

PRE- AND POST-COVID-19 STUDY OF SMART LIVING AND DEMAND ANALYSIS - A PART OF SMART CITY MODELLING

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Abstract

In the wake of the COVID-19 pandemic, the concept of "smart living" as a means of utilizing technology and the internet of things (IoT) to improve people's lifestyles has received increased interest. The purpose of this study is to examine the concept of smart living and its potential for fostering sustainable growth and boosting the quality of life. The urge to offer an equitable opportunity for all motivates the research. To achieve this objective, the study gives a statistical and technological examination of smart living, comparing the current state of the art to the era preceding the epidemic. The paper provides a thorough introduction to smart living, including case studies and market analysis of the associated technology. The paper also explores the benefits and drawbacks of smart living and suggests future research and innovation directions. Our primary result is that the pandemic has expedited the use of IoT and smart living technologies, hence fuelling the demand for additional research into their potential. We conclude that smart living shows significant promise for tackling social concerns and enhancing people's well-being in the post-COVID-19 era, and that continued research efforts are required to reach its full potential. This work contributes to the expanding body of literature on smart living and offers insights to scholars, practitioners, and policymakers interested in this field.

Keywords: Smart city demand, Smart living, Social point of view, Technical analysis.

1. Introduction

Smart devices are a crucial component that plays a major role in the daily lives of humans [1]. Everyone around the globe is adopting smart systems to make their lives easier and more comfortable. In every aspect of their lives, including daily activities, official jobs, and transportation, these technologies have a positive impact. Implementing smart devices such as sensors, cameras, and robotics to install water heating/cooling systems, lighting systems, utility management systems, water pumps, parking bays, and utility bill-paying systems would improve security and efficiency and save time [2, 3]. Many cities worldwide are attempting to use smart living technologies to develop sustainable construction concepts that minimize carbon emissions and improve the environment. The number of big structures continues to rise, yet safety becomes a serious worry in developing nations such as Bangladesh. Smart gadgets have a significant impact on enhancing the safety of buildings through the construction of smart buildings. Intelligent buildings offer improved lighting management, energy efficiency, and air conditioning regulation. It is possible to reduce the amount of solar load entering a structure by installing smart windows with enhanced performance [4]. Technological advances are the primary factor for the improvement of urban living conditions. The urban populace has adopted automated services, digital networks, intelligent information, and communication technologies. These technologies improve urbanites' quality of life, financial leverage, and performance [5, 6].

Due to the enormous breakout of the COVID-19 pandemic in March 2020, millions of lives were impacted on a global scale [7, 8]. Due to the higher prevalence of COVID-19 in urban areas and the need to halt the virus's transmission [9, 10], cities and large metropolitan centres worldwide have become at the forefront of the fight against the pandemic. Smart cities in industrialized nations initiated a pandemic resilience strategy for metropolitan areas in response to the COVID-19 outbreak. After the disaster, pandemic-resistant urban design and management measures were created to combat infectious sickness. In general, the COVID-19 pandemic and all of its negative effects generated new information, but they also refocused attention on resilience in the medium- and long-term response to the pandemic and urban recovery planning to an even greater extent than before [11, 12].

Sustainable development is seen as the norm in numerous domains, such as the environment, consumption, business, and research. All spheres of human activity must adhere to sustainable development ideals. One solution to these demands is the concept of a "smart city," which is an application of the fundamental concepts of sustainability [13-15]. Academics from around the world are focusing more and more on smart cities. Due to the high rate of urbanization, it is challenging for traditional metropolitan regions to meet the needs of this growth. Consequently, they are compelled to alter how they provide their populations with a decent, sustainable standard of life and employment [16-18].

In conjunction with modern technology, the urban environment, and the household setting, a lifetime of appliances will alleviate our challenges and make our lives easier. Better energy efficiency, increased security, time savings, and a more pleasurable way of living are among the fundamental demands of modern existence, and they are all quite advantageous to us. The Home Automation project has taken a significant step toward the future of state-of-the-art living to provide a high level of comfort and an efficient manner of living. With a home automation

system, you can automate the control of all of your appliances. This paper discusses the motivations for living in a smart city, as well as its historical context, the current state of affairs, design features of smart cities, and future developments. In addition, a statistical analysis of the social desire for smart city living is offered. Technology development in society has increased the opportunities for enhancing services, creating new production techniques, and streamlining daily chores [16, 19]. Because of its digitalization, the smart city has become the epicentre of ongoing technological advancements. IoT technologies are currently regarded as one of the most important pillars of the fourth industrial revolution because of their vast potential for innovation and positive effects on society as a whole. However, the use of finite resources by each development has various negative effects on the environment, including pollution and many others. IoT-based technologies provide an entirely new perspective on the future development of numerous industries, including engineering, agriculture, and health, as well as unknown ones [20-22].

There are a lot of factors to consider when contrasting the state of Smart Living Styles before and after the pandemic. In this study, we dove deep into the many facets of the smart lifestyle and talked at length about every one of them. The developments across the two periods are then compared, and probable explanations for each are offered. The prospect of such a radical shift occurring in the future is also considered.

2. Synopsis of Smart Living - Pre-COVID

The first smart city was established in Kansas City, Missouri. Inside the two-mile cable car passage of the metropolitan, it is associated with intelligent lamps, a stylish booth, and more than 50 complimentary universal Wi-Fi sections. The data server for the metropolitan area normally provides access to information about available parking spaces, traffic patterns, and everyday hotspots. To reduce traffic and parking and improve civic security, natural attentiveness, and overall movability for its residents, San Diego was outfitted with 3200 intelligent sensors in 2017. Solar energy, an electric charging terminal, and offices and cameras that are connected can be used to power electric automobiles and monitor traffic. In the capital of Singapore, sensors and IoT active cameras are used to monitor the cleanliness of public spaces, population density, and the operation of publicly listed transportation in light of the importance of smart cities. Companies and residents who practice smart management are those who continuously track how much energy is being used, how much garbage is being produced, and how much water is being used. Senior citizen health is monitored by autonomous cars that have all the features of robotic vehicles and an automated senior care system, which are now two significant experimental projects in Singapore.

In Dubai, smart technology is used for shipping, framework planning, and transportation routing. Along with smart homes, smart exploration, smart education, and smart service, the metropolis also makes use of healthcare and smart fitness care. In Barcelona, Spain, intelligent bus systems and smart transportation systems are interconnected. The management offers free Wi-Fi, a USB charging station, and updates to the bus schedule for patrons. A bike distribution program with integrated wired cash facilities and smart parking app features. Numerous sensors have been employed to monitor moisture and precipitation, as well as pollution, warmth, and blast. In northern America, the demand for smart homes expanded quickly in 2014. In the beginning, it grew at a pace of 75%, and by the end of the year, it had reached 10.2 million. It was estimated that 8.3 million were made for a specific purpose, while 1.8

million were multipurpose or capable of managing the entire home. It was expected that 7.9 million houses would have more than one smart technology. It represented 6.0 % of all households, making it a significant global market. The number of smart homes is expected to increase at a rate of 37 % each year between 2014 and 2019, reaching 38.2 million. Market revenue in 2014 was US\$4.2 billion. The market is anticipated to grow by 48 % annually. Before 2014, neither the North American nor the European markets were sufficiently developed. In the EU28+2 nations, 3.3 million smart home systems were launched in total in 2014. This increased from 1.75 million the year before. Of those, 2.93 million were certain answers, while 0.34 million were multipurpose. This indicates that at the end of the year, 1.2 % of household appliances were intelligent. To predict their eventual growth, the European household appliance industry is increasingly implementing smart house monitoring systems. After the pandemic hit the world, the practice changed drastically, and the value rose about 10 to 20 times higher than the previously documented and extrapolated ones.

3.Smart Living Technologies - Pre-COVID

Metropolitan areas are home to a sizable portion of the world's population [23, 24]. A smart city concept is currently taking shape. The concept is used all over the world under many nomenclatures. A smart city is referred to as a metropolitan area that monitors and coordinates the condition of all of its intricate infrastructure, such as all highways, airports, metro rail, underpasses, crossings, seaports, transportation, facilities for power and water, etc. Its goal is to make the most of all available resources, adhere to security procedures, and maintain services so that the resident can receive the best possible service. Energy use and efficiency should be the key priorities of a smart city. When there aren't any automobiles or pedestrians around, smart streetlights can be dimmed.

Smart grid technology enables efficient management of the power supply. A citizen can check on the status of his overall management by using the IoT-enabled system. Such as the environment, sanitation, drinking water quality, drainage, wastewater removal, etc. Intelligent sensors will notify the public about natural disasters like floods and earthquakes. Landslides or hurricanes. Citizens' safety will increase as a result of this. The construction of smart buildings is required for the smart city initiative. The structure will control safety and security as well as keep an eye on the building's structural integrity. The building will have a sensor connected that can detect damage and will alert authorities to make repairs if necessary [5, 6, 25, 26]. This technology will increase the productivity of urban farming and industry, which will enhance energy and space management and open up new job opportunities.

4.Concept of Sustainability in Smart City Planning - Pre-COVID

Sustainability is one of the key considerations for a smart city concept. 50 years ago, 60% of Americans lived in metropolitan regions; today, that number is 80%, and it is anticipated that urbanization will expand significantly. Thanks to advances in smart devices, citizen welfare, and governmental effectiveness, the next generation will be capable of maintaining a city's and country's growth. Nowadays, smart sensors are used in a few towns to monitor anything from water meters to manhole covers. One of the most crucial elements of a smart city is freely accessible public Wi-Fi. The objectives of smart city development are to benefit travellers, locals, and entrepreneurs and to

make their lives more comfortable. The idea of a "smart city" inspires people to use open and democratic data for all residents, which benefits people's understanding of technology. When individuals understand why they participate in this smart system and what the rewards are, more of them will be motivated to participate.

5. Pre-existing Challenges of Smart Cities

Maintaining cooperation between the public sector, the private industry, and the citizens who are voluntarily giving to the city and society and who will be actively involved in this is essential for preparing a smart city. The involvement of inhabitants will rise as a result of new concepts, innovations, more cooperation, and contemporary technical advancements. In a smart city initiative, an accessible mobile app or open data portal can be available to provide the necessary transparency and information. With the use of a smart city app, homeowners can keep track of their own, such as how much energy their home uses, pay their basic expenses like their gas, water, and electricity bills, and locate transportation. The smart city initiative needs to carefully examine a few drawbacks. Because a security issue arises when all information is accessible to everyone and when you monitor or view all the info. Since security cameras are watching everything, anyone can try to hack both personal and official data. Residents may be concerned about the security or manipulation of their personal information.

6. Implementation of Smart Home - Pre-COVID

The term "smart home" refers to a home that has been furnished with smart objects, which can detect and transfer all information to the online world so that we can observe and view our daily necessities using a smart device like a smartphone. When all of our objects are closely connected and can be operated from any location with appropriate security, we can refer to our houses as smart homes. The domestic network connects every item in the house, making it possible to check the status of every item. In any uncomfortable circumstance, the items automatically send their status to the citizen. The resident can inquire about the objects to understand their condition and provide them with guidelines. Citizens can make video contact with an object if they so choose, and they can then supervise or command the materials to ensure protection or safety. However, a high-speed internet connection is necessary for this type of surveillance or contact.

House automation is required to describe how a smart home may be controlled and monitored and has some components replaced by automation from the user's perspective. According to Berg Insights, a smart home system is required to include a mobile application. Using this app, the user can switch between devices, set a timer, and perform other functions outside just sensing and regulating. The six different categories for the implementation of smart homes. are:

- Energy management and climate control systems
- Security and access control systems
- Lighting, window and appliance control systems
- Home appliances.
- Audio-visual and entertainment systems
- Healthcare and assisted living systems.

The smart home concept provides a comfortable life by using technology; from waking up to going to bed, everything will be technological. For example, when a person enters the room, if sufficient light is not available in the room, then the light switch is automatically ON, and it also senses how illumination is required and it also adjusts the brightness of light as required. Morning waking up alarm, breakfast time, how many calories are needed in breakfast, how many glasses of water are needed to drink, medicine taking time, and all other necessary services will be available in the smart home concept, and it is possible because of technological improvement. Figure 1 shows the list of the prerequisites for a theoretical model of a smart house as well as the services that must be available in order one.

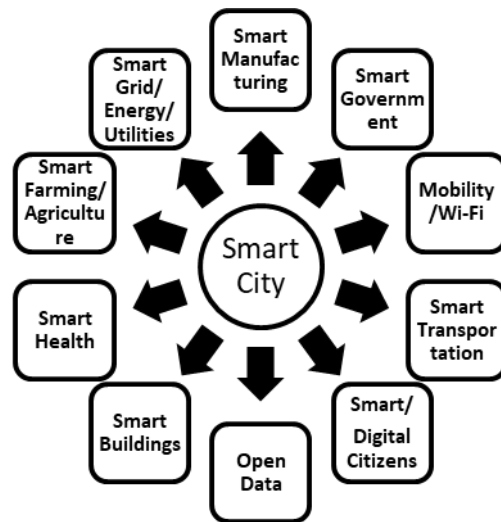


Fig. 1. Components of a Smart City.

The concept of a smart home must incorporate energy conservation and environmental architecture. Home automation/security, home help (Tele-Assistance), e-Health, e-Education, and e-Commerce are emerging technologies. Remote appliance monitoring, communications, entertainment, security, outdoor lighting control, and kitchen appliances. A theoretical model of smart house requirements, electrical power distribution players, smart building control specialists, and building application corporations supplying HVAC, lighting, home security, home appliance suppliers, and information technology.

7. Technological Development in Schools - Pre-COVID

The entire planet has become a globalized world, and technology has a significant impact on all facets of our everyday lives and economy. Due to their interconnectedness, higher participation, expertise, and efficiency are required. See a glimpse inside a student's day and how networking and innovation improve his interests, work, and play.

A technology-based education and training facility that offers distance learning is called Smart School. Technology-enhanced smart school designs provide a better possibility for teachers and students to interact in real time. A learner is encouraged to learn more effectively by this sophisticated method. Because both students and teachers can easily reach one another, learning is improved, and it takes less time

for both parties to respond. When a smart school system is put into place, the learning sessions for the students involve more visuals using various types of kits, such as video conferences, live chat, Presentation slides, audio sessions, and instant conferences, which provide a better knowledge of a student and enables him or her to learn many things outside of the curriculum [10].

With real-time communication, the smart school concept allows for improved engagement between students and teachers. For example, students can submit practice tests and coursework to their teachers, who can then check them by sharing a screen and conducting surveys from both ends. The teacher responds quickly to the pupils' questions whenever and wherever they are. Continuing to communicate with one another outside of the facility also helps to establish a solid relationship between them.

8. Development of Smart Vehicles and Traffic Management - Pre-COVID

Automobile producers seek to take the lead in fuel management advancements and fuel efficiency improvements in response to the rapid rate of global warming and energy shortages. Finding a clever substitute for oil will help cut down on the number of carbon emissions that come from burning it. The new smart design of a vehicle introduces lower fuel consumption and carbon emission with a new model of alternative green fuel usage in the context of smart life. An electric motor, for instance, powers electric vehicles and plug-in electric vehicles. The technology from which smart vehicles collect information and transmit signals will be integrated into their intelligence. The newest smart cars automatically determine the best parking spot based on the amount of traffic on the route. To assure the security, safety, and control of smart vehicles, as well as the infrastructure of roadways and towns, LTE and other wireless high-speed data networks, are connected to them [11].

A key component of the idea of a smart city is smart vehicle management. As an illustration, consider smart car parking, smart fuelling, and smart payment methods. The drivers can simply find open spaces for parking and fill up with petrol by using a mobile application, and they can pay for the fuel conveniently using their phone.

Smart traffic management is frequently used to monitor and investigate the flow of traffic depending on rush-hour schedules, optimize streetlights, and avoid having very congested roads. To ensure that public transportation fulfils user demand by enhancing efficiency and passenger pleasure, smart public transport is another component of smart cities. As part of the idea of a smart city, the public service can be enhanced by employing the shared vehicle model

9. Evaluation of Statistics in terms of Smart Cities - Pre-COVID

Demands for smart living are increasing, and research was used to track them. More than 100 people participated in the survey that was done among the lecturers and students of the University of Asia Pacific. The investigation was primarily supported by the Department of Electrical and Electronic Engineering because both faculty and students there has significant involvement in this field of study. According to this socio-techno metric research, many technocrats think that a smart city will be practical and reliable, and they would prefer to see a decentralized, centralized, or hybrid waste management system.

While the majority of the younger generation of engineering students view smart living to be a cost-effective and environmentally friendly lifestyle, only 34 out of 70 technocrats from the engineering faculty at the University of Asia Pacific agree. Consequently, there is a fundamentally distinct style of thinking. These technocrats believed that a smart city would have cleaner forms of energy, a pollution-free city, as well as new concepts for comfortable livelihood and a friendlier transport system. They preferred to travel by bus and bicycle in a smart city. Suggestions for improved living and a welcoming public transit network

The Smart Cities were ranked overall by the Easy Park group [12] on a scale of 1 to 10. Four key factors were selected for additional band score-based ranking, including (1) Transport and Mobility, (2) Sustainability, (3) Governance, and (4) Innovative Economy, after a thorough calculation and statistical data analysis. The average of four important individual band score values - smart parking, smart private vehicle, smart public transit, and smart traffic signal - comprises the ranking of transportation and mobility among them. Tokyo placed second, with Copenhagen taking first place overall. In Table 1, the top 10 cities have been ranked with a focus on sustainability and intelligent living. Once more, four separate band scores are in Table 1.

Table 1. Scores of top 10 Smart Cities in Transportation and Mobility, Sustainability, Governance, and Innovation Economy - pre-COVID.

City, Country	Score				Average Score
	Traffic Signal, Transportation, and Parking Facility	Waste Disposal, Smart Building, Energy, and Environment	Digital government, urban planning, education, and smart citizen	Digital Banking System, Smart Economy	
Copenhagen, Denmark	8.4	7	7.7	9.13	8.1
Tokyo, Japan	8.1	6.3	6.1	8.55	7.3
Boston, USA	7.9	5	6.9	10	7.5
Amsterdam, Netherlands	7.6	5.4	8.1	7.23	7.1
Zurich, Switzerland	7.5	9.1	7.1	9.74	8.4
Melbourne, Australia	7.1	4.4	8.5	7.33	6.8
Singapore, Singapore	7	6.4	7	8.36	7.2
Stockholm, Sweden	6.7	8.3	8.5	9.57	8.3
San Francisco, USA	6.6	4.9	6	9.91	6.9
Geneva, Switzerland	6	9.4	7	8.65	7.8

10. Post-COVID Analysis

The COVID-19 outbreak has slowed the expansion of numerous cities due to the global economic slowdown caused by compulsory lockdowns, decreased government revenues, and higher expenses to combat the pandemic. The COVID-19 pandemic nevertheless required several new procedures and services that had an impact on the urban policymaking and planning necessary for smart cities [5, 11].

10.1. Short- and long-term repercussions

Following the first pandemic of the decade, where AI-based digital technologies quickly took over both personal and professional lives, it was suggested that existing and emerging digital technologies be used in addition to conventional remedies. In the three phases of the pandemic-pre-crisis, during the crisis, and post-crisis-smart cities play diverse roles. They play a crucial part in catastrophe preparation for the "new normal" after COVID-19. Policymakers and academics are interested in using smart city platforms for epidemic control, information screening, and medical resource matching during the pandemic. The intellectual ramifications of utilizing the most recent technologies that have developed to handle environmental threats like the coronavirus pandemic were studied by researchers from various academic backgrounds pertinent to city planning and architecture [27-31].

A major global test of whether smart city technology might lessen the COVID-19 crisis's severe effects has emerged. Cities that have adopted digitalization projects and practices have improved their post-crisis resilience and sustainability, as well as their ability to respond effectively. To create an environment that is built to resist future pandemics, these technology-driven policies and actions should be incorporated into daily life at many sizes in the urban environment, from individual buildings to urban spaces and units, neighbourhood communities, and the city level [30-32]. Large-scale technological use, however, poses serious issues with social exclusion, secrecy, privacy, and misinformation, as well as with ineffective remote working and teaching [21-25]. The COVID-19 crisis's probable short- and long-term effects on the smart city concept are compiled in Table 2, where we can see significant improvement over the previously measured values.

Table 2. Scores of previous top 10 Smart Cities in Transportation and Mobility, Sustainability, Governance, and Innovation Economy - post-COVID.

City, Country	Score				Average Score
	Traffic Signal, Transportation, and Parking Facility	Waste Disposal, Smart Building, Energy, and Environment	Digital government, urban planning, education, and smart citizen	Digital Banking System, Smart Economy	
Copenhagen, Denmark	9.8	8.5	9.85	12.2	9.45
Tokyo, Japan	9.6	7.22	7.6	9.66	8.65
Boston, USA	11.2	6.12	7.45	11.5	8.36
Amsterdam, Netherlands	10.1	5.88	8.65	8.33	8.5
Zurich, Switzerland	9.2	9.8	7.85	10.25	9.25
Melbourne, Australia	9.5	5.6	8.95	8.54	7.25
Singapore, Singapore	12.3	7.23	7.35	8.76	8.33
Stockholm, Sweden	7.5	8.51	8.98	10.22	9.65
San Francisco, USA	6.9	5.5	8.22	11.25	8.25
Geneva, Switzerland	6.5	10.2	7.68	8.95	9.22

10.2. Future scope in renewable sectors

A lot of research is being done in the renewable energy fields right now, including hybrid solar and wind technology, off-grid supercapacitor storage systems for low wind speed, real-time control interfaces for operating voltage, and others. For the next generation of smart living, all of these could be viable B2G (Building to Grid) and V2G (Vehicle to Grid) sources [13-18].

11. Conclusions

Smart city living represents a significant technological development that holds great promise for addressing societal challenges and improving people's well-being. This paper has provided a comprehensive overview of the technological landscape, including case studies, statistical analyses, and living requirements for smart cities. The COVID-19 pandemic has highlighted the urgent need for research and innovation in this area, and there is growing interest in involving researchers, scientists, and students in this effort. To this end, various scientific organizations, research institutes, and government agencies are actively promoting smart city living and funding research in related fields. For instance, the Bangladesh Energy and Power Research Council (EPRC) has been established to support cutting-edge research in energy and power industries. Despite the challenges posed by the pandemic, there are encouraging signs of progress, and citizens around the world are working diligently to realize the goal of smart city living. We hope that this paper will contribute to the ongoing conversation on this important topic and inspire further research and innovation in this area.

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