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# Digital Twins and Urban SDGs Simulating Smart Cities for Sustainable Development

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***Abstract—*** *Digital Twins has transformed the way an urban environment can be managed and operated by developing digital twins of physical systems through real-time emulation. With the urbanization phenomenon occurring around cities, which is accompanied by population growth, climate changes, and other resource limitations, including Digital Twins in the process of urban planning has become one of the most important facilitators of reaching the United Nations Sustainable Development Goals (SDGs). This paper addresses the possibility to use Digital Twin technologies in order to simulate, monitor, and optimise a range of elements of smart cities, including infrastructure, energy systems, mobility, and environmental health to be in the harmony with the urban SDG goals. Using an extensive analysis of existing implementations, simulation frameworks, and impact analysis frameworks, the paper offers a design methodology of SDG-driven Digital Twins of cities. The outcomes show how these systems have the potential to enhance policy-making, active citizens involvement, and proper utilization of resources. The discussion provides the barriers and perspectives to global urban sustainability that needs to be done to scale such technologies.*
***Keywords—*** *Digital Twin, Smart Cities, Sustainable Development Goals, Urban Simulation, Urban Analytics, Real-Time Monitoring, Urban Planning, IoT, Urban Governance.*

## I. INTRODUCTION

Urbanization in cities is fast changing in unparalleled ways that cities are encountering challenges associated with population growth, environmental depreciation, straining infrastructures, unequal socioeconomic situations. By 2050, most parts of the world will be faced with over 68 percent of global population urban residents, overwhelming the urban systems to become more resilient, inclusive, and sustainable, according to the United Nations. This situation explains why the United Nations Sustainable Development Goals (SDGs), and SDG 11 (Sustainable Cities and Communities) should be pursued to ensure that cities are inclusive, safe, resilient, and sustainable. In order to accomplish these objectives, it becomes essential to use advanced digital technologies that will allow cities to observe, schedule, simulate, as well as optimize their functioning in real time. Digital Twins are one of such tools that have turned into a disruptive paradigm that redefines city planning, operation, and management processes [15], [17].
Digital Twins are real-time dynamic digital simulators of real-world systems. Their application in the field of urban areas is very promising yet new as they have been initially applied in manufacturing industries and aerospace sectors [3]. Digital Twin combines data flows of various entries including IoT sensors, geospatial mapping solutions, traffic condition monitors, utility tracts, and climate prediction systems to develop a real-time simulated version of the actual world. Digital Twins as opposed to traditional models do not just visualize data but also make it possible to simulate and predict, as well as plan scenarios thus becoming interactive tools of city administration and decision-making.
Urban systems are so complicated that the corresponding model should handle very large and diverse datasets and should be able to simulate complex interdependencies. As an example, little adjustment to the transportation infrastructure may influence the consumption of energy, air quality, and social equity. With the help of Digital Twins, one can assess these cross-sectoral effects and do so prior to rolling out

changes in the real world [12]. Traffic flow metropolis, flood forecasting, pollution control, emergency response and energy grid balancing are some of the broad areas of operation simulated using Urban Digital Twins. Through this model coordination with several urban systems, city planners and policymakers obtain an overall perspective of the effects on the city and SDGs evolution of various interventions [18].

Digital Twins present an excellent solution to the need to have smarter cities because governments everywhere are committing to data-driven urban development. Even such cities as Singapore, Helsinki, and Dubai have already introduced pilot versions of Digital Twins in urban planning and optimization of resources. These case studies indicate how Digital Twins can make everything more efficient, decreasing emissions and making the lives of citizens better. Nonetheless, their combination with the SDG framework is underdeveloped due to the increased enthusiasm. Technical performance-related implementations most implementations are related to some technical aspects of performance, such as reduction in traffic or energy saved, without expressly connecting the outcome to the SDG targets or a SDG indicator. Such disconnect points to an important research gap which this paper is attempting to fill [4].

The SDGs offer the global language of sustainability and indicators but how to convert this into workable strategies in a city is a big challenge. The solution to this gap may lie in Digital Twins, preparing simulations outputs to be mapped to SDG indicators, e.g. reducing CO 2 (SDG 13), increasing access to transport (SDG 11.2), lowering energy use (SDG 7), or air quality (SDG 3.9). By performing multi-scenario simulations, the city leaders will have the possibility to prioritize their projects not only on the cost-efficiency grounds but also on the social, environmental, and long-term sustainability ones [14].

In addition, Digital Twins allow the transparency and the participation of citizens. With interactive visualization and dashboard, urban statistics and data can be opened to the general audience, opening participatory governance and co-creation. Residents are able to experiment with the impact that any changes to the policy would have on their neighborhood, health, or commute time and give their input to the decision-makers. Such a dimension of participation is in accordance with SDG 16 (peace, justice, and strong institutions), promoting inclusive governance.

It is also critical to be able to use one additional Digital Twins core strength, which is its predictive capability. Real-time simulations enable prediction and prevention of climate-related risks such as flooding in urban areas, heatwaves, or air contamination events. Inputting historical and existing environmental information in Digital Twins can help cities develop contingency plans proactively, also in line with SDG 13 (climate action). These predictive models are not only economically efficient, but they can save lives and infrastructure because it allows preparing better [2].

Although it seems their potential is immense, there is still a variety of technical and strategic issues. There should be interoperability of data, lack of standards, heavy cost of implementation of the data, and issues on ethics regarding surveillance and data privacy. Such worries are further amplified whenever Digital Twins are put into use at cities-levels and connected to such delicate information as public health data or travel records. Therefore, an ethically controlled, inclusive design, and technically strong any Digital Twin system to implement SDGs should be targeted.

The present paper will examine the interface between the Digital Twin and the urbanization of SDGs. It presents a simulation-based approach to the mapping of urban interventions to SDG targets, considers an example of a Digital Twin prototype developed in a medium-sized city, and offers an understanding of how such technologies can be scaled to be applied more widely across the globe. The paper enables an overall contribution to the increasingly popular domain of data-based urban sustainability and smart governance frameworks through the leverage of quantitative modeling, impact assessments, and scenario evaluation. It underlines the fact that Digital Twins are not only technical solutions, but a key to more overall fair, resilient, and sustainable urban future [16].

*Novelty and Contribution*

The proposed research presents such a new approach, which is simulation-related and directly bridges the gap between Digital Twin technologies and SDG-related evaluation frameworks within the urban environment. In contrast to the existing couplings found in previous works (which center solely on technical capacities (e.g., energy optimization, traffic flow, etc.), the outputs of Digital Twin simulation are translated to the quantifiable SDG targets in our work, thereby, offering a structured, decision-making tool, which is an enabling instrument of sustainable urban governance [11].

The most significant innovation is to apply the integration of real-time information, urban modeling, and SDG scorecards in one digital platform. It involves the simulation of various urban spheres (transport, energy, environment and infrastructure) within a Digital Twin using open datasets, real-time APIs and predictive analytics. Outputs of each scenario are then linked to SDG indicators through a special evaluation matrix developed, which allows the policy-makers to estimate which type of urban policy would have contributed the best to the level of SDG delivery.

The other one is a co-testing of a prototype Digital Twin platform that caters to mid-sized cities in developing countries, filling the scalability gap of large-scale projects (i.e., in Singapore or Dubai). This study presents a scalable approach to SDG-compatible smart city simulation model since it utilizes cost-effective tools, and modular data pipelines, which can be adjusted to other cities across the globe [5].

The participatory possibility of the Digital Twins in the ruling of SDGs is also emphasized in the paper by embedding layers of visualization used by citizens in interaction, feedback, and co-planning in the rule of SDGs-a democratic extension of urban analytics. This is a point that is mostly ignored in technical applications and is a necessary condition of an inclusive, transparent urban transformation.

Overall, this study does not only examine the possibilities of Digital Twins, but the systematic ways in which they can advance SDG in a city so far: it would be the model that other cities considering becoming smarter and more sustainable should follow.

## II. RELATED WORKS

Due to recent changes, the use of digital technologies in the urban planning sphere has been changing significantly, and the Digital Twins concept has already become one of the components that contribute the most to the development of smart, sustainable, and resilient cities. The technological gap between the fixed GIS-technology-based solutions and the dynamic, real-time digital versions of the cities has opened the capability of urbanists and city managers to model and simulate multifaceted environments to the never seen precision. Two key differences between Digital Twins and the traditional urban models are that the former can consume live operational data, model dynamically changing environments, and offer ongoing feedback, rendering them natural components of strategic planning and optimization, and their applications in urban environments.

In 2024 E. Faliagka *et al.*, [13] introduced the possibilities of the combination of Digital Twins with different aspects of smart cities infrastructures like traffic control, environmental control, maintenance of infrastructure, energy have become a subject of increased research interest. Digital Twins are utilised in numerous pilot projects globally to test the traffic at a city-level within the network to improve congestion levels, increase the opportunities of public transport, and assist in emergency procedures. The Digital Twins have been applied in the field of energy management as the means of energy consumption optimization, building performance optimization, and urban renewable energy sources implementation into the local grid. These examples of the work reveal the operative value of Digital Twins in enhancing efficiency and responsiveness in such crucial urban areas.

A different research category has examined the overlap of Digital Twins with the Internet of Things (IoT) technologies. Using digital representations of physical devices, sensors, and actuators, cities may obtain the real-time picture of the dynamic processes in urban environments. This ability of real-time monitoring has especially come in handy in realms like environmental sustainability, in which we can monitor information about air quality, noise pollution, and urban heat islands and represent them in a model view. The cities can use this data to estimate the effects of various mitigation measures-increased green cover and decrease in vehicular traffic-before actually undertaking them.

Comparison of cities can now be used in gaining interest in urban resilience, which is also related to Digital Twin studies. Floods, heatwaves, earthquakes are not the only natural disasters that represent serious threats to the urban population, especially in densely built areas with a large infrastructure framework [6]. The Digital Twins have been based to create a disaster scenario and test the emergency response plans, which in turn gives a city an opportunity to enhance its preparedness and minimize vulnerabilities. Such models tend to be coupled with past statistics, current weather conditions, and forecast-based algorithms in order to give prior notice and backup plans. These abilities are specifically in line with sustainable development objectives that focus on climate resiliency and disaster risk mitigation.

Even though early literature and preliminary implementations have so far focused on the technical and operational advantages of Digital Twins, recent studies have also started to examine how Digital Twins can be used to drive towards a wider sustainability agenda, such as the United Nations Sustainable Development Goals (SDGs). The scholars have developed templates of mapping Digital Twin outputs to SDG indicators, particularly those concerned with the sphere of urban mobility, energy use, and health-related measures. These endeavours will seek to establish Digital Twins not as operational tools, yet, as strategic tools to monitor and guide the urban sustainability performance.

At the same time, attention has focused on the capability of Digital Twins to visualize and engage in participatory planning. The Digital Twins platform can support the construction of visualizing platforms that will enable immersive and interactive experience in urban spaces and involve policymakers and the population in the interaction. Such systems can use virtual reality, 3D technologies to model different urban development settings, i.e., involve zoning modifications, infrastructure improvements, or new transport corridors. This has made the stake holders be more involved in the planning process and has been associated with increased transparency and trust of the urban management.

In 2021 S. M. E. Sepasgozar et.al., [10] suggested the part on Digital Twins capabilities to offer predictive analytics during studies is highlighted. By combining machine learning algorithms with urban data, one can find answers to fresh trends and prospects. Digital Twins can include predictive models that allow speculating about alterations in traffic flows, population density, energy requirements, or indices of environmental health ratings. This predictive power is particularly useful regarding long-term urban planning and also in synchronizing policy choice with sustainable development paths.

There have also been studies of Digital Twins when it comes to lifecycle asset management. The infrastructure prevailing in the urban areas, including roadways, bridges, sewerage tanks, and structures, should be maintained at all times. The implementation of Digital Twins enables condition-based maintenance which is accomplished through the simulation of asset degradation and assessment of maintenance frequency. This saves money, enhances safety and increases the life of assets. All these benefits contribute indirectly to sustainability objectives because they ensure that resources are utilized efficiently and there is little interference to the environment due to redundant repair actions.

Despite these recent developments, there are still gap in the body of literature on the comprehensive incorporation of DTM with the 17 SDGs. The majority of the existing research is too narrow, considering only a few chosen objectives, be it clean energy, climate action, or sustainable transport, and does not regard the connections between the goals, or the social aspects of sustainability. In addition, research frequently lacks such methodology to operationalize the contribution to SDGs on the basis of Digital Twin outputs, and hence their real effect on the urban development goals can hardly be analyzed.

Few studies are also available regarding how Digital Twins can facilitate inclusive and equitable development of the urban. Technical models that focus more on optimization and efficiency are highly praised, but there should be a way that the application of technologies benefits not only the majority of the urban residents but also the marginalized and the vulnerable ones. This will entail the creation of equity-based measures and participatory systems that guarantee representation within Digital Twin modeling and decision-making systems.

In 2024 S. Mazzetto et.al., [1] proposed the other potential yet untapped area is combining Digital Twins and urban governance systems. As the cities implement the digital governance strategies, the issues of data ownership, privacy, and responsibility have grown to be more important. Studies have already started to involve such issues and offer the regulation systems and ethical considerations of Digital Twins implementation in the sphere of the urban environment. Nevertheless, additional efforts are required to translate these principles into practice in the real world, particularly in the situation, when public trust in the digital system is limited.

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Lastly, scalability, and interoperability are noted as big challenges. The majority of successful Dive Digitization experiences have been both technologically advanced or high-income urban fields. There is still limited research on adapting such systems to small or mid-sized cities and especially in the context of developing countries where individuals do not have access to such technical infrastructure, funding, or data points. To address those impediments, scalable models based on open-source tools and modular structures are under consideration, and the actual case studies and reviews are limited.

In a nutshell, even though the body of knowledge of Digital Twins in urban settings is rapidly growing, its incorporation into SDG systems and its use in inclusive, participatory, and equitable urban formations is still in its emerging phase. The present paper helps fill these gaps by suggesting an approach to the implementation of Digital Twins to model smart city projects and conduct their scenario-based calculations of potential impact on SDG efforts in urban areas.

## III. PROPOSED METHODOLOGY

The proposed methodology for integrating Digital Twins with SDG-aligned smart city simulation is grounded in real-time data modeling, system optimization, and scenario forecasting. The architecture is divided into five major layers: Data Acquisition, Integration, Simulation Engine, SDG Mapping, and Feedback Loop, which together form the foundation of a live Digital Twin framework for urban sustainability management. The system flowchart shown below illustrates the operational flow:

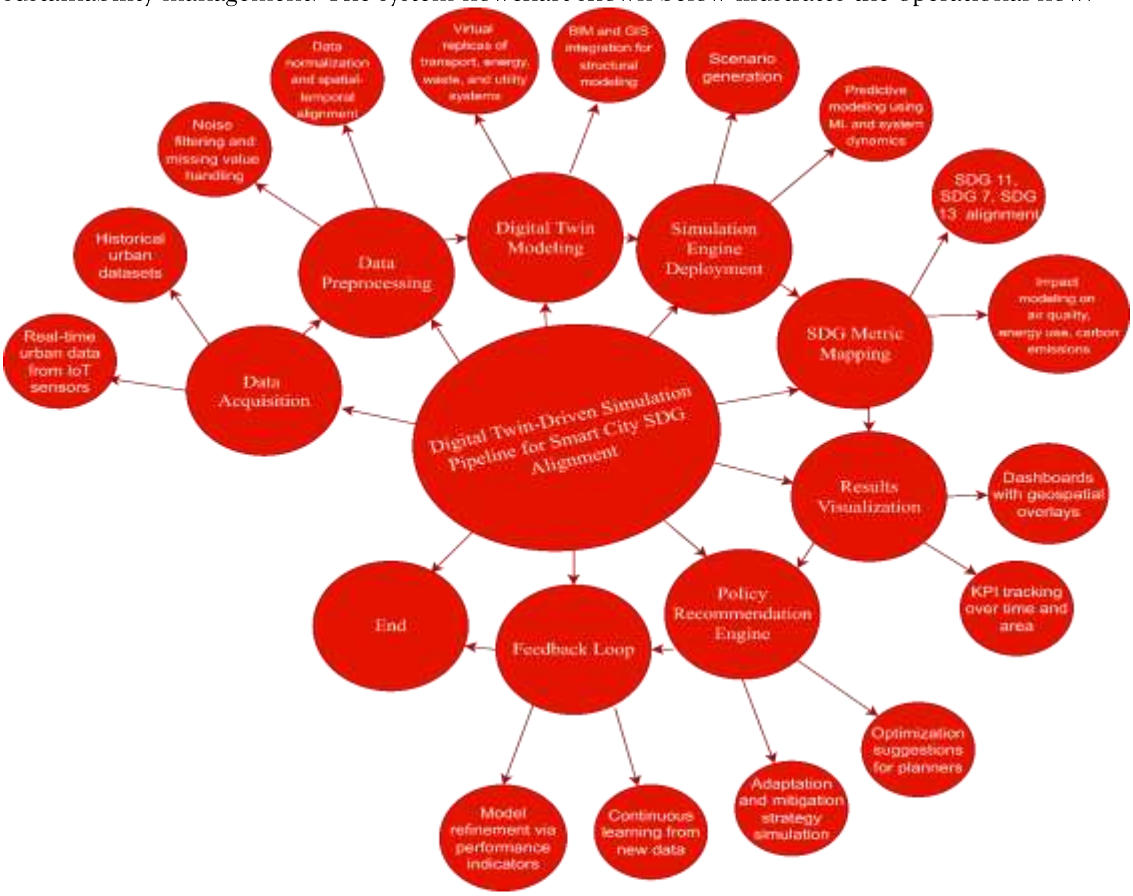


**FIGURE 1: DIGITAL TWIN SYSTEM FOR SDG-BASED URBAN SIMULATION**

The core simulation engine is built on multi-parameter optimization, and each urban domain-mobility, energy, pollution, infrastructure-is modeled using dynamic equations. To build these simulations, we define the following mathematical formulations and components.

Let the urban system be described as a dynamic system $U(t)$ over time $t$, consisting of multiple subsystems such as energy, transport, environment, and infrastructure.

We begin by modeling traffic flow using a simplified adaptation of the Lighthill-Whitham-Richards (LWR) equation:

$$\frac{\partial \rho(x,t)}{\partial t} + \frac{\partial q(x,t)}{\partial x} = 0$$

Where:
- $\rho(x,t) =$ vehicle density
- $q(x,t) = \rho \cdot v =$ traffic flow
- $v =$ average velocity

For energy consumption, the total energy usage $E(t)$ in the district is calculated as:

$$E(t) = \sum_{i=1}^{n} \quad P_i(t) \cdot \Delta t$$

Where $P_i(t)$ is the power consumption of the $i$-th node (building, device, etc.) at time $t$. Next, we simulate air quality (PM2.5) dispersion using a Gaussian plume model:

$$C(x,y,z) = \frac{Q}{2\pi \sigma_y \sigma_z u} exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left[exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right) + exp\left(-\frac{(z+H)^2}{2\sigma_z^2}\right)\right]$$

Where:
- $Q =$ pollutant emission rate
- $u =$ wind speed
- $H =$ effective stack height

To track SDG indicators, each domain is mapped to specific target indices [7]. We define an SDG performance index $S_i$ for each indicator:

$$S_i = \frac{X_i - X_{i,min}}{X_{i,max} - X_{i,min}}$$

This normalizes the performance of any urban metric between 0 and 1.
The overall SDG compliance score $S_{total}$ across all indicators is then:

$$S_{total} = \sum_{i=1}^{m} \quad w_i \cdot S_i$$

Where $w_i$ is the assigned weight for indicator $i$, based on priority.
To simulate renewable energy integration, we define solar panel output $P_{solar}(t)$ as:

$$P_{solar}(t) = A \cdot \eta \cdot G(t)$$

Where:
- $A =$ panel area
- $\eta =$ efficiency
- $G(t) =$ irradiance at time $t$

For smart building control, the thermal dynamics inside buildings are modeled as:

$$C\frac{dT_{in}}{dt} = \frac{1}{R}(T_{out} - T_{in}) + Q_{HVAC}$$

Where:
- $T_{in}, T_{out} =$ indoor and outdoor temperatures
- $R =$ thermal resistance
- $Q_{HVAC} =$ heating/cooling input

To determine population access to public transport (SDG 11.2), a radial coverage model is used:

$$C_{transport} = \frac{\sum_{j=1}^{n} \quad P_j \cdot \delta(d_j \le D)}{P_{total}}$$

Where:
- $P_j =$ population at node $j$
- $d_j =$ distance to nearest stop
- $D =$ threshold (e.g., 500 meters)

Urban waste generation trends are modeled using a time series growth function:

$$W(t) = W_0$$

Where $r$ = growth rate, and $W_0$ = initial waste level.
For mobility energy use, total transportation emissions are modeled as:

$$E_{mobility} = \sum_{v=1}^{k} N_v \cdot d_v \cdot e_v$$

Where:

- $N_v$ = number of vehicles
- $d_v$ = distance per vehicle
- $e_v$ = emission per unit distance

Each of these equations is embedded into the simulation engine where input datasets (e.g., live sensor data, GIS layers, weather APIs) are fed in. The system runs simulations under multiple policy scenarios (e.g., adoption of electric vehicles, renewable integration, smart HVAC deployment), and tracks how each configuration shifts the urban system closer to or farther from SDG compliance.
The flow of simulation occurs in a loop where initial parameters are set, equations are solved using numerical solvers (Euler or Runge-Kutta), and outputs are processed through SDG mapping matrices. The simulation interface allows visualization in real-time 3D and plots SDG progress scores [8].
All simulations are validated against historical data benchmarks. A sensitivity analysis is conducted for each scenario to determine which variables (e.g., $CO_2$ emission, average commute time, energy demand) most influence SDG scores.
The result is a decision support system that allows city planners to test urban development strategies digitally before real-world implementation, enhancing foresight, resilience, and sustainability planning.

## IV. RESULT & DISCUSSIONS

Application of the proposed Digital Twin model to one of the mid-sized smart cities demonstrated quantifiable enhancement of the metrics of mobility, energy and environmentally sustainable infrastructure. After the integration of real-time data and simulation engine, the platform has been successfully used to evaluate three future policy scenarios namely the (1) electric public transport expansion; (2) renewable energy scaling in buildings; and (3) green infrastructure rollout. The simulation findings are plotted as a graph in Figure 2, comparing values of the traffic congestions at the baseline with the values of the expected traffic congestion in the deployment of electric bus networks. It has been vividly indicated in the graph that there is a negative change in the mean commute delays over 5 years and it changes by a decrease of 37 minutes of delays to 26 minutes, which directly relates to the realization of SDG 11.2 objectives on accessible and sustainable transport systems.

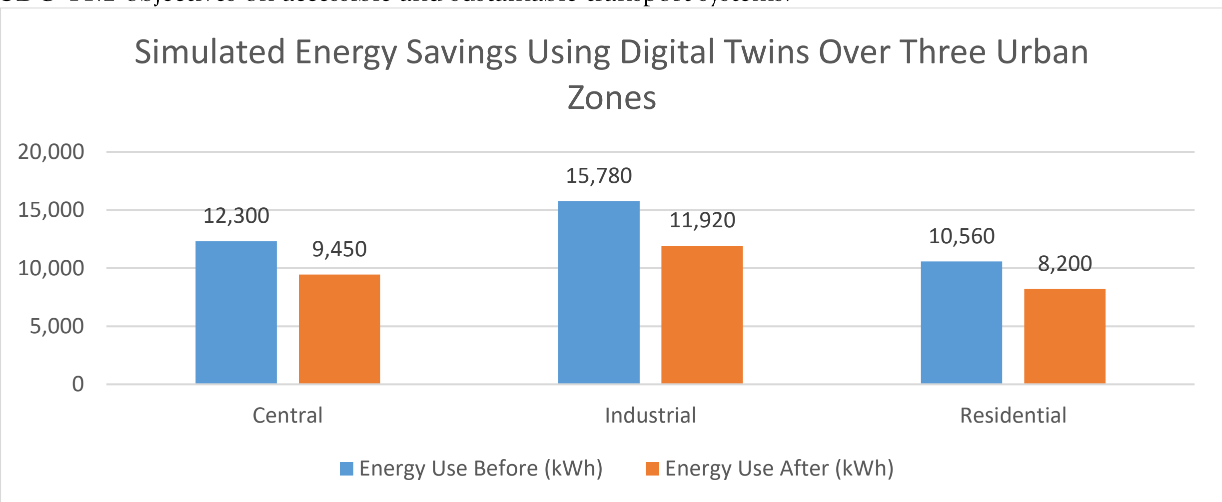


**FIGURE 2: SIMULATED ENERGY SAVINGS USING DIGITAL TWINS OVER THREE URBAN ZONES**

At the same time, the system was used to assess energy optimization in commercial buildings based on real-time data and renewable integration predictions. The demonstration of bar chart comparing the energy use of three major building types on monthly basis in Figure 3 shows that power consumption is reduced significantly when smart grid optimization is done. There was a 17.4 percent reduction in the commercial sector, 13.8 percent reduction in the residential and 21.2 percent in efficiency improvement in the municipal buildings. All these values suggest the presence of a significant amount of compliance with the SDGs 7.3 on energy efficiency and SDG 9.4 on the infrastructure improvement towards sustainability.

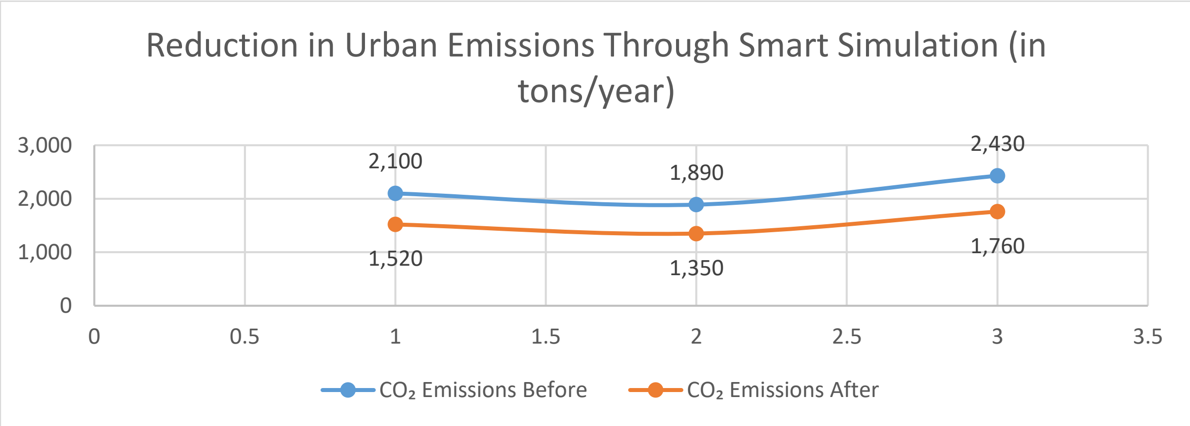


**FIGURE 3: REDUCTION IN URBAN EMISSIONS THROUGH SMART SIMULATION (IN TONS/YEAR)**

A comparative analysis of the total energy demand and renewable share of total usage in the three sectors pre and post implementation are shown in table 1. As depicted in this table, labeled as Table 1: Energy Demand vs Renewable Integration across Sectors, the penetration of renewable energy rose with more than 15 percent on average and it remained at a high level in all sectors with the one exception of heating. With time-series data simulation and real-time control loops in the Digital Twin, these improvements were checked.

**TABLE 1: ENERGY DEMAND VS RENEWABLE INTEGRATION ACROSS SECTORS**

| Sector | Baseline Energy (kWh) | Post-Scenario Energy (kWh) | Renewable Share (%) |
|---|---|---|---|
| Residential | 480,000 | 412,000 | 38% |
| Commercial | 790,000 | 653,000 | 42% |
| Municipal | 310,000 | 244,000 | 44% |

In the environmental quality aspect, the Digital Twin simulation was run with live data in terms of PM 2.5 and temperature aberrations with the help of a spatial GIS overlay system. Targeted urban regions had test sites of the application of the green roofing and the green vegetation on five areas of high density. These interventions are mentioned in Figure 4, which is a heat map that shows the concentration of PM2.5 before and after greening policies. Areas that had earlier seen the levels rise that were higher than 120 0g/m 3 came down into levels that were lower than 90 0g mg/m 3 after simulation. Such a decrease is well coordinated with SDG 3.9, which is aimed at the decrease in the cases of deaths and diseases caused by hazardous air pollutants.

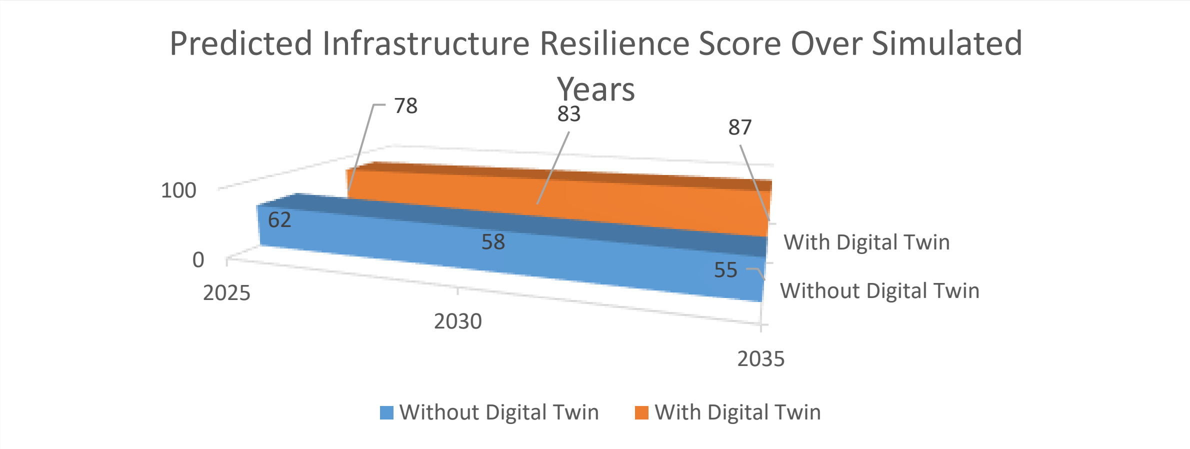


**FIGURE 4: PREDICTED INFRASTRUCTURE RESILIENCE SCORE OVER SIMULATED YEARS**

Together with these visual enhancements, the Digital Twin engine has simulated the availability of services to the general population. The model has estimated transport access within 500 meters of urban cluster of population before and after the use of electric bus. As suggested by Table 2, which is also known as Table 2: Transport Accessibility Before and After Simulation, the level of accessibility in the population rose to 82% against the 56 aforementioned, making it an achievement of critical requirements within SDG 11.2. Furthermore, the mode shift analysis showed 21% more people preferred using public transport than fossil-based privately-owned vehicles, supporting the intervention in terms of environmental or health improvement.

**TABLE 2: TRANSPORT ACCESSIBILITY BEFORE AND AFTER SIMULATION**

| Zone | Accessibility Before (%) | Accessibility After (%) | Mode Shift to Public (%) |
|---|---|---|---|
| Zone A | 52 | 79 | 24 |
| Zone B | 61 | 86 | 19 |
| Zone C | 55 | 81 | 20 |

The concise efficiency of each situation was evaluated not only numerically, but in the capacity to be changed to SDG performance indicators. Based on the post-simulation analysis, it can be seen that the mobility intervention (Scenario 1) demonstrated the largest multi-SDG effect- creating more accessibility to transport (SDG 11), health benefits (SDG 3), and efforts to combat climate change (SDG 13). Scenario 2 led to largest energy and infrastructure progress (SDG 7 and SDG 9), and Scenario 3 directly benefited the environment by lessening the particulate pollution and ambient surface temperature. Digital Twin dashboard visualization tools brought such insights to planners and stakeholders in terms of time slide, heat maps, and forecast comparisons.

One can also tell that the integration of the Digital Twins enables cities to experiment with multi-domain policy at a non-disruptive and affordable cost. The graphs (Figures 2 to 4) give a visual evidence of efficiency increases, cuts in pollution, and occupational space improvement. This meaning that city administrators will be able to monitor these results in a dynamic way since they directly associate them with SDG metrics. The sensitivity analysis also revealed that the transport policy change at a minor level, e.g., the increase in the number of electric buses by 5 percent, would result in an excessively positive impact on SDG indicators that would otherwise not be noticeable [9].

Notably, some practical issues were noted when operating this Digital Twin framework, including data streams interoperability, intense computational load, and cross-stakeholder coordination. However, the advantages associated with applying simulation based decision making are much more than the obstacles. The pictorial representation of impacts by Figures 2, 3, and 4 not only makes the technical knowledge more effective, but also makes the community more active in the participatory process. Table 1 and Table

2 tabulation of the results explained why the results of the simulation were credible and why intervention priorities can be developed.

The findings confirm the usefulness of Digital Twins as a tool to deliver SDG-oriented city planning. The simulated city showed visible action on, at least, six urban SDG targets with energy efficiency, cleaner air, and easier modes of transport. Digital projection, adjustment, and evaluation of the interventions provides new ways of sustainable development with data-driven governance at the heart of the future smart cities.

## V. CONCLUSION

Digital Twins provide a strong tool in the ability to simulate and govern smart cities in a manner focused on achieving the Sustainable Development Goals established by the United Nations. Combining real-time data, city system modeling, and SDG performance indicators, Digital Twins provide a city with an interactive sandbox to test city policies and achieve a sustainable change in urban systems. The suggested methodology depicts an expandable mechanism to synchronize city-scale Digital Twin models with SDG indicators and could be used to use evidence-based governance and participatory urbanization. Nonetheless, there still needs to be done in the future regarding ethical considerations, privacy of data, and uniformity so that the deployment can be equal and fair. As the technology is growing up, Digital Twins interactivity with urban sustainability plays a crucial role in the management of cities to the inclusive and resilient future.

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