International Journal of Sustainable Development and Planning
Vol. 19, No. 8, August, 2024, pp. 2979-2990
Journal homepage: http://iieta.org/journals/ijsdp

Exploring the Transformative Effects of GPS and Satellite Imagery on Urban Landscape Perceptions in Baghdad: A Mixed-Methods Analysis

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https://doi.org/10.18280/ijsdp.190815

Received: 15 June 2024
Revised: 1 August 2024
Accepted: 9 August 2024
Available online: 29 August 2024

Keywords:
technological advancements, urban landscape perception, Geographic Positioning Systems (GPS) navigation, urban planning, digital transformation

ABSTRACT

This study explores the transformative impact of technological advancements, specifically satellite imagery and GPS systems, on the urban landscape perceptions of Baghdad residents. With urban environments increasingly integrating digital technologies, understanding these changes is vital for urban planning and improving urban life quality. This research examines how technology integration affects residents' connections to their city, influencing navigation, social interactions, and urban experiences. Employing a mixed-methods approach, the study combines qualitative interviews and quantitative surveys, using descriptive statistics and correlation analysis to evaluate the relationship between technology usage and urban perception. Baghdad serves as an ideal case study due to its historical significance and rapid urban development, offering a rich context for analyzing traditional and digital navigation intersections. The study addresses how to integrate digital technologies into urban settings without eroding cultural identity and familiarity with landmarks essential to heritage and belonging. Findings reveal that while GPS enhances navigational efficiency, it leads to decreased familiarity with physical landmarks, with respondents showing moderate reliance on GPS (mean score 2.77) and low landmark familiarity (mean score 1.27). Despite this, a strong emotional connection to the city persists, indicating that digital tools have not fully diminished sensory and emotional engagement with Baghdad's urban landscape.

1. INTRODUCTION

In the contemporary epoch, technological advancements have dramatically reshaped our interaction with urban environments, altering not only the physical landscape but also our perceptual and experiential engagement with cities. This research delves into the nuanced interplay between such technological advancements and the urban landscape, with a focus on Baghdad—a city emblematic of rapid urban transformation amidst technological proliferation. By employing a mixed-methods approach that integrates qualitative interviews, quantitative surveys, geospatial analysis, and statistical analysis, this study seeks to uncover the layers through which satellite imagery and GPS systems have influenced residents' perception of their urban milieu. Amidst the backdrop of global urbanization trends, this investigation is not merely academic but speaks to the core of urban planning, social cohesion, and the psychological well-being of city dwellers.

Despite extensive research on digital technologies in urban planning, a significant gap exists in understanding how GPS and satellite imagery directly affect perceptions of the urban landscape, especially in rapidly evolving cities like Baghdad. Many studies overlook how technology adoption varies across different generations and genders, leaving a critical gap in understanding the social dynamics involved. This research aims to bridge these gaps by studying how digital technologies have reshaped urban perceptions and navigation habits among residents of Baghdad. The study focuses on the effects of GPS reliance on landmark familiarity, explores demographic variations in technology use, and provides insights for urban planning that balance technological advancements with the preservation of traditional urban experiences.

At the intersection of the physical and digital realms, this research seeks to enhance our understanding of how technology shapes our urban experiences and perceptions. This is especially relevant in the age of smart cities and digital navigation, where urban life is increasingly filtered through screens and interfaces. The study aims to provide insights that will guide urban planning and policy, ensuring that technological progress enhances, rather than diminishes, the vibrancy and livability of urban environments.

2. THEORETICAL FRAMEWORK

2.1 The interplay between urban landscape and residents' daily lives

Residents' perceptions of the urban landscape and its impact

on their daily lives represent a deeply interconnected aspect of everyday urban existence. This dynamic is not merely a passive backdrop for daily activities but an ongoing process of interaction and mutual influence. Recent studies highlight the urban landscape as an active element in shaping individual behaviors and interactions with their surroundings. Visual elements such as towering buildings, statues, and billboards, extend beyond aesthetics, playing a critical role in guiding and facilitating urban mobility [1].

Visual cues within the urban landscape serve as silent guides, organizing the flow of daily life for its inhabitants. Research by Olsen et al. [1] underscores the significant contribution of skyscrapers and public art in enhancing individuals' navigational abilities within the city, thereby reducing the psychological stress associated with orientation and movement in complex spaces. These markers help in creating stable reference points, aiding individuals in locating themselves and their directions, which in turn fosters a sense of security and belonging. Beyond directing movement, the urban landscape also acts as a catalyst for social and cultural interactions. For instance, public squares and green areas not only offer spaces for rest and recreation but also function as social melting pots, enhancing interactions among individuals and strengthening community bonds [2]. These spaces contribute to forming robust social networks and enhancing social cohesion, playing a vital role in improving the quality of urban life.

Hence, it can be concluded that thoughtful planning and design of the urban landscape effectively impact residents' psychological comfort and social connections. The role of visual guidance and mobility in comprehending the complexity of city life is vital, as highlighted by Olsen et al. [1] and Alizadeh and Hitchmough [2]. This understanding emphasizes the crucial role of urban landscape elements in enriching the urban living experience.

2.2 Harmonizing visual and kinetic axes in urban design

The synergy of visual and movement axes shapes the urban experience, where vision and motion intertwine to guide interactions and mobility within urban spaces. The visual axis refers to how individuals perceive the city through its visual elements such as landmarks, architecture, and public spaces, which contribute to forming a mental image that aids in navigation and place recognition. This visual perception enhances a sense of belonging and impacts residents' daily experiences, enabling them to interact with their urban environment in meaningful and aesthetic ways [3, 4].

On the other hand, the movement axis addresses the functional dimensions of the city, focusing on transportation networks, pedestrian pathways, and road planning that facilitate the actual movement of individuals. This aspect of the urban experience forms the foundation that allows residents to move efficiently, whether for work, accessing services, or engaging in social and cultural activities [5].

The integration of visual and movement axes contributes to shaping residents' perception of the urban landscape, where the city emerges not just as a space to navigate through but as a living environment that interacts with the senses and emotions. Understanding this integration is vital for urban planners and policymakers aiming to enhance city experiences that are both effective and sustainable, rich in visual and emotional experiences. By designing urban scenes that respect and celebrate both axes, cities can become more inclusive and appealing, reflecting the diversity and richness of urban life [6, 7].

Despite the intrinsic importance of this visual and kinetic integration in the urban landscape at all levels, it remains susceptible to a range of changing factors, including temporal transformations experienced by cities.

2.3 Evolving urban landscapes: A journey through time and technology

Throughout history, the integration of visual and movement axes in urban landscapes has played a critical role in shaping the interaction and perception of residents within their urban environments. This interaction has undergone considerable transformations over time with the advancement of ages. Initially, cities were centered around key attractions such as markets and temples, making visual and movement axes confined to these vital centers that facilitated communication and exchange among residents. As eras progressed and cities expanded, the complexity of these axes increased to include defensive walls, palaces, and organized residential districts, leading to a diversification of urban living experiences and the emergence of functional and class distinctions. The industrial age brought deeper changes by introducing industrial infrastructure and transportation networks, extending movement axes to include roads and railways traversing the city, radically altering urban dynamics [8, 9].

The advent of the digital technology era marked another transformation in the urban landscape, where digital and technological elements increasingly influence the urban living experience. Technologies such as GPS, augmented reality, and smart cities have not only changed how residents move and interact with the city but have also facilitated new forms of social interaction and urban planning [2, 10].

This ongoing evolution of the urban landscape reflects not only technological advancement and urban expansion but also changes in how residents interact with their urban environment and redefine the meaning of city life. The continuous transformation highlights the need for urban planners and policymakers to adapt to these changing dynamics to enhance urban experiences that are efficient, sustainable, and rich in visual and emotional experiences [11, 12].

2.4 Navigating the digital shift: Transformations in urban landscape perception

To understand the impact of digital transformation on the perception of the urban landscape, it's crucial to consider the temporal evolution of this perception. Previously, direct experiences and visual axes, such as roads and buildings, provided a reference framework for residents' mobility and interactions with the city. With the technological advancement and widespread adoption of digital devices and applications, a fundamental shift in this dynamic has emerged. Applications based on Geographic Information Systems (GIS) and GPS have introduced a new way of interacting with urban space, leading to changes in how residents perceive their cities. The "point-to-point" navigation and movement axes have begun to overshadow traditional visual elements [13, 14].

This shift reflects a change in the value given to visual components and the spatial experience of the city. Individuals who previously relied on visual landmarks as reference points for navigation and understanding urban space now increasingly depend on digital data and electronic guidance.

This reliance on technology might lead to a "dismantling" of the intimate relationship that connected residents with their urban landscape, potentially affecting their ability to perceive and understand the urban space in a comprehensive and interconnected manner [15-17].

2.5 Digitization and the reshaping of place experience

In a world witnessing continuous technological advancement, our ways of interacting with and perceiving urban environments are radically changing. Cass Sunstein in "Place: The Networking of Public Space" delves into the profound impact of digital technology on our everyday experience of place, highlighting how virtual networks and digital connections become dominant over the physical spaces we inhabit. This transformation clearly illustrates the loss of a sense of place as digital links and virtual networks start to overshadow spatial relationships and real-world interactions [14].

Parallelly, William Mitchell explores the new dynamics created by digital communications in urban perception in "Cyber Cities: Visual Perception in the Age of Electronic Communication". Mitchell emphasizes the opportunities that technology provides for reimagining the urban landscape, contributing to the enhancement of social and cultural dimensions within the public space.

Furthermore, other studies, such as the research on "Digital Spaces, Material Traces: How Smartphones Shape Urban Life", directly address the impact of smart devices on our experience of place and mobility within urban environments. These studies demonstrate how sensory perception of place is transformed through continuous interaction with screens and digital services, reshaping our ways of consuming and interacting with urban spaces [13, 18].

The shift induced by digital technology entails a radical change in how we explore and understand the world. Instead of relying on traditional maps and verbal descriptions, dynamic and interactive navigation applications have become the primary tools, reshaping our experience of the urban space and our interactions within it. Previously, sensory perception and spatial memory were fundamental in navigation, with prominent landmarks used as reference points to enhance spatial relationships and appreciate cultural diversity. Today, digital navigation replaces these traditional methods, leading to a commodification of the spatial experience, focusing on the destination rather than the journey. This transition from sensory-based spatial orientation to primarily technology-dependent navigation carries profound cultural and social implications, reshaping our concepts of belonging and spatial identity. The deep understanding of place, encompassing history, culture, and geography, is sidelined in favor of efficiency and speed in accessing information, impacting how we connect with each other and with the urban space around us [19, 20].

2.6 Digital abstraction and its impact on sensory perception

In an era where digital technologies intersect with all aspects of our lives, there's an increasing need to understand how these changes affect our experience of urban spaces. As our reliance on digital tools for navigation and interaction grows, questions arise about how our perception of place and the urban landscape forms in this changing context. Digital navigation applications provide information in an abstract manner, focusing on efficiency in reaching a destination without delving into the journey's details. This abstraction disconnects users from the sensory and cultural elements of a place, potentially leading to a loss of richness in the spatial experience. Environmental psychology underscores the importance of sensory engagement with the environment, enhancing spatial memory and a sense of belonging. The growing dependence on digital navigation diminishes this engagement, reducing the emotional depth and memory associated with a place. The emotional relationships built with a place during a journey play a significant role in shaping our experience, and the excessive focus on the destination by digital applications may limit the opportunities to form these deep connections, reducing the subjective value of the spatial experience. Cultural geography highlights how culture and technology influence our understanding of place. Direct spatial experiences deepen cultural and historical comprehension of a place, and the gradual replacement of these experiences with digital navigation can lead to a decline in this understanding and sensory connection to a place [21-23].

2.7 Reevaluating the relationship between technology and place experience

In the midst of digital advancements, understanding the urban landscape and place requires a multidisciplinary approach that combines digital technology, environmental psychology, and cultural geography to provide comprehensive insights into how these transformations affect our everyday experiences and our relationship with urban spaces. The search for a balance doesn't lie in rejecting digital technology but in finding ways to integrate it in a manner that enhances rather than replaces our sensory and emotional experience of place. Applications can include features that encourage exploration and attention to the cultural and natural details of a place, designing technology empathetically by developing navigation technologies that recognize and encourage exploration and interaction with the place can help preserve the sensory and emotional connection to the place, even in an era of advanced digitization [24-27].

By fostering empathetic digital design and technologies that acknowledge and encourage exploration, we can maintain the sensory and emotional bonds with places, bridging the gap between the digital and physical realms. This integration can transform the way we perceive, interact, and connect with urban spaces, ensuring that our emotional and sensory experiences are enriched rather than diminished in the digital age.

2.8 Critical literature review and research gaps

While extensive research has been conducted on the integration of digital technologies in urban environments, several significant gaps remain unaddressed. First, most existing studies have predominantly focused on Western cities, leaving a gap in understanding the unique challenges and impacts in non-Western contexts, such as Baghdad. Moreover, the majority of research has emphasized the technical aspects of GPS and satellite imagery, with limited exploration of their sociocultural impacts on residents' perceptions and experiences of urban landscapes. This study

aims to address these gaps by examining the cultural and emotional dimensions of technology integration in Baghdad's urban environment. Additionally, it highlights generational and gender-based differences in technology adoption, offering a comprehensive analysis that enriches our understanding of digital navigation's role in shaping urban life. By doing so, this research provides new insights into the interplay between digital tools and urban experiences, contributing to more inclusive and culturally aware urban planning strategies.

3. RESEARCH METHODOLOGY

3.1 Approach

This study focuses on evaluating the impact of technological advancements, specifically GPS and satellite imagery, on the perception of the urban landscape among residents of Baghdad. The methodology employed involved a detailed description of the study area according to Lynch's five elements and the distribution of a questionnaire to a random sample of 100 residents.

3.2 Data collection

Data was collected through the following methods:

Study area description: The study area was described based on Lynch's five elements: paths, edges, districts, nodes, and landmarks. This framework helped in understanding the spatial organization and key features of Baghdad's urban landscape.

Questionnaire survey: A questionnaire was distributed to a random sample of 100 residents. The survey included questions designed to capture detailed information on various aspects related to urban navigation and perception, focusing on the following:

Demographic information: Age, gender, educational level, and residential area within Baghdad.

Navigation methods: Primary means of navigation within the city, whether relying on GPS technologies or traditional methods such as urban landmarks and main streets.

Evaluation of navigation methods: Degree of reliance on GPS technologies or traditional navigation methods, perceived advantages and challenges of each method, and their impact on familiarity with city landmarks.

Urban landscape perception: Knowledge of major urban landmarks, emotional connection to the urban landscape, and sensory experiences while navigating the city.

Choice of travel routes: Factors influencing the choice of travel routes, preference for familiar routes versus exploring new ones, and the perceived impact of technology on urban experience.

3.3 Sample size and statistical analysis procedures

The study involved a random sample of 100 residents from various districts in Baghdad, selected to ensure demographic diversity in age, gender, and educational background. This sample size was determined through statistical power analysis, ensuring adequate power to detect meaningful effects and providing reliable insights into the population's behavior and perceptions.

Data analysis was conducted using SPSS software. Descriptive statistics were employed to summarize demographic trends and key findings, while Pearson correlation analysis was used to examine relationships between technology usage and urban landscape perceptions. Assumptions of normality, linearity, and homoscedasticity were verified to ensure the validity of the statistical tests.

3.4 Analysis methods

The survey responses were analyzed to quantify variations in perceptions among the population. The analysis methods included:

Descriptive statistics: Provided an overview of demographic trends and summarized the key findings from the survey responses.

Inferential statistics: Correlation analysis was used to examine the relationship between reliance on GPS technologies and traditional navigation methods and the perception of the urban landscape.

3.5 Ethical considerations

The study adhered to strict ethical guidelines to ensure participant anonymity and data confidentiality throughout the research process. Participants were informed of the purpose of the study, and their voluntary participation was obtained. Data was anonymized and securely stored to protect participant privacy.

3.6 Description of Dora District in Baghdad

The Dora District in Baghdad is considered one of the vital and significant areas in the Iraqi capital. Located in the southern part of Baghdad, it lies on the western bank of the Tigris River. The district includes a mix of residential, commercial, and industrial neighborhoods, making it a multifunctional and important area. Here is a comprehensive description of Dora District based on Kevin Lynch's five elements:

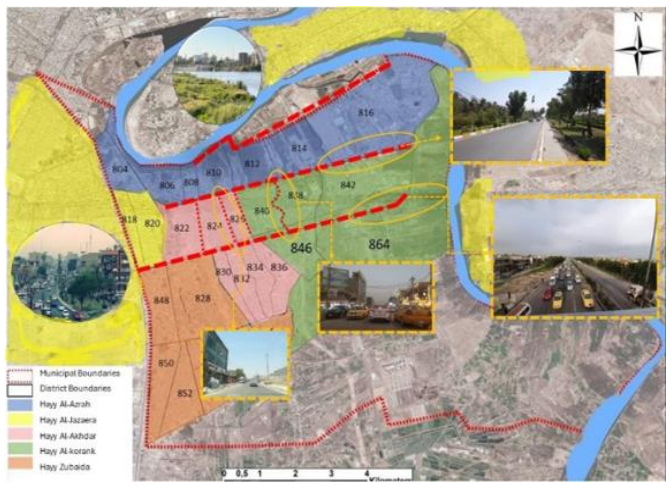

Figure 1. Edges and paths in the study area

Paths: Dora has a network of major and minor roads, the most significant being the Baghdad-Babylon highway, which traverses the area and connects it to the rest of the city. Additionally, Abu Tyara Street serves as a major commercial and residential axis in the district.

Edges: Dora is bordered to the north by the Al-Saydiya district, to the east by the Tigris River, and to the south by

other industrial and residential areas. These boundaries help define the district's features and separate it from neighboring areas, contributing to a distinctive identity for Dora (Figure 1).

Districts: Dora consists of various neighborhoods such as Al-Mualimeen, Al-Athoriyeen, Al-Mechanic, and Al-Jumhuriya. The area features a wide range of land uses, including residential, commercial, and industrial zones. Key facilities in the district include the Dora Oil Refinery and the power generation plant, which are crucial to the area's infrastructure.

Nodes: The district contains major commercial centers and markets such as the central Dora market, in addition to public transport stations that facilitate movement within the district. These nodes are essential gathering points and contribute to the vibrancy and activity within the area (Figure 2).

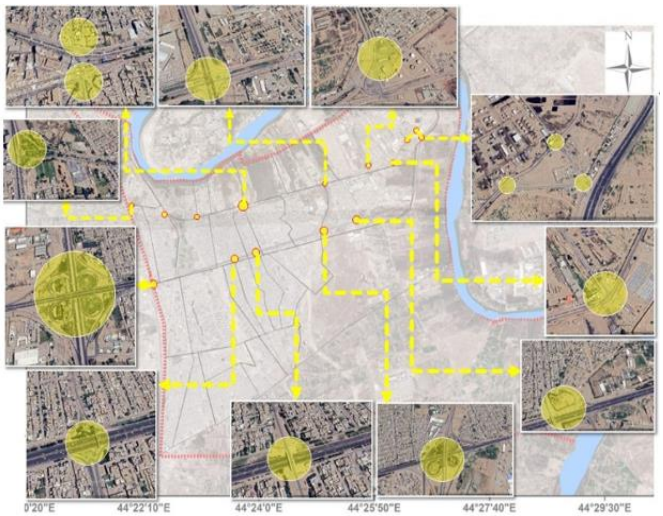

Figure 2. Nodes in the study area

Landmarks: Dora boasts several prominent landmarks, including St. George's Church, the power generation plant, and the Dora Oil Refinery. These landmarks serve as key reference points for residents and visitors and play a significant role in shaping the cultural and historical identity of the district (Figure 3).

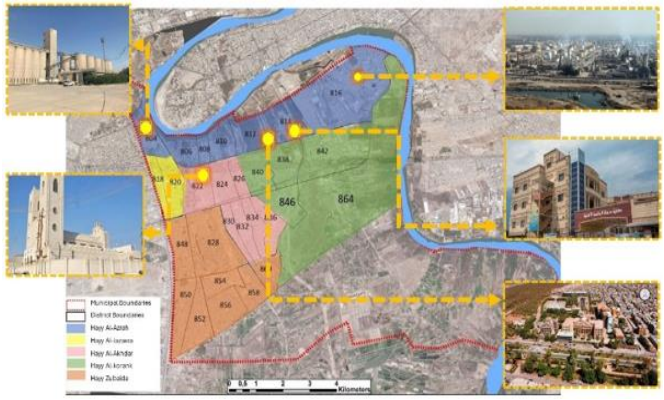

Figure 3. Landmarks and Districts in the study area

4. FINDING

4.1 Correlation of GPS usage and urban landscape perception

Understanding the correlation between GPS usage and urban landscape perception is crucial for comprehending the broader impact of technological advancements on urban experiences. This analysis is essential as it highlights how GPS technology, while improving navigational efficiency and convenience, may also detract from residents' familiarity with physical landmarks. Despite this, strong emotional and sensory connections to the urban environment persist, indicating a complex interplay between digital and traditional navigation methods. These insights are vital for urban planners aiming to integrate technology without compromising the richness of traditional urban experiences. Table 1 delves into these aspects, providing a detailed summary of the survey responses that reflect these dynamics.

Table 1. Summary of survey responses on GPS and traditional navigation methods

	Mean	Median	Mode	Standard Deviation
Reliance on GPS for navigation	2.77	4	0	2.264594
Advantages of GPS - Speed	2.7	4	0	2.213366
Advantages of GPS - Accuracy	2.68	4	0	2.196784
Advantages of GPS - Comfort	2.75	4	0	2.244522
Advantages of GPS - Real-time updates	2.71	4	0	2.216991
Familiarity with city landmarks using GPS	1.27	1	0	1.237911
Reliance on traditional landmarks for navigation	1.57	0	0	2.060965
Knowledge of major urban landmarks in Baghdad	3.7	4	4	0.904534
Advantages of traditional methods - Personal knowledge	1.62	0	0	2.0927
Advantages of traditional methods - Enjoying the journey	1.35	0	0	1.799972
Advantages of traditional methods - Reliance on experience	1.46	0	0	1.90385
Emotional connection to the urban landscape of Baghdad	3.48	3	3	1.039425
Sensory experience (visual, auditory, tactile) while traveling in the city	3.59	4	3	0.985706
Factors influencing choice of travel routes within the city	4.05	4	4	0.925235
Preference for familiar routes vs. exploring new routes	2.87	3	3	1.011599
Impact of technology on urban experience	3.49	3	3	0.979538

The survey results, as summarized in Table 1, Figure 4, provide a detailed overview of the sample's reliance on GPS technology and traditional navigation methods, along with their perceptions of the urban landscape. The key findings from the table are as follows:

Reliance on GPS for navigation: The mean score for reliance on GPS is 2.77, indicating a moderate level of dependency among the respondents. The median value is 4, suggesting that a significant portion of the sample heavily relies on GPS, even though the mode is 0, showing a variation

in responses.

Advantages of GPS: The perceived advantages of GPS technology, such as speed (mean = 2.7), accuracy (mean = 2.68), comfort (mean = 2.75), and real-time updates (mean = 2.71), all have relatively similar mean scores, with medians at 4, indicating that respondents acknowledge these benefits significantly.

Familiarity with city landmarks using GPS: The mean score is notably low at 1.27, with a median of 1, suggesting that heavy reliance on GPS may reduce familiarity with the city's physical landmarks.

Reliance on traditional landmarks for navigation: The mean score of 1.57 and a mode of 0 highlight a decline in using traditional methods for navigation, reflecting a shift towards digital reliance.

Knowledge of major urban landmarks in Baghdad: The mean score of 3.7, with a median and mode of 4, indicates that despite the reliance on GPS, respondents still maintain a good level of knowledge about major urban landmarks.

Advantages of traditional methods: Scores for personal knowledge (mean = 1.62), enjoyment of the journey (mean = 1.35), and reliance on experience (mean = 1.46) are low, with modes of 0, emphasizing a decreased reliance on traditional navigation benefits.

Emotional and sensory connection: Emotional connection to Baghdad's urban landscape (mean = 3.48) and sensory experience (mean = 3.59) are moderately high, suggesting that residents still feel a strong connection to their environment, despite digital navigation trends.

Factors influencing travel routes and preferences: Factors influencing route choice (mean = 4.05) and preference for familiar routes (mean = 2.87) indicate that while efficiency is crucial, there is still a notable preference for familiar paths.

Impact of technology on urban experience: The mean score of 3.49 shows that technology significantly impacts urban experiences, balancing between enhancing navigation and potentially detracting from traditional sensory engagement.

The findings reflect a complex interplay between the use of modern GPS technology and traditional navigation methods, highlighting the dual nature of technological advancements: they offer convenience and efficiency but may also lead to reduced engagement with the physical urban landscape.

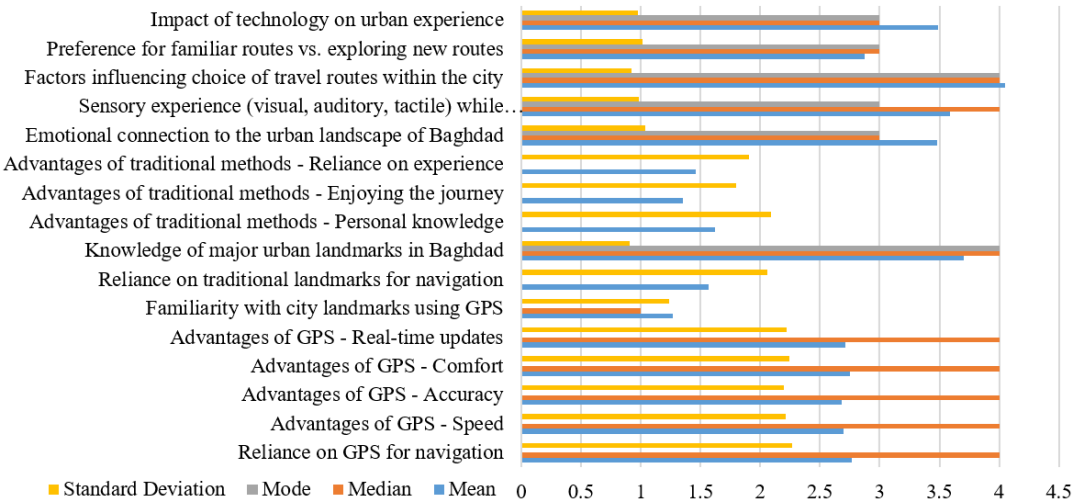

Figure 4. Distribution of survey responses on GPS and traditional navigation methods

Table 2. Gender-based analysis of GPS usage for navigation

Gender	Rely on GPS	Count	Percentage	Average_Age
Female	Does Not Use Modern Technology (GPS)	18	41.86047	50
Female	Uses Modern Technology (GPS)	25	58.13953	34.76
Male	Does Not Use Modern Technology (GPS)	21	36.84211	48.95238
Male	Uses Modern Technology (GPS)	36	63.15789	30.86111

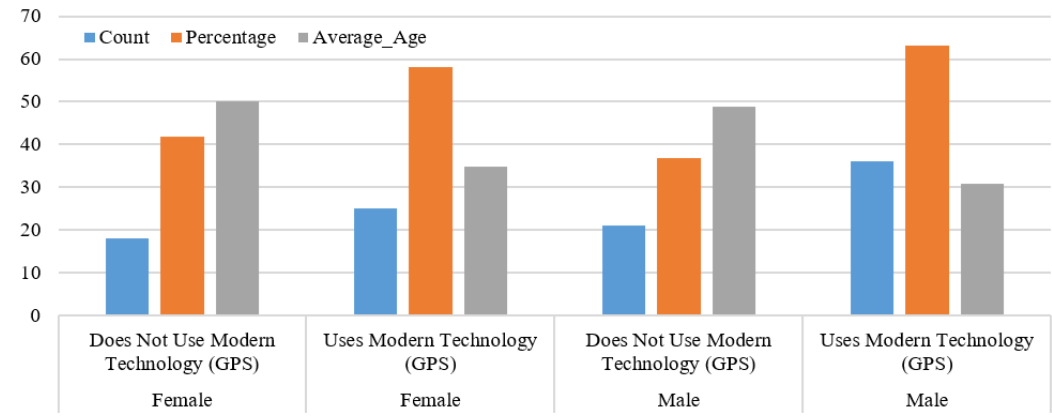

Figure 5. Gender-based analysis of GPS usage for navigation

4.2 Gender-based analysis of GPS usage for navigation

Analyzing GPS usage based on gender provides valuable insights into the demographic differences in technology adoption and its impact on urban navigation experiences. This analysis is critical for understanding how different population segments engage with technological advancements, revealing trends such as younger individuals being more likely to adopt GPS technology compared to older individuals. Gender-based analysis also highlights how cultural and social factors might influence technology adoption, with varying degrees of reliance on GPS among men and women. These findings are essential for urban planners and policymakers to design inclusive strategies that cater to the diverse needs of the population, ensuring equitable access to technological benefits. Table 2, Figure 5 explores these gender-based differences, offering a detailed breakdown of GPS usage patterns among male and female respondents.

Table 2 summarizes the gender-based responses regarding the use of modern technology (GPS) for navigation, providing insights into the demographic differences in technology adoption and its impact on the urban experience. The key findings from Table 2 are:

Female respondents:

-Does Not Use Modern Technology (GPS): 41.86% of female respondents do not use modern technology for navigation. This group has an average age of 50 years, suggesting that older female participants are less likely to rely on GPS.

-Uses Modern Technology (GPS): 58.14% of female respondents use GPS for navigation, with an average age of 34.76 years. This indicates that younger female participants are more inclined to utilize modern navigation tools.

Male respondents:

-Does Not Use Modern Technology (GPS): 36.84% of male respondents do not use modern technology for navigation, with an average age of 48.95 years. Similar to the female group, older male participants tend to avoid using GPS.

-Uses Modern Technology (GPS): 63.16% of male respondents use GPS for navigation, with an average age of 30.86 years. Younger male participants are significantly more likely to adopt GPS technology.

The data from Table 2 underscores a generational divide in the adoption of GPS technology, with younger individuals (both male and female) more likely to use modern navigation tools. This trend suggests that as digital natives, younger respondents are more comfortable and reliant on technology, whereas older respondents might prefer traditional methods due to familiarity and a lack of digital proficiency.

The higher percentage of younger users among both genders highlights the transformative impact of technological advancements on urban navigation practices. The reliance on GPS among younger populations could lead to a decrease in traditional navigational skills and a diminished connection to physical landmarks, as indicated by the lower familiarity scores with city landmarks in Table 1.

Conversely, the older age group's lower adoption rate of GPS and their higher familiarity with urban landmarks suggest that traditional navigation methods foster a deeper, more intrinsic understanding of the urban environment. This generational gap highlights the need for urban planning strategies that integrate both technological efficiency and the preservation of traditional urban experiences to maintain a balanced urban landscape.

Furthermore, these findings suggest that urban planners and policymakers should consider tailored educational and training programs to bridge the technological divide, ensuring that older populations are not left behind in the digital transformation of urban navigation. Encouraging a hybrid approach that leverages both modern technology and traditional knowledge could enhance the overall urban experience, fostering a more inclusive and navigable urban environment for all residents.

By understanding these demographic differences, urban planners can design more effective navigation systems and urban landscapes that cater to the diverse needs of the population, enhancing both the efficiency and the emotional connection to the city.

4.3 Comparison with existing literature and practical implications

The findings of this study align with several existing studies on the impact of digital technologies on urban navigation and perceptions, yet they also offer distinct contributions. For instance, research by Erçevik Sönmez and Erinsel Önder [22] highlighted the role of GPS in enhancing navigational efficiency in urban environments but noted a decline in spatial awareness and engagement with physical landmarks. This study corroborates those findings but goes further by exploring the cultural context of Baghdad, demonstrating that while GPS usage improves navigation, it may diminish the familiarity with local landmarks crucial for cultural identity. Additionally, unlike previous studies that primarily focused on Western cities, this research provides insights into a non-Western context, highlighting significant generational and gender-based differences in technology adoption.

The practical implications of these findings are manifold. Urban planners in Baghdad and similar rapidly developing cities should consider integrating digital navigation tools with efforts to preserve cultural landmarks and traditional navigation methods. This dual approach can ensure that technological advancements enhance urban life without eroding cultural identity. Furthermore, the study suggests the need for targeted educational programs to address demographic disparities in technology adoption, ensuring equitable access to the benefits of digital navigation across different societal groups.

4.4 Educational level and GPS usage for navigation

Examining GPS usage in relation to educational level provides crucial insights into how education influences the adoption of technological advancements. This analysis underscores the role of education in enhancing digital literacy and familiarity with modern navigation tools. Higher educational attainment often correlates with greater usage of GPS technology, indicating that educational exposure equips individuals with the skills and confidence needed to leverage digital tools effectively. Additionally, this relationship can reveal disparities in technology adoption among different educational groups, highlighting the need for targeted educational interventions to bridge the digital divide. S Such insights are crucial for urban planners and policymakers who aim to ensure inclusive access to technology and enhance overall urban navigation experiences. Table 3 and Figure 6 detail the patterns of GPS usage across various educational levels, providing a comprehensive overview of how education

influences the adoption of GPS technology among the population.

Table 3. Educational level and GPS usage for navigation by gender

Gender	Educational Level	Rely on GPS	Percentage for Female	Percentage for Male
Female	Bachelor's	Does Not Use Modern Technology (GPS)	40	38.46154
Female	Bachelor's	Uses Modern Technology (GPS)	60	61.53846
Female	Diploma	Does Not Use Modern Technology (GPS)	50	50
Female	Diploma	Uses Modern Technology (GPS)	50	50
Female	High school	Does Not Use Modern Technology (GPS)	25	33.33333
Female	High school	Uses Modern Technology (GPS)	75	66.66667
Female	Less than high school	Does Not Use Modern Technology (GPS)	46.15385	35.71429
Female	Less than high school	Uses Modern Technology (GPS)	53.84615	64.28571
Female	Postgraduate	Does Not Use Modern Technology (GPS)	50	14.28571
Female	Postgraduate	Uses Modern Technology (GPS)	50	85.71429

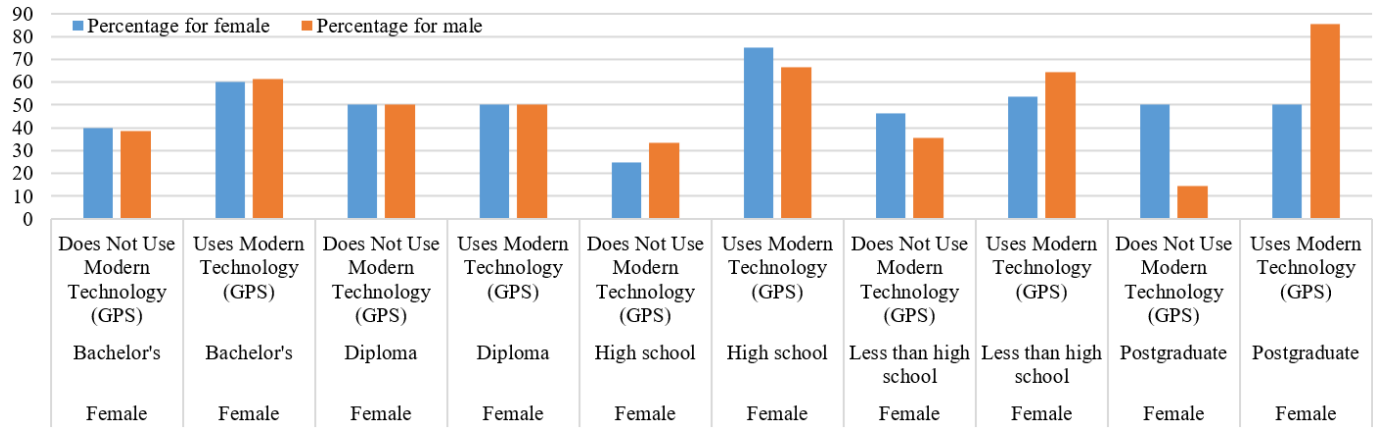

Figure 6. Educational level and GPS usage for navigation by gender

The findings from Table 3 highlight the impact of educational attainment on the adoption of GPS technology for urban navigation. Generally, higher educational levels correlate with greater usage of modern technology across both genders. This trend suggests that educational exposure enhances familiarity with and confidence in using digital tools, including GPS systems.

Educational influence: The higher the educational attainment, the more likely individuals are to adopt GPS technology. This is especially evident among postgraduate degree holders, who show the highest percentages of GPS usage. Education likely provides the necessary skills and exposure to technology, facilitating its adoption.

Gender differences: While both genders show increased GPS usage with higher educational levels, there are subtle differences. For example, at the postgraduate level, males are significantly more likely to use GPS than females, indicating potential differences in technology adoption behavior that might be influenced by factors beyond education, such as cultural or social norms.

Policy implications: The data suggests that urban planners and policymakers should consider educational interventions that enhance digital literacy across all educational levels, particularly targeting those with lower educational attainment. By improving digital skills, these interventions can help bridge the technology adoption gap, ensuring equitable access to the benefits of modern navigation tools.

Urban experience: As reliance on GPS increases with education, there is a potential trade-off with traditional navigation skills and engagement with physical urban landmarks. This reinforces the need for urban designs that integrate digital navigation aids with physical wayfinding elements to maintain a balanced urban experience.

In conclusion, the analysis of Table 3 within the context of the study underscores the importance of education in facilitating the adoption of digital navigation technologies. It also highlights the nuanced differences between genders, suggesting that comprehensive urban planning should address these educational and gender-based disparities to create inclusive and navigable urban environments.

4.5 Correlation matrix analysis of GPS usage and urban landscape perception

The Correlation Matrix is a vital analytical tool that elucidates the relationships between various factors influencing GPS usage and urban landscape perception among Baghdad residents. This analysis is crucial for understanding how different demographic and experiential variables interact with the adoption of GPS technology. It highlights the generational divide in technology usage, the impact of GPS on spatial awareness and familiarity with physical landmarks, and the varying degrees of emotional and sensory engagement with the urban environment. By identifying these correlations, urban planners and policymakers can develop more nuanced strategies that balance technological integration with the preservation of traditional urban experiences. The Correlation Matrix in this study offers a detailed examination of these relationships, providing essential insights into the multifaceted impact of GPS technology on urban living.

The correlation matrix analysis reveals several important insights into the relationships between demographic factors, GPS usage, and perceptions of the urban landscape among Baghdad residents.

Firstly, there is a significant negative correlation between age and reliance on GPS technology for navigation (correlation coefficient: -0.72), indicating that older individuals are less likely to use GPS. This generational gap suggests that younger residents, being more digitally literate, are more inclined to adopt modern navigation tools, whereas older residents might still prefer traditional methods.

The analysis also shows a strong negative correlation (-0.78) between reliance on GPS and familiarity with city landmarks, suggesting that heavy dependence on GPS can diminish one's spatial awareness and familiarity with the physical aspects of the urban environment. This finding underscores the potential downside of digital navigation, where efficiency and convenience might come at the cost of reduced engagement with the city's traditional navigational cues.

Despite this, the data indicates moderate positive correlations between reliance on GPS and the perceived advantages of GPS technology, such as speed (0.27), accuracy (0.26), comfort (0.25), and real-time updates (0.28). These moderate correlations highlight that users who rely on GPS technology appreciate its benefits in enhancing navigational efficiency.

Gender appears to have a negligible correlation with GPS usage, suggesting that both males and females have similar tendencies towards adopting GPS technology. However, educational level shows a more pronounced impact, with higher educational attainment correlating positively with increased GPS usage. This trend emphasizes the role of education in equipping individuals with the skills and confidence to utilize modern digital tools effectively. Specifically, respondents with higher education levels, such as bachelor's and postgraduate degrees, are more likely to use GPS technology compared to those with lower educational levels. This indicates that education not only enhances digital literacy but also fosters a greater acceptance and reliance on technological advancements.

Interestingly, there is a strong positive correlation (0.92) between reliance on traditional landmarks for navigation and familiarity with the city's landmarks, indicating that those who prefer traditional navigation methods tend to have a better understanding and knowledge of the urban landscape.

Furthermore, the correlation between reliance on GPS and emotional connection to the urban landscape (-0.19) and sensory experience (-0.07) is weakly negative. This suggests that while digital navigation may slightly affect sensory and emotional engagement with the city, the overall impact is relatively minor.

Overall, the correlation matrix analysis offers a nuanced understanding of how demographic factors and navigation methods interact with perceptions of the urban landscape. These insights are essential for urban planners who aim to balance technological integration with the preservation of traditional urban experiences, ensuring that advancements in navigation technology enhance rather than detract from the richness of urban life (Figure 7).

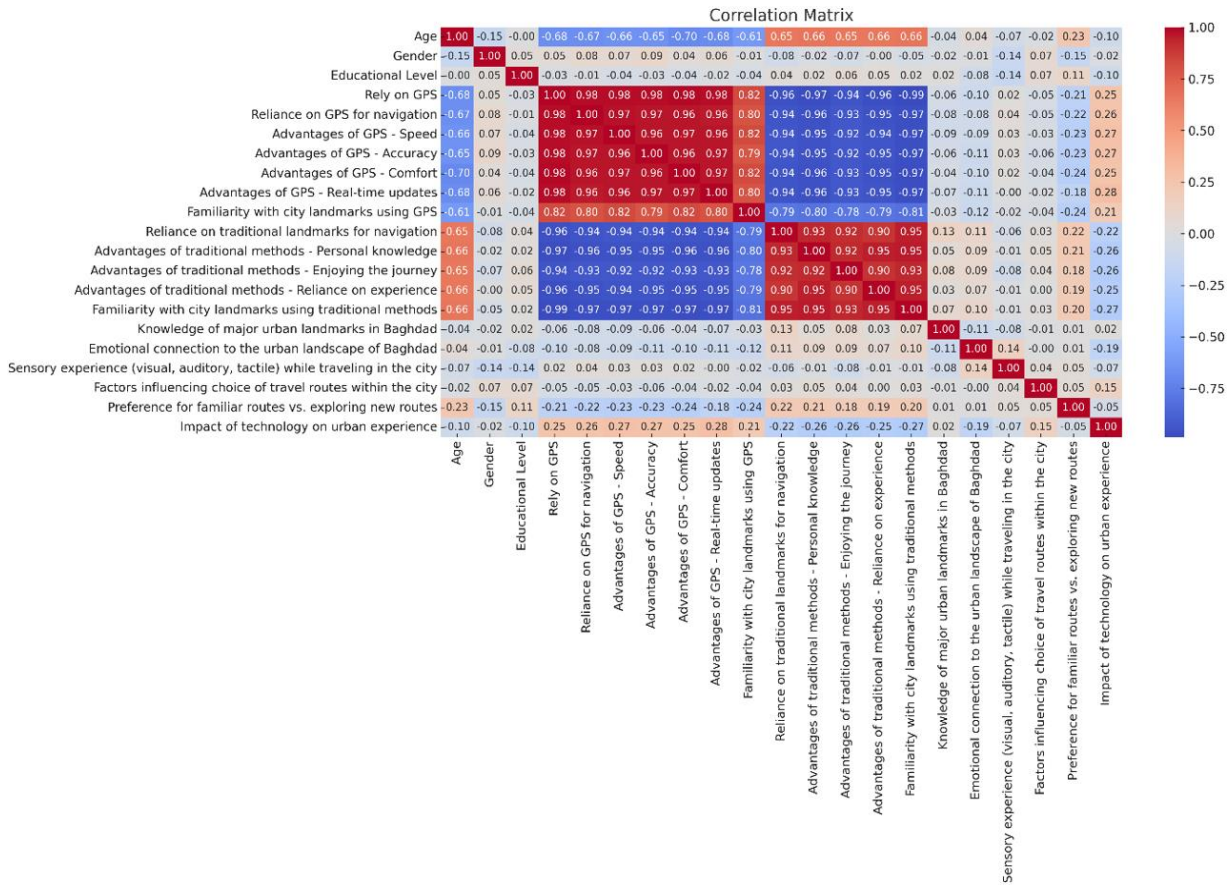

Figure 7. Correlation matrix

5. RESULTS

The study aimed to evaluate the impact of technological advancements, particularly GPS and satellite imagery, on urban landscape perceptions among the residents of Baghdad. Through a mixed-methods approach combining qualitative

interviews and quantitative surveys, the following key results were derived:

Reliance on GPS for navigation: The analysis revealed a moderate reliance on GPS technology among respondents, with a mean score of 2.77. The median score of 4 indicated that a significant portion of the sample heavily relies on GPS, despite the mode being 0, reflecting varied responses. This suggests that while many residents find GPS essential for navigation, a notable segment still relies on traditional methods or other means.

Perceived advantages of GPS technology: Respondents acknowledged several benefits of GPS, including speed (mean = 2.7), accuracy (mean = 2.68), comfort (mean = 2.75), and real-time updates (mean = 2.71). These advantages were consistently rated high, with median scores of 4, underscoring the recognized efficiency and convenience of GPS systems.

Impact on familiarity with urban landmarks: Heavy reliance on GPS appears to negatively impact familiarity with physical landmarks in the city, with a notably low mean score of 1.27 and a median of 1 for familiarity with city landmarks. This finding aligns with concerns that digital navigation may reduce direct engagement and spatial awareness of the urban environment.

Use of traditional navigation methods: The study found a decline in the use of traditional landmarks for navigation, highlighted by a mean score of 1.57 and a mode of 0. However, respondents still maintained a good level of knowledge about major urban landmarks (mean = 3.7), suggesting that traditional knowledge coexists with modern technology to some extent.

Emotional and sensory connection to the urban landscape: Despite the shift towards digital navigation, respondents reported a strong emotional connection to Baghdad's urban landscape (mean = 3.48) and a rich sensory experience (mean = 3.59). This indicates that digital tools have not entirely diminished the sensory and emotional engagement with the city.

Generational and gender-based differences: Analysis of GPS usage by gender revealed significant generational differences. Younger respondents (both male and female) were more likely to use GPS technology, whereas older respondents preferred traditional methods. This trend suggests a digital divide influenced by age and possibly digital literacy. Female respondents showed varying degrees of reliance on GPS based on educational levels, with higher education correlating with increased GPS usage. Male respondents with postgraduate degrees exhibited the highest usage rates of GPS, indicating that education plays a crucial role in technology adoption.

Influence of educational attainment: Higher educational levels correlated with greater usage of modern technology across both genders. Postgraduate degree holders showed the highest percentages of GPS usage, highlighting that educational exposure enhances familiarity with and confidence in digital tools. This finding underscores the need for urban planners to consider educational interventions that enhance digital literacy, ensuring equitable access to modern navigation tools across all educational levels.

Impact of technology on urban experience: The study highlighted a complex interplay between modern GPS technology and traditional navigation methods. While GPS offers convenience and efficiency, it may also lead to reduced engagement with the physical urban landscape. The mean score of 3.49 for the impact of technology on urban experience indicates a significant influence of digital tools, balancing between enhanced navigation and potential detraction from sensory engagement.

Correlation matrix findings:

-Age and GPS usage: There is a strong negative correlation between age and reliance on GPS (correlation coefficient: -0.72), indicating that older residents are less likely to use GPS for navigation.

-Familiarity with city landmarks: A negative correlation of -0.78 exists between reliance on GPS and familiarity with city landmarks, suggesting that heavy reliance on GPS technology may reduce an individual's familiarity with physical city landmarks.

-GPS advantages: Positive correlations are observed between reliance on GPS and perceived advantages of GPS such as speed (0.27), accuracy (0.26), comfort (0.25), and real-time updates (0.28). These moderate correlations indicate that users who rely on GPS recognize its benefits in terms of efficiency and convenience.

-Gender and GPS usage: The data shows no strong correlation between gender and GPS usage, suggesting that both males and females have similar tendencies towards using GPS technology.

-Traditional navigation methods: Reliance on traditional landmarks for navigation has a strong positive correlation (0.92) with familiarity with city landmarks using traditional methods. This suggests that those who use traditional navigation methods are more familiar with the city's physical landmarks.

-Emotional and sensory connection: There is a weak negative correlation between reliance on GPS and emotional connection to the urban landscape (-0.19) as well as sensory experience (-0.07). These weak correlations indicate that while digital navigation may affect sensory and emotional engagement with the city, the impact is relatively minor.

6. RECOMMENDATIONS

•Urban planners should adopt a balanced approach that incorporates both modern GPS technology and traditional navigational methods. This can involve designing urban spaces with clear and distinct physical landmarks alongside digital navigation aids. Such a dual approach will help maintain residents' familiarity with their urban environment while leveraging the benefits of digital tools.

•Develop educational programs aimed at improving digital literacy across all age groups, with a particular focus on older populations who may be less familiar with modern technology. Enhancing digital skills through these interventions can bridge the technological divide and ensure that all residents can benefit from advancements in navigation technology.

•Create digital navigation tools that promote exploration and engagement with the urban environment. These tools should feature highlights of cultural and historical landmarks, provide detailed information about the surroundings, and suggest scenic or interesting routes to enhance the sensory and emotional experience of using digital navigation.

•Urban planning strategies should aim to preserve traditional urban experiences by integrating spaces that encourage physical interaction with the environment. Public squares, parks, and pedestrian pathways should be designed to facilitate social interactions and sensory engagement, counteracting the potential detachment caused by over-

reliance on digital navigation.

•Recognize and accommodate the varying preferences and needs of different demographic groups in urban planning. Younger residents may prefer technology-driven solutions, while older residents might value traditional methods. Inclusive urban designs that cater to these diverse needs can create a more navigable and engaging urban environment for all residents.

•Encourage the design of urban spaces that stimulate the senses and foster emotional connections. This can be achieved through the use of varied textures, colors, sounds, and smells in public spaces, enhancing the overall sensory experience of the urban landscape.

•Regularly collect and incorporate feedback from residents regarding their navigation experiences and preferences. This participatory approach ensures that urban planning and technological implementations align with the actual needs and desires of the community.

•Utilize advanced technologies such as GIS and augmented reality in urban planning to create more interactive and informative urban experiences. These tools can provide planners with valuable data for designing spaces that are both functional and engaging.

•Encourage the use of hybrid navigation methods that combine digital and physical cues. For instance, digital maps could include references to physical landmarks, and wayfinding signs could incorporate QR codes that link to digital information, creating a seamless blend of traditional and modern navigation methods.

•Urban planners should adopt a balanced approach that incorporates both modern GPS technology and traditional navigational methods. This can involve designing urban spaces with clear and distinct physical landmarks alongside digital navigation aids. Such a dual approach will help maintain residents' familiarity with their urban environment while leveraging the benefits of digital tools.

-Urban planners should prioritize the creation of digital maps that integrate with physical wayfinding signs, potentially using QR codes to provide historical and cultural context for landmarks. This approach not only enhances navigation but also enriches the urban exploration experience by providing deeper insights into the city's cultural and historical significance.

-Implement educational programs aimed at increasing digital literacy across all age groups, with a particular focus on older populations who may be less familiar with modern technology. By enhancing digital skills, these interventions can bridge the technological divide and ensure that all residents can benefit from advancements in navigation technology.

-Advocate for the protection and restoration of key urban landmarks that hold cultural and historical significance, integrating them into digital navigation systems as primary points of interest. Collaborating with local cultural organizations can promote awareness of the historical importance of these landmarks, encouraging community involvement in their preservation.

-Encourage the design of urban spaces that stimulate the senses and foster emotional connections. This can be achieved through varied textures, colors, sounds, and smells in public spaces, enhancing the overall sensory experience of the urban landscape.

-Utilize advanced technologies such as GIS and augmented reality in urban planning to create more interactive and informative urban experiences. These tools can provide planners with valuable data for designing spaces that are both functional and engaging.

Continue researching the impact of technological advancements on urban experiences and regularly update urban planning practices based on the latest findings. This adaptive approach will help cities remain resilient and responsive to the evolving needs of their residents.

7. FUTURE RESEARCH DIRECTIONS

The findings of this study open several avenues for future research that can build upon the insights gained from exploring the impact of GPS and satellite imagery on urban landscape perceptions in Baghdad. Future research could focus on:

•Conducting longitudinal studies to track changes in urban landscape perceptions and technology adoption over time. This approach can provide deeper insights into how technological advancements continue to shape urban experiences and whether the trends observed in this study persist or evolve.

•Exploring similar studies in different cultural and geographic contexts to compare how various cultural factors influence the adoption of digital technologies and perceptions of urban landscapes. Such comparisons can help identify universal trends and context-specific differences.

•Investigating how the integration of digital navigation tools affects social interactions within urban environments. This includes examining how these technologies influence community dynamics, social cohesion, and the formation of social networks.

•Analyzing the role of emerging technologies such as augmented reality (AR) and virtual reality (VR) in enhancing urban navigation and experience. Future studies could assess the potential of these technologies to provide more immersive and engaging urban experiences.

Evaluating the impact of different urban planning policies on the integration of digital technologies in urban environments. This research could provide valuable insights into how policy frameworks can support or hinder the effective use of technology in urban planning.

ACKNOWLEDGMENT

The authors wish to thank the Urban and Regional Planning Center for Postgraduate Studies at the University of Baghdad for their invaluable support and resources during the research process. Special thanks go to all the study participants for their cooperation and insights, which were crucial in shaping this research's outcomes. We also appreciate the constructive feedback from peer reviewers, which significantly improved the quality of this paper.

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