

# Smart Cities and Social Inclusion: Analyzing the Equitable Distribution of Digital Resources and Services

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**Abstract:** *The main objective of this study is to determine whether residents' access and utilization of digital resources and services significantly differ according to the selected demographic profile of residents within smart cities. A sample of 150 Metro Manila residents was chosen to participate in the research. Using the stratified sampling approach, these participants were selected from Quezon City, Makati City, and Manila City in order to create a sample population that best represents the whole population of Metro Manila. According to the study's findings, the majority of the respondents were female, in their young adulthood, and had low-level monthly family income while being graduates of high school. The majority of residents claim they are satisfied with the digital resources and services included in their city, finding that they enhance their quality of life. Residents' access and utilization of digital resources and services has no significant differences according to sex. However, age and monthly family income have significant differences between availability and accessibility while high educational attainment significantly influences accessibility. Additionally, residents collectively recognize potential challenges and barriers to achieving an equal distribution of digital resources and services.*

**Keywords:** *Smart Cities, Social Inclusion, Digital Resources, Digital Services, Access and Utilization*

## I. INTRODUCTION

In response to the global need for knowledge-based, sustainable, and efficient societies to address a range of urban environment-related problems and difficulties, smart cities have emerged. Smart cities use digital technology and rely on data-driven knowledge and innovation to create well-informed judgments and clever solutions in order to improve the general quality of life.

In 2018, Metro Manila was recognized as one of the Philippines' smart cities and was included in the ASEAN Smart Cities Network (ASCN). In a recent report conducted by the International Institute for Management Development (IMD), Manila ranked 115<sup>th</sup> out of 141 cities included in the 2023 Smart City Index, significantly lower than its 102<sup>nd</sup> rank in 2021. The concept of smart cities is a relatively new project that the Philippines is just beginning to explore and endeavor, as the government is creating plans to create many smart cities. Studies on smart city projects have been carried out in an effort to assess and present data on their efficacy and impact.

As more cities adopt smart technologies to enhance urban living, addressing the fundamental issue of social equity in the digital age becomes even more apparent. This study discussed the concept of smart cities and its relationship with social inclusion, by bridging the digital divide through analyzing the equitable distribution of digital resources and services, and adapted the perspectives of the Digital Divide Theory as defined by Castree, Kitchin, and Rogers (2013). In order to guarantee an equitable distribution of digital resources and services, the research looks into how Metro Manila's growing smart cities utilize digital technologies and services such as internet access, smart transportation systems, and smart infrastructure. It looks at how these resources are used,

made accessible, and affordable for all residents, regardless of their background or circumstances. The research serves to advance the understanding of digital inclusion in the context of smart cities and act as a valuable resource for other developing smart cities in creating more inclusive, accessible, and equitable smart cities for the future.

In addition to analyzing the success of digital inclusion programs and their influence on enhancing social inclusion outcomes, the study aimed to identify the barriers and challenges that stand in the way of achieving equal distribution. It explored strategies, policies, and solutions from evidence-based insights and recommendations and shared research findings to foster collaboration and knowledge sharing among researchers, policymakers, urban planners, and stakeholders working toward digital inclusion and social equity in smart cities.

### Conceptual Framework

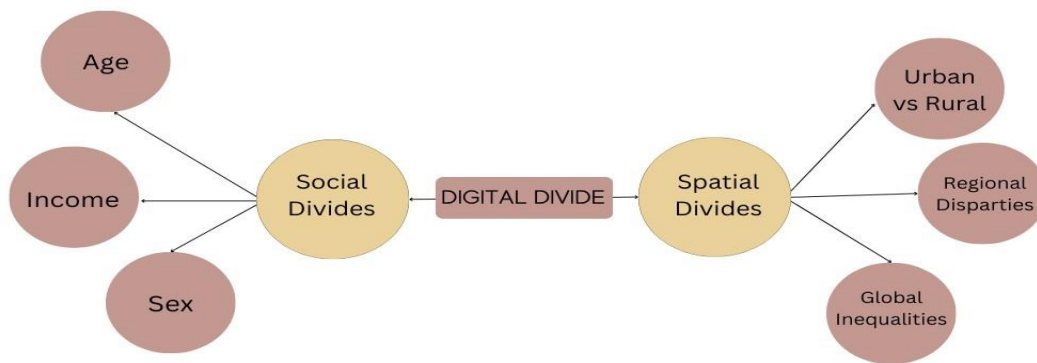


Fig. 1. demonstrates the multifaceted nature of digital inequality, influenced by both social and spatial determinants.

## LITERATURE REVIEW

### Emergence of Smart Cities and Its Implications to Society

The modern concept of smart cities originated as part of IBM's marketing campaign to incorporate technology into cities in order to better manage services. Broader perspectives on smart city improvement include a wider range of services such as education, health care, and telecommunications. Smart cities are characterized by their steadfast reliance on digital technology. Information and Communication technologies (ICT) are used in smart cities to improve the environment, transportation, traffic management, local economy, citizen- government engagement, and quality of life. Internet of Things devices are a fundamental part of a smart city. These devices' integrated sensors (ISs) gather important data or information that can be utilized to obtain important data. A smart city has a set of objectives, with sustainability, the community or its citizens, and social and economic development as its key points of emphasis (Sharma, 2020).

### Digital Resources and Services in Philippine Smart Cities

Smart cities offer a new framework that combines various information and communication technology (ICT) solutions to address urban challenges and enhance the quality of life for residents. A smart city is one that uses information and communication technologies to manage its social and human capital, ensures that resources are used wisely, has a systematic governance structure, and has infrastructures that can support economic growth to improve the quality of life for its residents (Wahab, Seow, Radzuan, and Mohamed, 2020). This research identified six digital resources and services: smart technology, smart mobility, smart governance, smart healthcare, smart security, and smart people.

### Smart Technology: Internet and Connectivity

Innovations in communication technology have been a well-known trend in recent years and are anticipated to be essential to the provision of connection in smart cities. The concept of connectedness is the foundation of the future paradigm for smart cities. In order to allow for interoperability access and interconnection among diverse smart city objects, connectivity undoubtedly plays a significant role in smart cities. Moreover,

communication networks, machine-to-machine (M2M), vehicle-to-vehicle (V2V), network virtualization, and gateways are just a few of the technologies that telecom infrastructures in smart cities can use to efficiently deliver high-quality information and services across a vast number of digital devices (Yaqoob, Hashem, Mehmood, Gani, Mokhtar, Guizani, 2017).

Sensors and other devices are connected via M2M through wired or wireless networks to ICT systems. As opposed to this, IoT symbolizes a paradigm that includes a collection of technologies, systems, and design ideas interrelated with the Internet network. The goal of IoT is to get to a framework like to the modern Internet, where links combine objects with the actual world, while the M2M technology facilitates as enabler. That being said, IoT serves as an addition to the current internet that includes automated data collecting, management, and oversight of tangible infrastructure, by means of remote surveillance. The significance of communication technology lies in its ability to facilitate connectivity and data exchange across many components within Smart City environments. Given that Smart City systems are used in larger, ideally urban regions and are capable of accommodating demands for quick growth and reconfiguration, wireless communications have clear advantages. The widespread use of mobile sensor nodes—nodes placed in different locations where it is challenging to build wired infrastructure—justifies the use of wireless technologies. And most importantly, a discernible drop in the cost and power consumption of communication modules and sensors (Dobrilovic, 2018).

### **Smart Mobility: Transportation Systems**

One of the most urgent issues in the Philippines is traffic and efficiency of public transportation. The Intelligent Transport System aims to improve transportation efficiency, including mobility and traffic management. Studies have identified various smart transportation solutions, such as real-time traffic monitoring systems, smart traffic lights, and a mobile app providing commuters real-time information on bus schedules and routes. These solutions aim to alleviate congestion, reduce travel time, and provide more reliable and convenient transportation options for residents in Metro Manila (Oladimeji, Gupta, Kose, Gundogan, Ge, and Liang, 2023).

The Land Transportation Franchising and Regulatory Board (LTFRB) in Metro Manila is collaborating with the Department of Science and Technology Advanced Science and Technology Institute (DOST-ASTI) to develop a bus management system based on real-time GPS location data. The system aims to improve efficiency and quality in the Philippine economy, particularly in the city's rapidly urbanized areas. The LTFRB will monitor bus locations in real-time, making necessary adjustments to routes and schedules to avoid overcrowding and reduce waiting times. This system will also provide passengers with accurate estimated arrival times, reducing frustration and dissatisfaction (Garcia and Retamar, 2016).

### **Smart Governance: E-Government**

E-government is defined by the United Nations (UN) as “the use of information and communication technologies (ICTs) and their application by the government for the provision of information and public services to the people.” It also agrees with other contemporary definitions that e-government is the use of ICTs by the government to provide citizens and businesses with the opportunity to interact and conduct business with the government through various electronic media such as telephone touch pad, fax, smart cards, self-service kiosks, e-mail, Internet, and electronic data interchanges (EDI). The World Bank (WB) defines e-government as “government-owned or operated information and communication technology (ICT) systems that transform relationships with citizens, the private sector, and/or other government agencies in order to promote citizen empowerment, improve service delivery, strengthen accountability, increase transparency, or improve government efficiency”. E-governance is receiving greater attention in developing one's own government through the provision of services that are effective, efficient, responsive, and fulfilling. E-governance is therefore seen as a crucial instrument in today's inventive environment for encouraging good governance in public administration. The national government of the Philippines ordered local government units to install web portals to facilitate online policy forums that cater to lively discussions between citizens and public administrators for the advancement of digital democracy. Local government organizations also made ICT investments in order to better equip themselves and influence the extent and direction of the government's e-governance initiatives. Because most Filipinos have greater access to the internet than to any other mass media, online policy forums have proven to be an effective means for public administrators to inform the public about government plans and initiatives aimed at improving policy enforcement (Pabatang-Hussien, 2023).

## Smart Healthcare

The concept of e-health made computing resources more affordable and increased the scale of integration. Technology developments and consumer demand also spread low-cost sensing devices able to detect elements of the human body and generate large amounts of data. These conditions also made it possible for large-scale data centers harnessing virtualization technologies to be deployed globally and made available to the general public, thereby implementing scale economies. The ensuing health systems give citizens more control over their own well-being through the availability of qualified and personalized health information and the ability to receive appropriate medical care through remote health monitoring (Aceto, Persico, and Pescapè, 2018).

Telemedicine represents a significant step towards the digitization of the city's healthcare system. This technological advancement facilitates remote consultations and treatments, thereby increasing the capacity of the healthcare system to care for a larger number of patients. By leveraging digital communication tools, telemedicine can enhance accessibility to medical services, improve patient outcomes, and streamline the efficiency of healthcare delivery across the city.

## Smart Security: Public Safety and Emergency Response System

Public safety is a vital component of a thriving and harmonious society. It encompasses a wide range of measures and initiatives aimed at protecting individuals, communities, and the general public from harm, crime, and emergencies (John, 2023). Urban public safety monitoring and administration have grown increasingly complex in response to the intricate and complex condition of urban public safety. It is difficult to diagnose, discover, and provide an early warning for urban public safety events using a single data source and traditional spatial data type. The process of monitoring urban public safety has been built using satellite and ground video monitoring with the development of the internet, IoT, social networks, and integrated observation systems (Jun, 2020).

Remote sensing data is crucial for a number of application areas, including climate prediction, remote surveillance, and disaster monitoring. Humanoid digital and physical systems can be effectively integrated to enhance quality of life and create smarter, more sustainable cities. The fundamentals of the spatial information (SI) framework, which combines social media, images, sensor-based observations, and geographic information system (GIS) characteristics. There are numerous potential applications for smart city applications when this remotely sensed data is paired with location-specific data that can be gathered locally or through IoT devices (Sharma, 2020).

## Smart People: Education Technology

Educational technology is a field of study that deals with the creation, implementation, and evaluation of the learning environment, learners, and the learning process. Pedagogies, which include instructional methods, models, and principles, are just as much technology as computers. They can be implemented by individuals or integrated into tangible tools and structures. Pedagogies, like other technologies, are assemblages in and of themselves that choreograph a variety of phenomena, chief among them being presumptions about how individuals learn. One possible definition of educational technology, otherwise known as learning technology, is any technology that integrates pedagogies into its orchestration of other technologies, whether on purpose or unintentionally. While some educational technologies are created specifically for this purpose and are available for purchase, other technologies, such as electronic whiteboards, learning management systems, and textbooks can also be used to enhance or support learning when paired with the right pedagogies (Dron, 2022).

Universities like UMa utilized the online application Moodle as the Official LMS of the institution. Moodle is a "learning platform which is considered an open-source software package designed to help educators, administrators, and learners with a single robust, secure and integrated system to create personalized learning environments" (Leaño, 2022). This strengthens the eLearning Program to expand its technical services; eLearning Program LMS was enhanced, and eLp mobile was developed ensuring that all online users can access all the learning resources/tools and find the teaching-learning process convenient just the same.

Literacy in the modern world encompasses more than just text comprehension. Digital literacy in the Philippines encompasses a range of skills and competencies related to the use of digital technology, including the ability to find, evaluate, utilize, share, and create information ethically and responsibly (Reddy, Sharma, and Chaudhary, 2020). Digital literacy training programs prove helpful in mitigating the digital skills gap to help create an inclusive and participatory ecosystem (Matli and Ngoepe, 2020). They are critical in keeping people's knowledge, competencies, and abilities up to date (Aleandri and Refrigeri, 2013).

## Digital Divide, Social Exclusion, and Its Effects in Fostering Social Inclusion

Van Dijk (2017) states that the difference between those who have access to forms of information and communication technology and those who do not is the standard definition of the term “digital divide.” The Internet and computers are the main examples of these types along with digital devices and applications, especially smartphones, are also mentioned. While according to Kularski as cited by Antonio and Tuffley (2014), the digital divide is composed of a skill gap and a gap of physical access to Information Technology (IT) and the two gaps often contribute to each other in circular causation. It is hard to acquire technical skills without access to technology, and it is pointless to have technology without the ability to use it.

Social exclusion is a multidimensional relational process of severing social ties, preventing access to institutions, denying opportunities for social participation, and impairing social cohesion and solidarity. It contributes to and is a result of poverty. Exclusion may be based upon cultural identities as well as on age, gender, sexuality, disability, poverty, unemployment, and other stigmatized categories (Silver, 2019). It is experienced as a lack of opportunity or the inability to make use of available opportunities, preventing full participation in society (O'Donnell, Moran, Geelen, O'Donovan, Van Den Muijsenbergh, and Elmusharaf, 2021).

Torres-Diaz and Duarte (2015) stated that digital exclusion is an effect of social inequality, thus, to a large extent it reflects previously existing social ills. However, even more importantly, the digital divide is becoming a cause of social exclusion since on one hand it affects those groups already facing disadvantage by aggravating and perpetuating existing inequalities and on the other, it places at a disadvantage a whole new set of groups and individuals cutting them off from avenues of personal, social, and economic development. Another skill gap is the lack of skilled labor that can handle sophisticated cyber-physical systems in smart cities. Cyber physical systems consist of thousands of IoT devices and sensors; hence, effectively managing them requires trained professionals. Other causes lie in overly advanced services, poor digital literacy and skills, and personal attitude barriers (Ahmad, Ahad, Alam, Siddiqui, and Casalino, 2021). Scholars have suggested that policymakers work towards liberating the process of digitization, which would increase the accessibility to services and improve digital literacy. The inclusive use of technology and service delivery are significant issues that need to be considered by policymakers (Hassankhani, Alidadi, Sharifi, and Azhdari, 2021).

## II. METHODOLOGY

### Design

Quantitative method was used for this research for its ability to collect and examine numerical data to quantify or measure social phenomena by understanding patterns or trends, and identifying relationships or differences between variables, which can be analyzed objectively. Social inclusion and digital resources and services, can be measured using quantitative metrics such as usage statistics, access rates, and demographic data. This is especially crucial for investigating social phenomena such as social inclusion in smart cities, as the intention is to uncover trends that extend beyond specific individual situations. This allows for the exploration of the equitable distribution of whether residents' access and utilization of digital resources and services in smart cities differ according to their demographic profile.

Furthermore, descriptive survey research design was implemented in this study to investigate the relationship between smart city initiatives and social inclusion, focusing on digital resources and services are distribution to different groups of the population. Descriptive survey research is a quantitative method that seeks to describe the characteristics of a phenomenon rather than determining why it occurs. This provides a deeper knowledge of the nature of the subject at hand and lays a solid foundation for future investigation. The survey descriptive research approach entails developing questionnaires and sending them to respondents, who subsequently complete the questions.

### Respondents

The study involved residents of the top three wealthiest Metro Manila cities by asset value according to the 2022 Commission on Audit (COA) Annual Financial Report, namely Quezon City (approximately ₱443.41 billion worth of asset), Makati City (assets of about ₱239.48 billion), and Manila City (asset value of approximately ₱77.51 billion) – pioneers in smart city developments. Due to the rigorous process of data collection and time constraint, a sample size of 150 respondents was collected. To gather the information needed in the study, the researchers created a research-made questionnaire conducted through online and face-to-face survey.

This study used stratified random sampling in the selection of the participants. In this research, the strata used were the sex and age of the respondents. This type of sampling method is beneficial because the researchers aim to study the population demographics and test the hypothesis that residents' access and utilization of digital resources and services in smart cities differ according to their demographic profile.

**Instrument Used**

**Enhance the Quality-of-Life Questionnaire**

This 13-item questionnaire assesses how digital resources and services enhance residents' quality of life, using a 4-point Likert scale (1 = Strongly Disagree, 4 = Strongly Agree). It was validated by experts and pre-tested on 30 similar respondents, yielding a Cronbach alpha of 0.79, indicating acceptable reliability.

**Access and Utilization Questionnaire**

This 38-item questionnaire evaluates residents' access and use of digital resources and services in terms of accessibility (14 items), affordability (12 items), and availability (12 items). It also uses a 4-point Likert scale. After expert validation and pre-testing on 30 individuals, the reliability was confirmed with Cronbach alphas of 0.85 (accessibility), 0.75 (affordability), and 0.87 (availability), all above the acceptable level of 0.70.

**Potential Challenges and Barriers Questionnaire**

This 13-item questionnaire identifies challenges in achieving equitable distribution of digital resources and services, using the same 4-point Likert scale. It was validated by experts and pre-tested on 30 individuals, with a Cronbach's alpha of 0.89, demonstrating high reliability.

**Statistical Analysis**

The researchers used percentage to indicate the proportion of the respondents according to their demographic profiles, and used mean to represent the residents' average response to each of the questions included in the instrument. It was specifically applied to measure the average response of residents' assessments on the enhanced quality of life, access and utilization, and potential challenges and barriers of digital resources and services integrated within smart cities. Mann – Whitney U Test was utilized to determine if there was a significant difference between the residents' access and utilization of digital resources and services in smart cities according to their sex, and Kruskal–Wallis Test to determine if there was a significant difference between the residents' access and utilization of digital resources and services in smart cities according to their age, education, and income.

**III. RESULTS AND ANALYSIS**

TABLE I  
DEMOGRAPHIC PROFILE

Variables	Categories	Frequency	Percentage
Sex	Male	74	49.33
	Female	76	50.67
Age	20 – 39 (Young Adulthood)	81	54
	40 – 59 (Middle Adulthood)	50	33.33
	60 and above (Late Adulthood)	19	12.67
Highest Educational Attainment	Elementary Level	6	4
	Elementary Graduate	6	4
	High School Graduate	91	60.67
	College Graduate	47	31.33
Monthly Family Income	Less than ₱12,082	58	38.67
	₱12,082 - ₱24,164	53	35.33
	₱24,165 - ₱48,328	29	19.33
	₱48,329 - ₱84,574	5	3.33
	₱84,575 - ₱144,984	4	2.67
	₱144,985 and above	1	0.67

Table 1 shows that 76 respondents (50.67%) were female and 74 (49.33%) were male. Most of the respondents belong to the 20 to 39 (n=81, 54%) age group. Meanwhile, 50 respondents (33.33%) are aged 40 to 59, and 19 (12.67%) are aged 60 and above. Additionally, 91 of the 150 respondents are High School Graduates (60.67%), followed by College Graduates (n=47, 31.33%). Moreover, the lowest respondents 6 (4%) are at the elementary level and elementary graduate. In terms of monthly family income, 58 respondents (38.67%) earn less than ₱12,082, 53 (35.33%) earn ₱12,082 to ₱24,164, 29 (19.33%) earn ₱24,165 to ₱48,328, 5 (3.33%) earn ₱48,329 to ₱84,574, 4 (2.67%) earn ₱84,575 to ₱144,984, and 1 respondent (0.67%) earns ₱144,985 or more. In summary, the majority of respondents in Smart Cities are female, aged 20 to 39, high school graduates, with a monthly family income of less than ₱12,082.

TABLE III  
DIGITAL RESOURCES AND SERVICES INTEGRATED WITHIN THE CITY

Digital Resources and Services	Frequency
Smart Technology: Internet and Connectivity	120
Smart Mobility: Transportation Systems	125
Smart Governance: E-Government	101
Smart Healthcare	82
Smart Security: Public Safety and Emergency Response System	126
Smart People: Education Technology	67

As shown in table 2, 126 respondents have access to smart security systems, as one of the digital resources and services integrated within their city. This is followed by smart mobility systems by 125 respondents; smart technology with 120 respondents; smart governance services with 101 respondents; smart healthcare with 82 respondents; and smart education technology by 67 respondents.

TABLE IIIII  
RESIDENTS' ASSESSMENT OF THE ENHANCED QUALITY OF LIFE BY DIGITAL RESOURCES AND SERVICES INTEGRATED WITHIN SMART CITIES

	Overall Mean	SD	VI
Enhanced Quality of Life	3.17	0.10	A

The results show an overall mean of 3.17 (Agree) with a standard deviation of 0.10. This mean indicates that the integration of digital resources and services in their city has positively impacted the residents' quality of life. The small standard deviation of 0.10 shows that the residents' responses were consistent, indicating few concerns about their quality of life. Overall, the residents agree and are generally satisfied with the improvements that the digital resources and services have brought to their quality of life.

TABLE IVV  
RESIDENTS' ASSESSMENT TOWARDS THEIR ACCESS AND UTILIZATION OF DIGITAL RESOURCES AND SERVICES

	Mean	SD	Verbal Interpretation
Accessibility	2.95	0.06	Agree
Affordability	3.10	0.05	Agree
Availability	2.95	0.06	Agree

Table 4 shows that residents' assessments of accessibility, affordability, and availability have means of 2.95, 3.10, and 2.95 (all Agree), with standard deviations of 0.06 and 0.05. The small standard deviations indicate consistent responses, with residents agreeing that digital resources and services are accessible, affordable, and available.

TABLE V  
 DIFFERENCE BETWEEN THE RESIDENTS' ACCESS AND UTILIZATION OF DIGITAL RESOURCES AND SERVICES IN SMART CITIES  
 ACCORDING TO THEIR DEMOGRAPHIC PROFILE

	p	Interpretation
<b>Sex</b>		
Accessibility	0.725	Not Significant
Affordability	0.489	Not Significant
Availability	0.756	Not Significant
<b>Age</b>		
Accessibility	< .001	Significant
*20 - 39 (Young Adulthood) and 40 - 59 (Middle Adulthood)	0.005	Significant
*20 - 39 (Young Adulthood) and 60 and above (Late Adulthood)	< .001	Significant
*40 - 59 (Middle Adulthood) and 60 and above (Late Adulthood)	0.004	Significant
Affordability	0.167	Not Significant
Availability	< .001	Significant
*20 - 39 (Young Adulthood) and 40 - 59 (Middle Adulthood)	0.010	Significant
*20 - 39 (Young Adulthood) and 60 and above (Late Adulthood)	< .001	Significant
<b>Highest Educational Attainment</b>		
Accessibility	0.004	Significant
*Elementary Level and College Graduate	0.022	Significant
Affordability	0.152	Not Significant
Availability	0.091	Not Significant
<b>Monthly Family Income</b>		
Accessibility	0.010	Significant
*Less than ₱12,082 and ₱12,082 - ₱24,164	0.005	Significant
Affordability	0.066	Not Significant
Availability	0.002	Significant
*Less than ₱12,082 and ₱12,082 - ₱24,164	0.001	Significant

Note: \* = Post Hoc Analysis

The data reveals that there is no significant difference based on sex when it comes to accessibility ( $p=0.725 > 0.05$ ), affordability ( $p=0.489 > 0.05$ ), and availability ( $p=0.756 > 0.05$ ) of these digital resources and services. This is because digital technologies are designed for universal usability, ensuring that they are accessible to everyone, regardless of sex. Furthermore, the global reduction in the cost of devices and internet services has eased affordability as a barrier, expanding access. Lastly, gender-neutral initiatives aimed at improving digital inclusion and literacy are helping to close gaps in knowledge and access.

There is a significant difference based on age in terms of accessibility ( $p < 0.001 < 0.05$ ) and availability ( $p < 0.001 < 0.05$ ). The table shows significant differences in accessibility to digital resources and services between the age groups of 20-39 (Young Adulthood) and 40-59 (Middle Adulthood) with  $p=0.005 < 0.05$ ; 20-39 (Young Adulthood) and 60 and above (Late Adulthood) with  $p < 0.001 < 0.05$ ; and 40-59 (Middle Adulthood) and 60 and above (Late Adulthood) with  $p=0.004 < 0.05$ . Moreover, there is a significant difference in the availability of digital resources and services between the age groups of 20-39 (Young Adulthood) and 40-59 (Middle Adulthood) with  $p=0.010 < 0.05$ , and 20-39 (Young Adulthood) and 60 and above (Late Adulthood) with  $p = < 0.001 < 0.05$ . These differences are largely due to the lack of digital knowledge and skills, particularly among middle-aged and older individuals. Younger individuals, being more familiar and digitally literate, often have better access to digital resources compared to older generations, who may struggle to adapt to new technologies. On the other hand, no significant difference was found in terms of affordability ( $p=0.167 > 0.05$ ).

The table also shows that there is no significant difference in residents' affordability ( $p=0.152 > 0.05$ ) and availability ( $p=0.091 > 0.05$ ) of digital resources and services based on highest educational attainment. However, a significant difference was found in accessibility ( $p=0.004 < 0.05$ ). The comparison between elementary level and college graduates ( $p=0.022 < 0.05$ ) reveals a significant difference in their accessibility to digital resources



and services. This is due to college graduates having more advantages and acquiring higher education, knowledge, and skills in utilizing digital technologies.

Residents' accessibility ( $p=0.010 < 0.05$ ) and availability ( $p=0.002 < 0.05$ ) of digital resources and services, based on monthly family income, reveal a significant difference. A monthly family income of less than ₱12,082 and ₱12,082 – ₱24,164 shows a significant difference in residents' accessibility ( $p=0.005 < 0.05$ ) and availability ( $p=0.001 < 0.05$ ) of digital resources and services. The accessibility and availability of these resources are not evenly distributed among residents, and a significant disparity exists in low-income families. Life in low-income families is more challenging in the digital age compared to middle- and high-income families, and these challenges will intensify as services increasingly become digital-by-default. However, no significant difference was found in affordability by monthly family income ( $p=0.066 > 0.05$ ). This is likely due to technological advancements reducing the cost of devices and internet services, making them more affordable across all groups.

TABLE VI  
 RESIDENTS' ASSESSMENT ON THE CHALLENGES AND BARRIERS FACED IN ACHIEVING EQUITABLE DISTRIBUTION OF DIGITAL RESOURCES AND SERVICES IN SMART CITIES

	Overall Mean	SD	VI
Challenges and Barriers	2.97	0.08	A

Table 6 explains the potential challenges and barriers that residents faced in achieving equitable distribution of digital resources and services. With an overall mean of 2.97 (Agree) and a standard deviation of 0.08, residents generally agree that there are several potential challenges and barriers faced in achieving fair and equitable distribution of digital resources and services.

#### IV. DISCUSSION

The study found that smart security: public safety and emergency response systems is the most commonly integrated digital resources and services within smart cities. It is likely due to the prioritization of public safety among residents. Effective integration of these systems addresses crime, emergencies, and disasters, fostering a sense of security (John, 2023). In addition, the residents generally agreed and satisfied in the integration of digital resources and services within smart cities which enhanced their quality of life. Digital resources and services especially the Internet have changed every aspect of human life. People have started to easily access all kinds of information on the Internet and have also started using it for social, educational, and entertainment purposes. It is clear that the internet is a huge source of information, and everything can be accessed quickly and easily. Moreover, with the internet, people can easily stay connected with family and friends, regardless of the distance. This has been especially important during times of crisis, such as the COVID-19 pandemic, when face-to-face interactions were limited (Wang, Xu, & Xie, 2022). Many residents have expressed satisfaction with how the internet has enabled them to stay connected with loved ones and participate in virtual gatherings, which has helped combat feelings of isolation.

The assessment of residents' access and utilization of digital resources and services is evaluated in Table 4. Obtaining an understanding of these evaluations is essential to improving social inclusion with digital resources and services. These favorable opinions may serve to increase community involvement with digital resources and services, suggesting that local authorities and institutions need to give priority to projects that maintain and improve accessibility, affordability, and availability. A study by Panda, & Chakravarty (2020) supports these findings, discussing the A5 solutions (availability, adequacy, accessibility, affordability, and appropriateness) as essential requirements for bridging the digital divide, with a focus on the availability of online learning platforms.

This study proves that sex has no significant difference towards their access and utilization of the digital resources and services in terms of accessibility, affordability, and availability. A study by Kaur & Sharma (2023) also proves that digital equity ensures equitable access to education and workforce opportunities. By providing women with access to online learning platforms, educational resources, and digital skills training programs, they get the tools they need to thrive in a technology-driven society. Regardless of sex, individuals can now access vast amounts of information, educational resources, and services with just a few clicks. Age reveals significant differences, particularly in accessibility and availability. The significant disparities between the age groups—especially between young adulthood (20-39) and older groups—align with studies by Clarke, Fruhling, Sitorius,

Windle, Bernard, & Windle, (2020) that shows younger individuals are more at ease and knowledgeable about technology than older ones. Furthermore, research by Vaportzis, Clausen, & Gow (2017) shows how despite their readiness to embrace new technology, older people have difficulties using tablet computers because they lack confidence, expertise, and instructions. Regarding educational attainment, a significant difference was found in accessibility between individuals with elementary education and those with college degrees, suggesting that better access to technology is associated with higher education levels. No significant differences were found in affordability of digital resources, suggesting that advancements in technology and government policies have improved affordability gap to digital resources. These differences show how specific policies are needed in order to increase access to digital resources, especially for low-income and elderly persons. Enhancing digital literacy initiatives might contribute to closing the gap and ensuring fair access for all, regardless of age or educational background. Future studies have to delve deeper into the enduring effects of these discrepancies on economic prospects and community involvement.

The income disparity in access to and utilization of digital resources can be largely attributed to the fact that lower-income households often struggle to afford essential digital devices and reliable internet access, both of which are necessary for utilizing these resources. These income-based differences are also tied to variations in education and digital literacy, as wealthier individuals tend to be more knowledgeable about and proficient in using digital technologies. As information, services, and resources increasingly shift online, digital inequality not only mirrors but also exacerbates other enduring forms of social inequality. Discrepancies in internet and device access align closely with longstanding income inequalities (Katz and Gonzalez, 2015).

Research from Resta, Laferrière, McLaughlin, & Kouraogo (2018) discusses how limited access to digital resources is considered one of the key challenges related to digital equity for social inclusion and education, which is consistent with the issues raised in this study. Additionally, Chetty, Qigui, Geora, Josie, Wenwei, & Fang (2018) highlights the importance of measuring digital literacy for bridging digital skills gaps and promoting digital transformation. Furthermore, Méndez-Domínguez, Muñoz, Díez, & De Mesa, (2023) examines how disparities in socioeconomic status cause gaps in digital skills and access, which could potentially be resolved by innovative educational resources that promote social inclusion. It is crucial to acknowledge these barriers in order to help local governments formulate policies that enhance affordability, accessibility, and availability while guaranteeing a fair distribution of digital resources and services.

## V. CONCLUSION

In conclusion, the findings show that residents of smart cities in Metro Manila with a diverse demographic profile, primarily female, young adults with low family income, and high school graduates benefit significantly from digital resources and services, particularly in areas such as public safety and emergency response, and express satisfaction with smart city initiatives, this can be attributed to the convenience that digital resources and services provide in residents' daily activities hence improved their quality of life. The study shows that the access and utilization of the digital resources and services are generally equitable across genders, indicating that both male and female benefits equally from the available digital resources and services. However, significant differences were found when age and monthly family income are taken into consideration, which both shows significant effect on the availability and accessibility to digital resources and services. Younger residents and those from higher family income tend to have a better access and utilization in digital resources and services, this reflects how younger, tech-savvy individuals and those with higher incomes are have better access of digital resources and services reflecting broader social and economic inequalities.

Moreover, educational attainment plays a crucial role in determining residents' ability to access digital resources and services. Those with higher levels of education are more likely to utilize digital resources and services, as those with higher education are more exposed and inclined to seek out and effectively use digital information. This emphasizes the need for specialized initiatives to help lower-educated groups benefit equally from smart city innovations. The study further finds that residents recognize the challenges and barriers that prevent equitable distribution of digital resources and services, such as old and insufficient internet infrastructure and poor technology for education. These challenges highlight the need for continuous improvement in technological infrastructure and educational programs to bridge the digital gaps in access and utilization. Overall, while smart city initiatives in the Philippines have significantly improved residents' quality of life, addressing disparities based on age, income, and education is critical to ensuring that all communities have the opportunity to participate and access available digital resources and services.

## VI. RECOMMENDATION

Based on the findings and conclusions of this study, it is recommended that communities can benefit from programs and training opportunities aimed at improving digital skills and knowledge. Collaborative efforts can promote digital inclusion, helping to bridge the digital divide. Furthermore, upgrading infrastructure and providing affordable services can improve access, particularly in underserved areas. Finally, research can explore factors that influence access to digital resources, providing insights for future development and initiatives.

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