Digitalisation for whom

The determinants of residents' use of the digital property address system in Accra, Ghana

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Abstract

Purpose- There is an emerging digital turn in urban management in Africa as part of addressing the challenges of rapid urbanisation. To ensure that this digitalisation agenda contributes to smart and sustainable communities, there is the need to trace residents' use of emerging digital technologies and address any impediments to broader utilisation. To this end, this paper examines the determinants of residents' use of Ghana's Digital Property Address System (DPAS) in suburban communities of Accra.

Design- Drawing on a detailed literature review of digital technologies and the factors that affect their use, this paper uses data from a cross-sectional survey of three suburban communities in Accra. A binary logistic regression model was then utilised to identify the significant factors that affect residents' use of DPAS.

Findings- The findings showed that socio-economic, housing, and psychosocial factors were the main determinants of residents' use of DPAS. Specifically, house ownership, education and expected benefits had a positive relationship with residents' use of DPAS. This paper highlights the need for urban policy makers to pay attention to systemic issues in Ghana's digital culture to ensure that digitalisation initiatives do not widen the digital divide and thus impede progress toward smart and sustainable urban development goals.

Originality and value: The growing scholarship on digitalisation in Africa has emphasised conditions, potentials, and challenges in the deployment of digital technologies with little attention to the determinants of residents' use of these emerging digital technologies. This paper contributes to filling this knowledge gap by bringing to fore foundational issues critical to engendering equitable digitalisation agenda in Ghanaian cities and beyond.

Keywords: Digital Property Address System, digitalisation, Accra, urban management, smart urbanism

Introduction

The 2014 State of African Cities Report raises the potential of Africa's urbanisation by emphasising that the demographic size, density and socio-economic diversity of African cities are a dynamic force for productivity, innovation and improved access to services (UN Habitat, 2014). Indeed, a well-managed urbanisation can also facilitate Africa's economic transformation (Turok and McGranahan, 2013). Yet, many African cities are far from fulfilling this potential given the current realities of highly "disorganized, unproductive and unsustainable urban development practices" within planning regimes often constrained by political, economic and institutional challenges at multiple governance levels (UN Habitat, 2010). Additionally, limited innovations in planning and governance, coupled with inefficient administration, poor service provision and limited investment in productive and sustainable infrastructure have stymied job creation, reinforced inequalities and stifled economic transformation (Dodman *et al.*, 2017; Lall, Henderson and Venables, 2017). The divergence in Africa's urbanisation potential and pervasive urban challenges have thus created an 'urban development conundrum' and undergirded calls for a nuanced understanding of and locally relevant actions to turn things around (Förster and Ammann, 2018, p. 1). Such calls are warranted given the differences in institutional and socio-economic realities across the continent.

It is against this background that the smart urbanism agenda and the associated push for digital technologies or solutions have gradually been promoted in Africa to enhance the role of urbanisation in development. The digitalisation agenda hold that cities of the future will greatly rely on digital technologies, especially in the area of planning and governance (Menychtas *et al.*, 2013; Solomon and van Klyton, 2020). Thus, the adoption of digital technologies and smart urban solutions provides opportunities to traverse many of the current urban development challenges in areas such as mobility, public services, and data gathering for planning and implementation. Already, digital technologies currently deployed in some African cities are used in areas such as intelligence infrastructure, e-governance, digital economy and digital planning. For instance, the city of Cape Town, South Africa has rolled-out the ICT-GIS for integrated land use planning and poverty mapping (Baud *et al.*, 2014) whereas smart parking has been introduced in Addis Ababa to reduce parking inefficiencies (Siba and Sow, 2017).

This paper notes that while the deployment of urban digital solutions is essential, equally important is the efforts to understand their use by residents. However, the research on urban digital solutions in Africa tends to focus on 'the problem-solving perspective' (Luque-Ayala and Marvin, 2016; Balkaran, 2019; Baku, 2022), emphasising technical outcomes with little attention to socio-environmental context that impacts use (Odendaal, 2016b, 2016a). The use of digital technologies by residents and an understanding of the factors that influence their use is essential in designing tailor-made solutions that fit the local context (OECD, 2019), and actualizing the benefits of digital technologies for transformative urban governance and development (D'Amico *et al.*, 2021).

This study examines the factors that determine the use of Ghana's Digital Property Address System (DPAS), a popularized digital initiative to improve public and private service delivery. By providing unique identification to all properties, the DPAS is expected to improve efficient location-based services, economic transactions, and mobilization efforts. The DPAS aims to improve property identification, easy navigation, and improve urban service delivery (such as responding to emergency services and household waste collection) (Ayakwah, Damoah and Osabutey, 2021). It is also intended to automate government business processes and improve digital trade (The World Bank Group, 2019), facilitate the implementation of key government policies such as the national identification system, banking, and tax reforms, and passport acquisition (Aboagye, Adu-Prah and Ansah, 2018). For urban policymakers, the introduction of the DPAS is essential to improve digital navigation within the built environment (Abebrese, 2019).

Thus far, studies about digital technology usage in Ghana has focused on how it has enhanced public programs (Agbozo, 2021), how it can be deployed in designing effective addressing system (Ecklu, 2011; Abebrese, 2019), and public perception of the benefits and challenges in accessing digital governance services (Demuyakor, 2021). To the best of our knowledge, this study is the first attempt to examine the determinants of residents' use of the DPAS in suburban communities in Ghana. The study expands the scope of the growing African urban scholarship on digital solutions (Demuyakor, 2021) to encompass socio-environmental attributes such as age, income, housing type and education and their role in the use of digital technologies. The study is exploratory and assumes no a priori relationship between socio-environmental characteristics and use of DPAS. However, it draws on related literature on the relationship between socio-environmental characteristics and use of digital technologies as a framework in guiding the analysis of the findings. Despite being largely exploratory, this paper sheds light on residents' attributes that need the attention of policymakers and planners to address any tendencies for digital initiatives to reproduce exclusions in the urban environment (Balkaran, 2019). This article continues with a brief overview of digital technologies and their determinants in Africa, the study context, materials and methods. This is followed by the results, discussions and finally policy implications.

Digital technologies and its application

Global south countries are welcoming digital technologies as critical interventions for efficient governance and public service delivery (Bhatnagar, 2005; Krishna and Walsham, 2005). This has partly contributed to the growth in the implementation of e-governance initiatives (Heeks, 2002; 2003), due to its potential in providing efficiency and effectiveness in public service delivery (Heeks, 2002, 2003). In Africa, digitalisation of the modern city is becoming a visible part of everyday urban life (Banga and te Velde, 2018; van der Hoogen, Scholtz and Calitz, 2021). This is due to the complex and numerous challenges accompanying African urbanisation and urbanism which include poor addressing regime, difficulties in land management, and weakness in spatial planning. These challenges have necessitated the deployment and use of digital technologies to address many development challenges in varying forms including the application of ICT-GIS for integrated land planning and poverty mapping in Cape Town, South Africa (Baud *et al.,* 2014), the introduction of Wi-Fi services into public transport in Kigali, Rwanda (Siba and Sow, 2017), and the introduction of smart parking spot to address parking spot deficiency in Addis Ababa, Ethiopia (Siba and Sow, 2017).

Of particular note is Digital Property Address Systems (DPAS), considered as highly essential for urban governance and planning purposes. The digital property address is a computer-assisted addressing system that generates unique postcodes to identify various locations in a geographical area (Mawunyega, 2021). Its key feature lies in its potential of making the private sector a critical partner for economic growth and leading the agenda for formalizing the economy (Mawunyega, 2021) as well as bringing efficiency in public and private service delivery (Meru and Kinoti, 2022). DPAS has been operationalised in several African countries in different forms. For example, in the Ivory Coast, it exists in the form of a digital mapping service called 'What3words' which assigns a three-word phrase to each three-meter sq. on a map (Shankland, 2016). In Ghana, the DPAS is operationalised using the 'GhanapostGPS' app which is used to generate unique address codes via smartphones (Meru and Kinoti, 2022).

Whichever form digital technologies take in Africa, observations are that these initiatives do not meet their expectations and end up in total or partial failure. Drawing on his extensive research on ICT for development in Africa, Heeks (2002; 2003) argues that digital failures in Africa largely occurs within the neglect of the socio-cultural and physical context of software design and the available conditions in the intended place of implementation. Heeks' conceptual framework of this "design- actuality gap" raises the importance of attending to community and users' needs in the implementation of digital technologies in Africa (Heeks, 2002; 2003). Cecchini and Raina (2004) add that user-centred design and implementation provide a sense of ownership to the people. Hence, the implementation of a digital technology should consider the needs of the community and the people it intends to serve, which in the opinion of Heeks (2002; 2003) can reduce the 'design-actuality' gap.

In the urban context, the digitalisation agenda and associated deployment of digital technologies to address urban challenges is dependent on its use by urban residents. Pivoting urban residents to the centre of digital initiatives invite scholarly and policy discourses around participation in digital initiatives and a critical engagement of factors that affect resident's use of digital technologies (Dada, 2006). While there are various factors that shape or determine the use of digital technologies across different socio-economic groups, this issue seems to be underexplored in Africa and much less in Ghana. The dominant strand of the literature is skewed, focusing on technical and hard infrastructure requirements (See Balkaran, 2019; Baku, 2022). This tends to pay little attention to the intended users—residents in the urban context—and consequently their attributes that could impede use and achievement of so-called smart urbanisms. The neglect needs to be taken seriously due to the tendency to fester already entrenched digital policy failures (Jaeger and Thompson, 2003). Here, soft components such as socio-physical and psychological aspects need to be considered to ascertain who are actually using existing digital technologies and the factors that shape these user outcomes. The potential benefits of various digital technologies applied in the urban context is dependent on its use by residents. However, there are various factors that shape or determine the use of digital technologies in different contexts. Residents therefore must be closely involved through local awareness initiatives and promotional campaigns (Dada, 2006). The neglect of active public education and citizenship engagement during design and implementation is likely to lead to failure (Jaeger and Thompson, 2003), especially in some African countries where internet penetration is woefully low (Odedra-Straub, 1995). The next section briefly reviews the literature on the determinants of digital technologies usage by residents.

Determinants of use of digital technologies

Socio-demographic factors

Socio-demographic factors such as age, sex, level of education, income status, and residential type are significant determinants of digital technology use, especially in global south countries (Mukoko, 2012). The role of demographic factors allows researchers to understand how different social groups adapt to and use new digital technologies, and how their needs and concerns can be factored into the effective deployment of digital technologies (Njoh, 2012; Myovella, Karacuka and Haucap, 2021). Studies have shown that socio-demographic variables such as household income and level of education affects resident's likelihood of adopting and using digital technologies (Mukoko, 2012). Here, low-income residents are unlikely to purchase digital technologies due to competing demands on household income and may be regarded as a luxurious good whose necessity may not be judged as immediate for the household (Mukoko, 2012). In addition, residents with low levels of education are less likely to use digital technologies because they might find them complex or difficult to use. In India, Gupta (2020) found socio-demographic factors such as age, sex, level of education, income status, and residential type as significant determinants of digital technology use.

Reporting on the situation in Cameroon, Mukoko (2012) argues that the relationship between age and adoption of digital technologies is not straight forward but also mediated by other factors such as level of education, income and exposure to use of digital technologies. This suggest that other background characteristics are important in drawing the age and digital technology use relationship In a highly developed country like South Korea, Shin, Park and Lee (2018) found that older people are more likely to purchase and use some specific types of digital technologies like smart homes than younger ones. With regards to sex, a study in the same country by Yang, Lee and Zo (2017) found that females adopt and use digital technologies such as smart home services more than males. Nonetheless, females are affected more than males when it comes to the cost of using such digital technologies due to income differentials. Indeed, a study in Hong Kong by Li and Luximon (2016) found that the attitudes of older people have a positive relationship with digital technology use. In the United States, George *et al.* (2020) found a weak relationship between digital technologies and socio-economic status of young people. In India, Gupta (2020), found that factors such as residential location, age, gender and education significantly influence the role of technology gap on the intention to use e-government services, which are mostly rendered with digital technologies. All these observations go to show that digital technologies may appeal to different demographics at different places.

Housing characteristics

The relationship between housing characteristics and use of digital technologies, although apparent (Birba and Diagne, 2012), has scarcely been explored in Africa (Abdul-Wakeel and Osabuohien, 2021). Outside Africa, a few studies shed insight on how different housing features influence digital technology use. In essence, For instance, Yang, Lee and Lee (2018) study in South Korea shows that residents residing in apartments or multi-family houses were less likely to have their houses automated with smart technologies, while residents residing in single family homes were more likely to have their homes automated with smart technologies. Providing explanation on their findings, Yang, Lee and Lee (2018) assert that automated homes reduce the inconvenient task of controlling, maintaining, and monitoring several home gadgets in a small space. Relatedly, in the Republic of Korea, Chang and Nam (2021) found that residents living in apartments had a high preference for and use of digital technologies than those living in non-apartment. Chang and Nam (2021) thus suggest that it is important to consider conditions of the residential environment in the design and implementation of digital technologies. In Cameroon, Mukoko (2012) found that people living in urban and sub-urban areas with electricity were more likely to purchase and use digital technologies than those living in rural areas without electricity. Further, Mukoko (2012) explains that differential geographic distribution in electricity and other essential services created unequal access to and use of digital technologies (Mukoko, 2012).

Psychosocial factors

The use of digital technologies is also influenced by psychosocial factors (Shih and Venkatesh, 2003; Ziefle, Himmel and Wilkowska, 2011). These factors are related to the mental constructs that individuals make about the ease or complexity of digital technologies. The role of psychosocial variables on residents' use of digital technologies are apparent in the literature (Shih and Venkatesh, 2003; Ziefle, Himmel and Wilkowska, 2011). For instance, Ziefle, Himmel and Wilkowska (2011) found that a positive perception towards a technology has a significant relationship with residents' use than a negative perception. Other studies have also shown that positive attitudes of residents towards digital technology significantly influence their use (Hsu and Lin, 2008; Parag and Butbul, 2018; Aldossari and Sidorova, 2020).

Overall, the literature points to a multiplicity of factors that influence resident's use of digital technologies. However, there is limited understanding on this with reference to the urban context in Africa. Some studies show that perceived benefits and perceived challenges influence the use of digital technologies in urban Africa (Olatokun and Bankole, 2011; Mukoko, 2012; Van Dyk and Van Belle, 2019). These include being difficult and complex to operate and costly (Balta-Ozkan *et al.*, 2013; Wilson, Hargreaves and Hauxwell-Baldwin, 2015)—even if these complexities are mental constructs (Davis, 1989). There are however different opinions regarding which factors have the greater influence on residents' use of digital technologies in the African context (Li*n et al*., 2012; Mukoko, 2012). This paper therefore extends the southern urban scholarship on digital technologies by exploring the factors that determine resident's use of digital technologies in an exemplary African urban context.

Study Setting

The study is geographically situated in three suburban communities of Agboba, Hatso (Ga East municipality) and Ashaley Botwe (Adenta Municipality), all within the Greater Accra Metropolitan Area. They are exemplar communities by evidence of their rapid residential and commercial property development at the fringe areas of Ghana's capital city of Accra. They exemplify some of the rationalities of governments' digital property address system in terms of formalizing the economy through the agenda of inclusiveness amid rapid property development and its associated socio-spatial transformations. They therefore provide a suitable context for exploring the factors that determine residents' use of the DPAS in Ghana.

Agbogba and Hatso have projected population of 13,060 and 8,062 respectively according to the 2010 Population and Housing Census (Ghana Statistical Service (GSS), 2014b). The Ga East municipality, where they are located is predominantly urban (93.78%) (GSS, 2021). In the past two decades, the municipality has gradually transformed from socio-economically predominant indigenous population in agricultural activities into a hub for middle-income housing and commercial development with a large informal sector. This transformation has been shaped by the relocation of middle-income residents driven by the quest for cheaper lands and advancement in socio-economic status.

Ashaley Botwe according to the 2010 Population and Housing Census has a projected population of 18,615 and the Adenta municipality where it is located is one of the completely urbanised local governing units. About one-fifth of the population works in the formal sector, mainly government sector jobs and private agencies (GSS, 2014a, 2021). It is also a residential area with an increasing middle-income settler population and housing properties due to the presence of affordable housing units built by the government and other parastatal agencies as well as the preference for personal residential apartments.

[INSERT FIGURE 1 HERE]

Materials and methods

Data collection process

The cross-sectional survey research design was adopted for this study. The cross-sectional survey research design is used to collect information on the attitudes and opinions of a particular group of people at a given point in time (Creswell, 2014). The survey was conducted using the Kobo Collect Application and the survey questions were basically structured. The survey questions were in two sections, the first section contained an introductory letter which was added to explain the purpose of the study and seek the consent of the respondents to take part in the survey as well as to take respondents socio-demographic characteristics, whereas the second section contained structured questions which were meant to answer the research questions. The unit of analysis were the households in the study neighbourhoods of the two municipalities and the target population were the household heads. The period for the data collection lasted for two months, and was done by trained graduate research assistants under the supervision of the project team.

Sampling and sample size

The 2010 Population and Housing Census data on households was used for determining the sample sizes for each study neighbourhood. In total, the number of households for the three study communities was 9,850; i.e., 4,645 for Ashaley Botwe, 3,206 for Agbogba and 1,999 for Hatso. Using an estimated household population of 9,850, a confidence level of 97% and a margin of error of 3%, the sample size was calculated using the Slovin's formula:

$$n = \frac{N}{1 + Ne^2}$$

where: n is the sample size, N is the total number of households, and e is the level of precision

After obtaining the sample size of 999, the respective number of questionnaires for the three study communities were calculated using the proportional representation method which was based on the formula:

$$s = \frac{H}{\sum H} * S$$

where: s is the sample size for the study community, H is the number of households in the study community $\sum H$ is the sum of the number of households for the three communities and S is the sample size for all three communities

The sample sizes for the three communities after the computation were 471 for Ashaley Botwe, 325 for Agbogba and 203 for Hatso respectively. One of the most widely used rule of thumb for sample size justification in regression is the approach recommended by Green (1991) and Harris (1985). They suggest the rule of thumb of N>50+8m (where m is the number of independent variables and N is the minimum sample size required). Therefore, VanVoorhis and Morgan (2007) emphasising on higher sample size to ensure adequate power and acceptable effect size recommend 30 participants per variable. The sample size of 999 is in accordance with the minimum sample size required for this study. A two staged sampling procedure was used in selecting the respondents. Firstly, a listing exercise was conducted in each of the two communities in order to have a sampling frame in which the respondents would be selected. The listing exercise was conducted in July 2021 and spanned across a period of three weeks. At the end of the listing exercise, 2,654 housing units were listed for Ashaley Botwe, 2,295 for Agbogba and 1,558 for Hatso. Lastly, the simple random sampling technique was then used to select specific housing units for the structured interview. In single-housing units which normally have one household head, the head of the household or in his or her absence a representative was selected to respond to the structured interview. For multi-habited housing units which normally have different household heads, only one household head was selected to respond to the structured interview. The purpose of the survey was explained to the respondents in a language they clearly understood, and their consent were sought before the structured interviews. In lieu of this, respondents who declined to take part in the survey were left out, whiles the enumerators moved on to the next housing unit.

Variables

The study variables were categorical and continuous. The dependent variable (DV) was a dichotomous response question about whether respondents use digital address when locating a place (see Table 1). Individual-level factors such as respondents' gender, age, level of income, and level of education were used as independent variables (IVs). Other IVs include housing characteristics such as the type of housing unit, occupancy status, and building material used for the construction of respondents dwelling unit. The final set of IVs were perceived benefits and the challenges with using the digital address for locating building property. Perceived benefits and the challenges with using the DPAS in this study were composite variables generated by summing up items measured using Likert scale ranging from 1-strongly disagree, 5=strongly agree (see Table 1). Perceived benefits had a Cronbach alpha reliability score of 0.769 while challenges with the use of DPAS had a Cronbach alpha reliability score of 0.834 indicating that both measures have high internal consistency (Atindanbila, 2013).

[INSERT TABLE 1 HERE]

Analytical procedure

The data was analysed using SPSS version 22. The first section of the analysis presents descriptive statistics of the DV and the IVs. Categorical variables were described using frequency and percentages, while continuous variables were described using range, mean and standard deviation. The next section of the result is the presentation of the binary logistic regression model. Variables labelled as covariates were continuous variables or categorical variables treated as continuous variables for the binary logistic regression. Essentially in this study, the dependent variable, residents' use of the DPAS is represented by Y, while the independent variables are shown in X_1-X_{11}. ε also represents an error term which is independent of other variables. Based on the variable adopted for the study, the regression model for residents' use of DPAS is expressed as:

$$Y = \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \varepsilon$$

The binary logistic was used to model the relationship because the DV was a dichotomous variable. In terms of the interpretation, odds-ratio greater than one represents an increase in the odds of not using DPAS, while an odds-ratio less than one represents a decrease in the odds of not using DPAS. To ascertain the percentage change of the odds, one was subtracted from the odds-ratio and then multiplied by 100 (Frimpong, 2021).

Results

Description of variables

Table 2 shows the summary of responses for the DV and the IVs used for the binary logistic regression. It also shows that 38% of the respondents indicated that they used DPAS when locating a place, while 62% of the respondents indicated that they do not use DPAS when locating a place. In terms of sex, male respondents constitute approximately 60% of the respondents. Approximately 33% of respondents were from Agbogba, while 20% of the respondents were from Hatso. Furthermore, 31% of the respondents resided in separate housing units, which in the context of this study were respondents residing in detached and semi-detached housing units. The remaining 69% of respondents resided in non-separate housing units, which in this study include multi-habited housing units and makeshift housing structures. About 31% of respondents were owner occupiers (Table 2). The result shows that the mean age was 36 years (SD=10.297), while the average income was GHC 902.00 (SD= 99.208). The mean value for perceived benefits shows that respondents agree largely on the perceived benefits of DPAS (Mean = 32, SD = 7.031). Concerning challenges with the use of the DPAS, the mean value shows that the respondents agree largely on the challenges with the use of the DPAS (Mean = 28.29, SD = 4.809).

[INSERT TABLE 2 HERE]

Predicting residents use of DPAS

Table 3 shows three different test statistics for the model. The first is the omnibus test of the model coefficient which is used to check whether the model with the full set of predictors is a significant improvement over the baseline model (null hypothesis) (Lu, 2018). Table 3 shows that the X^2 is a significant improvement over the base model (X^2 =156.673, df= 10, p-value = 0.000). Table 3 further shows the model summary which presents values for the -2 Log-Likelihood (-2LL) and the pseudo R^2 for the full model. The R^2 tells the proportion of variation in the model accounted for by the predictors. Using the Nagelkerke R^2, the test shows that 31.2% of the model is explained by the predictors. Lastly, Hosmer and Lemeshow indicate that the model is a good fit to the data (X^2 =12.564, df= 8, p-value = 0.228) since the p-value shows non-significance (Lu, 2018).

[INSERT TABLE 3 HERE]

Table 4 is the classification table (with all the predictor variables). It pits the observed data against the predicted values in terms of group membership based on the model. The model as observed in Table 4 correctly classifies the outcome of 65.6% of the cases which is higher than what was reported in the null model which predicted 50.3% (null model classification table not presented in this paper). Thus, Table 4 shows a marked improvement in the model.

[INSERT TABLE 4 HERE]

To the model itself, the result shows that age, level of income, and education were the demographic variables that showed a significant relationship with the use of DPAS. For instance, the result shows that a unit increase in age increases the odds of not using the DPAS by 2.977 times. In essence, as the age of respondents increase the likelihood of not using DPAS also increases. The result also shows that a unit increase in income and education reduces the odds of not using DPAS.

For instance, the odds that respondents will not use DPAS reduces by 50% as their income increases by one unit, while the odds that a respondent will not using DPAS reduces by 11% as their level of education increases by one unit. Essentially, what this result means is that, as the income and level of education of respondents' increases, the better the chances of using DPAS.

Regarding respondents housing characteristics, the result shows that occupancy status, and materials used for building were significantly related to the use of DPAS. For instance, the result for occupancy status indicates that, the odds of not using DPAS reduces by 32% for respondents who are owner-occupiers. The result also means that owners of building properties were less likely not to use DPAS. The result on building materials shows that the odds of not utilizing DPAS reduces by 53% for respondents who used brick or blocks for their building properties.

The result further shows that the odds of not using DPAS reduces by 2.2% as respondents' perceived benefit of DPAS increases by unit. Thus, the likelihood of not utilizing DPAS reduces as the perceived benefits of DPAS increase. The result also shows that a unit increase in actual challenges increase the odds of not utilizing DPAS by 1.079 times. Thus, the changes of not utilizing DPAS increase as actual challenges in using DPAS increase.

Discussion

The emerging digital turn in Africa's urban management and governance demands an understanding of factors shaping the use of digital technologies by intended users—the residents. Although design gaps still plague the successful deployment of digital technologies in Africa, the factors which determine their use among urban residents remain understudied. With specific reference to Ghana's recently implemented DPAS, this paper upholds its potential to address a number of challenges that affects service delivery and effective governance. However, wider use among urban residents is a prerequisite to the success of DPAS. Cognizant of the limited studies on the subject in Africa and informed by the broader literature worldwide, this paper underscores that non-technical attributes can shed insights on residents' use of digital technologies. Our findings indicate that a number of demographic factors influence residents' use of the DPAS, these include age, level of income and level of education of respondents. The study further shows that as age of respondents increase, the likelihood of using DPAS also reduces. Previous studies on the role of age on the use of digital technologies shows that geographic context is important in understanding such relationship—albeit dependent on other contextual factors and exposure to technologies (Mukoko, 2012; Shin, Park and Lee, 2018). A study by Shin, Park and Lee (2018) in South Korea also indicated that older persons were inclined to use digital technologies. The findings from this study can best be understood if situated within the digital culture of Ghana. Ghana's digital transformation process is a quite recent phenomenon and might probably take a while for the older generation to fully embrace these new technologies. Providing some insight on the above point, the GSS (2020) reports that about 58.4% of adults aged 20-59 years currently use smartphones in urban areas in Ghana, indicating that smartphone usage even in urban Ghana is not very widespread.

The findings on level of income and level of education are consistent with the previous findings on household use of digital technologies (see Njoh, 2012; Myovella, Karacuka and Haucap, 2021). The result also provides some insight on how the introduction of new digital technologies such as DPAS can increase the existing digital divide if additional efforts are not made to promote usage across different socio-economic groups. Regarding level of education, it was found that having a lower level of education reduces the likelihood of using DPAS which is consistent with other studies in the influential role of education on technology usage (Mukoko, 2012). This finding is also corroborated by the GSS (2020) report which found that about 93% of individuals with high school or tertiary education owned a smartphone in urban Ghana.

The link between housing characteristics such as type of homeownership and materials used for building property and use of DPAS provide important insight into how physical characteristics of building properties are key to the successful rollout of DPAS. In the context of homeownership, the inclination of homeowners to use DPAS is because their properties serve as permanent reference locations which can be used for business transactions and other services. This may not be the same for non-homeowners like renters who are likely to move from one location to the other for accommodation. The above finding resonates with Chan and Nam (2021) argument about how housing features that allows for appropriation facilitate the use of digital technologies within housing properties. Further, the finding on materials used for building also shows that the use of DPAS by residents residing in informal housing and makeshift structures is less. Given that about one-third of Greater Accra's population reside in some form of informal housing (Kita et al, 2019), this finding raises troubling concerns about how digital technologies like the DPAS can implicitly exclude informal residents and deepen existing cracks in socio-spatial inequities in everyday urbanisms.

On psychosocial factors, the study shows that perceived benefits and actual challenges influence the use of DPAS. Here, our findings demonstrate that residents' likelihood of using DPAS increased in the case of perceived benefits and decreased when challenges were envisaged. This aligns with the literature on how individual mental outlook and perceptions of specific digital technologies influence the extent of usage (see Balta-Oz*kan et al*., 2013; Wilson, Hargreaves and Hauxwell-Baldwin, 2015; Parag and Butbul, 2018; Aldossari and Sidorova, 2020). It needs mentioning that in inequitable urban environments, poor design and limited adaptability of digital technologies to local social realities can create design-reality gaps and in turn heighten perceptions of possible challenges especially among those residents with low socio-economic profiles. Perhaps, this partly contributes to recent observations about slow uptake of digital technologies in Ghana (Abebrese, 2019).

Conclusion and policy implications

The paper aimed at examining socio-environmental factors that influenced residents' use of DPAS. The findings from the study indicate that attention must be given to socio-demographic and contextual issues that are key to the implementation of the DPAS. One key issue here is the possibility of an imminent digital divide along income and educational dimensions as low-income earners and persons with little education are less likely to use the DPAS. This will defeat a purpose of the digital transformation agenda that aims for inclusion and ensuring its benefits for all segments of society. This brings to the fore the need for policymakers and urban practitioners to create avenues and platforms for broader and active participation in the framing, design and implementation of digital initiatives and technologies in urban management. The study also shows that per the current arrangement, only permanent building properties are likely to be identified. Here too, policy ambivalence to informal residents in the formulation and design of digitalisation policies need to be corrected. Policy rhetoric around 'leaving no one behind' in smart and sustainable urban policy agenda should be concretised through a recognition and integration of informal communities and their local institutions as socio-spatial constituents in the urban built environment. This an imperative, if informal urban communities are to be righty considered as places that are permanent components of African urbanisms often in a continuous process of change towards stability and durability. Otherwise DPAS, like other emerging digital technologies in Ghanaian and African cities, risk pushing the urban poor majority away and thus deprive them of the urban digital citizenship.

In view of the above, the paper suggests that stakeholders such as the Ministries of Local Government and Rural Development and Communications and Digitalisation must adopt a citizen-led collaborative strategy where issues about the demographics, neighbourhood physical characteristics and local perceptions of digital technologies are well understood to inform the deployment of DPAS and other digital technologies in the built environment. In other words, we call for socio-environmental awareness in the design and implementation in the digitalisation agenda. Relatedly, this invites a critical attention to the foundational issues such as disparities in access to internet services especially outside of the core cities and urban centres to ensure that primary infrastructure is provided and adapted to spatial settings, including offline use.

Theoretically, this paper demonstrates the need to consider soft dimensions such as socio-environmental attributes in the burgeoning discourse on smart cities and sustainable urbanisms in Africa and the global south generally. The present study is quite limited in terms of capturing residents' perspectives of the DPAS system to unravel additional insights on socio-environmental attributes that inform the use of digital technologies in urban contexts. To wit, future studies may employ mixed methods and participatory approaches to explore user convenience in the use of digital technologies, and institutional perceptions, adaptability and acceptability. This could contribute to new possibilities for researcher-practitioner engagements that improve the role of digital technologies for smart, inclusive and sustainable urban built environment in Africa and beyond.

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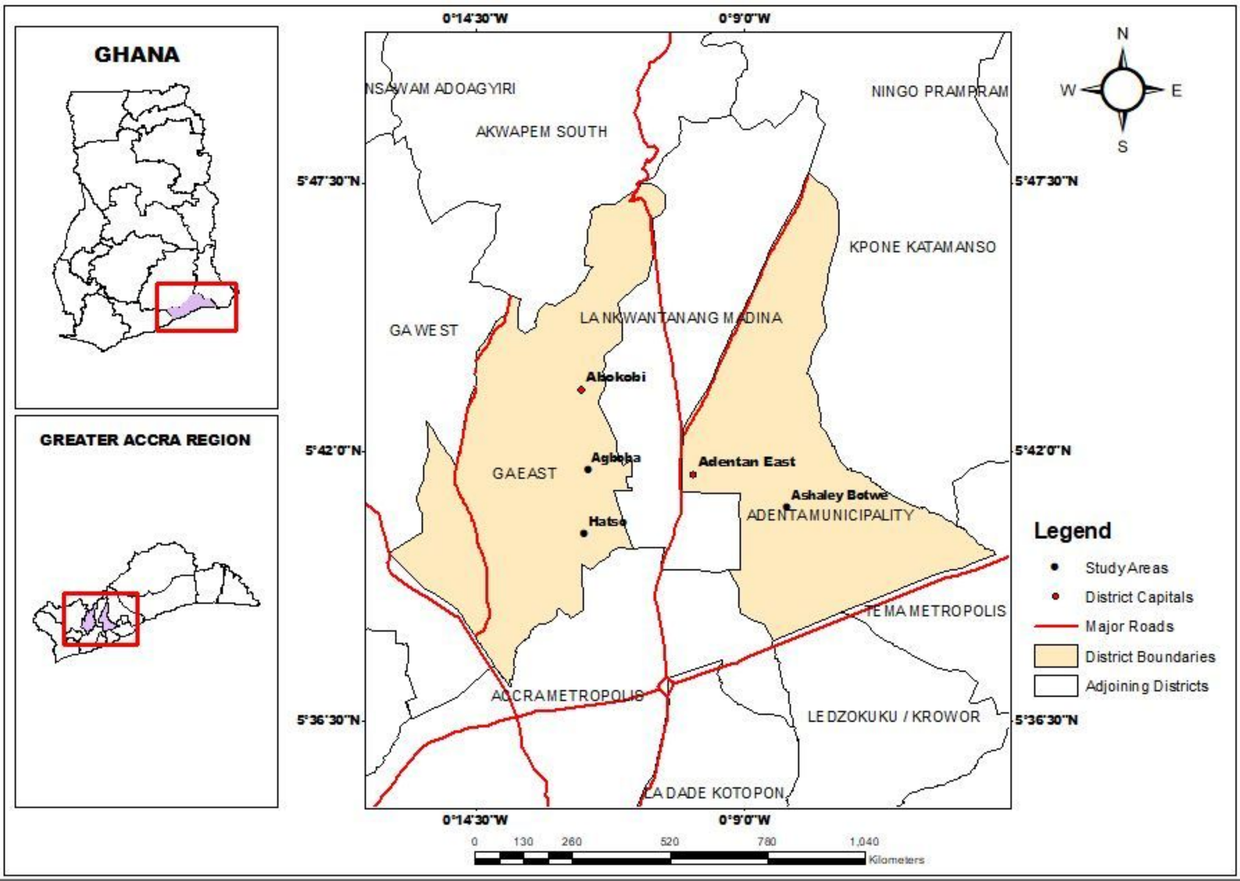
Figure 1: Map of the Study Areas



Source: Authors, 2021

Table 1: Variable description and coding of response categories

Variables	Response categories/coding
When locating a place do you make use of the digital address	1=no, 0=yes
Sex	1=male, 0= female
Location_Agbogba	1= Agbogba, 0= otherwise
Location_Hatso	1= Hatso, 0= otherwise
Type of housing	1= separate housing, 0= otherwise
Occupancy status	1= owner occupier, 0= otherwise
Material for building	1= brick/block, 0= otherwise
Age	Continuous
Income	Continuous
Education	1= no formal education, 5= tertiary
Perceived benefits	1-strongly disagree, 5=strongly agree
• *Receive services from utility companies*	
• *Receive waste management services*	
• *Quick police response to crime*	
• *Receive parcels from currier*	
• *Response to disasters*	
• *Response to health emergencies*	
• *Access to credit facilities*	
• *Locate retail services*	
• *Distributing property rates and local government services*	
Challenges with the use of DPAS	1-strongly disagree, 5=strongly agree
• *Uncomfortable using because of its complexity*	
• *Insufficient data to use the application*	
• *Not required for government and private transaction*	
• *Difficult to generate address and costly to operate*	
• *Cumbersome downloading the application*	
• *Agencies do not use the application and prefer I come over physically*	
• *Inadequate education on the use of the DPAS*	
• *High fee charges for pasting the address plate*	
• *Lack of understanding of the letters and numbers on the address*	

Table 2: Descriptive statistics of variables

Variables	Categories	Frequency (#)		Percentage (%)
When locating a place do you make use of the digital address	Yes	379		37.9
	No	620		62.1
Sex	Male	597		59.8
	Female	402		40.2
Location_Agbogba	Agbogba	325		32.5
	Otherwise	674		67.5
Location_Hatso	Hatso	203		20.3
	Otherwise	796		79.7
Type of housing	Separate housing	311		31.1
	Otherwise	688		68.9
Occupancy status	Owner occupier	311		31.1
	Otherwise	688		68.9
Material for building	Brick or block	876		87.7
	Otherwise	123		12.3
Age	Covariate	Range = 19-80	Mean = 36	SD = 10.297
Income	Covariate	Range = 200-5000	Mean = 902	SD = 99.208
Education	Covariate	Range = 1-5	Mean = 2.73	SD = 1.3
Perceived benefits	Covariate	Range = 9-45	Mean = 32	SD = 7.031
Actual challenges	Covariate	Range = 15-44	Mean = 28.29	SD = 4.809

Table 3: Model fits tests for regression model

	Omnibus Test of Model Coefficients		
	X^2	Df	p-value
Step	156.673	10	.000
Block	156.673	10	.000
Model	156.673	10	.000
	Model summary		
Step	-2 Log Likelihood	Cox and Snell R Square	Nagelkerke R Square
1	1228.210	.245	.312
	Hosmer and Lemeshow Test		
Step	X^2	Df	p-value
1	12.564	8	.228

Table 4: Classification table for all the predictor variables

		When locating a place do you make use of the digital address		Percent correct
		Yes	No	
When locating a place do you make use of the digital address	Yes	306	196	61.0
	No	148	349	70.2
Overall Percentage				65.6

Table 5: Binary logistic regression models of residents' use of DPAS

Variable	Beta	SE	Wald	Exp (B)	95% C.I for Exp (B)	
					Lower	Upper
Sex	.173	.148	1.396	1.136	.892	1.585
Age	.321	.008	10.032	2.977**	1.059	2.012
Income	-.612	.000	28.574	.500***	.344	.664
Education	-.099	.065	4.100	.879*	.671	1.300
Location_Agbogba	-.738	.169	19.391	.478	.299	.754
Location_Hatso	-077	.186	.287	.857	.771	.996
Type of housing	-.132	.159	.798	.876	.652	1.122
Occupancy status	-.014	.165	5.336	.682*	.557	.872
Material for building	-.029	.242	16.028	.467***	.410	.566
Perceived benefits	-.079	.011	6.619	.978*	.951	.993
Actual challenges	.586	.016	23.807	1.079***	1.048	1.117

Exp (B) is exponentiated beta (or odds-ratio), SE is standard error, *$p < 0.05$ **$p < 0.01$ ***$p < 0.001$