



# Next Generation Cities

Energy, mobility ... technical parts that will realize the smart cities have gradually become clearer. However, can you imagine the lifestyle concretely in future city you will live in? We examined the next generation cities from the viewpoint of the consumers.

## Introduction

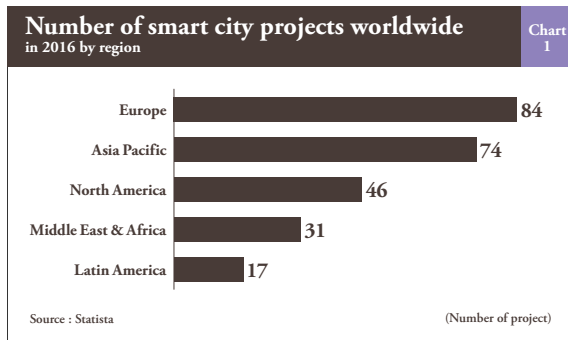
Disruptive technologies like autonomous cars, drones, 3D printing, smart sensors, augmented reality, virtual reality etc. are disrupting every industry, in such a disruptive world, how the future cities and living will look like?

## Urbanization

By 2050 the world population will double from current levels with two thirds living in

cities. Cities will contribute around 80% of the world GDP almost double of current levels. Most of the new cities will be created in Asia. By 2025, 7 out of top 10 largest cities will be from Asia. Cities especially in Asia are going to play a major role in future world economy. By 2020 worldwide spending on smart cities will be around USD 35 billion. Currently most of the smart cities projects are concentrated on mobility, infrastructure and energy.

Europe and Asia Pacific are front runners in smart city projects.



The biggest project is being built in Saudi Arabia. Saudi Arabia is planning to build the transnational future smart city called Neom from ground up with an investment of USD 500 billion in next 5+ years. Neom is an amalgamation of the word “Neo” – Latin for “New” – and the first letter “m” of the word “Mustaqbal” - Arabic for “Future”. The planned megacity is alternatively known as "Nowesa" means "north west Saudi Arabia" (Nowesa) in reference to the planned city's location. The ambitious 26,500 km<sup>2</sup> city is going to link Saudi Arabia, Egypt and Jordan. Saudi Arabia wants to make the city the future hub for both industry and citizens in the middle-east by using digital technologies and services. The city is going to be self-governing with its own tax and labor laws and judicial system. Robots will be used for security, logistics, home delivery, and caregiving. Neom will be 100% powered by wind and solar power. The first phase of the project is scheduled for completion by 2025.

In this article we would like to discuss how the technologies going to reshape the future transportation and living in cities.

## Future mobility

As per United Nations, public transportation in many cities remains unsustainable, unsafe, inefficient and inaccessible. Even though we have unlimited space in sky and underground, most of the mobility is land based which is getting scarce day by day. Transportation sector is responsible for nearly a quarter of energy-related greenhouse gas emissions and still

increasing. As per world health organization, more than 1.25 million people die each year as a result of road traffic crashes. The reasons for most of the accidents are human error.

To make the mobility sustainable, safer, efficient and accessible, it is vital to create alternate mobility models which will use resources efficiently, reduce accidents, stress free, environment friendly and overall provide a better quality of life. The future alternate mobility models will be driven by more connected, autonomous, sharing, electric, MaaS (Mobility as a Service) and sky.

Chart 2 gives the graphical representation of future mobility. Public prefer “Mobility as a Service” over owning a car. The rides are shared with others. The cars will be electric, autonomous and both land and air based. The mobility journey starts by placing the mobility request through smart speakers. In MaaS business model, car OEMs will become more as a mobility service providers rather than selling cars. So it is necessary for car OEMs to register with the smart speaker companies to sell their services. Similar to google ads, car OEMs compete for voice space in smart speakers. Autonomous driving creates lot of free time. Companies will try to sell in-car ecommerce, entertainment services etc to passengers. OEMs compensate the loss in car sales revenue by selling in-car entertainment services. It needs to be seen if OEMs can successfully transform to MaaS business model.

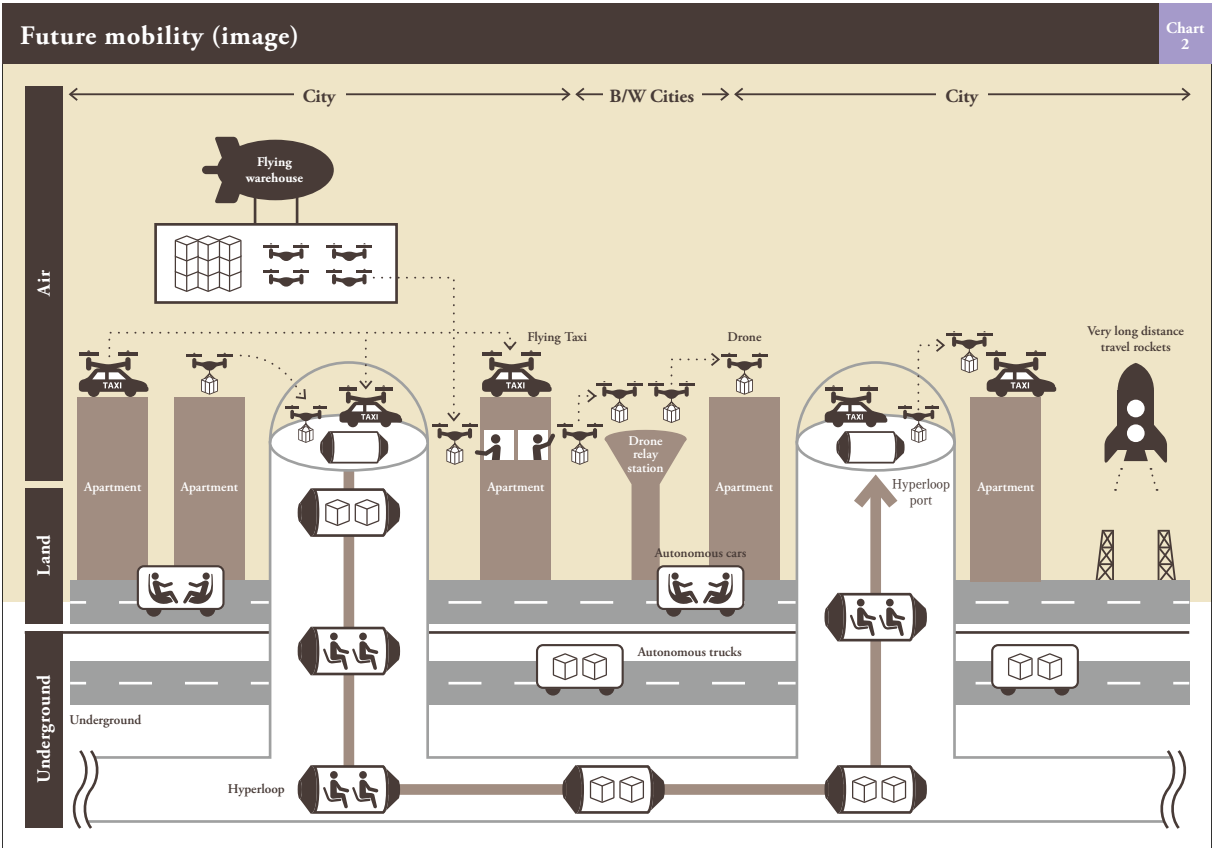
Air based Autonomous Electric Vehicles (AAEV), also known by other names like eVTOL (Electric Vertical Take Off and Landing), air taxis, flying drones etc will be popular. In terms of travel time, AAEV have advantage over land based av. As per uber, AAEV can reduce the travel time between San Francisco and San Jose to 15min. Currently with Uberx(car based service provide by Uber) it takes around 1 hour 40minutes. So overall there is a reduction of 85% of travel time. Uber is planning to start ride hailing services using Vertical TakeOff and Landing (VTOL) aircraft

by 2023. However AAEV cannot travel longer distances due to low battery energy storage density, most probably there will be a network of ports where the batteries are swapped.

For goods transportation, the major modes will be through autonomous cars and flying drones. Autonomous cars deliver goods using underground tunnels rather than land based. Existing tunnels will get freed once public move away from subways to on-ground/flying cars. In addition to land based autonomous cars, flying drones will be used to ship goods to customers. Overall this will create a lot of free space on ground which can be used for human instead of cars like parks, housing etc. There will be a network of drone stations for relaying the deliveries and people, drone parking, battery recharging and replacing. The drone stations will be run most of the time by renewable energy. For faster deliveries most probably small size inventories will be stored in flying warehouses and delivered via drones. Some companies like Amazon have

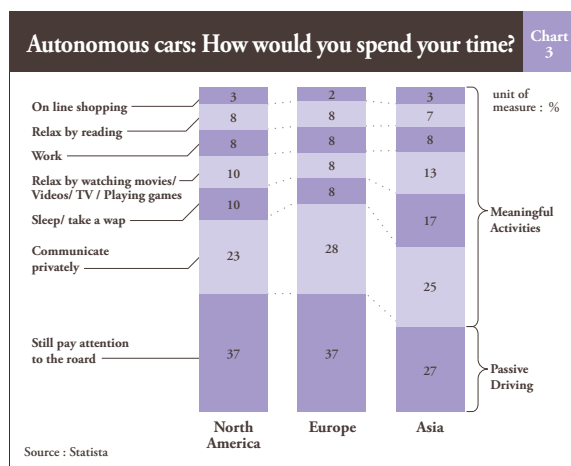
already patented flying warehouse concept.

For long distance mobility, the major mode of transportation will be Hyperloop and high speed rockets etc. Hyperloop will be used for both people mobility and goods transportation. Hyperloop is a sealed system of tubes through which a pod travels with no or minor friction transporting people or goods at high speeds. Currently Hyperloop concept is in research stage. Some startups researching in this area are The Boring Company, Virgin Hyperloop One, Hyperloop Transportation Technologies etc. However experts say Hyperloop may not be possible for very long distances with difficult terrain due to safety and high costs. High speed rockets will be used for very long distance people mobility. As per Elon Mask, rockets have the potential to carry passengers to anywhere on earth in under an hour with the same price as an economy airline ticket. For places where Hyperloop is not available, autonomous trucks will be used for long distance goods transportation.



Overall there are many benefits by using new modes of transportation. Like human lives can be saved by avoiding the traffic accidents using the predictive and avoidance functions of on board AI engine in the autonomous cars. More free time is created for commuters as the congestion and commuting time are reduced by ride sharing. Cities will be less polluted by transitioning to electric vehicles. Last mile problem will be solved as autonomous vehicles come all the way to home.

Mass deployment of new modes of transportation will most probably start from Asia. Around 75% Asians are more accepting to autonomous cars compared to 63% in North America and Europe. One of the reason might be Asian customers spend more time in traffic which can be used for something meaningful. By going autonomous, Asian customers can use the time for communication, more sleep, entertainment, work etc. On the other hand customers in North America and Europe still want to pay attention to the road even though they are in autonomous cars. So it can be said the demand for autonomous cars is high in Asia.



## Challenges

According to Joachim, a senior scientist and project manager for "next generation train development" at German Aerospace Center, "Most of the very futuristic solutions being advertised now are not finished as a holistic

systems approach. Quadrocopter are noisy which cannot be used in cities. Air traffic control is facing challenges to control the small number existing small quadrocopter. Also the Hyperloop doesn't answer the rescue plan during emergency struck in the vacuum pipes?"

In addition to battery, noise and security the major challenges for new modes of transportation will be;

### Infrastructure :

Although flying cars may not need roads but need infrastructure like charging stations, landing/takeoff places, parking, IT system, emergency backups etc. Currently such infrastructure doesn't exist. Most companies in this area are at concept/design stage. So it will take some more years to build the infrastructure. While designing the infrastructure it is important to consider factors like easy public access, adhere to noise and safety requirements etc.

To manage the autonomous vehicles, 5G infrastructure will be necessity. As per experts, to monitor and take control of autonomous vehicles remotely for disaster prevention requires a latency of 20 milli seconds which is possible only by 5G.

### IT Applications :

Without digital infrastructure like 3D (3 Dimensional) traffic management system, flying cars in skies will create lot of problems to public like hitting airplanes, hit buildings, falling from skies etc. As per an expert from 2getthere, a company which is developing autonomous vehicle systems for smart cities form last 25 years, "people become crazy if commercial companies will be flying drones everywhere, with uncontrollable traffic". There are not many startups in traffic management. One of the reason is everyone think it is government responsibility to sort out traffic management issues. Some emerging players in this area are AIRMAP, Skyward.io, KITTY HAWK, Unify etc. The platform of unify is helping in creating safer skies by connecting authorities with pilots to safely integrate drones into the airspace. Authorities can visualize and approve drone flights and manage no-fly zones in real-time. Drone pilots can manage their drones and they can plan and receive flight approvals in line with international and local regulation.

## Safety regulations and security :

Above infrastructure challenges can be sorted out in near future. But for autonomous vehicles and drones to succeed, public safety is very important. So it is necessary to create a regulatory organization to create and enforce the safety regulations.

Even if regulations are in place, public may not be ready to use autonomous vehicles. So most probably in the initial stages autonomous vehicles will be monitored remotely by expert drivers and during emergency the expert drivers will take control of the vehicle. Accordingly to Huawei Australia CTO, autonomous vehicles will be initially tele operated like someone in China driving a car in Australia remotely. Once people are assured of safety then there is no need to have remote monitoring unless during emergency.

According to Kathy Nothstine from Flyinghigh which is involved in shaping the future of drones in UK cities, testbeds at a small community level should be setup to resolve the technical challenges. Once those technical issues are resolved, the solution can be scaled to large cities. To scale to large cities investment should be made in critical areas like landing, parking, charging etc. The regulations should be evolved in step by step manner without hindering innovations. In each step it is necessary to involve multiple stakeholders like eVTOLs, city governments, public innovators, MaaS firms, regulators, consultancies, research institutions, autonomy providers, ATM service providers, infrastructure, battery manufacturers etc.

## Future living (housing, shopping)

Some of the major drivers of future living will be

- A. 3D printing
- B. Smart AI sensors(speakers, cameras, ...) and AI
- C. Zero emissions Technology

## A. 3D printing

Similar to home appliances, most homes in future will have 3D printer to print basic household items and replacement parts. For example, basic household kitchen utensils, replacement parts like car parts, plumbing etc and also food can be 3D printed multiple times just by downloading the design from the company website which owns the product design. Currently the worldwide end user spending on 3D printer is around USD 13 billion which is 8 times of 2015 market size. The spending is expected to accelerate further in future.

In 3D printing world, product manufacturers make more money from design file downloads rather than selling the products. For product manufacturers, wholesalers, retailers etc., transitioning to design download business model will save lot of costs like onsite visits, shipping, inventory storage etc. In addition to consumers, retailers will use 3D printers to print products either in the store or warehouse once they receive the order. This will reduce the inventory costs.

The major impact of 3D printing will be on developing countries. Once consumers start printing locally using 3D printing, outsourcing to low cost countries will decrease for such products.

There is also a negative impact due to 3D printing like printing of firearms. Nowadays it is possible to 3D print weapons by downloading the designs available for free in internet. It is necessary to strictly control the 3D designs by creating and strictly enforcing regulations.

## B. Smart AI sensors

Smart devices popularity is increasing day by day. In USA, around 26% of the households own at least one smart home devices and it is growing fast. Below graph shows the shipments of connected smart devices in USA. Smart Fitness trackers and smart speakers are in top 1 and 2. As you can see the growth of smart fitness trackers and speaker's shipments



more than doubled in last 4 years. Smart devices are used in areas like security, home automation, security, energy management, healthcare, medical, fitness monitoring etc.

As per Erik Overbeeke from Park Associates in Connected World Summit 2018, AI, machine learning and data analytics will transform the connected home experience to become more personal, proactive and predictive. According to him the leading use cases for AI are;

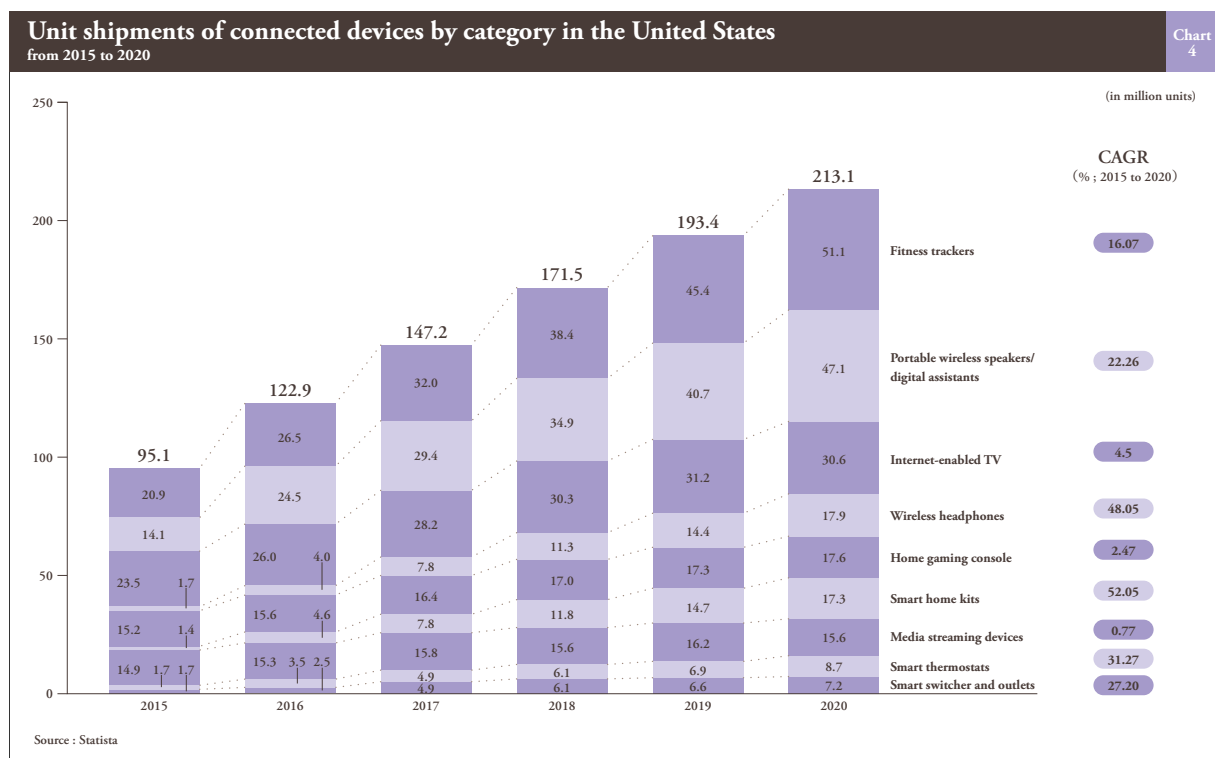
- Voice for convenient user interface to interact with smart devices
- Video/audio analytics for security, safety, personalized experiences, contextual information, reduction of false alerts
- Machine learning for predicting, personalized automation recommendations
- Anomaly detection
- Disaggregation of energy and water usage for improving transparency and recommendation of better solutions
- Connected health monitoring

- Smart device monitoring
- Predictive malfunction and maintenance

The global smart sensor market will be around USD 57 billion by 2022. Due to large benefits the IoT connected devices installed base worldwide going to triple by 2024 from current levels.

### C. Zero emissions home

Future home will be almost energy independent generating energy in-house. This can be achieved through renewable energy, storage and energy efficiency by using technology. As per comfortID founder, there is already technology to build energy independent house but unfortunately people are not yet ready to change their house to become energy independent due to reasons like costs for conversion. By matching the unused energy supply and unsatisfied demand between the commercial and households, emissions can be reduced to a large extent. For example industrial heat waste can be used in household during winter. Houses can be thermal independent by using the land



temperature. Surface level temperature of soil can be enough to cool a house in the height of summer and heat that house with the same efficient installation, when engineered well.

Some interesting disruptive startups in this area are Seab Energy and Polysolar. Seab Energy from UK is trying to generate decentralized solutions to convert home waste to energy at home itself rather than exporting to a centralized generation facilities. Polysolar UK is a leader in transparent PV glass. Using their technology all the city buildings glasses can be replaced with transparent PV glass. By using the transparent PV glass natural lighting is quite enough to lighten the interior. The generated solar energy will be quite enough to power the whole building in near future

## Consumer journey in future cities

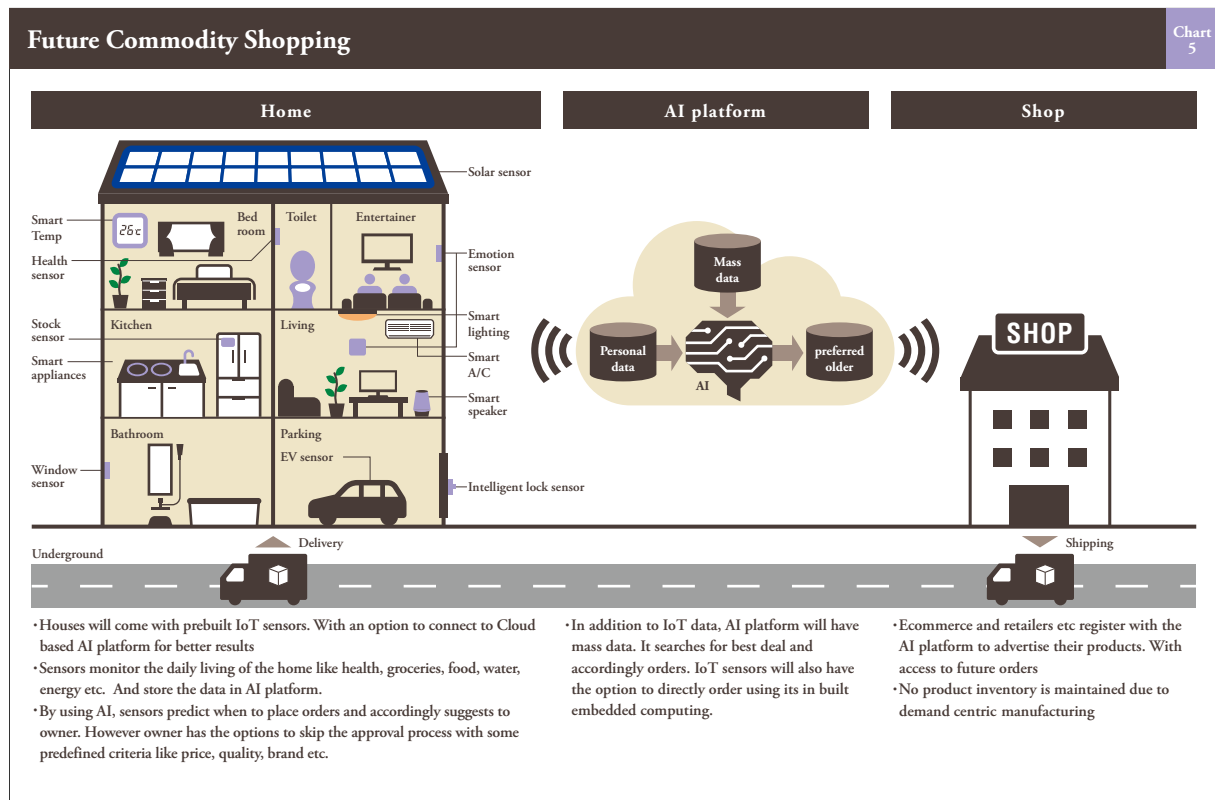
In below section we will discuss 3 consumer journey scenarios in future cities.

### 1. Shopping (commodity)

Smart sensors in home store the personal data in cloud. Users inform the smart speakers to automate the reorder process with criteria like price, brand, quantity etc. The AI in cloud will predict the next order based on various factors such as consumption, expiry, reorder date etc and accordingly searches various ecommerce sites to get the best deal. User is able to save a lot of money and time. The ordered products are delivered via autonomous vehicles. Due to predictive analytics, Ecommerce and retailers will be happy with fewer inventories.

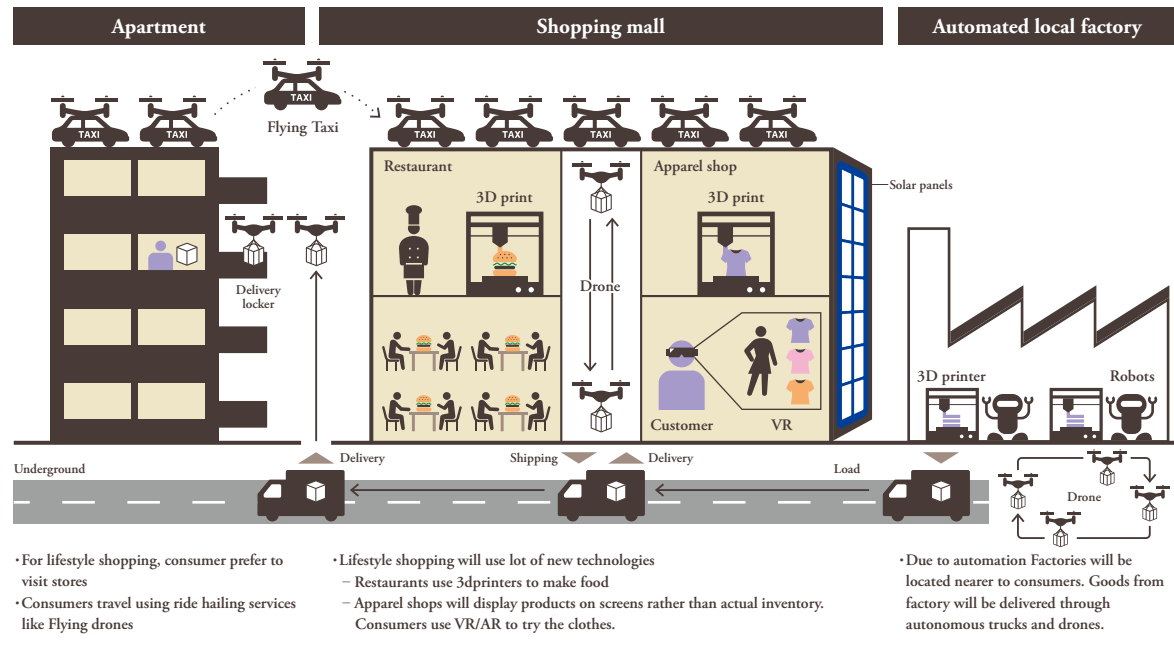
### 2. Shopping (lifestyle)

In future lifestyle shopping scenarios, apartment residents place an order for a flying taxi using smart speakers and board them from apartment rooftops. Flying taxis land on top of shopping mall. Customers order food in fast food restaurant which is 3D printed and served in minutes. Customers visit apparel stores with products displayed on screens rather than actual product. Customers use VR/AR to try the clothes and order. Simple designs are 3D printed in the stores. However



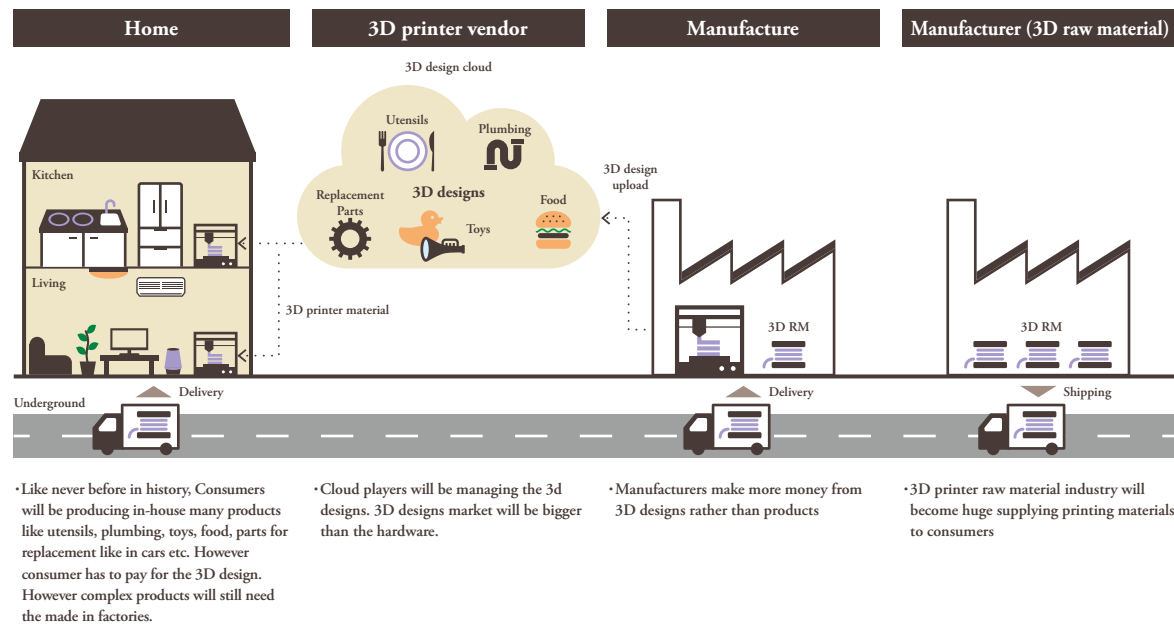
## Future lifestyle shopping

Chart 6



## Future maintenance and repair

Chart 7



complex designs are 3D printed in factories. Due to automation small factories will be located nearer to consumers. Goods from factory will be delivered through autonomous vehicles.

### 3. Maintenance & repair

Consumers have in-house 3D printers and raw material. Consumers buy 3D print designs online. Some 3D print products are utensils, plumbing parts, toys, food, parts for replacement like in



cars etc. Cloud players will be managing the 3D designs data. Manufacturers make more money from 3D designs download rather than products

## Implications

The drastic changes in future transportation and living will impact various industries. In this section, we will discuss the impact on different industries and governments and action to be taken.

### Regulations to accommodate new technologies

The success of new modes of transportation depends on active role of government. Most countries are slow in catching up the technology innovations and accordingly creating and enforcing regulations. Without a regulation roadmap, private players will not be eager to enter the market especially projects with huge investments. Singapore is quite active in drafting autonomous driving regulations. Singapore LTA (Land and Transport Authority) a government organization, in collaboration with NTU (Nanyang Technological University), Singapore has created a dedicated 2 hectare town to test the autonomous vehicles and create an AV database. Using the database it is planning to draft autonomous vehicle regulations in future. Government can use the database to monitor EV readiness for public roads. For example the EVs didn't perform well during rain. So EV can be deployed in places where there is no rain like tunnels etc.

### Efficient public transportation

In addition to regulations, government should improve the public transportation especially to resolve the last mile problem. Efficient public transportation will reduce the number of private vehicles in cities. Singapore where land is very scarce, reducing the number of private vehicles is very important. Dennis Mica from 2getthere which develops autonomous vehicle systems for smart cities says "if a city or region truly wants to benefit from self-driving technology, it should aim for smart public transport first. Self-driving sustainable public transit is ready to be implemented today and truly reduces the number

of vehicle movements and parking needs, offering an alternative to the private (self-driving) car."

Dennis also says "people using more private autonomous cars will create more problems rather than reducing the traffic jams. The solution is sharing the ride like public transportation."

### Impact on industry

Autonomous cars and smart homes will have impact on various industries like OEM, insurance, housing, construction etc.

In the automotive industry, currently there are two different types of companies aiming the market. Traditional OEM players will try to sell as many cars as possible by focusing on autonomous private car. Technology companies on the other hand try to sell the cheaper rides through shared shuttle service in cities, airports etc. According to 2getthere expert, the goal of automotive industry should be to create less vehicle movements. To sustain in the business, OEM makers have to transform their business model to MaaS. Otherwise they may end up as suppliers to ride hailing technology companies.

As per experts, 90% of the car accidents happen due to human error. By removing humans from driver seat through autonomous driving the number of accidents will be reduced to a large extent. A safer travel means less demand for car insurance. So most probably the cost of insurance will fall. Also in autonomous world the owners of the autonomous cars will not be individuals but companies like OEMs, ride hailing etc. Due to multiple stakeholders in this new business model, it will be difficult to decide liability when an accident occurs for example should the liability fall on OEMs, software companies, ride hailing service providers or insurance companies etc. Autonomous vehicles will be rich in data. Most probably the collected data can be used to decide the liability.

In future there will be huge demand for houses/apartments with inbuilt smart devices, pickup/drop-off/charging infra for autonomous vehicle mobility, renewable energy generation/circulation for energy independence etc.

IT Companies like Google, Amazon, and Apple are trying to enter the home with smart home solutions.



However, those companies are not providing complete solutions. Currently consumers have to integrate the AI speakers with various devices. To provide complete solution, it is necessary for IT players to tie up with players in the housing industry. A house with pre-built IoT devices according to best practices can provide better living. Recently Miami-based Lennar corp., the largest builder of houses in the USA, made a tie-up with Amazon for automating the houses using IoT and Amazon AI speaker Alexa. Their goal is to attract home buyers by using technology in home.

Home designers and builders should consider autonomous vehicle infrastructure in their designs like how the autonomous vehicle will be parked, charged, passengers are picked and dropped etc. Also how the drones deliver parcels like whether drones deliver to each individual household or place the parcel at a common space and inform the customers through smart speakers etc. For better planning, designers and builders should tie up with ride hailing companies.

## Conclusion

It may look like the future smart cities and smart homes are a fiction. But we believe it can happen sometime soon. Because most of the technologies are already there. Autonomous vehicles are already being used in Airports and in some cities. Drones are already being used in defence industry and test beds. Everyone is waiting for some visionary company to take the initiative. Once a visionary company takes such initiative in a big way, Everyone will follow. This is what happened in the case of smartphone. Apple took the initiative and other followed. We need such visionary companies to improve the living standards in cities and create sustainable cities.

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