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URBAN MOBILITY AND THE REALISATION OF THE INTERNET OF THINGS ON COMMUNITY SPACE: The expansion of Nigeria's transport system

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Abstract

Urban populations are growing and coming from diverse parts of the world, especially in emerging nations like Nigeria. Due to the potential for increased demand for urban services brought on by this hitherto unheard-of human population, the transportation infrastructure and emerging internet technologies will likely face additional strains. For individuals to access housing, places of employment, and other services, urban mobility is essential to the smooth running of any given community. Although internet mobile services haven't completely replaced urban transport systems, the current development has lessened the number of requirements put on transit inside urban mobility in our towns and cities. The purpose of this article is to assess how well urban mobility and the Internet of Things function in the transportation system. The article evaluates the degree of accessibility for travellers, the operational effectiveness of the Internet of Things, and the difficulties associated with urban mobility with the Internet of Things. The study found convincing evidence of a connection between urban mobility and the internet as well as a correlation coefficient.

Keywords: *Mobile networks, wireless fidelity networks, operational effectiveness, transport systems, urban mobility*

Introduction

The Internet of Things is advancing the globe by facilitating network systems and urban mobility. The urban transport operations that make up the Internet of Things are interconnected in a network and require intelligence to communicate with other embedded devices. The fusion of data collecting, computing, and Internet technologies is known as the Internet of Things [1]. By 2050, 66% of people will live in cities, where rapid urbanisation and rising congestion are already major concerns [2].

The demand for both public and private automobile ownership rises as a result of transit orientation development, which is focused on transport systems and alternative solutions to the problem of traffic congestion in our cities [3]. The current idea of

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smart mobility is made possible by the Internet of Things, which is necessary for new strategies in urban transport [2]. Because the performance made accessible to each consumer varies depending on time and place, the number of users accessing a network in a certain region or location can have an impact on service efficiency.

Intelligent transport system implementation greatly benefits from traffic predictions based on real-time data given by the Internet of Things [4]. Smartphones may communicate via Bluetooth and Wi-Fi communication technology as more electronic gadgets, like as cameras, laptops, and iPods, are made accessible in mobile phones [5]. Road congestion is conceptualised as traffic congestion when the metropolitan road network is unable to handle the volume of traffic at a certain location [6].

The development of low-power, wide-area networks have many applications in the modern period, helping to overcome the difficulties associated with technology selection [7]. Internet of Things provides an excellent device network solution, for various management system, coordination, retrieving, identifying, analysing storage over time [8].

By 2025, there will be 75 billion internet-connected gadgets, with a potential annual economic effect of $11.1 trillion [9]. Slums, sprawl, and population growth were all caused by population growth and mobility [10]. Through the expansion of economic activities, distant operations, and social contacts, the Internet of Things substantially aided in the development of linked life [11]. In driving circumstances where electronic control systems aid in making decisions for the driver easier, advanced drivers assistance systems have the potential to improve safety and comfort [12].

According to estimates from the Civic Air Transport Association [13], by the year 2050, roughly 100 cities worldwide would have automated air vehicle passenger transport services in place, with an average of 1,000 passenger drones operating in each city. In order to create intelligent systems, ubiquitous mobile accessibility, and cutting-edge technologies like intelligent transportation systems, physical items must be connected to the Internet [14]. Big Data is a technological system that was developed to deal with the information explosion brought on by the rise of internet and mobile data consumers [15]..

Automated toll collection is a tactic used to quell motorist complaints about the inconveniences of physically paying tolls at tollbooths [16]. The significant traffic congestion on city streets results in a relative loss of labour productivity and the loss of several hours of workdays [17]. According to Brief, (2018), the Internet of Things is a technological method for connecting physical items using embedded sensors, actuators, and other gadgets to gather and communicate data about network activities in real time.

In the section on transportation, this study evaluates the Internet of Things connection and urban mobility, as well as the relationship between urban mobility and service delivery and performance functions for urban commuters. The report elaborates on how customers' access to online retailers and drivers' responsiveness to passengers' requirements as they occur are bringing the Internet of Things into the transportation industry. The study found that there is a link between drivers and passengers and that urban mobility and performance services are practically cooperating to satisfy particular demands of transportation efficiency. This relationship was shown through interviews with both passengers and drivers. Additionally, aid in easing traffic congestion with the implementation of an automated toll device (ATD)-based toll gate collecting system. The study found that, in contrast to customary driver and passenger activities towards mobility services, urban mobility and internet of things technologies deliver immediate and urgent feedback.

Background of the Study

Urban mobility cannot be isolated from the internet of things globally, particularly in Nigeria, the most populated nation in Africa with over 214,368,000 residents. In contrast, road infrastructure is a big issue in the industrialised world because of excessive road usage and unsuitable speed. As long as urban transport modes were owned and operated by independent entities, such as agencies, car owners, and trucking firms that displayed little to no contact, they remained inactive. Urban mobility changes in response to the growth of information and communication technology, resulting in high levels of interconnection and usage. Mobile device accessibility provides the framework for communication between drivers and passengers, matching driver need with passenger desire. Using Google Maps and satellite pictures, urban mobility and the internet of things let tourists and drivers navigate urban roadways and alert drivers to hazardous conditions while they are driving.

Literature Review

Li & Wang, (2020) examined the impacts of Internet of Things technology applications on accuracy, comprehensiveness, stability, coordination, and economy while also proposing a model of urban and rural passenger transport regulatory information construction and development. Vaidian et al., (2019) investigate the consequences, difficulties, and technical solutions of the internet's effect on urban transportation. Through an online questionnaire, the study used a mixed-methods approach to analyse both qualitative and quantitative research. The study used descriptive statistical analysis and the Spearman's correlation coefficient.

The traffic forecasting performed by Y. Zhang et al., (2020) is a crucial precondition for the implementation of intelligent transport systems in urban traffic networks[20]. To describe the temporal and geographical correlation of traffic flows, the study used RNN and CNN/Graph Convolution Network (GCN). Ikpehai et al., (2019). Based on vehicle disruptions to geomagnetism, monitored vehicle flow and speed and utilised the slotted ALOHA protocol to communicate between data nodes [21][1]. To keep track of the location and speed of the cars, the research used a wireless sensor network. The performance and management of household appliances via the internet of things are examined by Ali & Bao, (2021) using a variety of remote controllers. H. Ugwuanyi et al., (2017). The improvement of driving machine safety and the prevention of accidents are the main goals of the automotive industry [12].

The Advanced Drivers Assistance System was created by Verbeke, (2010) as a human-machine interface that tends to somewhat increase road safety and reduce fatalities. They also explored ways to avoid over-speeding, vehicle crashes, and driver alertness systems. In order to analyse traffic cone detection with the help of course planning in certain traffic scenarios, [23], [1] gathered data from the Beijing Information Science and Technology University Laboratory. They used coloured and monochrome cameras to record the position of the cones. Shahrour & Xie, (2021) examined how to build smart cities using crowdsourcing and the Internet of

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Things. focuses on the data utilisation in smart city solutions and the design of the smart city idea.

The state of the art, attempts to protect the Internet of Things network, and issues with regard to privacy, a lightweight cryptographic framework, robustness, and resilience management are all examined by [25]. The Global System for Mobile Association outline how cellular networks in Asia-Pacific were created from utility networks and how many economic sectors might gain from improved connection (Asia & Intelligently, 2019), [27]. However, in-depth data analysis, and fresh perspectives. The effects of smart mobility and the underlying new technologies on society and transport infrastructure are examined by [28]. In order to emphasise the current scenario, Sinniah et al., (2021) evaluated the ascertainment of public transportation to estimate the effectiveness of the bus transportation system based on the analytical framework built from significant measurable variables.

Conceptual-Based Structure

In recent years, Nigeria, one of the leading countries in Africa, has attempted to recode a vast collection of data on the flow of vehicles and travellers, creating a demand for the development of new transport services that use data. The development of urban mobility and the Internet of Things an indicator for improving vehicle network connectivity and the growth of smartphones in the era of technological innovations. In 2021, there will be 71 million Nigerians using internet services, with each individual having an average of 3–4 SIM cards, according to the Nigeria Communication Commission and the Nigeria Identity Number (NIN). There will also be 14 million automobiles travelling every day. The Internet of Things is a model of interconnected computing devices, sensors, cars and digital machines, cars, objects, people, and goods that can exchange data over networks in human-to-human or human-to-network interlinkages, rather than a standalone technology.

Mobility as a Service (MaaS) is a new strategy that has the potential to transform and have an impact on transport users in such a way that online drivers and passengers' users' access to trip planning and scheduling, payment via online transfer or cash ranges, and travel information that can be quickly accessed by phone or tablet.

Urban Mobility Overview and Benefits of the Internet of Things

Urban mobility and the internet are undoubtedly related, even in other countries, but studies have proven that they are related in Nigeria. People used to go less frequently to buy online without wasting their time in malls and plazas as a result of persistent increases in traffic congestion and commuter travel time dependability. In addition, the Internet of Things may be incorporated into urban infrastructure and put on buses, trains, and tricycles. Streetlights and sensors on urban highways enable constant visibility in the transportation system. In order to provide high-quality services to urban commuters without reducing operational efficiency, transportation regulatory bodies combine data obtained by commuter-used devices.

Table 1. Internet of Things connected devices installed base worldwide from 2015 to 2025 (billions)

S/No	Year	Internet Users/Connected devices (millions)
1	2015	15.41
2	2016	17.68
3	2017	20.35
4	2018	23.14
5	2019	26.66
6	2020	30.73
7	2021	35.82
8	2022	42.62
9	2023	51.11
10	2024	62.12
11	2025	75.44

Source: Adapted from HIS Forbes Statista 2021 https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

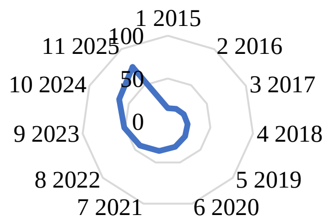

Figure 1. Global connected devices installed base worldwide from 2015to 2025 (billions)

Source: Author's Adaptation, 2021

Table 2. A Review of Malaysia Internet of Things and Communication Services

S/No	Service Provider	% of time download throughput ≥ 1 Mbps	% of time latency ≤ 250 m/s	Packet loss %	Average download put	Average round-trip time (RTT)
1	Celcom	98.10%	99.77%	0.12%	23.17Mbps	44.50ms
2	Digi	97.97%	99.07%	0.02%	25.32 Mbps	41.55ms
3	Maxis	98.76%	99.78%	0.00%	32.32 Mbps	39.15ms
4	U mobile	91.67%	99.26%	0.03%	14.40 Mbps	52.56ms
5	TM/Unifi Mobile	89.29%	99.47%	0.00%	11.26 Mbps	42.73ms
6	YES	98.16%	98.42%	0.00%	16.24 Mbps	60.09ms

Source: [30]

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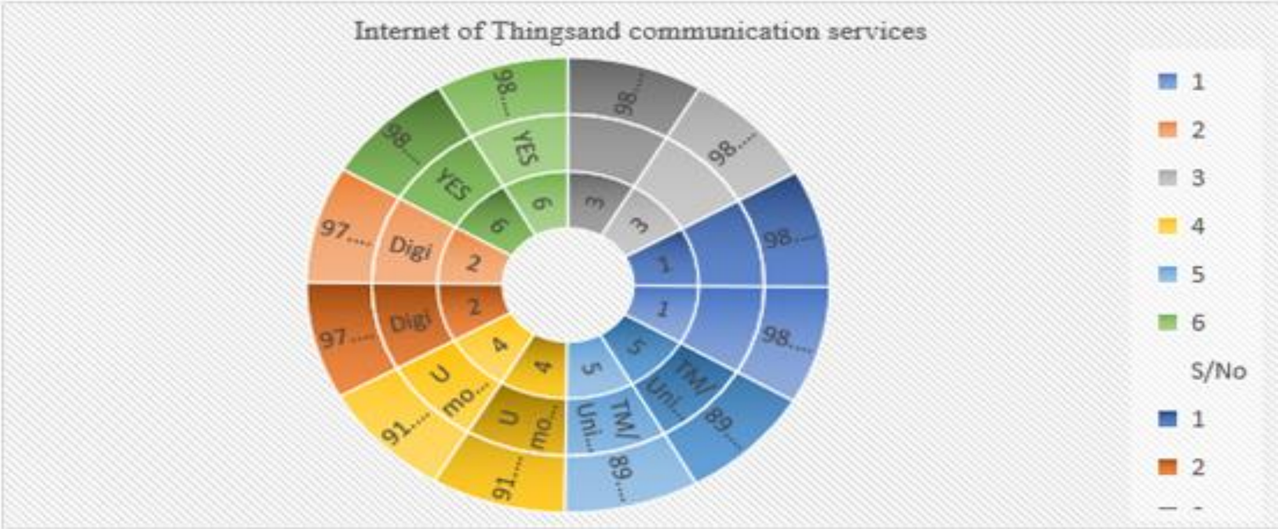

Figure 2 Global connected devices installed base worldwide from 2015 to 2025 (billions).

Table 3. Trends of Mobile Communication Network between in Nigeria 2015-2021

S/No.	Mobile networks	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021
1	MTN	42	40	36	N/A	37.3	39.56	39.53
2	Glo/Globacom	21	25	25	N/A	28	26.8	27.55
3	Airtel	21	22	27	N/A	27.2	27.26	26.23
4	9 Mobile/Etisalat	-	-	-	N/A	7.4	6.36	6.69
5	Visafone	-	-	-	N/A	0.1	0.00	0.00
6	Emirates Telecom corporation	16	13	12	N/A	-	-	0.0
	Total	100	100	100	N/A	100	100	100

Methodology

Methods of quantitative research were used in the study. The study's conclusions were based on controlled data processing and the six geopolitical zones. a detailed report on registered mobile sim cards, their use, and service availability as evaluated by the Nigerian Communications Commission and the Nigeria Identification Number (NIN); the time period covered by the data set is from 2015 to 2021. The study uses a proportionate sample design to administer its questionnaires online. 36 states, including Abuja, the capital of the country, received a total of 185 questionnaires, five for each state. To ascertain the efficacy, operational efficiency, performance level, accessibility, safety, and security tracking, simple regression analysis and Chi-square goodness of fit were used. The study found a considerable connection between urban mobility and mobile communication networks as well as between urban mobility and the Internet of Things.

Figure 2.2 Cellular and Wireless communication

Discussion and Results

The development of urban transportation, mobility enhancement, and the Internet of Things are discussed in this section as contemporary paradigms that influence how transportation companies, agencies, and Internet and mobile communication users perceive the advantages and satisfaction that come from utilising these facilities on a local and global scale. A low-power area network (LPAN) is a particular kind of network that covers a substantial geographic region with the express intent of facilitating networking. Table 1 summarises the worldwide

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evaluation level of the internet connection trend objective for the period of 2015 to 2025. Table 2 summarises Malaysia's performance on the Internet of Things and mobile communication assessments. The greatest download throughput was achieved by Maxis at 98.76 and 32.32 megabits per second. Table 3 examines Nigeria's communication trends as well as the effectiveness and performance of the MTN network as a whole.

As a result of the crimes committed online, Tables 4 and 5 explore user connectivity and the degree of internet connection in relation to cost effectiveness and internet security. The link between drivers' and passengers' degrees of satisfaction with using an online system to plan a trip without meeting in person is covered in Table 6. Urban mobility and the Internet of Things are related in Table 7, and the findings indicate a manageable coexistence where X2 = 1.5517 critical value 1.725. There is a known relationship between cellular and WiFi data plans, according to the examination of cellular and WiFi. For wireless cell tower devices to connect to the router and use the internet, cellular requires a data plan. With compelling proof of their interconnectedness, Table 8 analyses the correlation coefficient between urban mobility and the Internet of Things.

Table 4. Wireless Internet of Things Utilisation and Compatibility

Components of Urban Mobility	Internet of Things Data			
Mobility components	Cellular	Bluetooth	Wi-Fi	Low Power Wide Area Network
Mobile data connection	3	2	3	1
Travellers' accessibility /Safety	3	2	2	1
Cost-effective	3	2	3	2
Operational efficiency	3	4	3	2
Internet coverage and performance	4	4	3	3
Security and access tracking	2	1	2	2
Total	18	15	16	11

Source: Author's, 2021.
N.B: 5=Highly applicable; 4=Moderately applicable; 3=Slightly applicable; 2=Lowly applicable; 1= Not applicable.

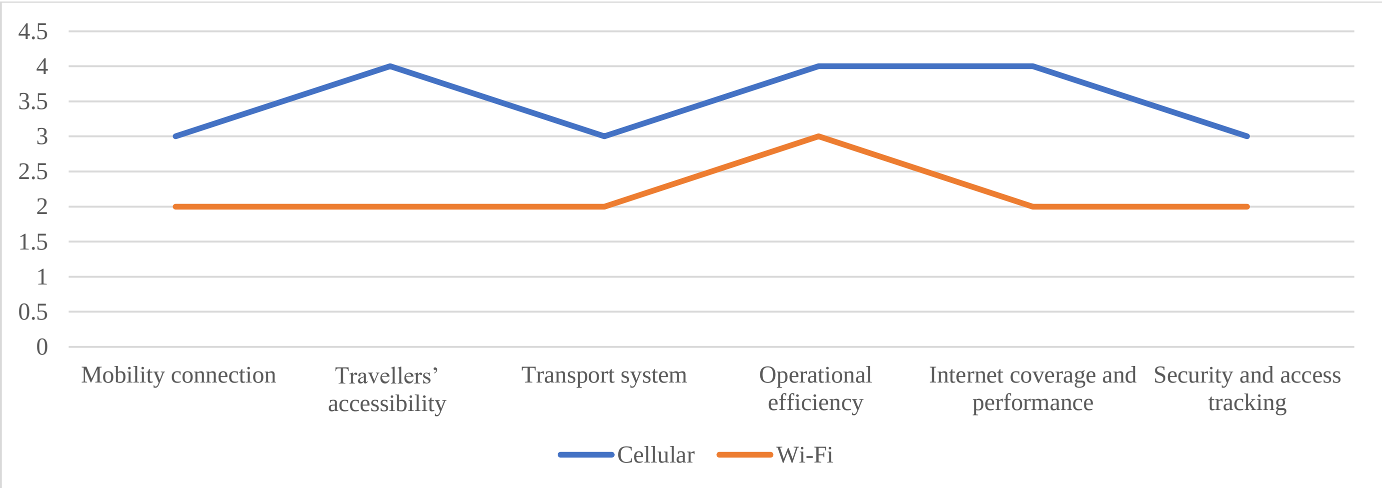

Figure 1. Relationship between urban mobility and the Internet of Things
Source: Author's, 2021.

Table 5. Urban Mobility and Community Network in Nigeria

Components of Urban Mobility		Mobile networks					
S/No.	Internet of Thing variable	Responses	MTN	Glo	Airtel	9 Mobile	Total
1	Mobile data connection	23	4	2	3	2	11
2	Accessibility/ and Safety	28	3	3	3	2	11
3	Transport/Cost effective	52	3	3	2	2	10
4	Operational efficiency	30	3	3	3	2	11
5	Internet cover/performance	38	3	3	2	2	10
6	Security/access tracking	14	3	2	2	3	10
	Total	185	19	16	15	13	63

Source: Authors, 2021.

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Table 6. Relationship Between Urban Mobility and the Internet of Things

Internet of Thing variable	Mobility Responses. O	Internet of Things E	(O – E)	$(O – E)^2$	$\frac{(O – E)^2}{E}$
Mobile data connection	23	11	12	144	13.09
Accessibility/ and Safety	28	11	17	289	26.27
Transport/Cost effective	52	10	42	1764	17.64
Operational efficiency	30	11	19	361	32.82
Internet cover/performance	38	10	28	784	7.84
Security/access tracking	14	10	4	16	o.1
Total	∑185	∑63	122	∑3350	∑97.76

Source: Authors, 2021.

$X^2 = \sum \frac{(O - E)^2}{E}$

$\frac{97.76}{63} = 1.5517$

$X^2 = 1.5517$

$\alpha = 0.05$

$\alpha = 0.1$

df = 6 - 1 = 5

5 - 1= 4

df=5 * 4 = 20

Decision: Since > 0.05

$X^2 = 1.5517 >$ critical value 1.725

Computed value is less than the critical value 1.725, H_0 rejected and H_1 accepted.

There is relationship between urban mobility and Internet of Things

Table 7. Relationship between urban mobility and internet of thing

S/No.	Internet of Thing variable	Cellular	Wi-Fi	Total
1	Mobility connection	3	2	5
2	Travellers' accessibility	4	2	6
3	Transport system	3	2	5
4	Operational efficiency	4	3	7
5	Internet coverage and performance	4	2	6
6	Security and access tracking	3	2	5
	Total	21	13	34

Source: Authors, 2021.

N.B: 5=Highly applicable; 4=Moderately applicable; 3=Slightly applicable; 2=Lowly applicable; E1= Not applicable, N/R =Not required

Table 8. Correlation of Coefficient between urban mobility and internet of thing

S/No.	Internet of Thing variable	X	Y	XY	X^2	Y^2
1	Mobility connection	3	2	6	9	4
2	Travellers' accessibility	4	2	8	16	4
3	Transport system	3	2	6	9	4
4	Operational efficiency	4	3	12	16	9
5	Internet coverage and performance	4	2	8	16	4
6	Security and access tracking	3	2	6	9	4
	Total	∑x 21	∑y 13	∑xy46	$\sum X^2$ 75	$\sum y^2$29

Source: Authors, 2021.

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$$X^2 = \sum \frac{(O - E)^2}{E}$$

$$\frac{97.76}{63} = 1.5517$$

$X^2 = 1.5517$

$\alpha = 0.05$

$\alpha = 0.1$

df = 6 - 1 = 5

5 - 1= 4

df=5 * 4 = 20

Decision: Since > 0.05

$X^2 = 1.5517 >$ critical value 1.725

Computed value is less than the critical value 1.725, H_0 rejected and H_1 accepted.

There is relationship between urban mobility and Internet of Things

Discussion

While the user is travelling along roadways linked to the telephone service area, a mobile phone, cellular phone, handphone, or cell phone is used to make and receive calls through radio frequency. Blue tooth is a low-range wireless technology that uses UHF radio waves in the SIM bands to transmit data over distances between fixed and mobile devices. However, the main drivers of urban density is population as the causa factor influenced city transport and internet services. The diverse economic, cultural, political forces, and the socially rooted urban land amongst service providers.

Significant Effects of Internet on Urban Mobility

- The improvement of corporate operations, transportation networks, cost, energy, and other internet gaps through the spatial and temporal coverage of network communities, regions, and nations.
- Increase transport efficiency and dependability with an assured network delivery solution. You may increase transport efficiency and dependability with an assured network delivery solution, you may increase transport efficiency and dependability.
- Users of the network are drawn in by operational effectiveness and service delivery. Users now have more alternatives based on their preferences thanks to network service availability and latency improvements.
- In Nigeria, MTN and GLO networks are the most competitive networks for subscriber data usage and communication. Another reason to enhance urban mobility is service cost and reliance.
- Users like networks with lower prices because they have a higher probability of doing so at any given time of day or night of accessing an urban transit provider.

The Challenges of the Internet of Things in Nigeria

The expansion of internet accessibility in developing nations where power and communication network coverage issues have an impact on Sustainable Development Goal targets, from which Nigeria cannot be exempt, depends greatly on the development of urban mobility and transport efficiency, the sufficiency and effectiveness of communication network resources and extents or spheres of influence, power, and regulatory frameworks. One of the biggest challenge's travellers face is security, particularly when they are targeted by robbers, kidnappers, cults, or farmers and when there are head-on collisions. In Nigeria, fraudsters are becoming more numerous and are using the internet to disseminate false information or agreements across the ecosystem in an effort to defraud bank clients in any way possible. Population density, diverse economic relationship, politics and interest on land, cultural and social values, as well as land speculation affects urban mobility and the Internet of Things in the development of transport system.

Conclusion

In today's world, urban mobility and the Internet of Things are essential for coordinating daily activities and providing access to housing, online employment prospects, and urban services. The academics discuss techniques that direct transport systems, particularly in Nigeria and throughout the world, as well as the efficacy and limitations of the Internet of Things in boosting urban mobility as one of the powerful ways of global communication. In order to protect applications connected regardless of location, urban mobility and the Internet of Things both extend to a global Internet network Protocol Exchange (IPX) derived from the Xerox Network System. Finally, it emphasises and provides appropriate defence against external threats by raising the alarm and signalling excessively.

Recommendation

Urban mobility and the Internet of Things are inextricably linked to digital data networks, as is evident from the development of personal and group chats that incorporate various types of transport data in a way that users can subscribe to and receive services that best meet their needs at all times. These services include social infrastructure transformation and urban transport systems. Tricycles, motorbikes, wheelbarrows, and handcarts are just a few of the private and public transportation options offered by Mobility as a Service (MaaS). The implementation of security architecture spheres early in planning, strengthening, and performance will enable maximal improvements at a low cost that benefits less privileged internet users, and a well-designed end-to-end approach is necessary.

This project advances information and assists stakeholders, policymakers, and transportation organisations in improving communication to better understand travellers and improve customer experience. Through, sensor data that determines every aspect of the anomalies such as vehicle speed, highway carriageway capacity, number of cars in wait, and helps transport operators implement and increase safety measures. Real-world

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information on rapidly evolving traffic patterns can be used to reduce traffic congestion and energy use. Boost operational effectiveness.

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