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INVESTIGATING EXPERIENTIAL GRAPHIC USER INTERFACE OF SMART CITY-ENABLED TRANSPORTATION SYSTEM IN LAGOS, NIGERIA

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Abstract. Smart cities leverage information and communication technology to boost operational efficiency, disseminate information to the public, and enhance the quality of government services and the welfare of citizens. Smart transportation is largely anchored in digital devices, which are heavily driven by visual elements. These visual cues include icons, illustrations, colours, typographic contents, menu bars, grids, spacing, animation, avatars, visual selectors, interactive maps, and other visual indicators. The appropriate use of visual cues determines the usability of these technological platforms. This study examines the graphic visual components that comprise the user interface-driven tools enabling the smart city transportation system in Lagos, Nigeria. The research design employed is a qualitative descriptive approach. Data were collected through both primary and secondary sources. The results indicated that user interface tools (ride-sharing apps, traffic delivery reports, and wayfinding systems) are indeed deployed with varying degrees to enhance smart mobility in the Lagos metropolis. Finally, the deployment of the user interface tools needs to be fully optimized to achieve better results.

Keywords: *Graphic User Interface, Information and Communication Technology, Smart city, Transportation System, Visual Cues.*

Rezumat. Orașele inteligente utilizează tehnologia informației și comunicațiilor pentru a spori eficiența operațională, a disemina informații către public și a îmbunătăți calitatea serviciilor guvernamentale și bunăstarea cetățenilor. Transportul inteligent este în mare măsură ancorat în dispozitive digitale, care sunt puternic influențate de elemente vizuale. Aceste indicii vizuale includ pictograme, ilustrații, culori, conținut tipografic, bare de meniu, grile, spațiere, animație, avatare, selectori vizuali, hărți interactive și alți indicatori vizuali. Utilizarea adecvată a indiciilor vizuale determină utilizabilitatea acestor platforme tehnologice. Acest studiu examinează componentele vizuale grafice care alcătuiesc instrumentele bazate pe interfața utilizator care permit sistemul de transport al orașelor inteligente din Lagos, Nigeria. Designul cercetării utilizat este o abordare descriptivă calitativă. Datele au fost colectate atât din surse primare, cât și secundare. Rezultatele au

indicat că instrumentele interfeței utilizator (aplicații de partajare a călătoriilor, rapoarte de livrare a traficului și sisteme de orientare) sunt într-adevăr implementate în grade diferite pentru a îmbunătăți mobilitatea inteligentă în metropola Lagos. În cele din urmă, implementarea instrumentelor interfeței utilizator trebuie să fie complet optimizată pentru a obține rezultate mai bune.

Cuvinte cheie: *Interfață grafică cu utilizatorul, Tehnologia informației și comunicațiilor, Oraș inteligent, Sistem de transport, Indicii vizuale*

1. Introduction

The overall appearance and user experience of technological devices is referred to as a graphic user interface (GUI). GUI is the medium through which users interact with digital devices, relying on graphical elements such as icons, including secondary notation, rather than text-based interfaces, typed command labels, or text navigation [1]. The effectiveness of a GUI depends not only on its functional capabilities but also on its design aesthetics, which influence usability, accessibility, and overall user experience [2]. Dixon [3] explained that the experiential graphic design (EGD) principle entails the use of digital technologies and systems that drive dynamic user interface content to create immersive, functional, and sensitive user experiences. This aspect of graphic design is largely influenced by the early form of environmental graphic communication, which emanates from the hieroglyphic cave paintings found in France and Spain. Wayfinding systems in city streets, highways, landmarks, hospitals, airports, and other public spaces are enlivened with experiential graphics. Architecture, however, acts as the canvas upon which EGD are embedded, enabling spatial orientation and enhancing the legibility of the city. EGD cues are essential in the planning and implementation of smart cities worldwide.

The density of human activity that characterizes urban centres across the world constantly strains infrastructure and developmental amenities available in urban environments. Modern cities are embracing innovative ideas to improve the efficiency of the limited infrastructure available and enhance citizens' quality of life. According to Jong, Joss, Schraven, Zhan, and Weijnen [4], metropolitan areas worldwide have deployed initiatives to improve urban infrastructure and services, creating better environmental, social, and economic conditions and further boosting cities' attractiveness and competitiveness. Globally, competitive cities leverage information, communication, and technological templates defined via the concept of "smart cities". Shea and Burns [5] defined a smart city as a municipality that integrates information and communication technology (ICT) to improve operational efficiency, share information with the public, and improve both the quality of government services and citizen welfare. Greco and Cresta [6] categorizes the smart city concept into three distinct approaches: (1) an approach that prioritizes 'hardware,' highlighting new technologies and infrastructure as essential for the smart city; (2) an approach that places significant importance on social and human capital in the definition of a smart city; (3) an integrated approach that characterizes a smart city by possessing both qualities above, as a smart city must ensure the synergy between technology and human and social capital to foster a conducive environment for ongoing growth and innovation.

The drive towards the actualization of smart cities has become necessary for global competitiveness amongst contemporary cities. Therefore, smart cities are anchored on enriching the city's infrastructure to stimulate economic growth and enhance residents' quality of life by exploring smart technologies and data analysis. According to the IESE

Business School [7], the performance indicators for ranking a smart, sustainable city in the global index of top-performing smart cities include economy, environment, governance, human capital, international outreach, social cohesion, technology, urban planning, and mobility and transportation. London tops the list of the smartest cities in the world, followed by New York, Paris, Tokyo, Berlin, Washington, Copenhagen, Oslo, Singapore, and San Francisco [7]. These cities were selected based on their high overall scores across several established performance indicators.

In Nigeria, Lagos, with an estimated population of over 20 million, is regarded as having the potential to attain smart city status based on its available infrastructure, human capital, and social integration [8]. However, the challenges of population growth, infrastructure deficit, and traffic congestion have created an urgent need for smart transportation innovations in cities, including Lagos. The Lagos State Government has introduced Smart City initiatives that leverage ICT to improve urban services, particularly transportation [9].

Transportation plays a central role in the development of smart cities as mobility is essential to economic growth and social interaction [10]. Ridesharing platforms, traffic reporting platforms, and wayfinding systems are smart mobility innovations that expand access to transportation, address navigation issues, and reduce vehicular congestion in the city [11, 12]. Taxi-hailing applications are powered by smart city infrastructures.

This study assesses the experiential graphic user interface of the smart city-enabled transportation systems in Lagos metropolis. Its specific objective is to appraise existing innovations in Lagos metropolis with a view to informing policies that will stimulate improvements in the transportation system within Lagos metropolis and cities with similar attributes.

2. Literature Review

2.1 Experience Design

Experience design involves creating holistic experiences across every aspect of services and products, both physical and digital. This includes what users encounter, the environment, the products, the interface, and many other elements, such as sound, smell, or taste, which are crucial for creating a positive user experience [13]. Experience design focuses on creating a positive relationship between users and the product/environment as an integrated whole. The feelings, memories, and perceptions of the users are fundamental to successful experience design. User interface maximizes the user-centeredness of products.

User Interface is the process designers adopt to create digital device interfaces, focusing on looks or style [14]. The development of user interfaces is often anchored in anticipating users' needs and goals. According to Stevens [15], the user interface designer considers the human user and how the mind works using patterns, spacing, and colour to guide the human user. Graphic icons and elements are the gateways to the usability of a digital interface. A graphical user interface (GUI) enables users to interact with electronic devices through graphical icons and visual indicators, such as secondary notation, rather than text-based interfaces, typed command labels, or text navigation [16]. Gube [17] defines user experience (UX) as the way a person feels when interacting with a system. The system, in this case, includes a website, a web application, or desktop software and, in contemporary times, represents some form of human-computer interaction (HCI). User experience (UX) addresses users' needs, values, and capabilities, as well as a website's limitations. Jordan [18] proposes a pleasure-based design approach that addresses four layers of users' needs: safety,

functionality, usability, and pleasurable experience. Thus, the quality of digital experiences, especially in transportation, depends heavily on the intuitiveness and inclusivity of GUIs.

2.2 Ridesharing Mobile Application

The concept of ridesharing emerged in the context of addressing the individual mobility problem [11]. Ride-sharing connotes the shared use of a motor vehicle by a driver and passengers, either for non-profit or paid service, based on billing information supplied by the attendees. The transportation mode offers significant economic and environmental advantages, such as mitigating traffic congestion during peak hours, reducing fuel consumption and emissions, minimizing travel time, and decreasing parking costs [Chan & Shaheen, 2012, cited in 11].

Ridesharing could either be dynamic, involving a network, organized on a trip-by-trip basis, and managed by the government, or carpooling and vanpooling that is casual and unofficial, usually run by participants. Mitropoulos, Kortsari, and Ayfantopoulou [19] posited that ride-sharing trips are characterised by matching applications made possible by drivers and passengers finding potential rides. The trips usually involve community-based trust mechanisms (for example, user ratings) and provide links to social networks, enabling prospective sharers to identify one another. Moreover, ridesharing improves traffic performance by matching travellers with similar routes and schedules on short notice [11]. Anthopolous and Tzimos [12] noted that the introduction of online platforms has revolutionized travel between service providers and users. User experience is fundamental to the usability and functionality of ride-sharing platforms. The ease of use of the ride-sharing user interface enables users to accomplish their goals.

2.3 Wayfinding System

A wayfinding system is a vital element for effective connectivity within human settlements [20]. The essence is to assist users in achieving prompt, precise communication and information on legibility, readability, and convenience. Its applications include city planning, infrastructure services, transportation, tourist destinations, and urban informatics, among others. For wayfinding, graphical elements and tools such as charts, colours, diagrams, graphs, images, typography, soundtracks, maps, symbols, and billboards, as well as information kiosks, are employed [21]. But it has received attention from researchers, particularly the transport planners.

Studies have explored various dimensions of the wayfinding system. van Lierop et al. [20] examined users' experiences with wayfinding along a cycle route on a highway in the Netherlands before and after the installation of two new pilot wayfinding systems. Findings indicated that changes to the location, size, and clarity of signage improved cyclists' experience. Cyclists reported that they navigate the routes easily, travel-related stress decreased, and travel time decreased. Minano et al. [22] studied the existing and future concepts of wayfinding systems with varying technical requirements within the UK transport industry, highlighting the merits and demerits of wayfinding technologies. From the review, it was concluded that industry information systems are not performing optimally because they rely on legacy systems that are not cost-effective to run, cannot easily integrate with new technologies, and require users to work around limitations. It was concluded that considering "the number of stakeholders and array of technologies, wayfinding in the transportation industry is a challenge that will likely result in an eventual system-of-systems created by multiple stakeholders." Ferri, Popp, and Wulfhorst [23] examined individual user

experience throughout the wayfinding journey to provide insights into the role and influence of smartphones during the process. They found that Google Maps is most widely used among other apps that provide integrated spatio-temporal information. It was concluded that smartphones helped survey participants overcome navigational stress, but they have limitations and do not always aid wayfinding because they can distract participants. This limitation is expected to make it difficult for designers to understand how people behave in public transport spaces and to ensure that smartphone navigation matches the real-world signs and directions in those spaces. It is noteworthy that wayfinding is beyond digitalisation, as may be assumed when referring to smart cities; rather, emphasis should be on functionality and usability, as Lai [21] has studied.

3. Materials and Methods

Lagos, in southwestern Nigeria, comprises 20 local government areas. Though Lagos is the smallest State in Nigeria, it is the most populous. The choice of Lagos, Nigeria, was based on the fact that it is not only one of the few states in Nigeria to have launched smart city initiatives, but has also demonstrated a level of commitment to achieving smartness within its jurisdiction [24]. The three aspects identified and examined in this study relate to addressing transportation problems within the state. For instance, Lagos State in Nigeria boasts the highest number of e-hailing ride operators using ride-sharing apps. The initiative to enable electronic Traffic Report Delivery System is the first of its kind in Nigeria. Lastly, Lagos State deploys a unique wayfinding system, which deserves examination.

A qualitative descriptive research design was employed. A descriptive study describes a situation, problem, or phenomenon but does not focus on the relationship or association [25]. The researchers sourced data from secondary sources comprising journal articles, newspapers, magazines, government publications, and books. The secondary data were complemented by primary data obtained from field surveys and observations. The data analysis focused on inductive exploration of data employed by [24] in a related study. The research explored some selected experiential graphic design-driven user interface tools that facilitate smart city transportation in the Lagos metropolis. These information technology tools include Ride-Sharing App Interface, Traffic Report Delivery System, and Wayfinding systems.

4. Results and Discussion

4.1 Ride-Sharing App

The rise of ride-sharing app-enabled services in the Lagos metropolis indicates the embrace of technology in redefining the transportation system. Information Technology drives the city of the future. Lagos State is leveraging ICT tools to actualize a smart city. Vehicle ride-sharing systems are changing the way citizens commute in their daily schedules by adopting new transportation scheduling models [26].

Rideshare was pioneered by Uber, which provides a service that connects drivers with commuters needing transportation without sharing space with a crowd [27]. Rideshare supports the public transportation system in Lagos, just as it does in other competitive smart cities worldwide. The interfaces of ride-sharing apps are significantly driven by visual cues to enhance usability. These cues include icons, illustrations, colours, typographic contents, menu bars, grids, spacing, animation, avatars, visual selectors, interactive maps, and other visual indicators. When the app opens, users are prompted by a text information menu bar asking for their destinations. In the lower section, three interactive icons with drop shadows create depth.

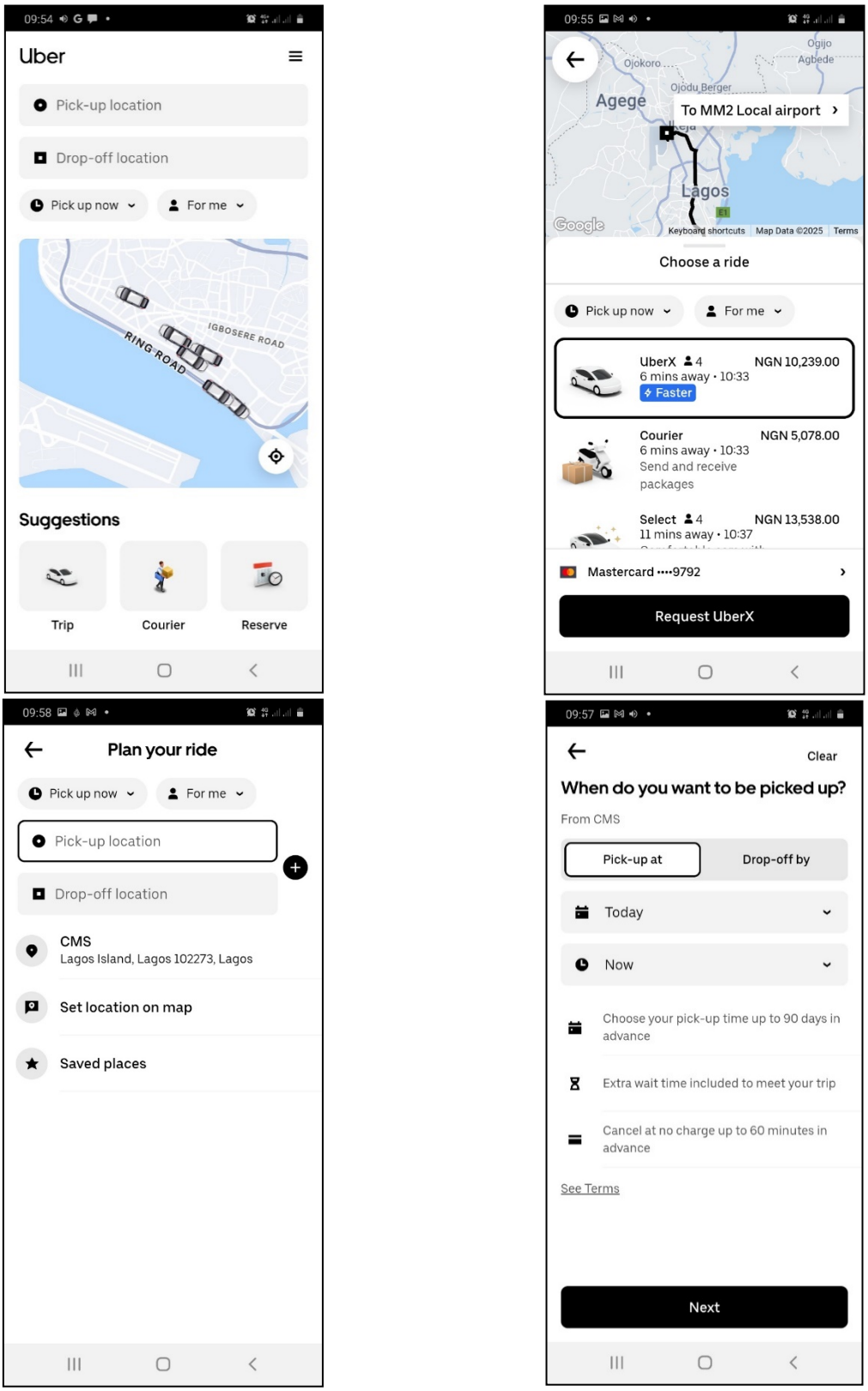

Figure 1. Uber Ridesharing user interface.
Source: Authors' Fieldwork (2025).

A graphical representation of a road with simulated cars serves as the background for the ride-sharing application's entry page. The user selects the pick-up location from the provided menu and taps and fills in the destination. The application interface is embedded with bold, bright colours that contrast with the bold, legible text. Blue is the dominant colour

of the interface to communicate safety and comfort. Users can also select their preferred vehicle, represented by a clip art image of a racing car. The user is supplied with the information, such as the driver's image and car plate number, in black text on a white, spacious background. The driver's arrival time is displayed on a green background with negative spaces. The exciting aspect of the app interface is the GPS-powered graphical map with animated clip art of a vehicle that shows the driver navigating to the user's location (Figure 1).

The study reveals that GUIs play a critical role in shaping user interaction with smart city-enabled transportation systems in Lagos. The findings show that different ride-hailing platforms, such as Uber, Bolt, and Rida, were the most widely used GUI-based tools in Lagos, and that intuitive design elements, such as icons, colour-coded indicators, and maps, significantly improve usability. However, global apps like Uber and Google Maps were rated highly due to their universal design frameworks and optimized user interfaces, echoing Helling's [27] assertion that good interface design enhances adoption.

4.2 Traffic Report Delivery

Findings show that the Lagos State government collaborated with an outdoor advertising agency to deploy a real-time traffic information system that provides commuters with advanced traffic information on busy routes. Lagos Traffic Information System (LATIS) collects traffic data. It transmits accurate traffic information across a dedicated network of smart advertising billboards located near designated stops, covering an estimated 210 kilometres of roads in the metropolis [28]. The reports are delivered in a typographic style with colours visible on a light background, enabling the audience to view the reports with ease (Figures 2 and 3). To achieve this, cameras are mounted at strategic positions across these routes. These cameras record traffic conditions along the routes and transmit them to the public via designated social media accounts [28].

Figure 2. Lagos Traffic Information System.
Source: Parrotnigeria [29].

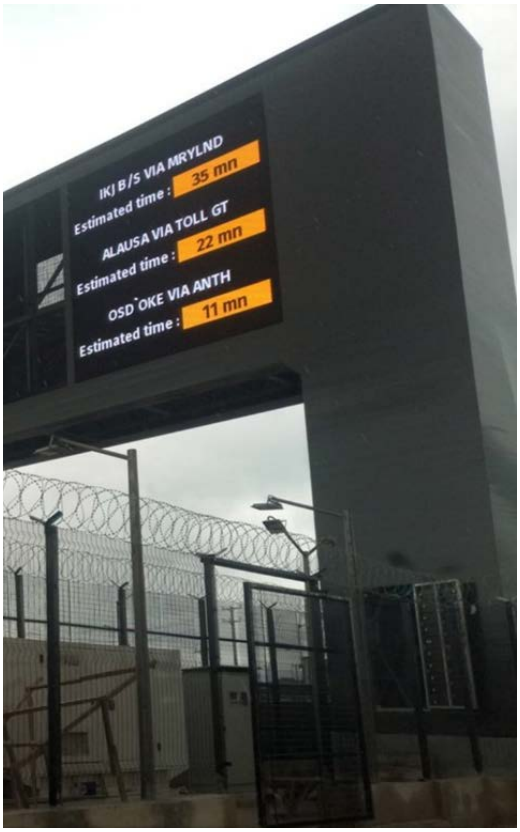

Figure 3. The estimated time to different locations is displayed on the advertising billboard within the metropolis.
Source: Billboard Arena [30].

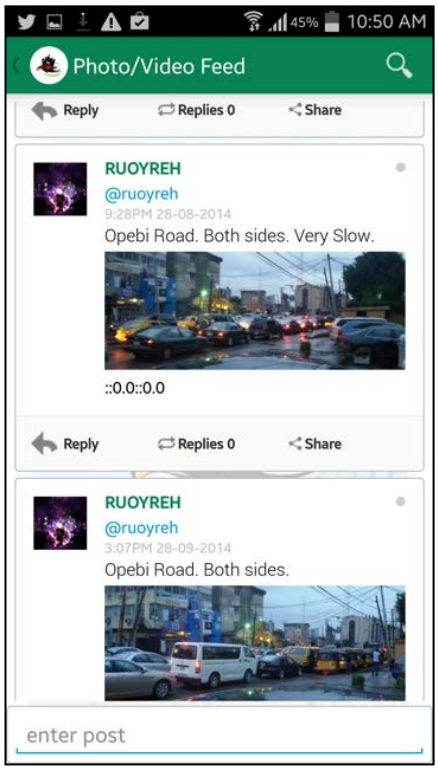

Figure 4. Gidi Traffic Twitter page interface.
Source: Authors' Fieldwork (2023).

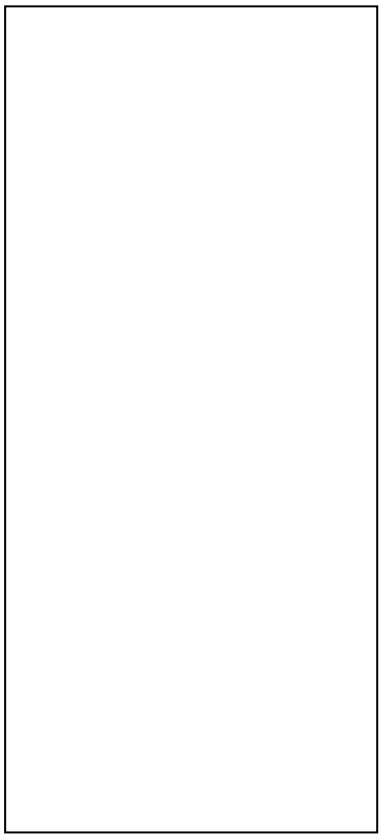

Figure 5. GPS user interface.
Source: Authors' Fieldwork (2019).

Other private entities provide traffic information for commuters in the Lagos Metropolis. Giditraffic is a private initiative in Lagos State that uses crowdsourced information to provide real-time, visually oriented traffic updates to Lagosians navigating the city (Figure 4). Giditraffic provides traffic updates by relying on its massive 16,000 Twitter followers, who report what they see around the city with visual images [31]. The Tsaboin Traffic Talk application enables commuters to share real-time traffic experiences via text updates and images. Navigation applications such as Google Maps use colour psychology to communicate traffic updates to people. The red track line indicates heavy traffic, while the blue line represents free-flow traffic (Figure 5).

4.3 Wayfinding Signage System

Wayfinding involves information systems that help people navigate a physical environment and enhance their experience of the planet. Therefore, wayfinding is vital in complex built environments, including healthcare facilities, campuses, and transportation hubs. However, the complexities of metropolitan environments require functional visual cues, such as maps, directions, and symbols, to guide residents and visitors to their destinations. Montello and Freundschuh [32] posited that wayfinding is the mental process of orienting oneself within an environment, which includes planning and choosing routes. Specifically, wayfinding is the process of identifying a current location and determining how to reach a destination as quickly and effortlessly as possible [33]. Easy accessibility and navigation in both familiar and unfamiliar environments enhance the functionality of such places. People visiting built environments are eager to accomplish their goal of visiting such places as quickly as possible, without negative feelings or spatial anxiety. The wayfinding signs in Lagos metropolis, as shown in Figure 6, are located on major roads and streets, showing traffic directions and street names. However, the look and feel of road signs, as well as their appropriateness of positioning, are vital in urban traffic corridors, especially in smart cities. TransportDay [34] explained that road signs provide illustrative guidance to road users for safer, more convenient travel. The signs on Lagos roads are constructed and erected in accordance with international standards [35]. However, some one-way roads in the metropolis are not marked. Motorists unknowingly drive against traffic, causing chaos on the roads. Drivers on Lagos roads reported that 30 per cent of the roads have no signs indicating one-way streets or other warnings [36]. These poorly placed signs do not align with the smart city value of seamless transportation. Lagos has both static and digital signs on.

Figure 6. Street Identification Signs.
Source: Authors' Fieldwork (2022).

Figure 7. Traffic Sign.
Source: Techcabal cited in [37].

5. Conclusions

The study explores experiential graphics users of the smart city-enabled transportation system in Lagos metropolis, Nigeria. It therefore assesses the smart city in transport management implementation in the metropolis. Findings indicated that the ride-sharing apps are embraced by citizens in the Lagos metropolis, thus supporting the public transportation system. Findings also showed collaboration between the Lagos State government and an outdoor advertising agency to deploy a real-time traffic information system. The collaboration implies that commuters have access to traffic information across various routes, enabling them to navigate busy routes within the metropolis. Additionally, the wayfinding system in the Lagos metropolis is widely deployed. Nonetheless, there is a need to integrate areas yet to be captured with the system to address the instances of driving against traffic, especially on unidirectional roads.

It is noteworthy that this is a preliminary study. While the researchers adopted a qualitative descriptive approach, which has its limitations, a broader quantitative study that would engage other stakeholders in Lagos metropolis, such as citizens, policymakers, and the private sector, to share their experiences and perceptions of the graphic user interfaces, is desirable and recommended for future research in Lagos, Nigeria.

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