

# Urbanization and Smart Cities in Nepal: Enhancing Urban Infrastructure and Transfer with Smart Technology

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## Abstract

*Nepal is becoming more and more urbanized, particularly in the city areas, which is creating serious problems with housing, infrastructure, and basic facilities. Due to the demand on infrastructure and resources caused by the migration of people from rural to urban areas, informal settlements with subpar living conditions are becoming more prevalent. This study looks at Nepal's urbanization trends, possibilities, and challenges. It also looks at how smart technology may be incorporated into urban infrastructure to help with these problems. The study explores how resource efficiency and sustainability may be improved through sophisticated waste management, intelligent water supply systems, and smart energy management. It also emphasizes how more functional urban settings may be achieved by utilizing smart transit systems, public safety initiatives, and citizen interaction platforms. Examining best practices and case studies, this paper offers suggestions for the successful execution of smart city in Nepal with the goal of improving urban living and advancing sustainable development.*

**Keywords:** Urbanization, smart cities, urban infrastructure, smart technology, sustainable development, traffic management, waste management, public safety, smart energy management, infrastructure challenges

## INTRODUCTION, PROBLEM, AND OBJECTIVES

As Nepal is landlock country located near Mount Everest, Nepal has neighbored two biggest population's countries; China is on north side and rest of side has India. The total population of Nepal is 30.03 million and the population living in urban areas is 17 million. There is an increase of 4.49% from 2020 as per CBS, 2021. Likewise, the total metropolitan cities are Bharatpur, Biratnagar, Pokhara, Lalitpur and Birganj; moreover, 11 sub-metropolitan cities and 276 municipalities.

Rapid urbanization has become a widespread phenomenon, transforming cities into vibrant hubs of social, environmental, cultural, and economic activity. Urban regions face significant challenges as a result of this exceptional expansion, including compromised infrastructure, increased air quality, traffic jams, food, air pollution, water supply system, and limited access to basic services. Nepal, a nation with an apparent rise in urbanization, is not free from these difficulties. There is an urgent need for creative and sustainable solutions to improve the quality of life in Nepalese cities as the urban population develops.

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Masdar City in Abu Dhabi and Lusail City in Qatar are two Smart City initiatives in the Gulf area whose development is being compared by Tok *et al.* [1]. According to their results, both cities are setting the standard for sustainable urban growth by addressing economic and environmental issues with cutting-edge technology and creative planning. The

authors contend that Lusail prioritizes luxury and cutting-edge infrastructure, whereas Masdar places a strong emphasis on sustainability and renewable energy. Both initiatives, in spite of their differences, have to deal with similar problems including high costs, scalability concerns, and the requirement for increased public participation.

The study identifies important gaps in these cities' integration of sustainable practices and cutting-edge technologies, while also highlighting their strengths in doing so. More reliable frameworks are required to assess the long-term effects of these initiatives, more effective ways to include locals in the design and execution phases, and all-encompassing regulations to guarantee that these smart cities may grow and change to meet new problems. To close these gaps and encourage the sustainable growth of smart cities in the Gulf area, it is essential to invest in advanced technologies, foster collaboration between public and private sectors, and implement robust urban planning strategies.

Nepal has been facing multiple issues resulting from rapid urbanization, including inadequate urban infrastructure, inefficient transportation policies, narrow roads and systems, and limited access to essential services. These challenges hinder economic development, degrade the environment, and impact the well-being of citizens. Therefore, addressing these issues has become imperative to ensure sustainable urban growth and improve the overall urban experience for the Nepalese population.

### Research Objectives

This research work aims to explore the potential benefits of smart technology in addressing the challenges associated with urbanization in Nepal. The study seeks to achieve the following objectives:

- To analyze the trends, patterns of growth, and difficulties that Nepal's cities are currently facing as a result of their urbanization.
- Examine how smart technologies, such as energy management systems, water supply, waste management, and smart buildings, may improve urban infrastructure.
- Analyze the possibilities of smart technology to enhance traffic control, retail and shop management, parking options, and public transit networks.
- Examine the ways in which smart technology might improve different facets of urban living, such as societal involvement, public safety, and health care.
- Find out what issues and problems would need to be taken into account for the effective application of smart technology in Nepalese cities.

### POLICIES AND IMPLEMENTATION TECHNIQUES FOR URBANIZATION AND SMART CITIES IN NEPAL

The 2007, National Urban Development Strategy (NUDS) gave a comprehensive framework for urban development in Nepal in order to address issues with urban expansion, infrastructure development, and environmental sustainability. Similarly, decentralized government, citizen participation, and sustainable urban development are strongly emphasized in the 2007 Urban Development Policy. Its main objective is to raise the standard of urban living via integrated planning and development methods [2, 3].

Likewise, the Urban Development Act of 2017 [4]: This law provides a legal basis for infrastructural development, urban planning, and environmental protection [5]. It was passed to regulate and guide urban development activities. The Local Government Operation Act of 2017 grants municipalities, both urban and rural, the ability to plan, carry out, and supervise neighborhood urban development initiatives. It encourages the application of sophisticated technology to service delivery and urban planning. Additionally, the 2019 National Smart Cities Strategy of Nepal (NSSCN), aims to transform a limited number of cities into smart cities by fusing technology, data-driven decision-making, and sustainable urban practices. It outlines the aims, primary goals, and focus areas for the development of smart cities [6]. In the 2015, National Information and Communication Technology (ICT) Policy: This strategy places a strong emphasis on utilizing ICT to support economic growth, enhance service delivery, and improve governance across a range of sectors, including urban development. The Data Protection Act:

The safeguarding and management of this 2021 law addresses personal data and ensures privacy and security in the digital era. It is necessary for the implementation of smart city projects that involve the collection, processing, and sharing of data.

## **REVIEWS FROM THE LITERATURE RELATED TO SMART CITIES AND URBANIZATION**

Smart city initiatives globally have made strides in leveraging innovative ICT solutions to address environmental and urban development challenges. Angelidou *et al.* find that while these applications significantly contribute to sustainability, the fragmented landscape of initiatives and lack of comprehensive integration pose substantial barriers to achieving holistic urban sustainability [7]. Similarly, Albino *et al.* emphasize the need for a precise definition and a unified framework for assessing smart city performance, highlighting the roles of people, institutions, and technology [8]. Hollands critically examines smart cities, arguing that many projects prioritize technical innovation and economic growth over sustainability and social inclusivity, necessitating a more comprehensive approach that includes social and political dimensions [9]. Neirotti *et al.* observe common themes in smart city projects, such as mobility and energy management, but note the absence of an all-encompassing framework that integrates these efforts across social, economic, and environmental aspects [10].

In the context of Nepal, Sapkota points out that modernization has led to significant economic and infrastructure developments, yet these advancements are unevenly distributed, exacerbating regional disparities and hindered by political instability and slow technology adoption [11]. Bhattarai *et al.* identify progress in Nepal's energy policy but note gaps in achieving comprehensive energy sustainability, emphasizing the need for better integration of renewable energy and effective policy enforcement [12]. Nam and Pardo argue for a synergistic incorporation of technology, people, and institutions in smart city initiatives to achieve sustainable urban growth, though they highlight the challenges of balancing technological advancements with social equity and the need for better evaluation metrics [13].

### **Summarization from the literatures**

Creating comprehensive frameworks that evaluate smart city projects from the perspectives of social, economic, environmental, and technological aspects is essential to moving these programs forward. To do this, standardized assessment techniques that offer a thorough hold of their impact must be developed. In order to accomplish sustainability goals, policy integration should also concentrate on integrating smart technology and renewable energy into urban design. Putting social inclusion and fair benefit distribution first in smart city initiatives would help to close the gap between the regions and encourage inclusive growth. To assess the efficacy and significance of these activities and provide a foundation for ongoing enhancement, precise descriptions and resilient measurements are necessary. Moreover, strengthening institutional backing via improved cooperation across public, commercial, and community sectors would provide a conducive environment for sustainable urban growth.

## **CHALLENGES AND OPPORTUNITIES OF URBANIZATION IN NEPAL**

Nepal's population has grown significantly, especially in urban areas, which has increased demand for housing, infrastructure, and services. Cities have rapidly expanded due to the fast migration of people from rural to urban areas, placing a pressure on the resources and infrastructure already in place. The growth of informal settlements, which are characterized by subpar living conditions and restricted access to basic facilities, is a noticeable trend in Nepal's urban regions.

Inadequate waste management systems, sanitation facilities, parking structures, water supply systems, and road networks and policies are common problems in Nepal's metropolitan areas. Air quality and transit efficiency have been adversely affected by traffic congestion in large cities like Kathmandu, which is a result of the growing number of motor vehicles and the usage of older cars. In addition, urbanization increases demand on finite resources like land, water, and power, which raises questions

regarding sustainable development. Many individuals are finding it more and more difficult to find cheap and adequate housing alternatives due to the rising cost of housing, especially low-income groups. Furthermore, urbanization can make social inequality worse by making it more difficult for disadvantaged populations to receive healthcare, education, and other necessities.

### **SMART TECHNOLOGY AND URBAN INFRASTRUCTURE IN NEPAL**

Incorporating intelligent energy management systems into Nepal's urban infrastructure has the potential to improve energy distribution, utilization, and monitoring. For the purpose of increasing productivity, cutting waste, and making it easier to integrate renewable energy sources, this would entail integrating smart grids, sophisticated metering equipment, and energy management software. The distribution and management of water resources might be enhanced in Nepal's urban regions by using intelligent water delivery systems. This might entail implementing data analytics, smart sensor deployment, and remote monitoring technologies to track water quality, find leaks, and optimize water use.

In Nepal's cities, smart waste management systems might improve garbage collection and encourage environmentally friendly trash management techniques. To increase effectiveness and reduce environmental effect, these systems could include recycling initiatives, garbage collection routes that are optimized, and sensor-based waste containers.

Integrating smart technology into buildings and infrastructure in Nepal might improve customer comfort, safety, and energy efficiency. Smart sensors, Internet of Things (IoT) devices, and automation systems might control security, HVAC, and lighting; and sophisticated monitoring and maintenance methods may guarantee the efficiency and security of public infrastructure, such as roads and bridges.

In Nepal's metropolitan centers, putting intelligent transportation systems into place might maximize transit effectiveness, lessen traffic, and increase road safety. To improve the entire transportation experience, this may entail implementing technology like intelligent traffic management systems, smart parking solutions, real-time public transit tracking, and smart mobility services.

Establishing strong digital infrastructure and platforms might facilitate public participation, effective service delivery, and participatory government in Nepal to establishing online forums for public input, communication, and cooperation between local governments. Authorities can promote urban development methods that are inclusive and responsive through these digital tools.

The urban infrastructure of Nepal can benefit from improved evidence-based planning and resource allocation through the use of data analytics and decision-making tools. Urban planners and politicians may make well-informed decisions about infrastructure construction, resource management, and service delivery by collecting and evaluating data from sensors, Internet of Things devices, and public comments.

### **Intelligent Water Supply and Waste Management**

Smart water supply systems can help Nepal's metropolitan regions better manage and distribute their water resources. Smart technology including leak detection systems, water quality monitors, and remote monitoring tools may assist in quickly discovering and fixing problems in the water supply network. Similar to how efficient trash management may be improved, smart waste management technologies, such as sensor-based garbage containers, waste collection optimization, and recycling programs, can encourage a sustainable use of the environment.

### **Smart Infrastructure and Buildings**

The implementation of smart infrastructure and buildings may improve Nepal's comfort, safety, and energy efficiency. Technologies like occupancy sensors, energy management systems, and automated HVAC and lighting systems can all be used in "smart" buildings. In addition, smart infrastructure may incorporate communication networks and smart sensors in highways, bridges, and public buildings for improved safety, real-time maintenance, and monitoring.

Nepal can improve service delivery, optimize resource management, increase energy efficiency, and create sustainable and livable urban environments for its citizens by integrating smart technology into urban infrastructure.

### **Smart Transportation Systems**

- *Intelligent Traffic Management:* Smart transportation systems in Nepal can incorporate intelligent traffic management solutions to improve traffic flow, reduce congestion, and enhance road safety. This can involve the use of advanced technologies such as real-time traffic monitoring, adaptive signal control systems, and traffic prediction algorithms. By analyzing traffic data and adjusting signal timings dynamically, intelligent traffic management systems can optimize traffic flow and minimize delays.
- *Smart Parking Solutions:* Implementing smart parking solutions in Nepal can address the challenges of limited parking space and inefficient parking management. This can include the deployment of sensors and IoT devices to monitor parking occupancy, digital signage to guide drivers to available parking spaces, and mobile applications for real-time parking availability and payment. Smart parking solutions can optimize parking space utilization, reduce search time for parking, and improve overall parking management efficiency.
- *Public Transportation and Mobility Services:* Enhancing public transportation and mobility services through smart technology can promote sustainable and efficient urban transportation in Nepal. This can involve the integration of real-time information systems, mobile applications for trip planning and ticketing, and intelligent transit systems for fleet management and optimization. Smart transportation systems can improve the reliability, accessibility, and convenience of public transportation, encouraging more people to use it as an alternative to private vehicles.

### **As per September 2021, Smart Transportation Systems in Nepal**

- *Intelligent Transportation Systems (ITS):* Nepal has been exploring the implementation of intelligent transportation systems to enhance the efficiency, safety, and sustainability of urban transportation. Intelligent transportation systems utilize advanced technologies, including sensors, data analytics, and communication networks, to improve traffic management, public transportation operations, and traveler information services.
- *Traffic Management and Control:* The Government of Nepal has been focusing on improving traffic management and control systems in urban areas. This includes the installation of traffic signals, development of signal control systems, and deployment of intelligent transportation technologies to optimize traffic flow, reduce congestion, and enhance road safety.
- *Public Transportation Services:* Efforts are being made to improve public transportation services in Nepal through the use of smart technology. This can include the implementation of electronic ticketing systems, real-time passenger information systems, and mobile applications for trip planning and fare payment. By integrating smart technology, the aim is to enhance the reliability, accessibility, and convenience of public transportation for commuters.
- *Sustainable Mobility Initiatives:* Nepal is also focusing on sustainable mobility initiatives, such as promoting cycling infrastructure, pedestrian-friendly urban design, and promoting non-motorized transportation options. These initiatives aim to reduce reliance on private vehicles, promote eco-friendly modes of transportation, and improve the overall quality of urban mobility.
- *Data and Information Sharing:* Efforts are being made to establish data collection and information-sharing mechanisms to support smart transportation systems. This involves collecting and analyzing transportation-related data, including traffic flow, travel patterns, and public transportation usage, to inform planning, decision-making, and infrastructure development.
- *Policy and Regulatory Framework:* The Government of Nepal has been working on developing policy frameworks and regulations to support the implementation of smart transportation systems. These policies cover aspects such as data privacy, cybersecurity, interoperability, and standards for smart transportation technologies and services.

It is important to note that the specific policies, strategies, and implementation mechanisms may vary at different levels of government (national, provincial, local) and across different cities or urban areas in Nepal. Furthermore, collaboration among government agencies, private sector entities, transportation authorities, and other stakeholders is crucial for the successful implementation of smart transportation systems.

For detailed and up-to-date information on smart transportation systems and policies in Nepal, I recommend referring to official government sources, urban development plans, and relevant policy documents, or reaching out to the concerned authorities and transportation agencies in Nepal.

### Smart Technology and Urban Life

- *Enhancing Public Safety and Security:* Smart technology can play a crucial role in enhancing public safety and security in Nepal. This can involve the implementation of smart surveillance systems, including CCTV cameras, video analytics, and facial recognition technology, to monitor public spaces and deter criminal activities. Additionally, the use of smart emergency response systems, such as panic buttons, mobile applications for reporting incidents, and geolocation-based emergency services, can improve the response time and effectiveness of emergency services.
- *Smart Health Services:* Smart technology can contribute to improving healthcare services and access in urban areas of Nepal. This can include the implementation of telemedicine solutions, where remote consultations and medical advice can be provided using digital platforms. Additionally, smart healthcare systems can facilitate electronic medical records, appointment scheduling, and health monitoring devices to enhance the efficiency and quality of healthcare services.
- *Citizen Engagement and Participation:* Smart technology can empower citizens and encourage their active participation in urban development processes. This can involve the use of digital platforms, mobile applications, and online portals for citizens to access information, provide feedback, and participate in decision-making. By promoting citizen engagement, smart technology can foster transparency, inclusivity, and accountability in urban governance.
- *Case Studies: Smart City Initiatives Improving Urban Life:* Studying case studies of successful smart city initiatives from around the world can provide valuable insights into how smart technology can improve urban life. Examples include:
  - *Barcelona, Spain:* Barcelona's smart city initiatives focus on improving the quality of life for residents. Smart technology is used for efficient waste management, energy optimization, smart lighting, and the provision of real-time information to citizens.
  - *Amsterdam, Netherlands:* Amsterdam has implemented various smart city solutions, including smart mobility systems, energy management, and digital platforms for citizen engagement. These initiatives have improved transportation, reduced energy consumption, and enhanced citizen participation in decision-making processes.
  - *Medellín, Colombia:* Medellín transformed itself into a smart city by utilizing technology to improve public transportation, enhance public safety, and provide digital access to education and healthcare services. These initiatives have contributed to the social and economic development of the city.

By examining these case studies, Nepal can gain insights into the potential benefits, challenges, and best practices for implementing smart technology to improve urban life. This can help in developing of tailored strategies and solutions that address the specific needs and context of Nepal.

It is important to note that the successful implementation of smart technology in urban life depends on factors such as infrastructure readiness, digital literacy, data privacy, and affordability. Collaboration among government entities, private sectors, communities, and citizens is crucial for realizing the full potential of smart technology in improving urban life in Nepal.

## CONCLUSION

The study's findings on urbanization and smart cities in Nepal highlight how smart technology has a lot of promise to improve public safety, healthcare, transportation, urban infrastructure, and citizen involvement. Still, there are a number of significant issues that need to be resolved, such as infrastructural needs, data privacy issues, and budgetary limitations. To better understand the problems and best practices associated with the adoption of smart technology, future study should focus on certain areas, such as digital governance and intelligent traffic management, via in-depth investigations. Investigating the social and environmental effects of adopting smart technology is also crucial for maintaining sustainability, equality, and inclusion in urban development initiatives.

Finding creative funding solutions and evaluating how prepared local governments and stakeholders are to implement smart technology are essential first steps. Examining the efficacy of sustainable urban development in Nepal by evaluating current programs and seeing chances for expansion. The implications for Nepal's urban development highlight the necessity of all-encompassing policies, frameworks for regulations, and cooperative methods amongst stakeholders, urban planners, and policymakers. Nepal can use the transformational power of smart technology to build sustainable, smart cities that enhance quality of life, promote economic growth, and accomplish national development objectives by embracing innovation and successfully tackling obstacles.

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