Green And Smart Mobility For Sustainable Future Cities: A Multinational View

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Abstract
In the last few years, rapid urbanization and development have strengthened the economies of the world remarkably. Every country indeed wants to develop its economic capabilities in near future. But this rapid development has its consequences which have aroused in recent years. Due to the rapid industrialization, increasing logistics, population and urbanization several other challenges with many benefits have increased. The cities are becoming populous because, a large number of people migrating from rural areas to urban areas for employment, career growth and earning their livelihood. To cater the services and amenities to the people of the city it is imperative to manage and expand the resources. Therefore, the concept called sustainable future cities is in policy agendas of many countries. Appropriate planning and implementation of sustainable future cities can easily manage the resources for public use for today and the future. Smart mobility and green mobility are the two key elements of sustainable smart cities. In the present study, the major focus has been given on smart mobility and green mobility with the help of multinational cases of future cities. The study further highlights the issues and challenges with few significant recommendations.

Keywords— Green mobility, Green Transportation, Smart mobility, Smart Transportation, Future Cities.

Introduction
In the fast-developing scenario around the world, there is an extreme demand for resources and infrastructure to support the further development process. The criteria for the development of any country is mainly represented by its economic indicators. This development is also observed by rapid urbanization around the world. According to the reports of the United Nations, the population of the entire world is expected to be around 9.7 billion in 2050 which could be highest at approximately 11 billion in 2100 (United Nations, 2018). The rural areas are shrinking and converting into urban areas in many developing countries. Additionally, those urban areas having maximum economic opportunities are blocked with a huge population. In India cities like Delhi and

Mumbai are much populated whereas, Shanghai and Beijing China are much-crowded cities. People are migrating rapidly from rural areas to urban areas for earning their livelihood, making their careers and growth. But, the increasing population in the urban areas developing new challenges (Sallis et al., 2016). These challenges are increasing pressure on the facilities and amenities of the cities as the population (the denominator of facilities and amenities) is increasing in urban areas. In the current scenario, the big cities which are also economic and business centers of the respective nations are suffering from various challenges which are making the quality of life poorer. These challenges are increasing crisis of basic utilities, the burden on public infrastructure, traffic congestion, the burden on the healthcare system, threat to the environment, and increasing concern towards safety, security, and poverty caused by increasing dearness (World Population Review, 2020). These urban issues are very difficult to solve with the conventional approach of repair and refurbishment. In the recent scenario of discussions over developing the urban areas, several new terminologies are introduced such as "smart cities", "future cities", "sustainable future cities", "eco-cities" and "green cities" etc. (World Population Review, 2020). But, these all are solving the same problem i.e. how to make the cities more livable with the help of increasing the existing resources and generating a new ones, by using techniques and technologies (Pandey and Bansal, 2014). Reading and understanding the several discussions sustainable future cities can be understood as the city which is equipped with all the resources which can enhance the quality of life for the public without compromising the needs of future generations. The sustainable future cities model conserves the resources for the use of present and future generations (National Geographic, 2020).
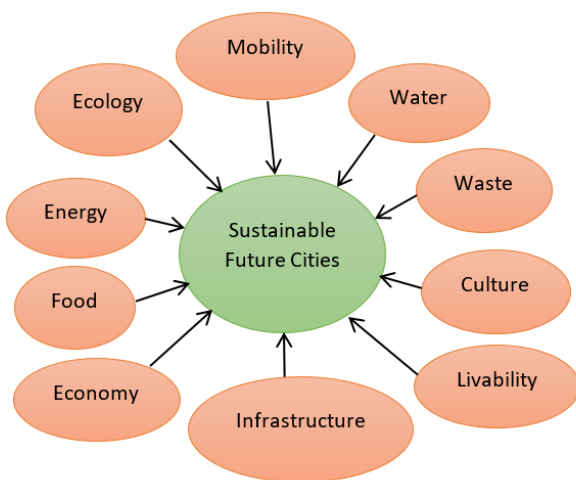

Fig.1 Ten Fundamental Principles of Sustainable Future Cities [5]

Fig.1 shows the ten principles suggested by the National Geographic team that plays a crucial role in establishing the sustainable future cities model. These principles (Ecology, water, energy, livability, waste, food, mobility, culture, infrastructure and economy). These ten principles are articulated on five scales which starts from the surroundings ecosystem to building interiors explained by Skidmore, Owings & Merrill (National Geographic, 2020). The research in the field of sustainable future cities or future cities are emerging in the present scenario and so far there are several studies available in multi-disciplinary areas of research. But, there is still a wide theoretical and empirical gap available in the research area of sustainable future cities (Sallis et al., 2016). To reduce the present gap, the present research work can also be added in this research domain of

sustainable future cities. More specifically, the present research is much more inclined towards the transportation elements of sustainable future cities.

The present research work is going to solve the following research questions that are:

- Research question (RQ)-1: Why smart mobility is required for sustainable future cities?
- RQ-2: Why green mobility is required for sustainable future cities?
- RQ-3: What are the challenges and issues associated with smart mobility and green mobility?
- RQ-4: What are the learnings from other cities around the world?

To solve the above research questions few objectives have been set these are:
- To study the existing literature available in research papers and online information.
- To identify opportunities, challenges and issues associated with smart and green mobility.
- To conclude the learnings from other cities of the world.

To meet the objectives of the study the present study has explored the available literature in research journals as well as online content. In the literature, the focus was to highlight the countries efforts towards the development of sustainable future cities with the implementation of smarter and greener mobility in their projects. The outcomes of the study will be helpful for the policymakers to take the decisions related to mobility towards developing sustainable future cities. The learnings from other developed nations towards planning sustainable future cities can also help developing countries.

After the introduction section, the present study is organised with few other sections such as review of literature, research methodology, discussion and conclusion. In the final sections, the study ends with, research implications of the study, limitations and future research scope.

Review of Literature
The literature plays a crucial role to fulfil the objectives of the present study. To bring the meaningful outcomes of the study several research articles published in quality international journals and articles available on reputed webpages were selected and read thoroughly. The search and selection of the literature were completed with the google search engine and google scholar. The search strings used while searching literature were 'sustainable future cities', 'future cities', 'smart cities', 'smart mobility, 'smart transportation' 'green mobility, 'green transportation', 'smart transportation and future cities', green transportation and future cities', sustainable future cities and countries', smart transportation countries', and green transportation countries. In this search and selection process, forty articles (journals, online magazines and reports) were selected and reviewed.

Sustainable Future Cities
The rapid urbanization and migration from small cities or villages to big cities are some of the leading causes for the dense population. Secondly, the limited resources such as water and limited land space are the extra burden on the development of any city (United Nations, 2018). Another reason for planning for sustainable smart cities is the need to upgrade with technological development. It has been noticed from the old civilizations that change and development is the

continuous process for the survival of the cities, and hence there is a need for planning for sustainable future cities (Sallis et al., 2016). The increasing various kind of life-threatening pollutions and other life challenges are the key reasons for planning and development for sustainable future cities. Cities equipped with the latest technologies and facilities that can provide basic to advanced utilities for living a safe life to the present and future generations are called sustainable future cities (Riffat et al., 2016). Sustainable cities can also be defined as "cities where people want to live now and in the future …" (KeTTHA, 2020). In the year 2014, there were 43 largest cities of the world with the highest population approximately between 5-10 million and it is assumed that it will be 63 million by 2030 (Riffat et al., 2016). According to the estimation of the United Nations (UN) by 2030, there will be around 40 mega cities across the world with an estimated population of 10 million each whereas, Shanghai, Tokyo and Delhi will have above 30 million people by the end of 2030 (United Nations, 2014). The cities growing population and expansion gives several challenges as cities are responsible for consuming almost 75 per cent of the resources produced globally and interestingly generates 70 per cent of all kind of waste with 70 per cent of carbon emission (Khan and Zaman, 2018). These crisis issues and increasing environmental threats lead to life threats to humanity. Therefore, sustainable cities are required for the future so that they can make human life easy. The sustainable future cities with information communication technology (ICT) in making mobility, security and safety for everyone is the key agenda for good governance around the world (Likitswat, 2019). The sustainable future cities can be mainly developed on key features of using sensors, use of non-motorised vehicles for transportation, use of technology for conserving resources for the future and avoiding various natural calamities that can be harmful to human lives. In today's scenario, several countries are engaged in the development of sustainable future cities. Although there are, many challenges associated with the development of these cities such as the crisis of space or land use, expensive technology, the replacement cost of the old infrastructure and the conflicts between planners and policymakers (National Geographic, 2020). Our past generations planned the current model of the cities, we lived a good life, and in the same way, what we plan today will be useful for our future generations (Riffat et al., 2016). The design of future cities should be based on a better environment, good socio-economic conditions, attractiveness, sustainability and the ability to adapt or mitigate uncertainties of risks (Likitswat, 2019).

Smart mobility and Future Cities
The smart mobility system is one of the foundations for future cities which not only makes cities smart with super convenient but also helps the environment to maintain its greenery. The smart mobility system consists of three significant dimensions, which are smart cells, ICT and developmental mechanisms. Smart cells cover elements as smart vehicles, unmanned vehicles, smart infrastructure and smart devices and smart base stations. ICT supports the internet of things (IoT) big data, cloud computing, mobile internet, artificial intelligence. Whereas, developmental mechanisms engaged with smart traffic management, and operational mechanisms of the sharing economy (Yan et al., 2020). The increasing population in the cities are creating problems in traffic management. Heavy traffic jams are some of the big issues for many countries like China and India. Poor traffic management not only makes chaos on the road but is also a responsible factor in increasing vehicular carbon emission (Pandey and Bansal, 2014). With the smart mobility system and with automated vehicle technologies this problem can be resolved. The technologies and

applications used with dedicated sensors such as global positioning system (GPS), controller area network (CAN) bus and light detection and ranging (LiDAR) make mobility smarter. To make the cities equipped with smart mobility it is also required to manage the crowd and hence there is a dedicated feature is also needed such as battery cycles or manual cycles for the commuters. (Boukerche and Coutinho, 2019).

Smart mobility is not only about the automated vehicles but also it is about the entire infrastructure of the mobility system, which should be automated and equipped with the latest technologies. Several cities in Asia pacific region around the have engaged paper-less work for ticketing system and all the system is based on the electronic payment system such as using Radio Frequency Identification (RFID) such as Taipei, Singapore, Malaysia, Korea, Japan, China and Hong Kong (Asia Pacific Smart Card Association, n.d.) But, still, the future cities are searching and making new solutions to the problem of mobility in every direction such as to manage the mobility for efficient logistics towards smooth supply chain secondly, to manage the smooth mobility for commuters and thirdly to manage the traffic and chaos caused by personal vehicles on the road (Sharma and Kushwaha, 2017). Studies say that around thirty percent of the deaths are caused because of the delays in reaching ambulances to the hospitals due to traffic jams another study highlights that around fifty per cent of the cases of heart stroke reaches late to the hospitals because of the traffic or unavailability of the ambulances (Bhushan, 2019). To solve these emergency mobility issues Britain uses artificial intelligence (AI) to provide support to traffic light management systems so that emergency crews can speed up their emergency task smoothly. A company based in Liverpool Red Ninja has developed an algorithm known as Life First Emergency Traffic Control (LiFE) which uses real-time data for managing traffic congestion (Red Ninja's smart tech clears the road for ambulance crews, 2017). In Fig.2, a simple smart mobility system is shown for better understanding. In this model, it is shown that in the smart mobility system everything needs to be connected with the help of ICT technologies so that a strong communications network can be established among all the elements those participates in the smart mobility system.
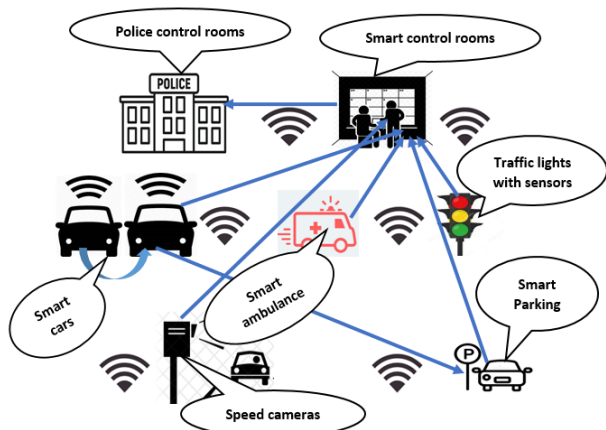

Fig.2 A simple model of smart mobility system [developed by author]

Green mobility and Future Cities
The green mobility system is essential to control the environmental threats caused by vehicular pollution. The increasing vehicle specifically fueled by conventional oil (petrol and diesel) on the road not only creating the problem of air pollution and another health hazard to the citizens of the

country but it also makes the city more challenging with the traffic congestion. Commercial vehicles and passenger vehicles on the road altogether constituting major pollution (air and noise) (Pandey and Bansal, 2014).In recent scenarios because of the economic development, there are majority of the people in the cities who can afford to buy a car. In sustainable future cities, there is no place for polluting vehicles and hence it is important to focus much more on electric cars and alternative fuel vehicles (AFVs) which can significantly reduce pollution . On the other hand, road traffic is also one of the main causes of pollution but the smart mobility system and green mobility solutions together can solve these issues (Abdel Wahed Ahmed and Abd El Monem,2020). There are several new techniques and ideas are emerging in the present technological world to make the green mobility system stronger such as vehicular social networks (VSNs) are developed to share information with neighboring commuters about their road experiences so that fuel consumption and air pollution can be controlled (Xia et al., 2017). Other techniques called genetic algorithm-based optimization model (GOM) emerges which can support and provide help in designing the green mobility system where economic and environmental strategies can be achieved (Lin et al., 2014). Other than the technical aspect there are several policies-based strategies that can also be adopted for making green mobility successful such as, in California there are green mobility taxes that emit less and pay less which motivates citizens to go for hybrid cars (Pandey and Bansal, 2014). Some countries planned green mobility with specific policies for example Taiwan in the year 2010, a four-year project (The Penghu Low Carbon Island Development Project) was planned with a budget of 300USD to target zero carbon emission in Iceland with searching innovative ways for energy conservation (Trappey et al., 2012). The green mobility system is beneficial for the environment and also for the public but it is also challenging for many countries as a study suggests that Beijing has still less infrastructure for bicycles, green travelling is low, speed of public mobility is still low, pedestrians also face problems and parking is still a major problem (Li, 2016). In Fig. 3 the World's top ten cities for sustainable public transport is shown as per the study of Arcadis in 2017 (Arcadis, 2017).

Fig.3 The World's top ten cities for sustainable Public Transport [24]

Countries working on Smart and Green mobility towards developing sustainable future cities.

According to the American society of mechanical engineers (ASME), there are ten potential future cities listed that are emerging and making a better fit towards the sustainability parameters. These cities are Singapore, Dubai, Oslo, Copenhagen, Boston, Amsterdam, New York, London, Barcelona and Hong Kong (Kosowatz, 2020).Various other studies also recommended few other cities that are

working hard to develop sustainable future cities such as Berlin, Shanghai and San Francisco (Wired, 2015). These cities are focusing on green and smart mobility with the help of innovative technologies and strategic methods. The target of Zurich towards green mobility is to lower down the carbon emission to 1 ton per person by 2050 additionally, the plan of Zurich is to maximum commute should be with the public transportation and reducing the number of privately owned vehicles (WWF, 2016). London is facing several challenges on its way to the development of smart and green mobility these challenges are dense population in the city, the problem of traffic, higher carbon emission and space-related issues. London is actively looking towards solving these issues and the aim is to make 80% of all the travel in the city dependent upon the walk, cycling and public transport by the end of 2041(Mayor's Transport Strategy,2018). Copenhagen, is highly concerned about climate change and air quality there is an urgent need to reduce carbon emission but significant but, the city so far has not permitted to implement a low emission zone for private and passenger vehicles. But, permission has been received in 2020 towards low emission areas for passenger cars. The city has a target to become the first carbon-neutral capital by 2025 following the world health organization (WHO) (Niss, 2019). Barcelona is set to trial its electric buses which can run for a full day on a single charge that eliminates the need for supplementary charging infrastructure (Intelligent Transport,2020). The famous Champs-Élysées a beautiful street is going to mark reduced traffic to facilitate pedestrians (Minchin, 2020) San Francisco launches a traffic monitoring system in real-time with the connected corridor pilot it uses traffic signal sensor data to inform signal timing settings. Here the pilot collects information to provide aid to increase the efficiency and street safety measures (Stone, 2020). In Table-I multinational initiatives towards developing sustainable cities and their challenges are presented based on the secondary information available from various sources.

Table:1 Multinational initiatives toward developing sustainable future Cities and Challenges

Place	Smart and green mobility	Challenges	Source
Singapore	Electronic road pricing systems (ERP), Intelligent Transport Systems, free public transportation, vehicle quota system, congestion charges etc.	Lack of available physical space.	(Stone, 2020)

Hong Kong	Traffic management system using data and technology. Free tolling by 2024. Real-time adaptive traffic signal systems for walkers or pedestrians and vehicles. Trial and use of autonomous vehicles in various areas in the city.	Heavy traffic density and space issues. A large number of private cars. Lack of car parking and roadside space.	(The Road to Sustainable Transport in Hong Kong, 2020.
Zurich	Making higher dependency on excellent public transport. Target to make the city with the lowest carbon emission place by 2050. Lowering private car ownership. The intelligent transportation system.	Replacement and modification in built spaces.	(WWF,2016)
Oslo	Oslo planning to run buses with biofuels and batteries. Reduction of traffic with congestion charge by	Traffic congestion and built infrastructure.	(Weebly,2020)

	2030. Target to reduce emission by 50 per cent.		
London	Smart transportation is driven based on data and IoT. Target is to make 80% of mobility dependent on foot, cycles or using public transport by 2041.	Population density and traffic.	(Mayor's Transport Strategy,2018).
Shanghai	The city has a mission "Shanghai 2035" towards making the city a model for future cities. It includes green mobility systems and autonomous vehicles. The major agenda is to lower carbon emissions.	The population density and environmental and infrastructural constraints.	(Xiang and Yue, n.d.)
Copenhagen	Zero-emission zone by 2030. Free parking for electric vehicles. Prioritizing E-Taxis in strategic places. Eliminating	Issue implementing urban charging equipment in the built-up city infrastructure.	(Niss,2019)

	diesel buses by 2025. Increasing infrastructure for bicycles. Development and expansion of charging infrastructure.		
Barcelona	Use of asphalt sensors for parking availability. Banning old vehicles. Use of autonomous vehicles with IoT. Use of 5G technologies for speedy connectivity. Development of 'superblocks' to facilitates pedestrians, bicycles and public transport	Traffic and Crowd.	(Intelligent Transport,2020); (Taylor, 2019)
Dubai	Dubai Autonomous Transportation Strategy (DATS) has planned to transform its transportation to autonomous mode by 2030. Planned 42,000 electric cars on the roads by 2030.	Implementation of overseas strategies. Resource utilization and infrastructure management and Big Data management issues.	Smart transport for a smart city(n.d)

	Dubai has set to the world's first functional 'Hyperloop' network.		
San Francisco	The San Francisco Municipal Transportation Agency (SFMTA), has set its connected corridor pilot for use of traffic signal sensor data to inform signal timing adjustments. The mobility is based on the data for street safety.	Several challenges towards data management for signal operations.	(Minchin, 2020)

Research Methodology

In the present study, the exploratory research design approach was adopted where the idea was to reveal theoretical knowledge based on the existing information. The secondary source of information is collected from various research papers, online reports and other web-based information. The outcomes of the research are based on secondary data analysis (Church, 2002). The present study is an example of a qualitative study (Irwin, 2013) where the observations have been done on secondary data and a conclusive outcome is drawn. The systematic research process of the study was started by defining the research problem in form of research questions. In the next step, various secondary information was collected selectively from several secondary sources and further collected information was noted and concluded in the research.

Discussion and Conclusion

In the present research, the emphasis has been given to the development of sustainable future cities based on the smart and green mobility initiatives around the world. The development of sustainable smart cities requires different kinds of initiatives starting from building infrastructure to set a perfect social culture among the citizens. But, smart and green mobility is a serious concern for the development of any future city. Increasing pollution and population are difficult to handle by the local administrations and these problems create resource crisis. Therefore, smart mobility in all the ways whether it is about the smart car or the smart infrastructure both gives an imperative means

to live a good life for the people. The problem of traffic and parking have become the biggest challenges because of the increasing private ownership of cars and lowering the dependency on public transport. Therefore, the central idea of the concept of smartly managing the parking spaces and availability with smart sensors are the key policies for upcoming future cities. The study shows that patients die because of ambulance delays due to traffic congestion in many cities worldwide. This is only one example there are many examples where people in urban areas face problems in living a normal life. The smart mobility option in sustainable future cities is the solution for such problems. There are several latest technologies such as GPS, CAN LiDAR and IOTs etc. used in smart transportations systems.

Green mobility is a wider term which not only refer to using a battery car but it's all about how to reduce carbon emission with the help of green mobility that involves even walking and cycling. Therefore, future cities are planning more and more pathways for pedestrians and cyclists. These initiatives not only help in reducing the carbon footprints but also helps in maintaining the good health of the residents. But, the study also highlighted several challenges which are important to overcome for the development of sustainable future cities. Several recommendations need to be addressed by the city planners while developing the future cities these are:

- The heavy commercial vehicles used for the logistics need to be replaced with electric vehicles like passenger electric vehicles.
- There is a need for more motivation towards owning an electric vehicle.
- Battery charging parks, which are becoming popular in many cities, must be encouraged in all the upcoming cities.
- The pedestrian and cycle path with appropriate safety measures must be available to all the busy roads of the city.
- The government should encourage the use of public transport by making it very cheap or free with ultra-modern facilities for the commuters.
- The upcoming infrastructure should be based on smart technologies.
- The development of future cities should be flexible so that it can be expanded over time when it is required as per the demand.
- Use of IOTs and data analytics for best path predictions on the go to drivers to avoid traffic congestion.

The study shows smart and green mobility examples taken from several places from different countries those who are working in the development of sustainable future cities. These cities also have different kinds of challenges and the planners cannot address many of them but they can be modified as per the current needs of smart and green mobility.

Research implication
The present study based on smart and green mobility, which are very significant elements for making the future cities can give few interesting ideas to implement. The study discusses various smart mobility aspects which can be adopted in the development of future cities. The challenges shown in the study can be addressed with the help of competent experts. Overall, the present study could be meaningful for the city planners, the government, and the researchers for further research.

Limitations and Future Research Scope

The study has few observed limitations as the study could have been more enriched if it could have used few empirical data showing the impact of smart and green mobility on the environment and life of the residents. This limitation can be overcome in future studies. The sustainable future cities still researched less and it contains a large future scope of research in multiple disciplines of the research.

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