Revolutionizing Urban Life: Smart Mobility and Smart Cities in Bangladesh

Quazi Monjur E-Elahi, Syeda Umme Habiba and
Md Sufi Ahmed Talukder
Department of Mechanical and Production Engineering
Ahsanullah University of Science and Technology (AUST)
Dhaka, Bangladesh

Abstract

Smart Cities embody a holistic approach to urban development, leveraging modern technologies to enhance citizens' quality of life, adapt infrastructure, and promote sustainable growth. Central to this concept is Smart Mobility, a vital response to urbanization and rising populations. This study underscores widespread acceptance of Smart City implementation, with Smart Mobility as a pivotal component. It highlights three key facets of Smart Mobility: intelligent use of ICT, smart public transport, and advanced parking technologies. Notably, surveyed cities express a willingness to allocate funds for this transformative vision, indicating a strong commitment to address urban challenges. Smart Cities have rapidly gained momentum as a holistic solution to pressing urban issues like traffic congestion, pollution, energy consumption, and waste management. This integrated approach amalgamates various urban policies into a comprehensive strategy aimed at reducing environmental footprints and improving urban residents' quality of life. Mobility, a complex concern with environmental and economic dimensions, emerges as a focal point. Smart Mobility, deeply reliant on ICT, optimizes traffic and engages citizens to enhance urban livability and public transport services. Smart Mobility aligns with the UN's sustainable development goals and encompasses traffic reduction, ecological optimization, active mobility, green fuels, and citizen participation. The integration of IoT, AI, Blockchain, and Big Data technologies reshapes urban paradigms, heralding a future marked by innovations such as Mobility-as-a-Service, traffic optimization, and autonomous vehicles. This review unveils the evolving landscape of Smart Mobility, emphasizing its pivotal role within the Smart City ecosystem and highlighting transformative opportunities and challenges in shaping the cities of tomorrow.

Keywords:
Smart City, Smart Mobility, Sustainability, Optimization, Development.

1. Introduction

The rapid urbanization and increasing population in Bangladesh have led to a surge in challenges related to urban mobility, infrastructure, and the overall quality of life in cities. In response to these challenges, smart cities have emerged as a transformative concept, harnessing advanced technologies to improve sustainability, enhance the quality of life, and optimize city services while reducing human intervention. This paradigm shift towards smart cities is significantly driven by the integration of information and communication technologies, digital machinery, and mechanical systems, all working in harmony to create a more efficient and responsive urban environment. A Smart City represents a comprehensive system of services implemented through modern technologies whose purpose and goal are to improve the quality of life for the citizens (Brčić et al. 2018). Smart cities have been evolving since their inception in the 1990s, with significant advancements in technology, especially the Internet of Things (IoT), playing a pivotal role in their development.

Smart cities are usually developed urban areas in which a system of interrelated information, communication, mechanical, and digital machinery technologies is implemented to minimize human involvement with the city services and improve the quality of services for citizens (Tahmasseby 2022)**.** These cities emphasize various key aspects such as life quality, technology, economy, sustainability, information and communication technology (ICT), and healthcare. They aim to meet the rising expectations of consumers, foster shared consumption practices, leverage multiple transportation options, and utilize emerging ICT technologies and big data analytics to create innovative, shared, and cost-effective solutions across various domains, including infrastructure, mobility, operations, energy, services, and utilities. The Smart City concept has been developed about progressing urban development and the resulting increase

in the needs of local communities, and also in relation to increasing financial and environmental costs (Orlowski & Romanowska, 2019)**.** While the role of technology, administration, and society in building efficient governance, smart mobility, and sustainable environments has been widely recognized, the specific focus on Information and Communication Technology (ICT)-enabled mobility in the context of smart cities deserves special attention. Smart mobility is an emerging concept that is increasingly aligned with sustainable world development, taking into account the 17 sustainable development goals set by the United Nations for 2030 (Paiva et al. 2021). In Bangladesh where urbanization continues at a rapid pace, thus the focus is established on the proposal that there is a need to explore and implement smart mobility solutions to alleviate the challenges associated with urban living. Furthermore, to shed light on the evolution of the smart city concept, with a primary focus on smart mobility within planned cities.

Objectives
The objectives of this research are:
To introduce and explore the relevance of smart mobility solutions in Bangladesh's urban environment.
To review existing smart mobility initiatives and their impact in Bangladesh and assess insights for future development goals.
To evaluate and transform the feasibility of smart cities in select Bangladesh's urban areas focusing on infrastructure, tech, policies, and citizen engagement.

2. Literature Review
Smart cities and smart mobility are two interrelated concepts that aim to improve the quality of life for urban residents by leveraging technology and data-driven solutions. The beauty of these concepts lies in their holistic approach to urban development. They aren't merely about futuristic gadgets or high-tech solutions; they are about human-centric innovation. Smart cities and smart mobility aim to create environments where citizens can thrive, offering safer streets, streamlined commutes, and sustainable living. They address the challenges posed by rapid urbanization, transforming cities into vibrant, efficient, and inclusive hubs that adapt and evolve with the needs of their inhabitants. Smart city is an urban environment that utilizes information and communication technology (ICT) to enhance the efficiency of city operations, improve the quality of life for its citizens, and promote sustainable development. Smart mobility is a subset of the broader smart city concept that focuses specifically on improving transportation and mobility within urban areas. It leverages technology to create more efficient, sustainable, and accessible transportation options. smart cities and smart mobility are part of a broader urban development strategy that seeks to use technology and data-driven solutions to make cities more efficient, sustainable, and livable while also addressing the challenges associated with urbanization, such as traffic congestion, pollution, and limited resources. Both concepts aim to enhance the overall quality of life for city residents by creating more connected, accessible, and sustainable urban environments. Moreover, the synergy between smart cities and smart mobility extends beyond efficiency; it's about creating a holistic urban experience. Citizens benefit from reduced commute times, cleaner air, and enhanced safety. This interconnectedness aims for a seamless urban lifestyle where data-driven insights empower decision-making for city planners and residents alike. As cities evolve, the fusion of smart technologies with urban planning becomes pivotal, ensuring sustainable, adaptable, and people-centric environments.

Figure 1. Synergy of Smart City with Smart Mobility

2.1 Smart City

The global trend of urbanization and growing environmental awareness have risen concerns and demands to develop cities to become smarter (Paalosmaa & Shafie-khah, 2021)**.** A smart city is not just a geographical location but a living ecosystem. It's a dynamic network of interconnected components - infrastructure, technology, governance, and people - working in harmony to create a sustainable, efficient, and livable urban environment. At its core, a smart city leverages cutting-edge information and communication technologies to collect and analyze data, make data-driven decisions, and enhance the quality of life for its residents. Smart city initiatives have been researched primarily in the developed country context (Vu & Hartley, 2018a)**.** While the promise of smart cities is vast, challenges remain. Privacy and data security concerns, digital divides, and the need for significant investments are just a few of the hurdles to overcome. However, as technology continues to advance and cities gain more experience in implementing smart solutions, these challenges can be addressed. The concept of smart cities represents an evolution in urban planning and development. It's a testament to humanity's ability to adapt and innovate in the face of growing urbanization**.** Local urban identity, culture and knowledge ecosystems continue to shape innovative capacity and technological acceptance despite global exchange in talent, trade and technology. This has important implications for the development and implementation of future smart cities (Sepasgozar et al. 2019)**.** By harnessing the power of data, connectivity, and sustainable practices, smart cities are paving the way for a brighter, more efficient, and more livable urban future. The journey is ongoing, and as technology continues to advance, the possibilities for smart cities are only limited by our imagination.

Figure 2. Smart City

2.2 Smart Mobility

In an era marked by rapid urbanization and technological advancement, the way we move within cities is undergoing a profound transformation. The topic of mobility is an important aspect of today's growing cities. The transportation of people and goods within the city is crucial for the development of the economy and the everyday life on it (Baucells Aletà, 2016)**.** Smart mobility, a critical component of the broader smart city concept, is revolutionizing transportation in urban environments. Smart Mobility is not a unique initiative, but a complex set of projects and actions, different in goals, contents and technology intensity (Benevolo et al. 2016)**.** It encompasses a range of innovative solutions and strategies designed to make transportation more efficient, sustainable, and user-friendly. As we navigate the future of transportation, smart mobility stands as a beacon of innovation and progress. It seeks to create transportation systems that are not only efficient but also sustainable and accessible for all. By embracing these innovative solutions and making urban transportation smarter, we are taking significant steps toward improving the quality of life in our cities and reducing our environmental impact. The journey towards smarter, more efficient mobility is an exciting one, and it holds the potential to revolutionize how we move within our urban landscape.
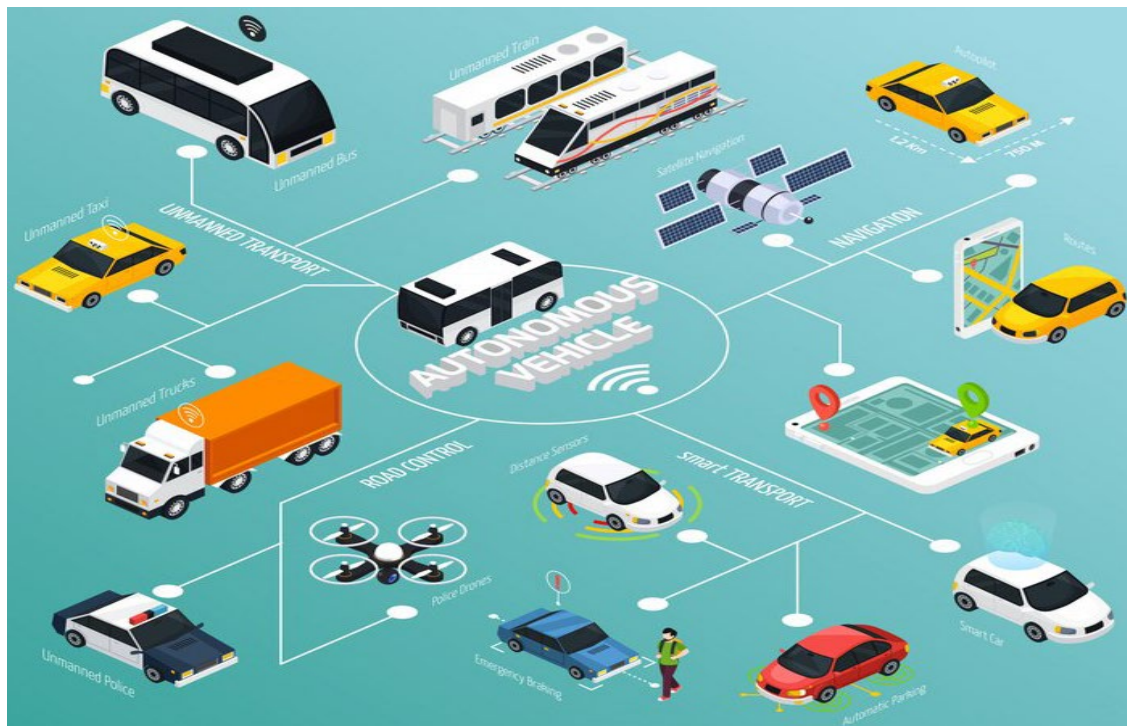
Figure 3. Smart Mobility

2.3 Qualitative Analysis

Smart mobility initiatives should prioritize the engagement of local communities in decision-making processes. This may involve public consultations, citizen feedback, and community-driven mobility solutions tailored to the specific needs of neighborhoods within a smart city. Beside to assess how smart mobility solutions address will add disparities in transportation accessibility. This includes evaluating whether public transportation options are designed to cater to underserved communities and economically disadvantaged individuals. It is evident to examine the regulatory environment that governs data usage in smart mobility. This includes ensuring that data privacy and security are upheld to build public trust in the collection and utilization of mobility data. Furthermore, to analyze the effectiveness of public-private partnerships in developing and implementing smart mobility solutions and to assess whether these partnerships align with the city's long-term goals and are accountable to the public. A consideration should be made for the user-friendliness of smart mobility applications and services. To consider whether these technologies are accessible to people of all ages and abilities, and whether they provide a seamless and enjoyable experience. To analyze how smart mobility initiatives impact people's behaviors, travel patterns, and choices. Identify whether these solutions promote sustainable and socially responsible commuting habit. Finally, to assess the ecological footprint of smart mobility initiatives within the city. To evaluate the contribution to reducing emissions, alleviating traffic congestion, and improving air quality. And if there is a possibility to examine the extent to which smart mobility solutions integrate renewable energy sources, electric vehicles, and sustainable infrastructure, fostering a culture of environmental responsibility.

2.4 Transformation: How Smart Mobility Shapes the Smart Cities of Tomorrow

The integration of smart mobility in smart cities extends well beyond transportation efficiency. It bolsters disaster resilience by improving evacuation plans, route optimization, and response agency coordination. Cybersecurity safeguards critical infrastructure and sensitive data. Culturally sensitive initiatives honor a city's heritage and encourage lifestyle shifts, enhancing quality of life. Enhanced urban infrastructure aids functionality and accessibility, while scalable solutions accommodate future growth and technology advancements. This holistic evaluation underscores the broad impact of smart mobility, shaping resilient, culturally vibrant, and efficient smart cities that adapt and thrive in a rapidly changing world. Information accuracy and decision-making speed are of paramount importance in managing today's mobility of goods and people inside the city (Mangiaracina et al. 2017)**.**

Understanding these qualitative aspects of smart mobility within the context of a smart city provides a holistic perspective on how technology, policy, and community engagement work together to shape urban transportation for the better. It underscores the need for a multidimensional approach that goes beyond data and numbers, focusing on the societal, economic, environmental, and cultural impacts of these transformative initiatives. This study underscores widespread acceptance of Smart City implementation, with Smart Mobility as a pivotal component.
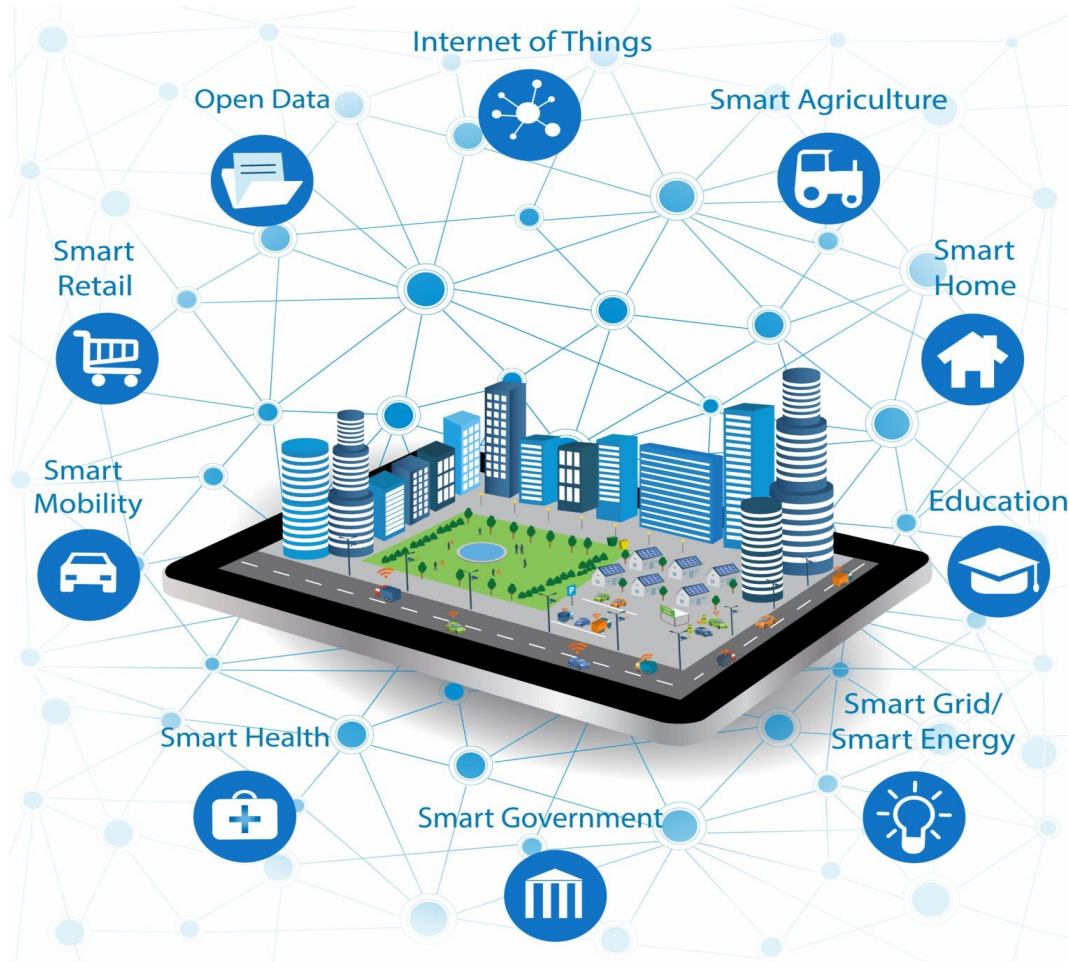

Figure 4. Evolution of Smart Mobility & Smart Cities of Tomorrow

3. Methodology

Implementing an integrated transportation system that leverages real-time data and connectivity can optimize various modes of transport. This approach reduces congestion, minimizes environmental impact, improves accessibility, and enhances the overall quality of life for residents.
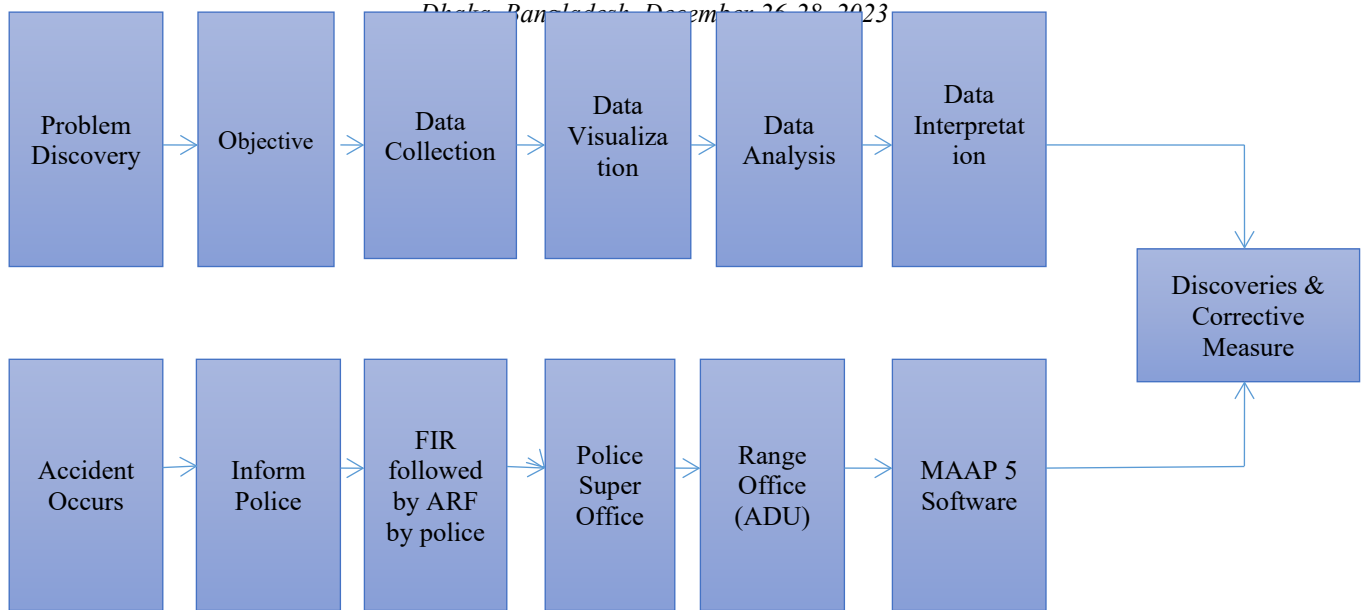
Figure 5. Transport Optimization System

This proposed methodology aims to ensure widespread acceptance of smart city implementation in urban areas like Bangladesh through advancing smart mobility. It addresses the unique challenges and opportunities of the region while fostering inclusivity, sustainability, and adaptability to local needs.

4. Data Collection

Accident statistics depend critically on the accuracy of data itself as well as on the reliability of the sequence of information. (Institution of Engineers (Bangladesh) et al. 2011). As can be seen from the Table 1 of road accidents of the last six years at the table, andsee the age of the victims of road accidents, it is seen that most of them were in the age group of 36-40 years total of 247 accidents. And the second-highest 234 accidents in the age group of 21-25 years old. 26–30-year-olds were involved in the third-highest number of accidents (232) on the road. The age bracket of 71 to 75 years had the fewest accidents, with only 7 totals. Looking at the table, it appears that young people were the main victims of road accidents.

Table 1. Age distribution of traffic fatalities and injuries in Dhaka city (2015 to 2020) (yu et al., 2021)

Age (years)	Fatal	Grievous	Simple	Total
0-5	13	4	2	19
6-10	29	10	12	51
11-15	42	19	8	69
16-20	88	45	15	148
21-25	116	89	29	234
26-30	107	80	45	232
31-35	124	60	31	215
36-40	157	61	29	247
41-45	98	50	20	168
46-50	90	45	12	147
51-55	40	14	1	55
56-60	54	14	4	72
61-65	23	12	6	41
66-70	25	3	0	28
71-75	6	1	0	7
<76	11	1	1	13

Total	1023	508	215	1746

Table 2 shows, the highest number of road accidents occurred on Friday at 272 accidents, which is 16% of total accidents. The second-highest accidents with 266 accidents (15% of total accidents) occurred on Monday and Thursday. Table 4 also shows that 248 and 249 road accidents occurred on Tuesdays and Wednesdays, and a minimum of 223 and 232 accidents occurred on Saturdays and Sundays.

Table 2. Weekly distribution of total accident (yu et al., 2021)

Weekday	Fatal	Grievous	Simple	Collision	Total
Monday	179	63	14	10	266
Tuesday	183	41	14	10	248
Wednesday	172	59	09	08	249
Thursday	177	60	11	09	256
Friday	197	53	13	09	272
Saturday	160	51	08	04	223
Sunday	171	46	08	07	232
Total	1239	373	77	57	1746

Table 3 shows the accident pattern in Bangladesh for the next six years, from 2015 to 2020. In 2015, there were 390 accidents and 390 people wounded, which is much more than the previous and subsequent years' totals. Second-height accidents 326 happened in 2016. But in 2017 and 2018 it decreased a bit and in 2019, this trend has become worse. It has gone above 300+ again. But one thing to note in the Table 3, the number of accidents in 2020 is relatively low. One of the main reasons is vehicles and pedestrians most of the time could not move during the COVID-19 lockdown.

Table 3. The number of accidents, number of causalities in Dhaka city in the six years (yu et al., 2021)

Year	Number of accidents			Number of Causalities	
		Fatal	Grievous	Simple	Collision
2015	390	287	67	24	12
2016	326	236	68	09	13
2017	267	186	56	16	09
2018	273	195	60	05	13
2019	318	218	82	12	06
2020	172	117	40	11	04
Total	1746	1239	373	77	57

5. Results & Discussions

Dhaka's road traffic accidents were alarming from 2015-2020, peaking in 2015. COVID-19 lockdown in 2020 reduced incidents. Pedestrians, males, and Fridays were disproportionately affected. Furthermore, accident reporting in Bangladesh involves FIR or GD entries by police, data collection at ARF, and analysis through MAAP software by ARI. However, issues like incomplete forms, lack of comprehensive reporting, and untrained officers result in many accidents going unrecorded or reported inaccurately, impacting road safety measures. So, it is necessary to further understand local challenges and to engage in diverse stakeholders. To educate citizens and involve the community in decision-making. Establish adaptable policies and address data privacy and cybersecurity concerns. Invest in ICT infrastructure, including high-speed internet and road network upgrades. To further implement data collection and analysis for real-time traffic and transportation information. To improve public transportation quality and convenience with contactless payment and tracking. Deploy smart parking solutions and variable pricing strategies. Create a seamless multi-modal transportation network. Promote low-emission vehicles and establish charging infrastructure.

Ensure accessibility for all citizens. Define KPIs and maintain a feedback loop for continuous improvement. To highlight transformative opportunities and challenges in shaping the cities of tomorrow. Smart City formed through Smart Mobility.

6. Conclusion

The integration of urban governance and technology, generally referred to as "smart cities," is driven both by global private enterprise and by local and national governments seeking to strengthen economic competitiveness and improve quality of life (Vu & Hartley, 2018b). Smart cities and smart mobility are the future of urban development, and in the context of Bangladesh, they offer immense promise for addressing the unique challenges faced by its rapidly growing urban centers. The proposed methodology underscores the need for comprehensive planning, stakeholder engagement, and data-driven decision-making to transform these areas into smart, efficient, and sustainable urban hubs. As Bangladesh moves forward, the implementation of smart mobility solutions will reduce congestion, improve accessibility, and enhance the quality of life for its citizens. The adoption of advanced parking technologies, intelligent use of ICT, and efficient public transportation systems will play a pivotal role in this transformation. In the future, we can expect further innovations in smart city technology, increased environmental sustainability, and even more personalized mobility solutions. By prioritizing inclusivity and accessibility, Bangladesh can pave the way for a brighter urban future that sets an example for sustainable development in a rapidly urbanizing world. The journey toward smart cities in Bangladesh is not just a vision but an imperative, and it holds the potential to shape the nation's urban landscape for generations to come.

References

Baucells Aletà, N., SMART MOBILITY IN SMART CITIES, *Libro de Actas CIT2016*, *XII Congreso de Ingeniería Del Transporte*, CIT2016, Congreso de Ingeniería del Transporte, 2016.

Benevolo, C., Dameri, R. P., & D'Auria, B., Smart Mobility in Smart City: Action Taxonomy, ICT Intensity and Public Benefits., In T. Torre, A. M. Braccini, & R. Spinelli (Eds.), *Empowering Organizations,* vol. 11, pp. 13–28, Springer International Publishing, 2016.

Brčić, D., Slavulj, M., Šojat, D., & Jurak, J., The Role of Smart Mobility in Smart Cities, 1601–1606, 2018.

Institution of Engineers (Bangladesh), Noor, M. A., & Institution of Engineers (Bangladesh) (Eds.), *Proceedings of the 4th Annual Paper Meet and 1st Civil Engineering Congress*, Dhaka, Bangladesh, Civil Engineering Division, Institution of Engineers, Bangladesh, December 22-24, 2011.

Mangiaracina, R., Perego, A., Salvadori, G., & Tumino, A., A comprehensive view of intelligent transport systems for urban smart mobility, *International Journal of Logistics Research and Applications, 20(1), 39–52,* 2017.

Orlowski, A., & Romanowska, P., Smart Cities Concept: Smart Mobility Indicator, *Cybernetics and Systems,* 50(2), 118–131, 2019.

Paalosmaa, T., & Shafie-khah, M., Feasibility of Innovative Smart Mobility Solutions: A Case Study for Vaasa, *World Electric Vehicle Journal,* 12(4), 188, 2021.

Paiva, S., Ahad, M., Tripathi, G., Feroz, N., & Casalino, G., Enabling Technologies for Urban Smart Mobility: Recent Trends, Opportunities and Challenges, *Sensors,* 21(6), 2143, 2021.

Sepasgozar, S. M. E., Hawken, S., Sargolzaei, S., & Foroozanfa, M., Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies, *Technological Forecasting and Social Change,* 142, 105–116, 2019.

Tahmasseby, S., The Implementation of Smart Mobility for Smart Cities: A Case Study in Qatar, *Civil Engineering Journal,* 8(10), 2154–2171, 2022.

Vu, K., & Hartley, K., Promoting smart cities in developing countries: Policy insights from Vietnam, *Telecommunications Policy,* 42(10), 845–859, 2018.

Yu, J., Rabbi, F., Bin Siraj, M. S., & Zhenzhen, L., Road Traffic Accident Situation in Dhaka City, Bangladesh, 6, 12, 2021.

Biographies

Quazi Monjur E-Elahi, is a newly graduate student of Industrial and Production Engineering (IPE) under the Department of Mechanical and Production Engineering (MPE) at the Ahsanullah University of Science and Technology (AUST). His research interest includes the area of Industrial Management, Manufacturing process, Supply Chain Management, Quality Assurance & Control, Advanced Material Processing, Lean Manufacturing, Technology Management and Industry 4.0. He has vast experience in content writing and research, documentation management process, content research, content quality assurance & control (QAC), team management. He has proficiency in Microsoft Word and Excel. He is also focused in the research of the aerospace industry and wants to work within such an industry. He also participated in a multiple number of engineering & business case competitions showcasing his ability to solve complex problems and work collaboratively in a team. He was also the former Vice President of IEOM Society AUST Student Chapter. Furthermore, he was also the former Chief Advisor and President of Josephite Chess Club.

Syeda Umme Habiba, is a newly graduate student of Industrial and Production Engineering (IPE) under the Department of Mechanical and Production Engineering (MPE) at the Ahsanullah University of Science and Technology (AUST). Her research interests encompass areas like Industrial Management, Manufacturing processes, Advanced Material Processing, Lean Manufacturing, and Industry 4.0. With experience in content writing, research, and proficiency in Microsoft Word and Excel, she possesses a solid theoretical and practical foundation in her field. Her specific interest in the aerospace industry reflects a clear career goal in a high-tech and innovative sector. She also participated in a big number of engineering & business case competitions showcasing her ability to solve complex problems and work collaboratively in a team. She was also the former Director of News Letter & Publication of IEOM Society AUST Student Chapter. Furthermore, she was also the former executive member of SAGC Science Club.

Md Sufi Ahmed Talukder, is a newly graduate of the Mechanical Engineering (ME) program under the Department of Mechanical and Production Engineering (MPE) at the Ahsanullah University of Science and Technology (AUST). His research interest includes Automobile, Aerospace, Industrial management, Manufacturing processes, Robotics, Power plant, Renewable energy, Simulation and Modeling. He has vast knowledge in team management, documentation management processes, content writing and research. He has proficiency in Microsoft Excel and Word. He also participated in a various number of engineering competitions, like (IMECHE UAS Challenge 2023), showcasing his ability to solve complex problems and work collaboratively in a team. His skills and passion for innovation position makes him asset in engineering and technology aspects. Furthermore, he was also the former General Secretary of IMECHE AUST Student Chapter.