have high safety issues. The news of accidents from around the world might have had a significant impact on their judgements towards these autonomous vehicles.
- 19% of the people were concerned about the Indian labour market and were worried if the artificial intelligence would take over human jobs in a place like India where there is so much competition regarding jobs and opportunities.
- 18% of the sample size were doubtful about the performance of the AVs, keeping in mind the current heterogenous traffic and inadequate infrastructure in India.
- Some people think that it would be too much of a hassle to collect and relate all the data to keep track and implement these AVs any soon, as they are more concerned about the implementation part.
- Few of the respondents were totally against the idea of this as they think that it is in a way encouraging private cars, and not encouraging public transport, non-motorised transport or active travel.

There were factors that the respondents thought that could be the barriers to AV penetration in the Indian market. Some of them were:

- 28% people think the existing infrastructure could be a problem for the implementation of the AVs in the Indian roads.
- 22% people said that the mixed traffic could be a problem for the artificial intelligence to detect suddenly appearing elements and the ability to detect and react would be not very efficient and effective. Therefore,

this might cause safety issues which might cause a problem for the functioning of these AVs.

- 15% people think that the perception of the people is something that cannot be changed easily. Some people just enjoy driving and hence they would never give up on that, and hence they cannot be seen as potential AVs customers in any time soon as they wouldn't enjoy the drive of it, if be replaced by artificial intelligence.
- 12% people think that India is currently suffering and struggling with many other third world problems such as poverty, unemployment, pollution, congestion, deprivation. Rather than taking care of these, to concentrate on such fancy things might be like building superstructures on a very rudimentary base.

India needs to focus on the following key areas to catch up with autonomous vehicle development in other markets:

- Greater collaboration and funding from the government, industry associations and automakers for start-ups developing autonomous solutions.
- Clearer government policies to support the development, testing and roll out of electric and autonomous vehicles.
- Increased focus and state funding for roads and traffic infrastructure critical to the development of autonomous vehicles and related systems.
- Creation of domestic intellectual property by attracting leading talent and experts from advanced markets, such as the US and EU to develop capacity and capabilities for developing batteries, powertrains and hardware and software integration.
- More public-private partnerships between city developers, driving infrastructure and solution providers, automakers and government.
- Increased acquisitions and partnerships between automakers and other companies involved in the development of software, microchips, GPS and navigation.
- Development and implementation of a policy to phase out petrol and diesel-powered vehicles to make space for electric and autonomous platforms.
- Autonomous vehicles when combined with electric shared mobility would probably act as the best considering the India market and road conditions and issues such as mixed traffic and absence of lane driving, etc.
- Developing network of industry, academic and government experts to improve R&D capabilities (Consulting, 2017).

The question remains unjustified as to if India should specifically look at autonomous vehicles in terms of public transport or intermediate public transport in digital era of new mobility, or should still go for private vehicles in terms of cars which in no way is adding to benefits of the environment and the leading issues such as air pollution, road fatalities, congestion etc. Hence if at all the autonomous vehicles run under controlled environment, due to India's mixed traffic and lack of designated lane driving, it should be tested for public transport, specifically in BRTS (Bus Rapid Transit System) where the buses have designated lanes for their operation, and hence significantly less hindrance to the regular heterogeneous traffic.

It is also evident from the concerns of the people that were interviewed and surveyed that it is still a big question that if autonomous vehicles should come to India at all! People are highly concerned about the employment issues as India has a huge population share that is related to automobile industries in terms of driving, and if artificial intelligence comes and takes over it, it will be a real hindrance to the common man's source of income and lifestyle.

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