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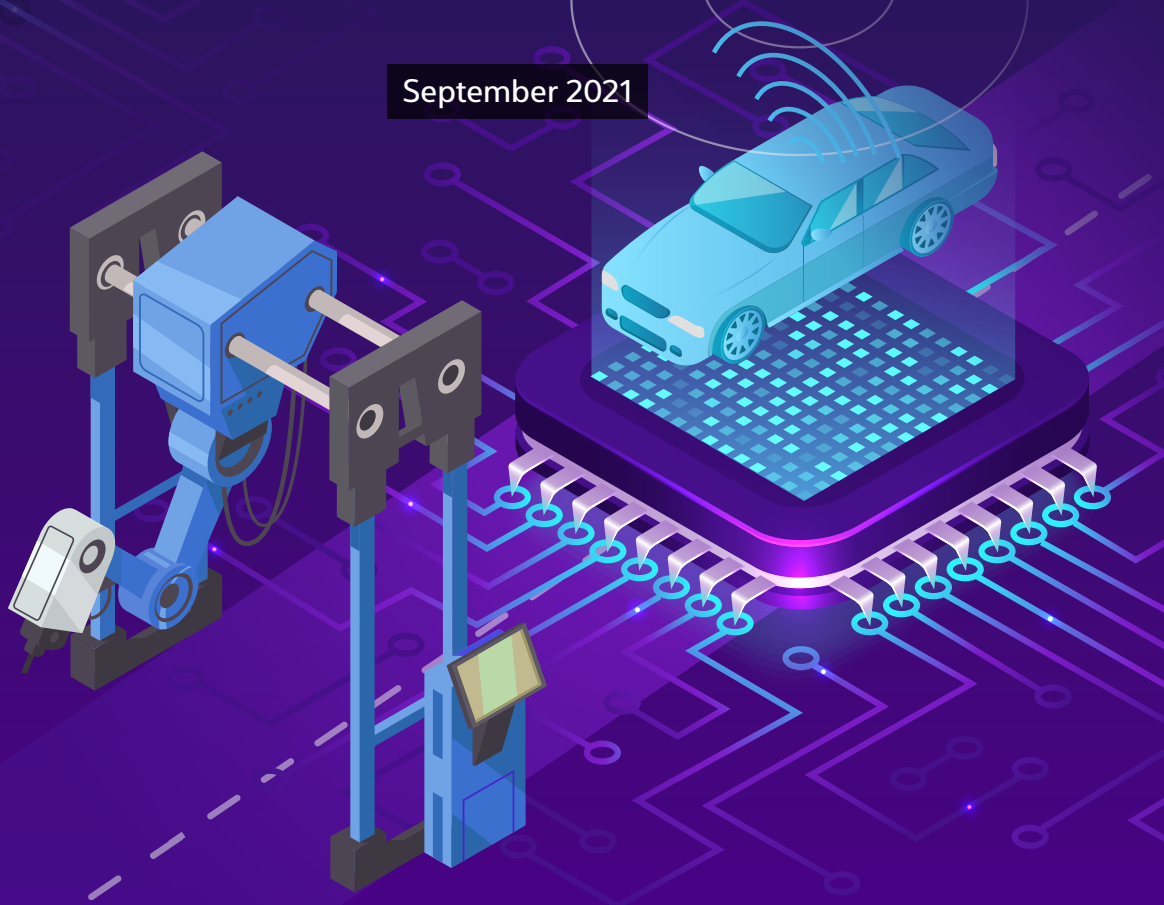
Research

The Future of Mobility

Automation, Aerial Transport & Convergence

September 2021



Research

The Future of Mobility

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September 2021

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Introduction

The twenty-first century has seen major changes in the mobility space, with the advent of newer technologies which began from the internet and culminated in artificial intelligence (**"AI"**). In the present day, innovations ranging from self-driving cars, drone taxis and hyperloops are revolutionizing the transport sector. The extent to which these have captured the public's imagination can be seen from the extensive deployment of self-driving cars at the Tokyo Olympics 2020.[1]

At the same time, there has also been rising public consciousness on the impact of traditional mobility technologies which use fossil fuels and internal combustion engines, that have contributed significantly to pollution levels and congestion across the world. Mobility innovations in recent times have been going beyond simply seeking to transport people and goods across distances with greater speed. They are also now trying to give solutions to the rising issues of accessibility, pollution and scarcity of resources.

Though the pandemic has slowed down industries across the world, it does not appear to have impaired the rate of progress in the mobility sector. In fact, the future of the mobility industry looks bright, and emerging technologies like 5G, edge computing and block chain are likely to enable the sector to progress even further. In this paper, we have examined the future of mobility and the extent of various legal and regulatory frameworks which will need to evolve to accommodate these advancements.

1. World's Biggest-Ever Self-Driving Experiment To Coincide With Tokyo Olympics, available at https://www.forbes.com/sites/peterlyon/2020/01/28/tokyo-olympics-to-coincide-with-biggest-self-driving-demonstration-in-history/?sh=1ed954bf1797(last accessed September 15, 2021)

1. Mobility-As-A-Service and Shared Mobility

I. Mobility as a Service

Mobility as a Service (**"MaaS"**) is the integration of mobility services into a single digital platform accessible on demand.[2] An MaaS platform aims to offer end-to-end trip planning, booking, electronic ticketing, and payment services across public and private modes of transport on the same platform.[3] By providing a single point of access to multi-modal transport options, the concept of MaaS, could be key to adapting the existing transport infrastructure to the demands of the future.

The most prominent initiative on this front has been the MaaS Alliance, a public-private partnership enabling MaaS solutions primarily in Europe.[4] The MaaS Alliance has partnered with several private and public organizations to provide appealing alternatives to private modes of transport.[5]

MaaS has garnered attention in India as well, with the city of Cochin, in the state of Kerala, having initiated plans to implement the concept.[6] The city planning authority will soon launch "Kochi One", a publically available app which would allow users to plan their trips and make bookings across modes of transport as diverse as the metro rail, public and private buses, private three wheelers (auto rickshaws), water jetties and bicycles.[7] This emphasis on integrating traditional public transportation methods with the more informal modes of transport, commonly known as "Intermediate Public Transport" like buses and rickshaws, is one that is unique to the Kochi One project. Other cities, like Mumbai[8] and Pune[9] also plan to follow suit in the near future.

An issue which MaaS faced in its infancy in various countries is the integration of public and private transportation into a single interface, and the resultant issues in finding a balance between the state and private players in the market. In addition, providing a digital marketplace for mobility also raises consumer law issues, since the question of liability is made murky by the involvement of multiple players.

Additionally, the quality of service rendered by MaaS platforms is dependent on the range of real-time transport related data that they have access to, as well as their ability to analyse this data and provide consumers with options between various transport service providers.[10]

Private players are also beginning to view MaaS as a feasible investment opportunity, as evidenced by the recently proposed "Beckn" app." Beckn seeks to use the capabilities of MaaS to remedy the issues faced by users in having to opt between mass transit which is state-owned (like railways, buses, etc.) and private ride services like Ola,

2. What is Mobility as a Service?, available at https://medium.com/@transitprotocol/what-is-mobility-as-a-service-6722590 66c87 (last accessed 15th September 2021).
3. Warwick Goodall et al., The Rise Of Mobility as a Service, Issue 20, Deloitte Review (2017).
4. The Mobility as a Service (MaaS) Alliance, available at https://maas-alliance.eu/the-alliance/(last accessed 15th September 2021).
5. MaaS Alliance Partners with Uber to Support Shared Mobility, available at https://maas-alliance.eu/2017/10/16/maas-alliance-partners-uber-support-shared-mobility/(last accessed 15th September 2021).
6. Mitashi Singh, India's shift from mass transit to MaaS transit: Insights from Kochi. Transportation Research Part A: Policy and Practice, Vol. 131, Transportation Research Part A: Policy and Practice (January, 2020).
7. **Ibid.**
8. Urban Mobility Lab: Think & do tank plans major makeover for Pune's transportation, available at https://www.financialexpress.com/industry/urban-mobility-lab-think-do-tank-plans-major-makeover-for-punes-transportation/1378884/(last accessed 15th September 2021).
9. Mumbai: Integrated Ticketing System to make daily commute faster, easier, available at https://indianexpress.com/article/cities/mumbai/mumbai-integrated-ticketing-system-to-make-daily-commute-faster-easier-5110424/(last accessed 15th September 2021).
10. The Importance of Data in MaaS, available at https://www.intelligenttransport.com/transport-articles/69051/the-importance-of-data-in-maas/ (last accessed at15th September 2021).

Uber, etc.[11] The contractual relationships between various parties in such an arrangement on a privately owned platform are bound to raise some interesting legal issues in this context.

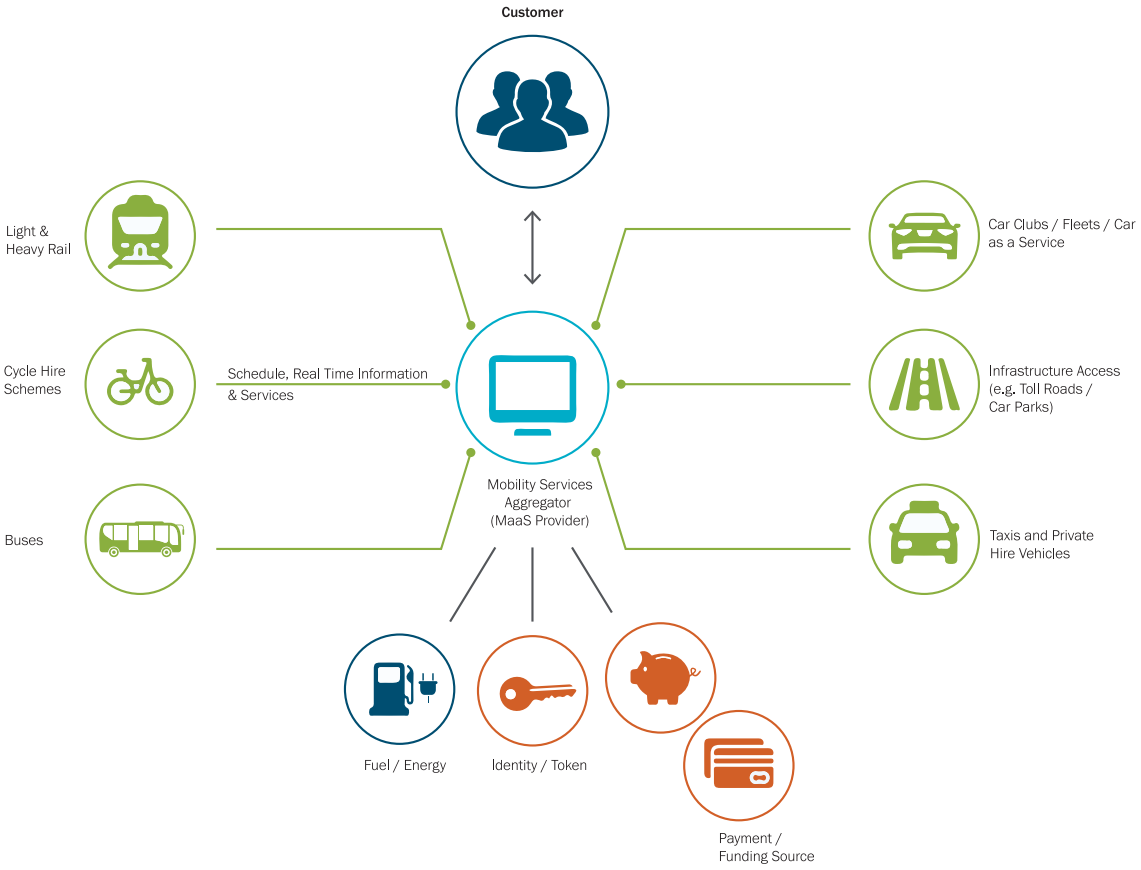

Figure 1: The various aspects of Mobility as a Service; Source: Marinelli, Giuseppe, et al, Introducing TrønderMaaS: investigating business models, sustainability and users' acceptance of a MaaS system in Stjørdal and Trondheim region, Norway, Proceedings of 8th Transport Research Arena TRA (April 2020).

II. Shared Mobility

Despite the well-developed modes of public transport available in most urban areas in India, recent trends in mobility in the country have been centered around private ownership of vehicles.

Shared mobility includes any system of sharing modes of transport on an as-needed basis.[12] It can take various forms, including mass/public transit, ride-sourcing and ride-splitting, ridesharing (carpooling and vanpooling), bike/cycle/scooter/car sharing and peer-to-peer (**"P2P"**) lending.

Shared mobility has relatively obvious benefits it can offer individual users, as well as the society at large. For users, shared mobility offers a cheaper alternative to private vehicle ownership, by eliminating costs incurred not only for the purchase of modes of transport, but also for further maintenance and fuels. The primary societal incentive to shift to a shared model of mobility is that it allows modes of transportation to be shared by users

11. Urban Mobility Challenges Warrant Ecosystem Thinking, Beckn Mobility (2019), available at https://beckn.org/wp-content/uploads/2020/01/Beckn-Mobility-Concept-Paper.pdf.

12. NITI Aayog et al, Moving Forward Together, MOVE Global Mobility Summit (September 2018).

based on need, thus limiting the wastage of resources in the mobility sector.[13] Greater use of shared models of mobility would decrease traffic congestion, which has been a significant issue that Indian urban mobility has been grappling with in the recent past.[14] With the population explosion in the country's urban centers, there is also the issue of reduced parking space which could be addressed by shared mobility models. Shared mobility can also play a role in reducing emissions and energy consumption, thereby ensuring a move to a more sustainable mode of mobility without forcing consumers to reduce their transportation needs.

Shared Mobility in the Indian Context

The Indian market is uniquely placed to take maximum advantage of the benefits offered by shared mobility models. Compared to more developed countries, India has a lower percentage of vehicle owners (as low as 5% in 2016), meaning that the percentage of consumers willing to participate in the various shared models of mobility (both as users and facilitators) is very high.[15] Additionally, the Indian government has affirmed its commitment towards easing the entry barriers to shared mobility in India by releasing guidelines to simplify the process of obtaining taxi permits in the country.[16] The increasing internet penetration in the country could also offer a highly supportive environment for app-based shared mobility services in the future.

Apart from user-specific difficulties, health emergencies like COVID-19 have very evidently had a detrimental effect on shared mobility providers – For instance, social distancing norms forced service providers like Rapido and Uber to take up the task of moving packages rather than people.[17] It has also caused Bounce and Yulu (bike rental services in Bangalore) rides to drop by 40-50%.[18]

13. **Ibid.**
14. India's Urban Mobility and Congestion Problem, available at https://www.livemint.com/Opinion/ OAH01QV5YWUfdDRA7Uf7xK/Opinion--Indias-urban-mobility-and-congestion-problem.html (last accessed 15th September 2021)
15. Report of the Committee Constituted to Propose Taxi Policy Guideline to Promote Urban Mobility, available at https://smartnet.niua.org/sites/default/files/resources/Taxi%20Policy%20Guidelines.pdf (last accessed 15th September 2021).
16. **Ibid.**
17. Aditi Shrivastava, available at https://m.economictimes.com/small-biz/startups/newsbuzz/shared-mobility-companies-take-a-u-turn-to-stay-on-the-road/articleshow/75543475.cms (last accessed 15th September 2021).
18. Shreya Nandi, available at https://www.livemint.com/auto-news/future-investment-in-shared-mobility-space-likely-to-be-compromised-says-report-11603631808805.html (last accessed 15th September 2021).

2. Connected Mobility

I. Connected Mobility: An Overview

Connected mobility refers to the deployment of wireless communication technologies in various forms to integrate the data ecosystem with the mobility sector for various ends. Connected mobility can take numerous forms- including Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I).[19] Beginning with the integration of GPS navigation in cars, culminating in the recent attempts to introduce block chain capabilities in automobiles, the degree to which users can interact and connect with their vehicles has been evolving at an advanced pace over the years. Connected vehicles are increasingly becoming the norm. Public transport is not exempt from such initiatives- In the state of Odisha, the State Transport Corporation has been operating buses which have SIM cards embedded in their seats, which are in turn connected to digital billboards that display the number of vacant seats available in real time.[20]

A. V2V Connectivity

Using the V2V functionality, vehicles can communicate with other vehicles, monitor the presence of such vehicles and use this data to avoid collisions.[21] If the data generated by V2V connectivity is made available to law enforcement officials at scale, it could also be useful for traffic decongestion and overall fleet management.[22]

Driver assistance is a prime example of the benefits of V2V connectivity. For instance, consider a scenario where a person driving on the highway has to unexpectedly slam the brakes and come to a sudden stop. Chances are, the driver in the vehicle behind will not be able to react quickly enough to avoid a collision. If this vehicle could sense the change in velocity of the first vehicle, process this information, and alert the driver to the situation, a collision could be averted. V2V connectivity could provide an elegant solution – when a driver slams the brake, his vehicle automatically notifies all surrounding vehicles, so that they can respond immediately. V2V communication can also be useful for sharing information about pot holes, road closures, weather conditions, and more.

In fact, as early as 2015, India's Department of Telecommunications (**"DoT"**) recognized the potential of V2V connectivity in preventing vehicle theft, fuel consumption, etc.[23] It also encouraged entrepreneurs to develop apps which use V2V connectivity to monitor fuel consumption, locate petrol pumps and pre-cool cars.[24] Models with V2V capabilities have also penetrated the Indian market, assisted by collaborations between automobile manufacturers and telecom service providers.[25]

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19. Kersten Heineke, et al, Development in the mobility technology ecosystem—how can 5G help?, McKinsey Center for Future Mobility (June 2019) available at https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/Development%20in%20the%20mobility%20technology%20ecosystem%20how%20can%205G%20help/Development-in-the-mobility-technology-ecosystem-how-can-5G-help.pdf (last accessed 15th September 2021).
20. As revenues dry up, telcom companies target machine-to-machine apps, available at https://economictimes.indiatimes.com/industry/telecom/as-revenues-dry-up-telcom-companies-target-machine-to-machine-apps/articleshow/12089815.cms?from=mdr (last accessed 15th September 2021).
21. **Ibid.**
22. Advantages of Vehicle to Vehicle Communication, available at https://www.azuga.com/blog/vehicle-to-vehicle-communication-benefits (last accessed 15th September 2021).
23. National Telecom M2M Roadmap by Ministry of Communication and Information Technology, available at https://dot.gov.in/sites/default/files/National%20Telecom%20M2M%20Roadmap.pdf (last accessed 15th September 2021).
24. **Ibid.**
25. Vodafone Idea to power Hyundai's Connected Car services in India, available at https://newmobility.global/connected-car/vodafone-idea-power-hyundais-connected-car-services-india/ (last accessed 15th September 2021).

B. V2I Connectivity

V2I connectivity is an ambitious development in the field of mobility, and aims to enable connectivity between vehicles and the surrounding road infrastructure. Introducing V2I will require large scale modifications in the existing road infrastructure, to enable bidirectional communication between automobiles and their surroundings. Some ways to enable V2I connectivity could include pavement markings which are easily visible to humans and machines[26], "smart" traffic lights which use sensors to direct the flow of traffic, and sensors installed in parking spots which connect to a centralized data collection point.[27] The progression to V2I technology can be observed in various developments throughout the world, including India.[28] This includes the implementation of "roads that honk", introduced in NH1, Srinagar, one of the most dangerous terrains in the country. This technology uses poles placed near bends in the road which detect vehicles heading towards each other, and which subsequently emit a honk to avert a collision.[29] Although this is not fully-fledged bidirectional V2I communication, it is certainly a promising sign for the future of Indian road infrastructure.

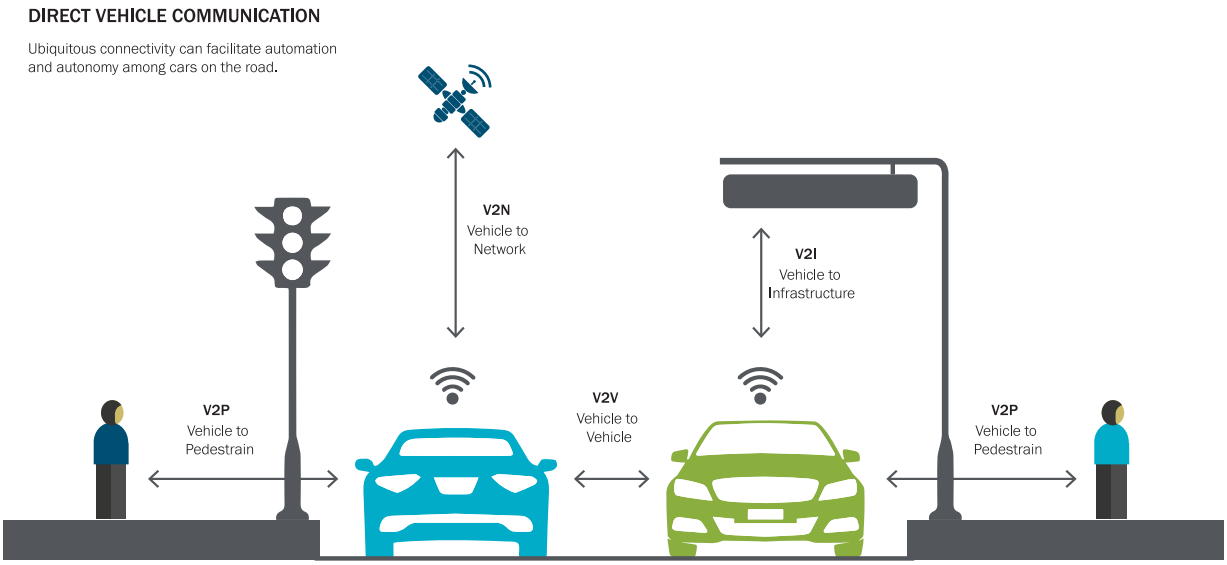

Figure 2: A connected mobility model showing how vehicles, people, networks and infrastructure can be interconnected; Source: V2X: What is Vehicle to Everything?, available at https://www.thalesgroup.com/en/markets/digital-identity-and-security/iot/industries/automotive/use-cases/v2x **(last accessed 15th September 2021)**

II. 5G Technology

Both V2V and V2I technologies use short range bands to detect infrastructure, vehicles and in some cases, pedestrians within the line of sight (**"LOS"**) of sensors in a vehicle. They use the Dedicated Short Range Standard (**"DSRC"**), which is largely based on existing Wi-Fi technology.[30]

26. What is Vehicle-to-Infrastructure (V2I) Communication and why do we need it?, available at https://www.3mindia.in/3M/en_IN/road-safety-in/resources/road-transportation-safety-center-blog/full-story/~/what-is-vehicle-to-infrastructure-v2i-communication-and-why-do-we-need-it/?storyid=0b95359f-9389-4233-9db4-63e307d36b70 (last accessed 15th September 2021)
27. What You Should Know About Vehicle-to-Infrastructure Communication, available at https://www.azuga.com/blog/what-you-should-know-about-vehicle-to-infrastructure-communication (last accessed 15th September 2021).
28. Smart highways are the road to the future, available at https://www.thehindubusinessline.com/opinion/smart-highways-are-the-road-to-the-future/article22168122.ece1 (last accessed 15th September 2021).
29. **Ibid.**
30. Neelu Sinha, Emerging Technology Trends in Vehicle-to Everything Connectivity, Wireless Telecommunications Symposium (2019) available at https://ieeexplore.ieee.org/document/8715535.

For non-LOS objects and data, connectivity to a larger network over a broader range would be required. For such "Vehicle-to-Network" (**"V2N"**) communication, the cellular modem chipsets used in vehicles would need to enable access to bandwidths which allow lesser delays/latency and more precision, which can transmit larger volumes of data. Various high-end models currently being produced have 4G capabilities, but with the entry of 5G enabled vehicles, the possibilities for connectivity in mobility becomes nearly limitless.[31] Currently, India's National Frequency Allocation Plan, 2018 (**"NFAP"**), states that the high-frequency band from 5 875 to 5 925 GHz could be considered for use for DSRC by intelligent transportation systems.[32] This appears to have been in response to demands raised by the Indian automobile manufacturing industry for access to such higher bandwidths to enable greater connectivity for vehicles manufactured in India.[33]

III. IOT and Data

As connectivity in automobiles improves, they are fitted with more sophisticated sensors, capable of capturing high quality data, and a part of the Internet of Things (**"IOT"**) ecosystem. A fully automated car with Vehicle-to-Everything (**"V2X"**) connectivity (which includes V2V, V2I and V2N) generates almost four terabytes of data per day.[34] With these levels, it has been predicted that car-generated digital data may become a 450-750 USD billion dollar industry by 2030, having overlaps with industries including the insurance and telecommunications sectors.[35]

IV. Connected Mobility on the Block Chain

Blockchains are most often thought of in the context of cryptocurrencies, since they form backbone of all crypto-based technology.[36] But the technology also has myriad applications in various other forms, and in the mobility sector in particular. In the context of the mobility industry, the idea is to use blockchain to store data about the different components of the system, i.e., people, vehicles and infrastructure, so that they can work together transparently, efficiently and securely.

The Mobility Open Blockchain Initiative (MOBI), a non-profit comprised of industry leaders and other non-profits in the mobility space, has been working on blockchain-based solutions for the mobility industry.[37]

One of the innovations introduced in the automotive sector by MOBI is that of the first ever standard for a blockchain-based vehicle identification (VID).[38] VID involves the creation of a digit twin to a physical vehicle, and can be used to "establish existence, manage access control, confirm ownership history and contain key events in the life of a vehicle."[39] This VID can also be used with an integrated vehicle wallet for seamless payments.

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31. For a comprehensive discussion on the possibilities of 5G technology, please see our paper available at https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/5G-Technology-in-India.pdf
32. National Frequency Allocation Plan 2018 by Ministry of Communications, available at https://dot.gov.in/sites/default/files/NFAP%202018.pdf?download=1 (last accessed 15th September 2021).
33. Auto Industry Asks Govt to De-License Several Spectrum Bands for Telematics Tech, available at https://www.business-standard.com/article/companies/auto-industry-asks-govt-to-de-license-several-spectrum-bands-for-telematics-tech-115021700826_1.html (last accessed 15th September 2021).
34. Supra note 20.
35. Monetizing Car Data-New Service Business Opportunities To Create New Customer Benefits, available at https://www.mckinsey.com/~/media/mckinsey/industries/automotive%20and%20assembly/our%20insights/monetizing%20car%20data/monetizing-car-data.ashx (last accessed 15th September 2021).
36. We have discussed the potential of blockchain technology and its various applications in our paper available at http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research%20Papers/The_Blockchain.pdf.
37. MOBI-What We Do, available at https://dlt.mobi/ (last accessed 15th September 2021).
38. **Ibid.**
39. MOBI-Working Groups, available at https://dlt.mobi/mobi-working-groups/ (last accessed 15th September 2021).

Vehicles could be directly charged based on the infrastructure used, without any need to stop or even slow down to pay tolls. This would save a tremendous amount of time and fuel. Experts estimate that in India alone, approximately INR 12,000 crore worth of fuel-time is wasted because of the existing methods of toll collection.[40]

The vehicle wallet functionality doesn't end here. When a vehicle is parked in a lot, the parking charges can be automatically tracked and deducted from this wallet. Vehicles can also be charged for operating in a congested area and for the carbon footprint generated from its use.[41] The hope is that such charges would disincentive people from using their vehicles in traffic-prone areas, thereby reducing the congestion and facilitating network management within a city.[42] VIDs also pave the way for a new pay-per-mile business model, since a vehicle's every move is tracked and logged on the blockchain.[43]

Automatic payments using a vehicle wallet are made possible using smart contracts embedded in the blockchain. Smart contracts can be programed such that a payment is triggered by the occurrence of an event.

Commuters may be incentivized by infrastructure owners to use vehicles with renewable technology under the hood, by refunding some of the charges associated with the vehicle wallet. Credits may be given directly to vehicle wallets of commuters who report accidents, damaged or missing infrastructure, or sell their vehicle data. Governments may also provide credit to people who choose to take public transportation over their personal vehicles.

Blockchain could also be helpful in addressing the privacy concerns related to car data, with companies like Carblock working on building encrypted data sharing platforms so that individuals have complete control over the ownership and use of their data.[44]

40. Fuel, time worth Rs 12,000 crore wasted at toll plazas per year, available at https://timesofindia.indiatimes.com/business/india-business/fuel-time-worth-rs-12k-crore-wasted-at-toll-plazas-per-year/articleshow/72285581.cms (last accessed 15th September 2021).
41. **Supra** note 39.
42. **Ibid**
43. **Ibid**
44. CarBlock, available at https://www.carblock.io/ (last accessed 15th September 2021).

3. New Age Automation

I. Driverless Cars[45]

When connected mobility and V2X capabilities are fully exploited and integrated with sensor-based technology, the result is the fully autonomous car, capable of interacting with its surroundings, analyzing the data obtained and implementing decisions on that basis. It's not surprising that the big technology companies and car manufacturers are the primary players in this spEace, because it is still in its infancy, and millions of dollars need to be spent on R&D. Most companies simply do not have the budget for complete in-house driverless car technology. But there are many companies that work on developing specific aspects of the technology, like the internal computer or automation software. In fact, very few self-driving car companies manufacture all the internal components because the technology has become so sophisticated that they need specialists working on each aspect.

Under the hood, there are a lot of different automation algorithms that help the vehicle drive itself. They are all related, but a good place to start is with the navigation component. In order to navigate autonomously, first and foremost a computer vision system is needed. The computer vision system is responsible for identifying cars, pedestrians, traffic lights, stop signs and other such things that a human driver would need to pay attention to. The computer vision system uses two main sensors: a Light Detection and Ranging system (**"LiDAR"**) and a camera system to achieve this task. A suite of state-of-the-art machine learning algorithms work together with the sensors and internal computers.

Once the computer vision system has identified something, the control systems need to drive the vehicle appropriately. For instance, if there is a red light or a pedestrian, the car should brake automatically. There have been some cases where self driving cars vision system failed to identify another car or identified it too late, resulting in an accident.[46] This is one of the primary challenges faced in the deployment of self driving cars, since they are not always adept at identifying and reacting to scenarios they have not encountered previously.[47] The implementation of self driving cars on a large scale has also been impeded by perceptional issues among the public.[48] Algorithmic bias is also an issue which has been faced in the decision making process adopted by autonomous vehicles, where the artificial intelligence (**"AI"**) systems have been shown to be less effective in detecting dark skinned persons.[49]

For the time being, driverless cars may be limited to the west, since most Indian cities provide environments that are simply too complicated for a driverless car to safely operate in. The Union Minister of Road Transport and Highways, Nitin Gadkari has said that driverless cars will not be permitted in India because their widespread adoption will result in loss of too many jobs.[50] Further, India's infrastructural and connectivity issues, in combination with the lack of an adequate regulatory framework for autonomous vehicles, have resulted in the

45. The concept of driverless cars has been explored in-depth in our paper, available at http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research%20Papers/Preparing_For_a_Driverless_Future.pdf

46. The Family of a 15-Year-Old Killed in a Car Crash with a Tesla On Autopilot is Suing The Company, available at https://www.businessinsider.in/tech/news/the-family-of-a-15-year-old-killed-in-a-car-crash-with-a-tesla-on-autopilot-is-suing-the-company/articleshow/84177401.cms (last accessed 15th September 2021).

47. It's 2020. Where are our self-driving cars?, available at https://www.vox.com/future-perfect/2020/2/14/21063487/self-driving-cars-autonomous-vehicles-waymo-cruise-uber (last accessed 15th September 2021).

48. Americans would rather drive themselves to work than have an autonomous vehicle drive them, study says, available at https://www.washington.edu/news/2019/09/16/americans-would-rather-drive-themselves-than-have-an-autonomous-vehicle-drive-them/ (last accessed 15th September 2021).

49. Benjamin Wilson et al., Predictive Inequity in Object Detection, ArXiv (2019), available at https://web.archive.org/web/20201004134325/https://arxiv.org/pdf/1902.11097.pdf (last accessed 15th September 2021).

50. Won't allow driverless cars in India: Gadkari, available at https://economictimes.indiatimes.com/industry/auto/auto-news/wont-allow-driverless-cars-in-india-gadkari/articleshow/71282488.cms?from=mdr (last accessed 15th September 2021).

country being considered ill-prepared for their large scale use in the near future.[51] Though fully automated cars may be a long way off in India, the Indian market has seen entry of cars with lower levels of automation even in the non-luxury segment.[52]

II. Flying Taxis/ Urban Air Mobility

Flying taxis have recently emerged in many different countries. In the United States, Uber has a fleet of helicopters that can transport people in and around New York City for a roughly $250 per seat.[53] Helicopters however, tend to be quite large and extremely loud, making them unsuitable as a means of mass transportation. Similarly, one can charter a private-jet in most countries, however private-jets must take off and land at an airport, making them an impractical choice for short distance travel. Further, they are usually prohibitively expensive, costing thousands of dollars per seat. Therefore, neither helicopters, nor private planes are particularly well suited for use as a taxi service.

In light of the shortcomings of the above technologies, and advancements in autonomy, many companies large and small have begun looking into alternative forms of flying taxis. In China, a company called EHang developed a passenger drone capable of transporting 2 passengers up to 30 miles away.[54] The passenger drone is all electric and capable of vertical take-off and landing. In 2020, the company became the first to receive a commercial license for operations from the Chinese government.[55]

In Britain, a company called Vertical Aerospace is developing a prototype for a flying vehicle, called Seraph with vertical take-off and landing capability.[56] The company's goal is to transform the way people travel, especially in heavily populated areas. This vehicle's design is a true feat of engineering, because its propellers can change orientation mid-flight, transforming the vehicle to and from a helicopter-type configuration to a private-jet-type configuration as needed. Another unique selling point for the Seraph is that it is fully electric, and therefore carbon neutral in flight.

In the United States, many companies are working on similar technologies. Uber plans to supplement its helicopter service, Uber Copter, with a state-of-the-art electric areal ridesharing vehicle through a platform called Uber Air.[57] Aerospace giants like Boeing and Airbus are also working on flying vehicles and taxis. These companies are working on fully autonomous flying vehicles.[58]

India's first air taxi service was recently launched for transport between Chandigarh and Hisar.[59] These taxis are not as sophisticated as the flying machines described above. Rather, they are just small four-seater planes with an economical fare of roughly $25.[60] In Chennai, an IIT-Madras incubated start-up called The ePlane Company has developed a prototype electric flying taxi for commuting within the city. This vehicle is capable for transporting two

51. 2020 Autonomous Vehicles Readiness Index, KPMG International (2020), available at https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf
52. AI set to steer Indian cars in new direction, available at https://www-livemint-com.cdn.ampproject.org/c/s/www.livemint.com/technology/tech-news/ai-set-to-steer-indian-cars-in-new-direction/amp-11629652014913.html (last accessed 15th September 2021).
53. Uber expands helicopter service to all users with iPhones in New York City, available at https://www.usatoday.com/story/tech/2019/10/03/uber-helicopter-service-expands-all-iphone-users-new-york-city/3855008002/ (last accessed 15th September 2021).
54. Introducing The Mindboggling Flying Taxis Of The Future, available at https://www.forbes.com/sites/ bernardmarr/2020/06/29/introducing-the-mindboggling-flying-taxis-of-the-future/?sh=33eab6a218dd (last accessed 15th September 2021).
55. **Ibid**
56. Vertical Aerospace, available at https://www.vertical-aerospace.com/.
57. 7 Urban Air Mobility Companies To Watch, available at https://www.greenbiz.com/article/7-urban-air-mobility-companies-watch (last accessed 15th September 2021).
58. **Ibid.**
59. India's First Air Taxi Service Launched in This City, available at https://auto.hindustantimes .com/auto/news/indias-first-air-taxi-services-launched-in-this-city-41610717753679.html (last accessed 15th September 2021).
60. **Ibid.**

passengers at a time, and is likely to cost about 2x the cost of a regular taxi, making it extremely affordable.[61] The Indian government also seems to be awakening to the possibility of air mobility being introduced as a mass transit option in the country. The recently released Drone Rules, 2021[62] apply to drones weighing up to 500 kilograms, instead of the earlier regulatory framework for drones weighing up to 300 kilograms. The Minister of Aviation, Mr. Jyotiraditya Scindia has specifically stated that the new rules are intended to make drone taxis possible in the near future.[63] Further details on the new Drone Rules, 2021 have been provided in Chapter V below.

In terms of practical operations, an important challenge faced by developers of UAVs is that of collision avoidance. A possible solution for this could see the use of "collision avoidance technology", which would operate similarly to the V2X capabilities of AVs and avoid mid-air crashes by detecting surrounding objects.[64]

III. Alternatives to Combustion Engines

A. Electric Vehicles

Electric vehicles have many advantages. They do not require any oil changes, have very few moving parts and require little to no maintenance.[65] One of the limitations at present is the lack of charging station infrastructure, but this is improving with time. Hybrid cars offer a solution here – they combine electric technology with conventional engines. Hybrid cars have been around for a long time, but their adoption has been limited, because of the high prices.

Experts feel that automakers will face roadblocks in the near future that may get in the way of achieving profitability in the electric vehicle space.[66] Initiatives have been taken in the country by private players to promote increased use of electric vehicles, and have met with moderate success.[67]

This has been despite the various incentives provided by the central and state governments to adopt hybrid and electric vehicles.[68] Recently, the central government provided an extension to the second phase of the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (**"FAME"**) scheme.[69] It was introduced in 2019 with an outlay of INR 10,000 crore and the government expected to incentivize the purchase of 7,090 electric buses, 35,000 four-wheelers, 500,000 three-wheelers and 1 million two-wheelers. The scheme, which was supposed to conclude in 2022, will now stay in effect until 2024.

Globally, electric vehicles have been steadily gaining popularity, with several climate change advocacy groups and international organizations supporting their wide-scale adoption. Some of the world's largest car manufacturers, including Tesla, Nissan and Honda, have announced commitments to expand the sales of

61. Coming Soon From IIT-Madras Stable: Flying Taxis, available at https://timesofindia.indiatimes.com/city/chennai/coming-soon-from-iit-madras-stable-flying-taxis/articleshow/82058951.cms (last accessed 15th September 2021).
62. The Drone Rules, 2021, available at https://egazette.nic.in/WriteReadData/2021/229221.pdf
63. Air Taxis a Reality Soon Under New Drone Policy, available at: https://www.livemint.com/news/india/taxis-in-the-air-to-be-a-reality-soon-under-new-drone-policy-aviation-minister-11629974892279.html (last accessed 15th September 2021).
64. Tiny UK startup takes on Google's Wing in the race to a drone traffic control system, available at https://techcrunch.com/2019/07/19/tiny-uk-startup-takes-on-googles-wing-in-the-race-to-a-drone-traffic-control-system/ (last accessed 15th September 2021).
65. Are electric cars cheaper to maintain?, available at https://www.kia.com/dm/discover-kia/ask/are-electric-cars-cheaper-to-maintain.html (last accessed 15th September 2021).
66. **Ibid**
67. Will Ola Electric galvanize India's EV movement like how Tesla did worldwide?, available at https://auto.hindustantimes.com/auto/news/will-ola-electric-galvanize-india-s-ev-movement-like-how-tesla-did-worldwide-41626863253852.html (last accessed 15th September 2021).
68. For a further discussion on electric vehicles and various government initiatives to promote their use, see our paper available at http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/E_Mobility_A_Sustainable_Automotive_Future.pdf
69. India Extends FAME Scheme by Two years to Incentivise Purchase of Electric Vehicles, available at https://www.livemint.com/auto-news/india-extends-fame-scheme-by-two-years-to-incentivise-purchase-of-electric-vehicles-11624631393528.html (last accessed 15th September 2021).

their electric vehicle models multifold by 2030.[70] Experts predict that despite the detrimental effects seen as a consequence of the recent pandemic, electric vehicles are posed to become leading players in the mobility market. A major factor influencing this shift is various policy incentives provided to consumers using electric vehicles in jurisdictions like China, Europe and India. In addition, governments are also penalizing car manufacturers who release models into the market having above-average CO_2 emissions.[71] Other factors, like positive behavioral trends of consumers towards electric vehicles and availability of affordable models are also prime drivers of the growth of this sector. In India, ride-hailing service providers like Ola are looking to cement their position in the electric vehicle market, and have raised a loan for 100 million USD to build an electric-vehicle manufacturing plant with a capacity to produce 2 million electric vehicles a year.[72]

B. Sodium ion Batteries

Electric vehicles, like most other devices using a rechargeable battery, are dependent on lithium-ion based batteries. Lithium-ion batteries were a game-changer at the time of their invention, however, wide-scale use of lithium-ion batteries poses a challenge since lithium is a rare and expensive metal. For countries like India, the extensive use of lithium also presents strategic challenges, since it creates a dependence on countries like China, which have large deposits of the metal.[73]

Sodium-ion batteries are emerging just as several countries and corporations across the world have begun to question their dependence on lithium. Unlike lithium, sodium is abundantly found all across the world, and is inexpensive. Additionally, lithium-ion batteries cannot be transported unless they are at a partially or fully charged state, while it is relatively much easier to transport sodium-ion batteries.[74] In Europe, adaptation of sodium-ion batteries in electric vehicles seems to be the next big shift, with a French corporation named Tiamat Energy having raised nearly 5 million Euros to produce sodium ion battery cells for hybrid cars.[75] Recent innovations in the space have also managed to increase the energy capacity of the sodium-ion battery to be comparable to that of the lithium ion battery.[76] In India, the government is reportedly contemplating a new policy to develop next generation battery technologies for electric vehicles in an attempt to identify alternatives to lithium-ion batteries.[77]

C. Hydrogen

Among the more ambitious alternative clean fuels which have been gaining traction lately, "green" hydrogen is emerging as a front-runner. It is generated through the electrolysis of water into its constituent hydrogen and oxygen, using electric energy generated from renewable sources like wind and solar energy.[78] The hydrogen

70. Electric vehicles-Setting a course for 2030, available at https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/electric-vehicle-trends-2030.html (last accessed 15th September 2021).

71. Volkswagen faces EU fine for missing 2020 emissions targets, https://www.reuters.com/article/us-volkswagen-emissions-idUSKBN29Q1JI#:~:text=Concerned%20about%20global%20warming%2C%20as,of%20excess%20CO2%20they%20emit (last accessed 15th September 2021).

72. Ola's Electric Vehicle Arm Raise $100 Million from Bank of Baroda, available at https://www-livemint-com.cdn.ampproject.org/c/s/www.livemint.com/companies/news/ola-electric-signs-100-million-long-term-loan-with-bank-of-baroda/amp-11626070070323.html (last accessed 15th September 2021).

73. India Is at an Energy Crossroads, available at https://www.fairobserver.com/region/central_south_asia/india-electric-vehicles-sodium-ion-batteries-electric-cars-india-47938/ (last accessed 15th September 2021).

74. **Ibid**

75. European manufacturing plan for sodium battery technology, available at https://www.eenewseurope.com/news/european-manufacturing-plan-sodium-battery-technology# (last accessed 15th September 2021).

76. New sodium-ion battery advance could challenge lithium-ion, available at https://www.power-and-beyond.com/new-sodium-ion-battery-advance-could-challenge-lithium-ion-a-941730/ (last accessed 15th September 2021).

77. India To Come Up with a New Policy to Develop New Battery Tech for Electric Vehicles, available at https://www.theleaflet.in/india-to-come-up-with-a-new-policy-to-develop-new-battery-tech-for-electric-vehicles/ (last accessed 15th September 2021).

78. Green hydrogen is gaining traction, but still has massive hurdles to overcome, available at https://www.cnbc.com/2020/12/04/green-hydrogen-is-gaining-traction-but-it-must-overcome-big-hurdles.html (last accessed 15th September 2021).

which is generated from this process can then be used by fuel cells to convert it into energy for cars and other automotives, However, despite the numerous benefits that hydrogen offers as a fuel, there are numerous challenges to its implementation at a large scale. The fuel cells used in converting the hydrogen to useful energy in cars tend to be very expensive, and the charging stations required to refuel these cells are not fully developed.[79] Despite these challenges, hydrogen is slowly gaining prevalence around the world, with hydrogen-powered trucks being used to make McDonald's deliveries in Switzerland.[80] In India, the government has been trying to encourage the use of green hydrogen as a fuel in the fertilizer and oil refinery industries.[81] The National Thermal Power Corporation, the biggest power generator in India, has also recently invited expressions of interest from automobile manufacturers to make hydrogen fueled cars.[82] Hydrogen fueled cars are likely to see more initiatives by the Indian government to encourage their deployment in the near future, since it has committed to spend USD 200 million in the next 5-7 years to promote their use.[83]

79. **Ibid.**

80. Hydrogen with those Fries? In Switzerland, McDonald's Deliveries are by Hydrogen Fuel Cells Trucks, available at https://fuelcellsworks.com/news/hydrogen-with-those-fries-in-switzerland-mcdonalds-deliveries-are-by-hydrogen-fuel-cells-trucks/ (last accessed 15th September 2021).

81. Govt Charts Course for Usage of New-Age Fuel, available at https://www.livemint.com/industry/energy/govt-charts-course-for-usage-of-new-age-fuel-11625078901655.html (last accessed 15th September 2021).

82. Auto Cos Eyes NTPC's Hydrogen Fuel Pilot, available at https://www.livemint.com/companies/news/auto-cos-eye-ntpc-s-hydrogen-fuel-pilot-11617216138495.html (last accessed 15th September 2021).

83. India to spend $200 mln in next 5-7 years to promote hydrogen use, available at https://www.reuters.com/world/india/india-spend-200-mln-next-5-7-years-promote-hydrogen-use-2021-04-15/#:~:text=India-,India%20to%20spend%20%24200%20mln%20in%20next%205,years%20to%20promote%20hydrogen%20use&text=Oil%20minister%20Dharmendra%20Pradhan%20said,CNG)%20as%20a%20transportation%20fuel (last accessed 15th September 2021).

4. The Future of Mobility

I. Changing Trends in Mobility

The mobility sector has moved through various stages of exponential progress over recent years due to various factors including increased reliance on AI, focus on automation and climate change. In the following section, we examine how the future of mobility is shaping up.

A. Telematics

Telematics entails using the driver/vehicle data generated by such vehicles to improve the level of services provided to users.[84] In the past, the scope of telematics was restricted to integrating software with the hardware used in cars for applications like GPS, cruise control and remote lock/unlock of vehicles. However, with the advent of more connected and autonomous vehicles, telematics has developed into an industry of its own.

Today, telematics systems are used to gather data including vehicle location, driver behavior, vehicle speed, engine diagnostics and vehicle activity including faults.[85] Telematics systems are now commonly used by fleet managers This data is used to manage vehicles remotely and/or OEMs to provide post-sale services through a virtual cloud.

Traditionally, vehicle maintenance and troubleshooting have been restricted to being preventive or corrective, and generally occur after a defect has arisen.[86] The advanced methods of data collection using telematics and related technologies in connected vehicles also allows collection of data related to the performance and status of various parts of a vehicle. Using advanced sensors, technical data of the vehicle, such as oil temperature, malfunctions, etc. could be used to provide diagnostic and emergency services to consumers.[87] This also facilitates "predictive" maintenance of vehicles, where real-time data allows accurate predictions of what is likely to fail. This constant health monitoring of a vehicle would ensure that car owners have to invest only in those parts which are most likely to fail, and not others.

B. Environmental Impact

Traditional modes of mobility, which are reliant on combustion engines and fossil fuels, have been recognized as significant contributors to the global rise in emissions of carbon-dioxide and particulate matter.[88] In 2019, transport emissions constituted 24% of the total CO_2 emissions in the world.[89] Even in more developed jurisdictions like the United States, the share of the transport sector in greenhouse gas emissions has continued to show an upward trend.[90] In this context, entry of alternatives to traditional mobility becomes very important. It has been predicted that wide-scale adoption of electric vehicles could eliminate greenhouse gas emissions by

84. What is Telematics?, available at https://www.verizonconnect.com/resources/article/what-is-telematics/ (last accessed 15th September 2021).

85. What is Telematics?, available at https://www.teletracnavman.com/resources/resource-library/faqs/what-is-telematics (last accessed 15th September 2021).

86. Vehicle Remote Health Monitoring and Prognostic Maintenance System, available at https://www.hindawi.com/journals/jat/2018/8061514/ (last accessed 15th September 2021).

87. **Supra note** 37.

88. Niti Ayog, Transforming India's Mobility: A Perspective, MOVE Global Mobility Summit (September 2018) available at https://www.niti.gov.in/writereaddata/files/document_publication/BCG.pdf (last accessed 15th September 2021).

89. Everything You Need to Know About the Fastest-Growing Source of Global Emissions: Transport, available at https://www.wri.org/insights/everything-you-need-know-about-fastest-growing-source-global-emissions-transport (last accessed 15th September 2021).

90. **Ibid.**

2050.[91] Shared models of mobility as well, could play a vital role in moving away from privately owned vehicles, thereby reducing issues of congestion and pollution.

Significantly, AVs could also play a part in reduction of emissions by enabling efficient driving and smoother traffic flows.[92]

195 countries have made commitments to undertake measures towards countering climate change under the Paris Agreement.[93] Under the Paris Agreement, countries must regularly report on their emission levels and steps taken to curb them. To achieve their emission targets under the Paris Agreement, many countries have resorted to placing restrictions on conventional gasoline and diesel engines, which has led automobile companies to accelerate the shift towards electrification.[94]

II. IoT, Edge Computing and 5G

Connected and autonomous vehicles can become a part of mainstream mobility only if they continue to converge with emerging technologies, which are still taking shape.

One such technology, discussed (in the context of connected vehicles) above, is that of IoT. Integration of a vehicle with the IoT ecosystem can be immensely helpful in enhancing the ability of a vehicle to anticipate events and react to risks in its environment.[95] This in turn aids in improving road safety, regulation of driving speed, and optimizes fuel consumption.[96]

Edge computing is another emerging technology that can help the mobility industry in perfecting the concept of AVs. It is being considered as a replacement for the existing approach where data generated by IoT enabled devices is uploaded on the cloud before being processed and analysed. In such a traditional cloud computing model of data analysis, a time-lag occurs between the point of data generation by a vehicle and the implementation of a decision basis of data processed in the cloud. This time-lag can be avoided by using edge computing. In edge computing, the processing of data is carried out by local devices instead of being uploaded on the cloud. Thus, the final data which is shared with other IoT enabled devices is not "raw" data, but is rather processed and analysed by processors present on the original device itself.[97] This is helpful when decisions have to be made on a time-sensitive basis with minimum time spent on processing data. Thus, edge-computing is a technology that is ideally suited to AVs. Edge computing can also be used in case of electric vehicles to inspect battery health and alert owners in case of malfunctions.[98]

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91. E-Mobility Is The Best Solution For Both Climate and Economic Crises, available at https://theprint.in/economy/e-mobility-is-the-best-solution-for-both-climate-and-economic-crises/449891/ (last accessed 15th September 2021).
92. Moneim Massar et al, Impacts of Autonomous Vehicles on Greenhouse Gas Emissions—Positive or Negative?, Vol. 18(11) International Journal of Environmental Research and Public Health (2021).
93. 2020 Climate Targets: The Paris Agreement legally requires better targets this year, available at https://www.downtoearth.org.in/blog/climate-change/2020-climate-targets-the-paris-agreement-legally-requires-better-targets-this-year-69332 (last accessed 15th September 2021).
94. China Says It Will Stop Releasing CO_2 within 40 Years, available at https://www.scientificamerican.com/article/china-says-it-will-stop-releasing-co2-within-40-years/ (last accessed 15th September 2021); Biden set to rejoin Paris climate accord, impose curbs on U.S. oil industry, available at https://economictimes.indiatimes.com/news/international/world-news/biden-set-to-rejoin-paris-climate-accord-impose-curbs-on-u-s-oil-industry/articleshow/80369406.cms?from=mdr (last accessed 15th September 2021).
95. Self-Driving Vehicles and Iot Services Take the Stage in Versailles, available at https://erticonetwork.com/self-driving-vehicles-and-iot-services-take-the-stage-in-versailles/ (last accessed 15th September 2021).
96. **Ibid.**
97. Why autonomous vehicles will rely on edge computing and not the cloud, available at https://www.zdnet.com/article/why-autonomous-vehicles-will-rely-on-edge-computing-and-not-the-cloud/ (last accessed 15th September 2021).
98. Role of Edge Computing in Connected and Autonomous Vehicles, available at https://www.einfochips.com/blog/role-of-edge-computing-in-connected-and-autonomous-vehicles/ (last accessed 15th September 2021).

Combining high-speed 5G technology with edge computing and IoT would further reduce the response time and enable a smoother and safer operations. 5G technology[99] will usher in a much greater revolution than itself. At the base level, it will significantly increase the capacity and reach of existing mobile networks through greater data throughput and ultralow latency. But in a larger sense, 5G is likely to become the backbone of many fourth industrial revolution (IR4) technologies like Artificial intelligence, augmented reality/virtual reality, drones, internet of things, telemedicine, and autonomous vehicles. Autonomous vehicles generate and process a huge amount of data, owing to the multiple sensors that enable it. They also require a lot of bandwidth and lower latency in order to communicate and make quick decisions, that may be life saving for its passengers. 5G networks are best equipped to provide the sort of connectivity that is required to make such vehicles a safe possibility.

III. Inter-sectoral Impact of "New" Mobility

With the transformation in the mobility industry from being primarily product oriented to being service oriented, the sector holds immense potential that goes beyond impacting the original equipment manufacturers (**"OEMs"**), and extends to myriad other sectors. We examine below, a few key sectors which are posed to gain maximum benefits from new mobility.

A. Data-Driven Industries

Autonomous Vehicles (**"AVs"**) are the ultimate connected vehicles, and this connectivity ranges beyond navigational capabilities. Autonomous vehicles have a suite of sensors collecting a tremendous amount of data in real-time. The data is processed and used to drive the vehicle. Some of the data may be shared with the manufacturer to help them improves the autonomous driving capability. Some of this data may also be shared with infrastructure builders as geo-location and auto-braking data, which would help them identify high-risk areas and preemptively modify infrastructures to prevent accidents. Data sharing will mitigate the need for speculative decision making; which invariably leads to sub-optimal solutions.

It has been found that prospective owners of AVs would prefer to spend their time focusing on entertainment offers, and online shopping.[100] The in-car data generated by consumers will be valuable for several industries, including for enabling in-car e-commerce, and for providing targeted advertising inside the car. In addition, the location-specific data generated by cars could be utilized for providing higher accuracy geo-spatial and map data. Additionally, in the shared mobility ecosystem, sharing of traffic data between ride-sharing aggregators and public transport authorities will provide better avenues for MaaS to operate.

B. Media and Entertainment

The media and entertainment industry is likely to see a rise in consumption if AVs are adopted on a mass scale. Since there will be considerably less time spent driving, consumers will be left with more time on their hands, and with advancements in VR and immersive in-vehicle experiences, adoption of new mobility will be an unlikely yet significant driver of this sector.

99. For a more in-depth analysis of 5G technology in India, please see https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/5G-Technology-in-India.pdf

100. What happened in 2018, and what can we expect in 2019?, available at https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/reserve-a-seat-the-future-of-mobility-is-arriving-early (last accessed 15th September 2021).

C. Insurance

The insurance industry currently insures individual vehicles, and not drivers. However, as discussed above, the future will see a reduction in individual vehicle ownership and increased shared mobility models. In such a scenario, the traditional means of insuring a single vehicle may not be practical, and the insurance industry may need to update its approach to the mobility sector to accommodate this trend. In case of AVs as well, the insurance sector will have to update its approach.

Manufacturers and infrastructure providers will now need to be the subject of liability, rather than the direct consumers (owners). According to a report by KPMG[101], it would lead to a fall in premiums, change underwriting models which earlier depended on driver behavior and might even eliminate the need for car insurance for the individual vehicles. The insurance sector will have to adapt their business models accordingly. While accident related premiums are bound to come down in the long term, there will be different risks that need insuring such as the risk of an algorithm failing or cyber-attacks relating to driverless cars.

Improvements in the field of data analytics and information processing has also changed the approach taken by insurers towards risk analysis of their policy holders, i.e., the chances that an individual policy holder may make a claim. For example, researchers have demonstrated that allowing automobile insurers to access information like the type of house owned by policy holders may allow accurate predictions to be made regarding the chances of a policy holder being in a car accident in the future.[102]

D. Healthcare

As early as 2011, the potential of cars to track health data of their occupants and subsequently assist in averting crashes has been explored.[103] In 2016, Ford, one of the world's leading OEMs, developed a method to link heart-rate sensor data obtained from the driver's smartwatch to the adaptive cruise control system.[104] This allowed the car to automatically increase distance from other cars ahead upon a sudden increase in the heartrate of the driver. In addition, bio-sensors have also been proposed to be installed within the seats of autonomous cars, which can keep track of the vitals of drivers by collecting data like heart rate, speech, etc.[105] In case of medical emergencies during trips, these vehicles could alert medical authorities about the need for medical assistance, and could also automatically set its destination to the nearest healthcare center.[106] Though such innovations are only beginning to be explored, the intersection between mobility and healthcare is an area filled with great potential.

IV. Mobility Solutions

In addition to self-driving ground vehicles, there are two noteworthy emerging technologies with the potential to completely change the way we transport goods and people: Hyperloop railway and aerial drones. Just last year, Richard Branson's Virgin Hyperloop made history by completing the first set of passenger

101. KPMG & Center for Automotive Research, Self-Driving Cars: The Next Revolution (2012) available at https://institutes.kpmg.us/content/dam/institutes/en/manufacturing/pdfs/2017/self-driving-cars-next-revolution-new.pdf (last accessed 15th September 2021).

102. How a Google Street View image of your house predicts your risk of a car accident, available at https://www-technologyreview-com.cdn.ampproject.org/c/s/www.technologyreview.com/2019/04/30/135556/how-a-google-street-view-image-of-your-house-predicts-your-risk-of-a-car-accident/amp/ (last accessed 15th September 2021).

103. Health Sensing in Cars, available at https://cta.tech/Resources/i3-Magazine/i3-Issues/2019/November-December/Health-Sensing-in-Cars (last accessed 15th September 2021).

104. **Ibid.**

105. Md. Ibrahim Mamun et al., Healthcare Monitoring System Inside Self-driving Smart Car in 5G Cellular Network, IEEE 17th International Conference on Industrial Informatics (INDIN) (2019).

106. **Ibid.**

trials.[107] This system can transport passengers and cargo at speeds of over 1000 km/hour – even faster than an airplane.[108] The hyperloop system comprises of an electrically powered pod attached to rails, sealed in a low-pressure tube. Using the rather fascinating principles of magnetic levitation and propulsion, the pod can move at speeds which are currently out of reach for most modes of transportation available. In essence, levitation of the pod is achieved by mutually repellant magnetic poles, while propulsion is achieved by a combination of both magnetic repulsion and attraction.[109]

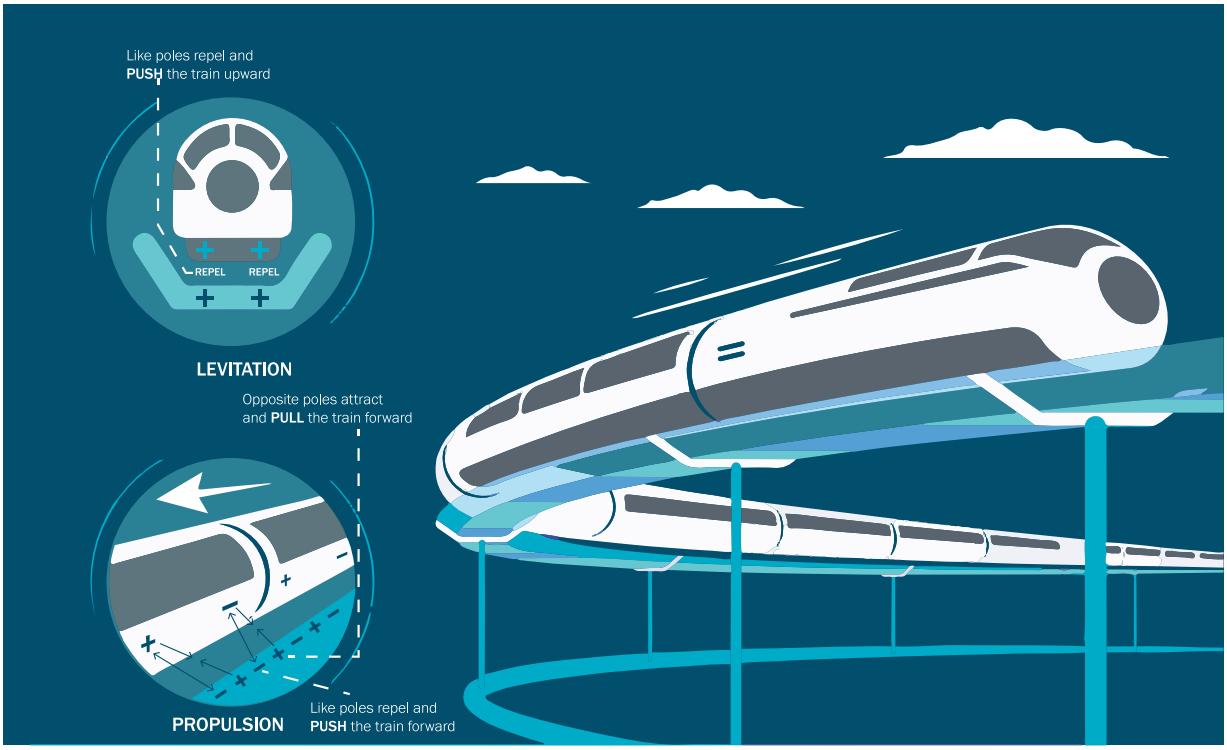

Figure 3: The principles behind hyperloop technology; Source: Hyperloop One: Transportation of the Future, available at https://medium.com/the-marc-project/hyperloop-science-piece-draft-265618bodoe7 **(last accessed 15th September 2021)**

Apart from speed, there are many advantages to this design. The near vacuum tube means that there is little to no aerodynamic drag force acting on the pod, increasing efficiency and minimizing noise. The sealed tube ensures that there are no delays due to bad weather and the autonomous operation of the pods ensures that there are no delays or accidents due to human error. The tubes can be installed underground or above ground as required, and the exterior of the tube wall can be fitted with solar panels. These solar panels may eventually be capable enough to power the hyperloop system. The Virgin Hyperloop team also argues that the system is more maneuverable, space-efficient and capable than conventional high-speed rail, while costing less for operations and maintenance.[110]

Virgin Hyperloop has been working with the Maharashtra government to build a hyperloop between Mumbai and Pune.[111] This would bring down travel times to just 25 minutes – making it more feasible for people to

107. Timeline: tracing the evolution of hyperloop rail technology, available at https://www.railway-technology.com/features/timeline-tracing-evolution-hyperloop-rail-technology/?utm_source=Army%20Technology&utm_medium=website&utm_campaign=Must%20Read&utm_content=Image (last accessed 15th September 2021).

108. Virgin Hyperloop, available at https://virginhyperloop.com/ (last accessed 15th September 2021).

109. How Does Hyperloop Work? Everything You Need To Know About Magnetic Levitation, available at https://www.alphr.com/technology/1006815/how-hyperloop-works-launch-magnetic-levitation/ (last accessed 15th September 2021).

110. **Ibid.**

111. Virgin Hyoerloop-Maharashtra, available at https://virginhyperloop.com/project/maharashtra (last accessed 15th September 2021).

commute between the two cities on a daily basis.[112] Another route is being planned between Bengaluru airport and the city.[113] NITI Aayog member V K Saraswat has said that hyperloop technology is still in the experimental phase and it will take several years before adoption will be possible.[114] However, he is optimistic about the benefits of the technology.[115]

V. Aerial Drones

Aerial drones, commonly known as Unmanned Aerial Vehicles (UAV), have many industrial applications. They can be used to transport all kinds of items, with the advantage of being able to do so over any terrain. International companies like Zipline have already developed drones for transportation of medical supplies over long distances.[116] Others like Amazon Prime Air are working on UAVs with the ability to pick, transport and drop packages from a warehouse to a customer's home.[117] And in a previous section, we briefly talked about the development of passenger UAVs. UAVs may be remotely piloted or fully autonomous. The latter in particular can be integrated into a connected mobility ecosystem. For example, UAVs can be used as traffic policemen, taking note of any violators and surveilling the roads for any accidents.

112. **Ibid.**

113. Demonstration tech for Virgin Hyperloop in India would be good move: Niti Aayog, available at https://auto.hindustantimes.com/auto/news/demonstration-tech-for-virgin-hyperloop-in-india-would-be-good-move-niti-aayog-41613650665422.html (last accessed 15th September 2021).

114. **Ibid.**

115. **Ibid.**

116. Zipline, available at https://flyzipline.com/ (last accessed 15th September 2021).

117. Amazon Prime Air, available at https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011 (last accessed 15th September 2021).

5. Legal and Policy Issues

Laws catered for traditional systems of mobility may not always be suited to modes of technology which were unimaginable at the time of their enactment. The Indian legal landscape in particular has several laws which may require a significant re-examination in the context of the various evolving trends in mobility. In the below section, we have considered some of the issues which could arise upon new mobility being adopted on a large scale in India.

I. The Motor Vehicles Act

The Motor Vehicles Act, 1988 (**"MV Act"**), regulates the various aspects of mobility in road transport, including vehicle permits, traffic regulation, insurance, etc.

The MV Act is a law intended regulate the more traditional aspects of road transport. Hence, it leaves a lot to be desired in the context of the integration of the mobility industry with the various technological developments discussed above. The provisions of the MV Act may need significant revisions with the large-scale adoption of these newer technologies. We have discussed below, some possible conflicts that could arise if the MV Act applies to developments like shared mobility and autonomous vehicles.

Some of the key concepts of shared mobility are those of car-pooling and P2P renting of cars. However, Section 53 of the MV Act expressly prohibits the use of motor vehicles "for hire or reward" in the absence of a valid permit for such use. Section 66 of the MV Act also contains a restriction on the use of motor vehicles for transport by their owners. The MV Act contemplates the use of vehicles for commercial purposes only when a contract carriage permit or a public service permit is issued by the relevant authorities. There have been instances where the provisions of the MV Act have been invoked against aggregators allowing their users to share private vehicles for rides.[118] Aggregators have attempted to take the defense that the expression "for hire or reward" in the MV Act cannot be used in cases where the aggregator does not stand to make a profit from carpooling activities by its users.[119]

In November 2020, the Central Government issued the Motor Vehicle Aggregator Guidelines, to be used by State Governments while granting licenses to aggregators under Section 93 of the MV Act.[120] Without making specific reference to the sections of the MV Act, these guidelines allow ride-pooling and vehicle sharing facilitated by aggregators.[121] However, no corresponding amendments have been made to the provisions of the MV Act to allow such ride pooling of motor vehicles.

Additionally, there may also be difficulties in adapting the framework of the MV Act for the entry of AVs into the Indian market. For instance, under the MV Act, a motor vehicle can only be driven by a "person" over the age of 18 with a valid driving license.[122] It is unclear to what extent these conditions would apply in case of self-driving cars.[123] Additionally, the Motor Vehicles (Driving) Regulations, 2017, mandates that **"Every vehicle or combination of vehicles, while moving on a road, shall have a driver."**[124] The MV Act defines a driver

118. After Hyundai i20 owner was fined, carpooling app shares legality of ride sharing, available at https://www.rushlane.com/hyundai-i20-car-pool-india-legal-12277963.html (last accessed 15th September 2021).

119. **Ibid.**

120. Motor Vehicle Aggregator Guidelines, 2020, Available at https://morth.nic.in/sites/default/files/notifications_document/Motor%20Vehicle%20Aggregators27112020150046.pdf (last accessed 15th September 2021).

121. Guideline Nos. 11 & 15 of the Motor Vehicle Aggregator Guidelines, 2020.

122. Section 3(1) of the Motor Vehicle Act, 1988.

123. For a further analysis of the applicability of the MV Act to autonomous vehicles, see http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research%20Papers/Preparing_For_a_Driverless_Future.pdf

124. Regulation 4 (1) of the Motor Vehicles (Driving) Regulations, 2017.

inclusively, but does not mandate a requirement for such drivers to be natural persons. The likely impact of this provision on the operation of AVs on Indian roads remains to be seen.

However, it is certainly a positive sign that in the latest amendment to the MV Act in 2019, a new section 2-B has been added, which allows the Central Government to exempt "certain types of mechanically propelled vehicles" from the applicability of the MV Act for promoting innovation in the field of vehicular engineering, and transportation in general.[125] In addition, the ability of regional transport departments to issue contract carriage permits under the MV Act should be utilized to the fullest extent, to maximize the gains for the shared mobility sector.[126]

Under Sections 140 and 163-A the MV Act, compensation for death or permanent disability caused by motor vehicles may be determined on the basis of a "no-fault" liability. Under Sections 140 and 163-A of the MV Act, "use" of a motor vehicle resulting in the death or permanent disability of another person would be sufficient to grant a compensation claim against the owner of such a vehicle. These sections state that such liability would exist even if a wrongful act or negligence is not established on the part of the owner. While interpreting Section 140, courts have followed a liberal approach. In the case of **Shivaji Dayanu Patil & Anr vs Smt. Vatschala Uttam More,**[127] the Supreme Court has held that damage caused when a vehicle is stationary would be covered by the term, "use" and an owner of such a vehicle would also be liable. According to the court, even an accident which does not have a direct and immediate connection with the use of a motor vehicle would be covered under this section.[128] Owners of AVs could be held liable to pay compensation even if death or disability is caused purely due to defective functioning of the operating system of the vehicle.

II. Drone Laws (Flying Taxis)

As discussed above, the regime on civil use of drones was overhauled in August, 2021. The Drone Rules, 2021 (**"Drone Rules"**) have, for the first time in the history of the drone regime, significantly liberalized the manufacturing and operations of drones generally. Importantly, the Drone Rules have done away with the restrictions on foreign-owned and controlled Indian companies from manufacturing and operating drones. This has opened up the potential for foreign investments in the sector and will be hugely beneficial for the future of drone-based mobility.

The Drone Rules also do not contain any express restrictions on beyond visual line of sight operations or carriage of payload. Therefore, drone taxi operations have been enabled by these rules and are being actively encouraged by the Government of India. However, since the current regime requires obtaining of a "type certificate" before a type of drone can be operated, a passenger carrying drone would also likely require such a certificate, based on its "type". It is currently unclear as to what requirements a drone taxi will have to fulfil in order to be granted a type certificate. These aspects will be required to be clarified subsequently.

As far as operations are concerned, under the new Rules, the entire Indian airspace will be divided into three zones namely: "Green", "Yellow" and "Red". Unless, a zone has been specified as Red or Yellow, it will be treated as a Green zone. This is going to make permitted operations absolutely clear for all stakeholders. Importantly, operations in the Green zone do not require any specific permission except a self-verification by the remote pilot of the drone of the restrictions on the intended area of operations. Operations in the green zone would therefore only require a type certificate and registration of the drone, which will be one-time procedures. Therefore, the Government appears to have taken a pragmatic view which takes into account security concerns but does

125. Section 2-B of the Motor Vehicle Act, 1988, inserted vide the Motor Vehicles (Amendment) Act, 2019.

126. Supra note 13.

127. 1991 AIR 1769.

128. **Ibid.**

not contain prohibitive requirements either. Hence, once a type certificate and unique identification number (through registration) for a drone taxi has been obtained, the current Drone Rules do not contain any specific compliance requirements.[129]

III. The Consumer Protection Act

The Consumer Protection Act, 2019 (**"CPA, 2019"**), which replaced the Consumer Protection Act, 1986 (**"CPA, 1986"**) as of July 2020, captures India's consumer protection law. The CPA, 2019 is considerably more comprehensive than its predecessor and a revamp of the law had been much awaited, considering the numerous developments that have taken place over the three decades since the enactment of the CPA, 1986. Issues pertaining to negligence, manufacturing defects, design defects, failure to warn, misrepresentation, unfair trade practices, breach of warranty and strict liability will fall under the CPA 2019. The CPA 2019 may be triggered in various instances that have been discussed in this paper. A product liability claim under the CPA 2019 may be brought against either or all the parties in the supply chain including the product manufacturer, product service provider and/or the product seller, depending on the facts and circumstances of each case for claiming compensation for the harm caused.[130]

While the erstwhile CPA 1986 did provide consumers with the option of initiating action over defective products, the Indian subcontinent has hardly heard of any class action claims. A more specific product liability regime has now been introduced by way of the CPA, 2019. There are now specific provisions addressing product liability and delineates when the product manufacturer, product seller and product service provider would be held liable to pay compensation for any harm caused by a defective product manufactured by a product manufacturer, serviced by a product service provider or sold by a product seller.[131] In case of autonomous vehicles, where the technology provided in the product plays a central role in operation, any defect in the product may lead to a greater degree of harm to the public compared to most products in the market.[132]

Innovations like MaaS also introduce several issues on consumer protection which could be quite complicated to tackle using the existing provisions of the CPA 2019. Since MaaS includes several transport service providers operating over a single electronic platform, any deficiency in the services provided in relation to such a platform could lead to complaints being filed against multiple entities.

In case of novel services like P2P lending as well, the CPA 2019 is bound to raise interesting interpretational issues. Although it is settled law that service providers like Uber / Ola are covered under the CPA 2019,[133] P2P lending blurs the boundaries between users and consumers by allowing owners of private vehicles to register with aggregators for ride-sharing. In this context, default in service provided by such owners are likely to be viewed differently from the existing approach taken towards drivers directly employed by aggregators.

129. Our detailed analysis of the Drone Rules is available at: https://www.nishithdesai.com/NewsDetails/4815.

130. For a further discussion on product liability under the CPA, please see https://nishithdesai.com/fileadmin/user_upload/pdfs/NDA%20Hotline/FAQ-Consumer-Protection-Act-A4.pdf

131. Chapter VI, The Consumer Protection Act, 2019; S. 82, The Consumer Protection Act, 2019.

132. For a further discussion on the interplay of the CPA and self-driving cars, please see our paper available at http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research%20Papers/Preparing_For_a_Driverless_Future.pdf

133. Ravi Kumar v. Ola Cabs, CC/453/2018.

IV. Data Protection Laws

A. Personal Data

The Information Technology Act, 2000 (**"IT Act"**) and Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011 (**"IT Rules"**) primarily govern the privacy and data protection laws currently in force in India. Automobiles are expanding from being solely- hardware centric to being focused on software (as in the case of block-chain integrated vehicles, and autonomous vehicles as discussed above). In this light, the IT Act and IT Rules would see increased application in the mobility industry and may also require to be updated to adequately protect the rights of vehicle owners. Data protection is also likely to become key if MaaS becomes ubiquitous in the country, since such applications are likely to collect traveler data such as location, services required, etc. Such questions have already been raised in jurisdictions like the European Union (**"EU"**), where the use of AVs and associated data breaches are becoming increasingly common.[134] In fact, in January 2020, the EU adopted Guidelines 1/2020 on Processing Personal Data In The Context Of Connected Vehicles And Mobility Related Applications (**"EU Guidelines"**) which specifically govern the processing of data generated by smart cars and mobility related applications.[135] The data generated may impact several stakeholders in the connected mobility ecosystem, such as the drivers, OMEs, insurance companies, etc.[136] Being designed specifically to govern vehicle data, these guidelines also classify such data into broad buckets including (a) Data processed within the vehicle; (b) Data exchanged with the user's personal devices and (c) Data sent to external entities like insurers and OMEs who wish to further process the data. This distinction is likely to become especially relevant in light of newer technologies like edge computing, which entail greater volumes of data being processed on a real-time basis. These guidelines also mention that data related to the location, biometrics and fines and traffic-related offenses must be treated as especially sensitive. They mandate that consent must be obtained before storage or access of data stored on a person's equipment. In India as well, users have expressed concerns over data privacy in the context of connected vehicles.[137]

The data privacy regime in India is set for a watershed change in the background of the proposed Personal Data Protection Bill (**"PDP Bill"**).[138] Once enacted, this is likely to impact the mobility sector in the country in various ways, especially in the context of connected/autonomous cars which require large volumes of data to operate. It will be interesting to see the approach taken by the legislature and courts in addressing this interaction.

B. Non-Personal Data

In the near future, India is likely to regulate the collection and storage of non-personal data. The Ministry of Electronics and Information Technology has set up a committee to explore the governance of non-personal data in the country, and has set up a committee for this purpose. As per this committee's latest report, NPD has been understood to be any data that is not 'personal data', or data that lacks any personally identifiable information.[139] The report also

134. Mobility And The GDPR: An Important but Uneasy Partnership, available at https://www.automotive-iq.com/autonomous-drive/articles/mobility-and-the-gdpr-an-important-but-uneasy-partnership (last accessed 15th September 2021).

135. Guidelines on processing personal data in the context of connected vehicles and mobility related applications, 2020 available at https://edpb.europa.eu/sites/default/files/consultation/edpb_guidelines_202001_connectedvehicles.pdf (last accessed 15th September 2021).

136. How much can your car know about you? – EU guidelines on data protection and connected vehicles, available at https://www.jdsupra.com/legalnews/how-much-can-your-car-know-about-you-eu-7783549/ (last accessed 15th September 2021).

137. Nearly 70% Indians concerned about data privacy in connected vehicles, Deloitte says, available at https://www.thehindu.com/sci-tech/technology/nearly-70-indians-concerned-about-data-privacy-in-connected-vehicles-deloitte-says/article33116256.ece (last accessed 15th September 2021).

138. The provisions of the PDP Bill have been comprehensively examined in our paper available at http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/Privacy-and-Data-India_s-Turn-to-Bat-on-the-World-Stage.pdf

139. Report by the Committee of Experts on Non-Personal Data Governance Framework, available at https://static.mygov.in/rest/s3fs-public/mygov_160922880751553221.pdf (last accessed 15th September 2021).

recognizes the creation of high value data sets (**"HVDs"**), which are "datasets that are beneficial to the community at large and shared as a public good, subject to certain guidelines pertaining to the management of an HVD and data sharing."[140] Under this report, transport data has been recognised to be a potential HVD. The report also envisions the Directorate of Urban Land Transport becoming a data trustee of traffic data with data inputs from multiple ride-sharing platforms and the city police department. It recognises the role of such data sets in easing traffic congestion in crowded urban centres in the country. Thus, the proposed framework for regulating NPD is likely to impact the mobility sector in various ways, and it remains to be seen whether this interaction will be positive.

C. Map and Geo-Spatial Data

As discussed above, vehicles with a high degree of connectivity, particularly AVs, require precise and sophisticated data, including geospatial and map data for their operations. Recently, the Department of Science and Technology of the Government of India issued "Guidelines for acquiring and producing geospatial data and geospatial data services including Maps" for regulating geospatial data and map data in the country.[141] These guidelines provide that Indian entities are free to inter alia create, generate, digitise, store and publish all Geospatial Data of any spatial accuracy within the territory of India including territorial waters. Under these guidelines, foreign entities have been prohibited from creating or owning Geospatial Data/Maps of spatial accuracy/value finer than prescribed values. The guidelines also prohibit such entities from various other related activities like conducting "terrestrial mobile mapping survey", "street view survey" and surveying in Indian territorial waters, regardless of the accuracy.[142] These restrictions are likely to have a negative impact on foreign entities who wish to provide high accuracy geospatial/map data for use in autonomous vehicles.

V. Intellectual Property Laws

The various evolving forms of mobility have been accompanied by technological progress, resulting in the introduction of new inventions to the global market. The rights to such inventions are regulated by country-specific intellectual property (**"IP"**) laws, and will require corporations asserting such rights over new technology to introduce robust systems for protecting their creations. The IP protection regime in India consists of a catena of legislations including the Copyright Act, 1957, the Patents Act, 1970, Trade Marks Act, 1999, Designs Act, 2000, and the Semiconductor Integrated Circuits Layout Design Act, 2000.

When protecting their IP, manufacturers and other players in the mobility market must ensure that the appropriate form of IP in the invention is identified, and protection is accordingly pursued. An important example in this regard is the nature of IP protection granted to computer software. As discussed above, the introduction of increasingly connected modes of transport is likely to be a result of advancements in the underlying software used by original equipment manufacturers (**"OEMs"**). In India, computer software "per se" lacks protection under the Patents Act, 1970, and is instead governed by the Copyright Act, 1957. Under the Patents Act, 1970, typically an invention which combines a software and a hardware could be patentable.

Of the various forms of IP protection available to protect the underlying technology in AVs, hyperloops, UAVs and other mobility inventions, patents could play a key role. In the context of AVs especially, there are several forms of technology which are considered essential across the industry, and which require access by all industry players for further research and development of the technology. In relation to AI as well, global standards are emerging

140. **Ibid.**

141. Guidelines on Geospatial Data, 2021 Available at https://dst.gov.in/sites/default/files/Final%20Approved%20Guidelines%20on%20Geospatial%20Data.pdf (last accessed 15th September 2021).

142. We have discussed these guidelines further at https://www.nishithdesai.com/information/news-storage/news-details/article/maps-and-geospatial-data-in-india-regime-liberalized.html

which may require all OEMs and industry members to access to certain IP for compliance with interoperability requirements. However, if standardized technologies are patented then it will create obstacles for the development of these technologies, since parties who wish to enter these areas would be prevented by the threat of potential patent infringement claims. Thus, there is a need to identify the specific technologies which may be required to be used by industry players across the board, and declare them as standard essential patents (**"SEPs"**).

Once inventions are declared as SEPs, standard setting organisations can impose conditions that such SEPs must be licensed on fair, reasonable and non-discriminatory (**"FRAND"**) terms.

In addition to protecting the IP in inventions forming the foundation for the future of mobility, a question that also arises is the ownership of the user data and other data sets created during the use of the said mobility solutions. This is because in the world of automation, data sets are likely to be created based on use of services/ products of more than one player including equipment manufacturers, software developers, etc. This would result in the creation of multiple data sets overlapping with the services of varied OEMs. Basis this, the inter-se contractual arrangements with the users and OEMs / car manufacturers would be critical in determining data ownership along with the usage rights of the respective parties associated in the mobility ecosystem.

VI. Standard Form/E-Contracts

With the migration of the mobility sector into the virtual space, an important issue which is likely to be encountered is the validity and enforceability of contracts. This would be relevant particularly in the context of shared mobility, for services like MaaS, online ride-sharing and ride-hailing platforms, etc. Under the Indian Contract Act, 1872 (**"Indian Contract Act"**), a valid contract can be entered into only between parties competent to contract with their free consent, for lawful object and consideration along with a valid offer - acceptance. Under the Information Technology Act, 2000 (**"IT Act"**) as well, certain requirements have been prescribed for an online contract to be legally enforceable. Under the IT Act, both electronic and digital signatures are recognised, provided that they comply with the requirements prescribed under the Act.

Under the Indian Contract Act, where a contract is alleged to be unconscionable or is unreasonable and which affects a large number of people, there is a possibility that such contract or clause(s) in a contract could be adjudged void. The Supreme Court of India has also recognised the same in various judicial precedents. Service providers would need to ensure that standard form contracts do not contain clauses which may be considered "unreasonable", or "arbitrary", hence creating a possibility that they may be adjudged void. Another risk that standard form contracts may pose is that in case of ambiguity, courts are likely to apply the principle of **contra proferentum,** and favour the interpretation that is against the party who drafted the contract, being the service provider.[143]

The concept of unfair contracts has been specifically addressed under the CPA 2019 as well. It allows consumers to file complaints challenging contracts which are unfair, unilateral and unreasonable. The definition of unfair contracts under the CPA 2019 applies to all contracts between a manufacturer or trader or service provider on one hand, and a consumer on the other, having such terms which cause significant change in the rights of such consumer. The CPA 2019 considers all contracts as unfair, where they **"impose on the consumer any unreasonable charge, obligation or condition which puts such consumer to disadvantage"**[144].

Basis the above, it is recommended that the standard form contracts / click wraps are carefully drafted especially with a certain degree of reasonability which could assist when the same need to be enforced against a customer / user.

143. Bank of India v. K. Mohandas, (2009) 5 SCC 313.

144. Section 2(6)(i) of the Consumer Protection Act, 2019.

VII. Traffic Management Systems

A. Terrestrial

With the introduction of driverless cars, traditional traffic management systems are likely to become obsolete. With computers controlling cars, traffic management may also move to a more centralized system. It is believed that driverless cars will reduce traffic congestion. The European Commission has analysed the large scale deployment of connected and autonomous vehicles and the impact they could have on the larger traffic management, and has concluded that it could be beneficial for both **road** and **vehicle.**[145] It says that on the level of traffic managers, such increased use of newer modes of mobility will be likely to improve compliance with existing traffic regulations, while manufacturers will also expand more resources on ensuring that the technology used in such technologies complies with traffic laws. The future of traffic management has been envisioned to be unrestricted by borders, as "Cooperative Traffic Management Services".[146] The exchange of vehicle data between public and private stakeholders could also assume significance in this context, and the EC has made recommendations on ensuring the interoperability of such data.[147] It has also envisioned the integration of road classification done by urban planning authorities into the route mapping processors on AVs, thus optimising suggested routes to a destination to be in compliance with the existing traffic laws. This would also ensure smoother flows of traffic in various zones. Innovations in the traffic management space have also been made by private start-ups who seek to use AI and edge-computing capabilities to enable intersections to process traffic data generated by sensors and generate traffic signals in a more efficient manner.[148]

In India, the existing framework on traffic management and associated rules to be followed by drivers can be found in the MV Act and the Motor Vehicles (Driving) Regulations, 2017. Individual states also have independent regulations around traffic management, which are generally encapsulated in the Police Acts of such states. However, these regulations are drafted for traditional means of mobility and may be adequate for autonomy. Since India has been facing issues of congestion and inefficient traffic management which have increasingly become more severe, an overhaul of the existing frameworks on traffic management may be required to ensure that these problems are adequately addressed.

B. Aerial

Aviation technologies such as drones and other UAVs operate in Very Low Level airspaces (**"VLL"**) below 1000 feet above ground level, which are as yet not controlled by most regulators. In India, for instance, the Drone Rules have designated the Green zone up to a height of 120 metres or 400 feet in the airspace, (except for the areas near airports where the height is 60 metres / 200 feet only). No specific permissions are required for operations in the Green zone, except a type certificate and registration of the drone, which are one-time procedures. All airspace above the Green zone has been designated as the Yellow zone wherein permissions from the air traffic control authorities will be required in order to operate drones.

Traffic management in the context of UAVs would raise demands for a separate traffic management network distinct from existing air traffic control regulations in place for commercial flights. In furtherance of this goal, agencies like NASA have initiated projects for developing traffic management systems for such flying taxis,

145. Report on Cooperative Intelligent Transport Systems (C-ITS), available at https://ec.europa.eu/transport/sites/default/files/2017-09-c-its-platform-final-report.pdf (last accessed 15th September 2021).

146. **Ibid.**

147. **Ibid.**

148. Startup using AI to improve traffic management at intersections; edge computing, available at https://www.greencarcongress.com/2019/11/20191101-notraffic.html (last accessed 15th September 2021).

to prevent possible aerial crashes.[149] Airspace design is likely to assume importance in this context, with the requirement for routes and lanes becoming necessary to effectively manage the movement of UAVs. Aerial roads are also being developed in the UK.[150]

India's Ministry of Civil Aviation had acknowledged the need to develop a full fledged system for the traffic management of UAVs in the draft National Unmanned Aircraft System Traffic Management Policy (**"Draft UTM Policy"**)[151], back in November, 2020. This policy sought to introduce the concept of "UTM Service Providers", who would enable data sharing between UAVs and a centralized platform called "BlueSky", among other things.

However, the new Drone Rules now provide that the Central Government may publish a policy framework on the Unmanned Aircraft System Traffic Management System (**"UTM"**), by end of October 2021. The policy framework will be in conformity with the Drone Rules and will facilitate automated permissions. The policy will also include (i) the framework for developing corridors for safe and seamless transfer of goods by drones within and across zones; and (ii) the roles, powers and responsibilities of the State Governments and Union Territory Administrations. Therefore, the laws regarding traffic management of drone taxis will have to be evaluated based on the final policy that is released by the Government.

VIII. Tortious Principles

In several jurisdictions, the tortious liability for crash of a vehicle is imposed on the entity which was in "control" of the vehicle at the time of such an accident.[152] However, this has historically depended on an analysis of the entity who was capable of directing the movements of a vehicle before the accident.[153] In the context of vehicles which are fully automated, the traditional approach under tort law may not hold good. In fact, rather than controlling an autonomous vehicle, an individual in the driver's seat of such a vehicle has been compared to being merely a passenger in a bus, since he is aware of the destination and influencing the vehicle to stop at a desired location. However, similar to a passenger in a bus, the driver of an autonomous vehicle also should not have liability for damage cause by the vehicle, owing to a lack of control. Hence, it cannot be said that a duty of care can be imputed on an occupant of an autonomous vehicle, since they have little to no control over the decision making process of the AI system. However, adopting the "control" test to impute liability in such cases may mean that it is the machine itself which would be liable for a crash. However, since most jurisdictions have not recognised the legal personhood of machine so far, this result is also unlikely.

The most likely candidates for imposing tortious liability hence are the OEMs, who will also be developing their own software to operate autonomous vehicles. In several jurisdictions, including the USA, law suits have been filed against manufacturers of AVs for damages caused during the operation of such vehicles.[154] When OEMs are faced with the threat of liability for accidents cause by autonomous vehicles, they are likely to train machines in a broader fashion, so that ethical considerations may be included in the decision making process of such vehicles. However, it has been pointed out[155] that this may also have undesirable results, like the prioritizing of expensive

149. Here's What's Needed for Self-Flying Taxis and Delivery Drones to Really Take Off, available at https://www.scientificamerican.com/article/heres-whats-needed-for-self-flying-taxis-and-delivery-drones-to-really-take-off/ (last accessed 15th September 2021).

150. U.K. Flying-Taxi Hub Aims to Develop Blueprint for Aerial Roads, available at https://www.bloomberg.com/news/articles/2021-05-12/u-k-flying-taxi-hub-aims-to-develop-blueprint-for-aerial-roads (last accessed 15th September 2021).

151. The National Unmanned Aircraft System (UAS) Traffic Managemnet Policy, available at https://www.civilaviation.gov.in/sites/default/files/National-UTM-Policy-Discussion-Draft-30-Nov-2020-updated.pdf (last accessed 15th September 2021).

152. R v. Morton [1970], 12 CRNS 76 (BCPC)

153. Keri Grieman, Hard Drive Crash: An Examination of Liability for Self-Driving Vehicles, Vol. 9, Journal of Intellectual Property, Information Technology and E-Commerce Law (2019) available at https://www.jipitec.eu/issues/jipitec-9-3-2018/4806/#ftn.N1022A.

154. GM sued by motorcyclist in first lawsuit to involve autonomous vehicle, available at https://www.theguardian.com/technology/2018/jan/24/general-motors-sued-motorcyclist-first-lawsuit-involve-autonomous-vehicle (last accessed 15th September 2021).

155. **Supra** note 156.

property over human lives by automated algorithm to minimise risk to the OEM. As discussed briefly above, the problem of algorithmic bias, where decision making has been demonstrated to favour some individuals/property is an issue that AVs will continue to grapple.

Keeping this in mind, some jurisdictions have introduced legislations like the Automated and Electric Vehicles Act 2018 in the United Kingdom. This law directly imposes the liability for damage caused by an autonomous vehicles on **insurers.** However, this approach has also been criticised as bypassing the contractual route of insurer liability, and instead imposing such liability statutorily.

IX. Cyber Security

The integration of the internet and connectivity to the mobility ecosystem has several benefits, but it also creates new vulnerabilities in the context of cyber security. If left unaddressed, the significant risks to pedestrians, general public and infrastructure owing to their cybersecurity vulnerabilities.[156] This could include intentional attacks , such as evasion attacks that entail manipulation of data fed into processors of such vehicles which in turn enables output of the said vehicles to be modified as per the attacker's requirements. Hackers could also execute DDoS attacks, which would result in the distributed denial of service by the vehicles, and consequently lock them from the outside world. As noted above, the large amounts of sensitive data collected and processed is likely to make the said vehicles a prime target for attackers who wish to exploit these vulnerabilities to gain access to it. Insufficient cybersecurity frameworks could also lead to their theft by hackers. Malfunctioning could also be caused by altering physical stop/speed limit signs on roads, which would deceive the AI operating systems into misreading these signs.[157]

Currently, with the exception of a few market players, most OMEs assemble the electronic control units of AVs based on hardware sourced from various sellers.[158] This could be a major source of vulnerability for the operating system of AVs, leaving them open to cyberattacks and manipulation by hackers. The EC has noted that a major security measure that OMEs should undertake is to ensure that AV components cannot be accessed by unauthorised third parties.[159]

Cybersecurity in such vehicles could be significantly improved by integrating them with blockchain and cryptographic security.[160] Using blockchain based networks to send and receive information could ensure that unauthorised attackers are not able to enter the mainframe of the said vehicles to execute their attacks.[161]

In India, the IT Act is the primary legislation which governs cyber security issues in the country. Section 2(nb) of the IT Act defines cyber security as "protecting information, equipment, devices, computer, computer resource, communication device and information stored therein from unauthorised access, use, disclosure, disruption, modification or destruction." Considering this wide definition, any cyber security incidents in relation to the mobility industry such as theft of car data, unauthorised control of an AV, etc. are likely to be punishable

156. EU Agency for Cybersecurity Says Autonomous Vehicles Highly Vulnerable to Various Cybersecurity Challenges, available at https://www.cpomagazine.com/cyber-security/eu-agency-for-cybersecurity-says-autonomous-vehicles-highly-vulnerable-to-various-cybersecurity-challenges/ (last accessed 15th September 2021).

157. **Ibid.**

158. Tesla teardown finds electronics 6 years ahead of Toyota and VW, available at https://asia.nikkei.com/Spotlight/Most-read-in-2020/Tesla-tear-down-finds-electronics-6-years-ahead-of-Toyota-and-VW (last accessed 15th September 2021).

159. Cybersecurity challenges in the uptake of artificial intelligence in autonomous driving, Report by the European Union Agency for Cybersecurity and the Joint Research Centre (2021) available at https://www.enisa.europa.eu/publications/enisa-jrc-cybersecurity-challenges-in-the-uptake-of-artificial-intelligence-in-autonomous-driving/ (last accessed 15th September 2021).

160. Autonomous Car Network Security Platform based on Blockchain, available at https://cryptorating.eu/whitepapers/CUBE/CUBEWhite_Paper-V1.3.pdf (last accessed 15th September 2021).

161. Saltanat Narbayeva et al., Blockchain Technology on the Way of Autonomous Vehicles Development, Vol.44, Transportation Research Procedia (2020).

under the IT Act. The IT Act has also introduced a well-developed system for tackling such incidents, with the establishment of the Indian Computer Emergency Response Team under Section 70B.[162]

X. Tax Implications

Developments in technology, internet, cloud computing and IoT have given rise to various tax issues globally. In the Indian context, global enterprises catering to Indian customers have faced difficulties with Indian tax authorities taxing e-commerce and internet-based business models in a manner that conflict with international approaches. There has been significant litigation in this respect, especially in relation to characterization of income and withholding taxes. Therefore, it becomes important to carefully structure mobility-based business models so as to mitigate tax risks.

A. Direct Tax Implications

Taxation of income in India is governed by the provisions of the Income Tax Act, 1961 (**"ITA"**). Under the ITA, residents are subject to tax in India on their worldwide income, whereas non-residents are taxed only on income sourced in India. However, non-residents, who are resident of a country with which India has signed a tax treaty, have the option of being taxed as per the tax treaty or the ITA whichever is more beneficial.

The corporate tax rate[163] in India is 30% (on fulfillment of certain conditions, the rate can be reduced to 22% /25% and 15% for manufacturing companies) for resident companies and 40% for non-resident companies (to the extent of income sourced in India). Further, subject to tax treaty relief, withholding tax of 10% (on a gross basis) is applicable in case of royalties and fees for technical services (**"FTS"**) paid to non-residents. In case of failure to withhold, the payer could be liable for the principal tax amount, interest (at 12% per annum) and penalty (up to 100% of the principal tax amount). Further, the payer could face the risk of not being allowed to claim expense deduction (for the royalty / FTS payment) while computing its taxable profits.

The use of IoT-based business models for providing connected mobility defined in chapter 2 could lead to two key issues: a) Characterization of income i.e. whether income earned is royalty, FTS or business income, and b) Risk of permanent establishment (**"PE"**) exposure on account of presence of any server / other electronic terminal in India, hosting of websites or other technical equipment, etc.[164]

From the government's perspective, the use of driverless cars defined in chapter 3 would run the risk of cutting down government revenues, which have traditionally capitalized on human errors, through collections from towing fees, speeding tickets etc.[165] Autonomous vehicles have the potential to eradicate such issues emanating from human flaws. While existing tax incentives are provided to Research and Development activities undertaken by companies, with most of the expenditure in this regard being allowed to be written off and further incentives being conditional on the approval of concerned authorities in the sector.[166] The government may try and realize this lost revenue through other taxes or duties specific to autonomous vehicles. However, for the promotion of these technologies and their timely advancement, tax benefits ought to be provided to incentivize start-ups in these sectors.

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162. For a further discussion on the role and powers of the Cert-In, see our article available at https://www.natlawreview.com/article/reporting-cybersecurity-breaches-india-it-time-to-overhaul-law

163. All tax rates mentioned in this paper are exclusive of surcharge and cess.

164. These concepts and issues relating to IoT have been discussed in detail in our paper, Internet of Things, Legal & Tax Issues https://www.nishith-desai.com/fileadmin/user_upload/pdfs/Research%20Papers/Internet_of_Things.pdf

165. Autonomous vehicles will have tremendous impacts on government revenue, available at https://www.brookings.edu/blog/techtank/2015/07/07/autonomous-vehicles-will-have-tremendous-impacts-on-government-revenue/ (last accessed 15th September 2021).

166. Available at http://www.ey.com/Publication/vwLUAssets/EYtax-incen-tives-in-india/$FILE/EY-tax-incentives-in-india.pdf

Further, as observed in Chapter 1, MaaS and shared mobility could offer a cheaper alternate to private vehicle ownership, and may contribute to preservation of fuels and resources and also be beneficial to the environment overall by decreasing issues like traffic congestion. Considering these positive effects of shared mobility, and the its commitment to easing the entry barriers to shared mobility, it can be expected that the government may consider introducing a various tax benefits like tax holidays, subsidies, deductions, etc., similar to electric vehicles recently for their contribution to a better environment.[167]

B. Indirect Tax Implications: Goods and Service Tax

GST, effective in India since July 1, 2017, has comprehensively replaced the erstwhile indirect tax regime. India has a dual GST system with both the Central Government and the State Governments (and Union Territories) levying separate but concurrent taxes on supply of goods and services. The legislative framework of GST primarily comprises the Central Goods and Services Act, 2017 (**"CGST Act"**) and the Integrated GST Act, 2017 (**"IGST Act"**) enacted by the Parliament and State GST Acts (**"SGST Acts"**) enacted by legislature of each state.

Section 7 the CGST Act provides the scope of supply to include inter-alia all forms of supply of goods or services or both made or agreed to be made for a consideration by a person in the course or furtherance of business. GST is payable as per the fixed slab rates defined by the government.

Based on a report endorsed by NITI Aayog based on shared mobility, various platforms like Bounce and Vogo have petitioned to Central and State government to re-evaluate the GST slab rates for urban commute, seeking a slab of zero percent GST or taxed under the 5 percent GST slab on par with cab aggregators.[168] It is likely that the government may take these suggestions into account, considering its recent move of reducing the GST on electric vehicles from 12 per cent to 5 per cent.[169] Further, the government could also consider providing various other tax benefits in the form of road tax exemption, better credit mechanisms, etc. The Tamil Nadu Government recently have also provided a 100% road tax exemption to Electric Vehicles, and such moves can be expected for shared mobility in the future.

C. Digital Tax Implications

- Equalisation Levy

Equalisation levy (**"EL"**) was introduced in India with effect from June 1, 2016 (**"EL 2016"**) under Chapter VIII of the Finance Act, 2016 (**"FA, 2016"**), as a separate, self-contained code, not forming part of the ITA, and was levied at rate of 6% on the amount of gross consideration received by non-residents for online advertisement and related services provided to i) a person resident in India and carrying on business or profession; or ii) an NR having a PE in India.[170] The Finance Act, 2020 (**"FA, 2020"**) expanded the scope of EL to apply EL at rate of 2 percent (**"EL 2020"**) on the amount of consideration received or receivable by 'e-commerce operators' from 'e-commerce supply or services' made or provided or facilitated by it to:

a. person resident in India; or

b. a non-resident under specified circumstances; or

c. a person who buys such goods or services or both using an internet protocol (**"IP"**) address located in India.[171]

167. Section 80EEB of the Income-Tax Act, 1961, provides for deduction in respect of purchase of electric vehicle.

168. India: Govt urged to lower GST slab for self-driven shared mobility, available at https://www.telematicswire.net/india-govt-urged-to-lower-gst-slab-for-self-driven-shared-mobility/ (last accessed 15th September 2021).

169. GST rate on all Electric Vehicles, available at https://pib.gov.in/newsite/PrintRelease.aspx?relid=192337 (last accessed 15th September 2021).

170. Section 165(1) of Finance Act, 2016.

171. Section 165A(1) of Finance Act, 2016.

Further, the term **'e-commerce operators'** has been defined to mean an NR who owns, operates or manages digital or electronic facility or platform for online sale of goods or online provision of services or both. The term 'e-commerce supply or services' is defined to mean i) online sale of goods owned by the e-commerce operator; ii) online provision of services provided by the e-commerce operator; iii) online sale of goods or provision of services or both, facilitated by the e-commerce operator; or iv) any combination of the above

It is likely that a non-resident MaaS platform would qualify as an e-commerce operator, and the supply of such services to the residents in India would qualify as e-commerce supply or services, with EL chargeable at the rate of 2%. Further, another key area of possible taxation is when software services in the form of updates, purchase of licensed software, continuous data streams, geospatial services and data management services, offered by service providers outside India to users of driverless cars within India. Such services would be paid for at intervals by either the user or the manufacturer of the car. Under the current tax regime, these services could be made subject to a 6% equalization levy, which will have to be withheld by the resident availing the service. In addition, GST may be applicable on such payments over and above the equalization levy payable.

- OIDAR Services

Business to Consumer (**"B2C"**) services by offshore service providers are exempt unless they qualify as online information and database access or retrieval services (**"OIDAR"**) services.[172] The IGST Act defines OIDAR services as services whose delivery is mediated by information technology (**"IT"**) and the nature of which renders their supply essentially "automated" and "involving minimal human intervention" and "impossible to ensure in the absence of information technology". Service which qualifies as OIDAR should be taxable as per the rate provided in the Services Schedule. These services should be taxable at 18% i.e. the residuary rate provided under the Services Schedule. In case where the services do not qualify as OIDAR, such services being a B2C import should not be taxable as such supplies are exempt.

As seen above in case of MaaS, shared mobility and collective mobility, these platforms involve the use of advanced technology, which render the supply of these services as automated and involving minimizing human intervention, thereby bringing them in the ambit of OIDAR services, being taxable at the rate of 18%.

172. OIDAR as a category has been created primarily for the purpose of determining place of supply of cross-border digital services and to provide for distinct registration requirements for suppliers of these services. It is not a separate category for determining rates.

6. Conclusion

Legend has it that Henry Ford, who introduced the concept of assembly-line cars, altering the face of the mobility industry, once said, "If I had asked people what they wanted, they would have said faster horses." Whether this is fact or fiction, there is no denying that disruption in any sector is almost always unpredictable, and may seem futuristic to the untrained eye. At present, no other industry makes this fact more evident than the mobility industry, which is posed to undergo a complete transformation in the near future. Transportation has evolved from being merely the movement of people or goods, and now encompasses a range of services and technologies which would have seemed utterly impossible even so little as ten years ago.

Currently, transportation in urban centres globally is faced with a host of problems, including those of pollution, congestion and inefficiency. The various advancements in shared mobility are specifically targeted at easing these issues while creating more economic opportunities. In combination with connected mobility solutions and autonomous vehicles, the existing problems are likely to see a fast-paced resolution. However, this does not mean that the road ahead for new mobility will be free of hurdles. Aside from the perceptional and regulatory issues created by an unprepared consumer base and legal system, such innovations are also likely to raise ethical questions on the data privacy of drivers and algorithm-driven decisions. Another major challenge which may be faced during the transition from traditional models of mobility is the lack of technical knowledge. The newer solutions in the mobility industry will raise demands for employment in IT and related sectors, and is likely to eclipse the existing roles, especially in the more informal transportation methods used locally. While adopting "new" mobility, policymakers and private players would need to consider integrating the workforce engaged in traditional sectors, including introducing programs to upskill this section to suit the evolving needs of the industry.

The mobility sector is presently advancing at a breakneck speed, and new innovations and solutions are constantly being developed with several more in the pipeline. The benefit of such progress can be reaped by the society at large, due to the wide-ranging impact on the environment and utilisation of resources facilitated by these newer modes of mobility. However, the law should not lag behind such advancements, since it may pose regulatory and litigation risks to industry participants who wish to improve the existing mobility system. Issues like those of data security, product liability, and intellectual property in particular are of significance to the mobility industry, and there is need for reforms to the existing regulatory framework so that the legal system does not act as a bottleneck which restricts the progress of the industry.

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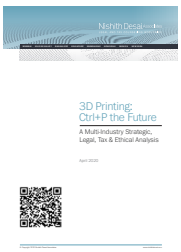

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