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A digital turn for urban management? Residents' perception and utilisation of the digital property address system in Accra, Ghana

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ABSTRACT

Rapid urbanisation and its associated challenges in Global South countries have necessitated the use of digital technologies in urban management. Key to their successful utilisation for urban management is residents' perceptions and utilisation of these technologies. Yet, little attention has been given to this area of research. Using data gathered from a cross-sectional survey in three suburban communities, the study examined residents' perceptions and utilisation of the digital property address system (DPAS) in Accra, Ghana. The findings revealed that residents understand the benefits of the DPAS. However, residents' perceived benefits, usage and challenges varied by socio-demographic groups. More importantly, the findings revealed that the use of the DPAS is beset with operational difficulties and non-use by government agencies. To ensure that digital technologies such as the DPAS provide opportunities for sustainable, inclusive, and resilient development trajectories in Ghana and Africa, it is imperative that residents' use and challenges of such technologies inform improvements in their design and implementation.

1. Introduction

The use of digital technologies in urban management is steadily taking shape in African cities to improve planning, service delivery, and the overall management of Africa's rapidly urbanising but largely unplanned cities (Dano et al., 2020). Often framed within the discourse on the digital city, the broader agenda for smart urban management and the use of digital technologies aim to deliver effective and efficient public services in land, housing, transport and infrastructure, and socio-economic development opportunities to improve living and working conditions (Ballon et al., 2011; Menychtas et al., 2013; Solomon & van Klyton, 2020). Indeed, Africa's rapid urbanisation— with an expected doubling of the urban population in the next 25 years— is challenged by weak planning and inefficient service delivery systems (Lall et al., 2017). These challenges raise concerns for current and future sustainable urban development (Okyere et al., 2021) and thus, reinforce the need for a digitalisation agenda (Yoon, 2020) on the continent.

The push for digital solutions to Africa's urban management problems has received significant attention from international organisations who provide strategic and technical support to national, regional, and local governments. Initiatives such as the Urban Observatory Model forms an essential part of attempts to support countries in the Global South to promote effective urban data monitoring, collection, analysis, policy formulation, information dissemination, and policy implementation using digital technologies (United Nations Human Settlements Programme, 2020a). For the United Nations Human Settlements Programme, supporting digital transformation in Global South cities is critical for the attainment of the Sustainable Development Goals (SDGs) and the New Urban Agenda (United Nations Human Settlements Programme, 2020a,b).

Generally, digital technologies in urban management come in many forms, including smart cameras for monitoring road traffic offences, smart homes, artificial intelligence, and Google maps and Global Positioning System (GPS) for locational and spatial analysis. These technologies also provide opportunities for residents to participate in urban service delivery and offer alternative ways of addressing the complex urban challenges that accompany urban agglomeration. Leveraging on the increasing penetration of internet accessibility from 2% to 19% between 2005 and 2017, and growing mobile phone use of 87% in 2019 in sub-Saharan Africa (Roser et al., 2018), digital transformation can po-

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tentially create economic and social opportunities for the growing urban population through the effectiveness in service delivery (e.g. access to quality education and healthcare services), increased reach of government services, efficiency in transportation, enhanced market linkages and Small and Medium Enterprises (SME) growth as well as an increase in financial inclusion (Singh & Said, 2020). Nonetheless, most of these digital technologies have been fraught with implementation challenges such as low public awareness and utilisation and the inability to raise funds to acquire them (Sausen, 2020).

In Ghana, the national government have introduced a number of digital technologies to expedite public services in urban and rural areas. In particular, the digital property addressing system (DPAS) was introduced to tackle persistent challenges in service delivery to households and improve emergency response. In tandem with the emerging digital turn in urban management in Africa (AbouKorin, 2018), this program arose out of global and domestic calls to adopt a system that can facilitate efficient location-based services and mobilisation efforts. Although this digital turn in urban management holds prospects for achieving Africa's Agenda 2063, the New Urban Agenda, and the SDGs, there has been a curious inattention to the growing African urban scholarship on residents' perceptions and utilisation challenges of the DPAS. Perception is important because it influences residents' use of digital tools and products. If the positive impacts of digital technologies on urban development (Jorgenson & Vu, 2016; Niebel, 2018) are to be realised in Africa, then understanding residents' perceptions and challenges that impede the utilisation of digital technologies is essential to inform policies and strategies that are tailor-made to local contexts. Additionally, residents' perceptions and challenges will offer insights to inform avenues for engaging residents in Africa's urban digitalisation agenda.

Studies on the Government of Ghana's digitalization drive have mainly focused on how it has enhanced public programmes (Agbozo, 2021), how to design an effective addressing system (Abebrese, 2019; Ecklu, 2011), and the benefits and challenges of accessing digital governance services (Demuyakor, 2021). Whereas these studies have explored the different aspects of the government digitalisation drive, residents' perceptions, and utilisation of the DPAS is underexplored. This is critical as residents' participation in the digital turn in Africa is the surest way of deriving the benefits that come along with smart cities. In view of the aforesaid, this paper aims to examine residents' (i) perceived benefits of the DPAS (ii) use of the DPAS, and (iii) challenges in using the DPAS in three suburban communities of Accra, Ghana. This study fits into the broader discussion of how digital technologies can improve urban management practices in a way that positions African cities on sustainable, inclusive, and resilient development trajectories (AbouKorin, 2018; Dano et al., 2020). Firstly, it complements previous literature on digital technologies and urban management in Africa, particularly in Ghana, by advancing understanding of issues related to residents' perceptions and utilisation of the DPAS. Secondly, it provides lessons for the urban research-practitioner community in devising ways to situate digital technologies within local contexts as well as deepen residents' role in urban management. The paper is structured as follows: after this introduction, the next section provides a conceptual overview of digital technologies, property address systems and urban management— including an overview of Ghana's DPAS. The next section provides the profile of the study communities. This is followed by the study methods. The findings of the study are presented next, followed by the discussion. The last section presents the conclusion and implications of the findings.

2. Smart cities governance in Africa: the premise, promise and failures

Information Communication Technologies (ICTs) undoubtedly offer the promise of efficiency and effectiveness in improving government service delivery, and this has informed the rise in the utilisation of e-governance policies in Global South countries (Heeks, 2003; Froehlich, 2020). The benefits of e-governance (*see* Fig. 1) encapsulate, but not limited, to the use of ICTs and the internet to foster maximum engagement between the government and the citizens and improve the relationship among government agencies and other development actors and activists such as Non-Governmental and Civil Society Organizations with the view of promoting social inclusion, accountability, and transparency in public service delivery (Heeks, 2002; Bernardo, 2017). In the case of Africa and other Global South countries, this can improve governance processes which have often been characterized by numerous bottlenecks and waste (Heeks, 2003; Makara, 2018). As a result, the digitalisation of services across Africa is a major manifestation of e-governance initiatives taking root in local and regional governance (Froehlich, 2020).

From the perspective of African urbanism, the deployment of digital technologies occurs within the push for smart (or digital) city and urban innovations (Baud et al., 2014). While there is no unified definition of a smart city, it can be generally conceived as an innovative means of managing the problems which are associated with urban accumulation (Nam & Pardo, 2011a). A smart city thus involves the process whereby information and digital technologies are made part of the planning and design of infrastructure in cities (Batty et al., 2012). In sub-Saharan Africa and other Global South cities, the adoption of digital technologies is borne out of emergent challenges in the urban and demographic transitions such as poorly managed urban growth and inadequate provision of urban services (Angelidou, 2017). According to Azevedo Guedes et al. (2018), urban development that embraces digital technologies has much potential in developing well-organised urban services and stands a greater chance of improving residents' quality of life. Hence, the move towards a smart city optimises system functioning and promotes economic growth (Bibri & Krogstie, 2019).

Informed by this reasoning, several African countries such as South Africa, Ghana, Ethiopia, Nigeria, and Rwanda are seeking to make their cities smarter: utilising digital technologies to improve the quality of life of their residents and ensure efficiency in government functions (Nam & Pardo, 2011b; Siba & Sow, 2017). A key feature of these digital technologies is location-based mobile technologies such as the GPS, intended to improve service delivery, monitoring, accessibility, and property addressing and identification (Ratti et al., 2006; Shoval, 2008). Across Africa, some examples of digital technologies application include the rollout of ICT-GIS for integrated land use planning and poverty mapping in Cape Town, South Africa (Baud et al., 2014). City authorities in Cape Town have also introduced Closed Circuit Television (CCTV) cameras to monitor criminal activities. Through the adoption of an open data policy and improved access to internet services, city authorities have also increased access to information and bridged the digital divide, respectively (Arnardu & Francke, 2021; Odendaal, 2015; Tshiani & Tanner, 2018). The Rwandan capital of Kigali, through its modernisation agenda, has also integrated Wi-Fi into public transport services (Siba & Sow, 2017). In addition, Kenya has introduced e-government initiatives to improve service arrangements (Banga & te Velde, 2018; Onyango, 2017). To solve the issue of parking spot deficiency, Ethiopia has also introduced smart parking in Addis Ababa, which uses advanced automated technology to park cars in steel structures (Siba & Sow, 2017).

As already indicated, digital technologies can make African cities smarter and there are reports that some of these tools are yielding benefits in terms of financial inclusion and service efficiencies (*see* Lyons et al., 2020). However, there are emerging concerns about the integration of users (or residents) needs in the deployment of digital technologies as digital tools become essential to everyday life (Balkaran, 2019). Here, the argument is that inculcating a digital culture in urban management goes beyond instituting and putting in place the needed digital infrastructure but also involves a population that is ready to embrace this new solution to their everyday urban life. This remains a challenge due to well-established issues around contextualisation of digital technologies to local environments (i.e., fit for purpose),

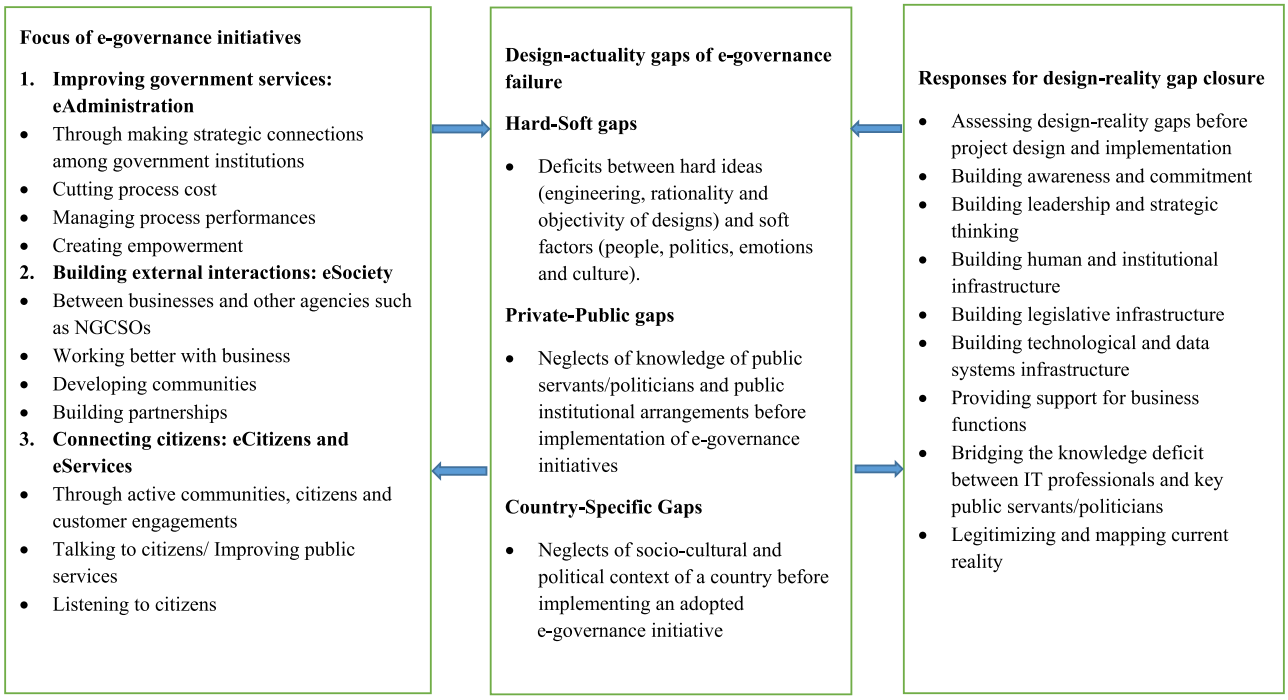

Fig. 1. Design-reality framework of e-governance intentions and failures in Africa.
Source: Adapted from Heeks (2002; 2003).

including expected users and institutional capacities for implementation (Abebrese, 2019). Other challenges such as the lack of residents' participation, institutional cooperation for implementation (Yildirim et al., 2014) within local and regional governments (Ministry of Local Government and Rural Development, 2011) and even street networks for address systems (Gah et al., 2018), impede the promise and potential of digital technologies in driving a smarter urban development agenda in African cities.

3. Conceptualising e-governance challenges in Africa: the design-reality framework

Heeks (2002; 2003) and Hatsu (2018) works on e-governance offer an important conceptual lens to understand the success and failure of digitalisation efforts. The literature points to a large gap between the design of projects and the realities of the implementation environment. For this paper, we draw on the design-reality framework (*see* Fig. 1) offered by Heeks (2002) as it highlights a commonality in the digital technologies' scholarship. Heeks offers an ontological argument that e-governance failure in Africa can be situated in three design-reality gaps: hard-soft gaps, public-private gaps, and country specific gaps. Specifically, e-governance initiatives neglect the socio-political, cultural, and behavioural context of the implementation environment and people. Viewed within this conceptual lens, the failure of digital technologies within Africa's urbanism stems from persistent challenges of design features not considering the realities of the implementation environment. As illustrated in Fig. 1, disconnections between infrastructure and socio-cultural context, weak interlinkages between public and private actors and poor adaptation to country-specific characteristics explain policy failures in the digitalisation agenda. This framework is useful as it converges the challenges of the urban digitalisation agenda disparately documented in different studies (*see* Abebrese, 2019, Yildirim et al., 2014). For the purposes of our work, these design-reality gaps allow us to better frame the intersecting political and technical issues that surround the implementation of Ghana's DPAS system. In effect, it justifies the need to position emerging digitalisation programs within user perceptual perspectives as alternative approach for reducing the likelihood of failure through the integration of social and behavioural dimensions of intended beneficiaries. This thus centres the design-reality gap closures (Heek, 2002, 2003) in Africa's e-governance or digitalisation initiatives.

4. Ghana's DPAS in perspective: political and institutional barricades

The DPAS was launched by the President of Ghana Nana Akufo-Addo, in October 2017 (Adogla-Bessa, 2017). It was initiated from the Vice-President office and has been one of the major digital projects intended to improve the delivery of urban services (e.g., household waste collection and access to healthcare), property identification, and easy navigation (Ayakwah et al., 2021). For policymakers, the DPAS is critical in urban management as it is intended to enhance navigation within the built environment by facilitating the operation of modern location-based devices and services such as the GPS, Google, and Open Street maps (Abebrese, 2019). The expectations are that it will help address urban challenges such as crime and insecurity, and emergency responses such as fire outbreaks (Ayakwah et al., 2021; Bokpe, 2017), facilitate the implementation of key government policies such as the national identification system, banking and tax reforms (Ansah & Longdon, 2021), and to automate government business processes and improve digital trade in Ghana (The World Bank Group, 2019). The DPAS is also anticipated to reduce the financial risk profile of people and improve their access to credit and financial services such as loans and opening of bank accounts (Adjei, 2017). In Ghana, the absence of a unique identification system that allows financial and credit institutions to track their borrowers is, in fact, a significant obstacle that frequently prevents financial and credit institutions from providing loans and credit facilities to the majority of people, especially those in the informal sector (Kuuire, 2017; Decardi-Nelson et al., 2012). This is a challenge that the DPAS also aims to address.

The Ghana Post Company Limited was tasked with creating the "GhanaPostGPS" app, which residents had to download to create their digital addresses, as part of the DPAS deployment. The GhanaPostGPS

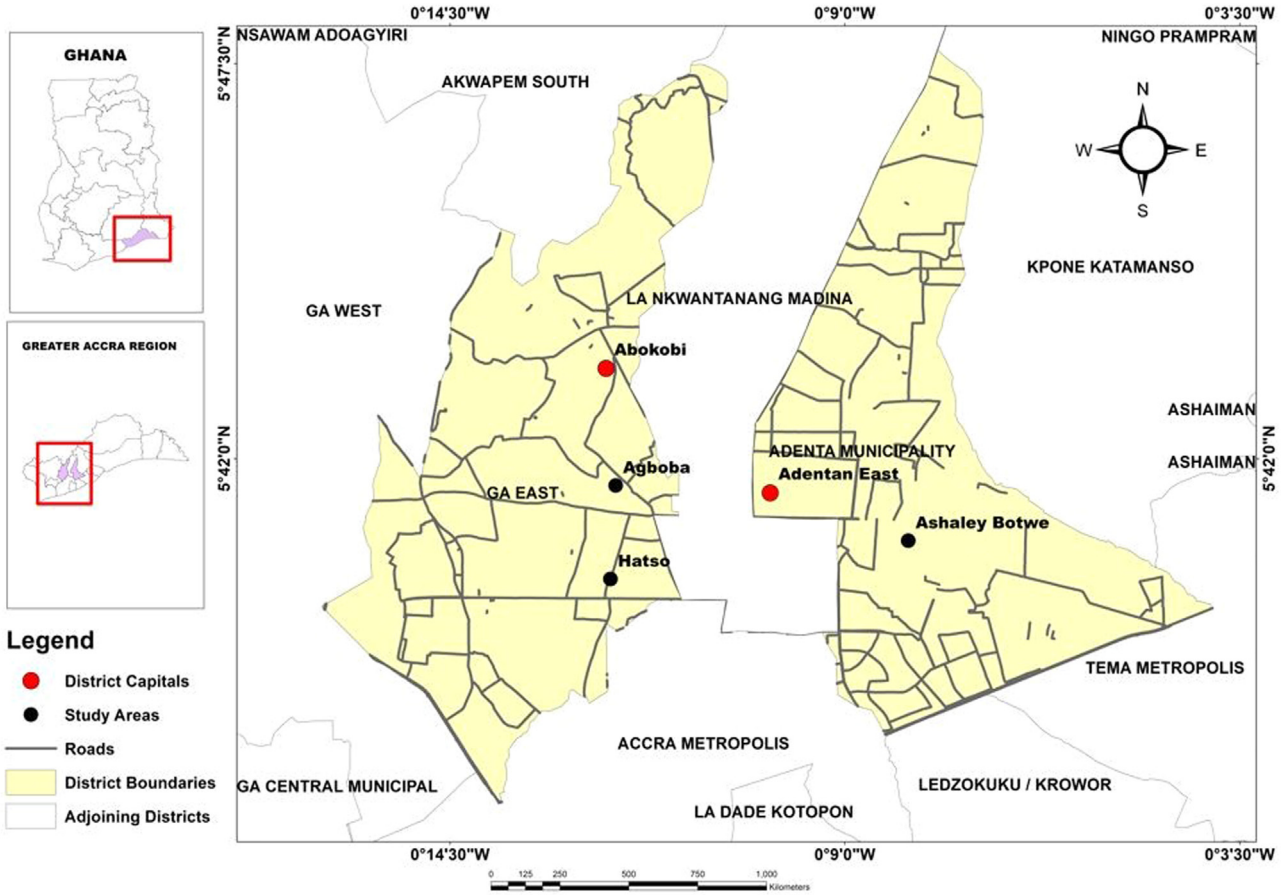

Fig. 2. Map of study areas.
(Source: Frimpong et al., 2022).

app has been in use since 2017. The Government of Ghana has followed this up with fixing a plate with the digital address on every house, which is expected to be completed in 2022. So far, about 7.5 million properties have been identified (Ansah & Longdon, 2021). In 2018, when the DPAS was in the initial stages of implementation, generation of the digital address was free and could be done by agents of the GPCL or by individuals with the GhaPostGPS app. However, tagging of the plate on properties was done at a cost of GHC50 (USD 6.47)[1] for residential buildings and GHC100[1] for commercial buildings (Adogla-Bessa, 2018). Since August 2019, the government set out to emboss the DPAS plates on every property at no cost (free) to property owners (Effah, 2019). At present, there have been cases of different agencies embossing the digital address plates on properties (old and new plates) which depicts lack of effective planning during the design and implementation phases.

In fact, the DPAS has received some criticisms from the civil society and policy circles. For a country where multi-habitation housing (compound housing) is predominant, it has become apparent that members of the same compound house will use similar but different digital addresses to reference the same property (Andorful, 2021b). Also, the policy think-thank, IMANI-Ghana, asserts that the implementation of the DPAS is largely occasioned by procurement factors with limited analysis and understanding of the problem contexts that necessitated the initiative (Simons, 2021). In comparison with UK and US, Simons (2021) notes that the DPAS implementation is centralized, top-down, with no proactive engagements of technical or professional bodies. Indeed, lack of active engagement— with relevant stakeholders operating in the ICT industry— has been cited among the reasons digitalisation initiatives often make little impact in Ghana, with some suggesting that the DPAS is likely to suffer the same fate (Abebrese, 2019). Another challenge is that neither Vodacom nor the GPCL— the two apparent co-developers of the GhanapostGPS app— has its own geospatial data or satellite feeds. The app relies entirely on data and infrastructure accessed through a Google API, which makes it possible to stand anywhere in Accra and generate a digital address without reference to any property (Simons, 2021).

Indeed, the literature point that the DPAS— similar to other digital initiatives introduced in Africa— failed to consider the socio-cultural, economic, political and behavioural context of the environment and people (Heeks, 2003; Simons, 2021). For instance, considering that over 80% of the Ghanaian economy is informal (Baah-Boateng & Kodwo, 2013), and over 2 million out of over 10 million properties are substructures such as metal containers, kiosk and wooden erections (Ghana Statistical Service, 2021), it is unclear how the DPAS is used by public and private institutions to track owners or occupants of these informal structures which are mostly mobile. The irony here is that some of these informal structures have been embossed with digital address plates and most of the occupants of these informal housing use different digital addresses to complete any transaction that requires it (Andorful 2021a). This undermines the potential of the DPAS to aid in any meaningful planning and socioeconomic development (Andorful, 2021a,b). These criticisms warrant the need to consider the use of the DPAS system from residents who are deemed as one of the core beneficiaries.

[1] Current exchange rate as at May 24, 2022

5. Profiling suburban Accra: Hatso, Agbogba and Ashaley Botwe

The three study neighbourhoods— i.e., Hatso, Agbogba and Ashaley Botwe— are located in two different local governing municipalities[2] in the Greater Accra Metropolitan Area (GAMA)[3]. The two municipalities are at the fringes of the GAMA and can also be described as suburban localities (see Fig. 2).

Hatso and Agbogba are located in the Ga East municipality. According to the 2010 Population and Housing Census, the Ga East municipality had a population size of 147,742. In 2021, the population increased by 91.8% with 140,015 being males and 143,364 females. The average household size of the municipality is currently 3.1, with a population density of 4223 persons per sq. km. The majority of the municipality's population remains urban (93.78%), with about 17,631 residents living in rural areas (Ghana Statistical Service, 2021). Many of the residents work in the informal economy, with only 20% of the workforce in the formal sector (Ghana Statistical Service, 2014b). Hatso and Agbogba in time past were inhabited mostly by indigenous families engaged in agriculture. The last two decades have witnessed massive residential and commercial development in these two areas and the relocation of middle-income settlers into the area. The development is also driven by housing and cheaper land for residential development.

Ashaley Botwe, on the other hand, is located in the Adentan municipality, which had a population of 78,215 according to the 2010 Population and Housing Census. As of 2021, it had an estimated population of 237,546 comprising 117,841 males and 119,705 females. It occupies a total area of 69 sq. km. The municipality's household size and population density are 3.2 and 3426 persons per sq. km, respectively (Ghana Statistical Service, 2021). Like the Ga East municipality, about 21% of the labour force is formal (Ghana Statistical Service, 2014a). Access to affordable housing and land for residential development has attracted many people into the municipality. The municipality has developed into a dormitory town of Accra, which is about 10km away from the national capital. Ashaley Botwe is an important residential neighbourhood in the municipality. It is characterised by mixed land-use. However, a substantial part of the area is residential and increasingly dominated by middle-income residents, albeit there are also low-income settlers in some neighbourhood quarters.

6. Methodology

The study adopted a cross-sectional survey research design. This research design allows for studying attitudes or opinions of a population at a point in time by focusing on a subset of that population (Creswell & Creswell, 2017). The cross-sectional survey was conducted using the Kobo Collect Application. The unit of analysis was households, while the target population was the household heads. The survey was conducted from August to September 2021 by trained graduate research assistants under the supervision of expert researchers in the project team.

The sample size for this study was based on household data from the 2010 Population and Housing Census.[4] The total number of households for the three neighbourhoods was 9850— 3206 for Agbogba, 1999 for Hatso, and 4645 for Ashaley Botwe. Using a confidence level of 97%, an associated margin of error of 3% and an estimated household number of 9850, the sample size was calculated using 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 (i.e., 999), the number of questionnaires administered in the three neighbourhoods were based on the proportional representation method using the formula below:

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

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

The three neighbourhoods' sample sizes were 325, 203, and 471 for Agbogba, Hatso, and Ashaley Botwe, respectively.

Respondents were selected using a two-stage procedure. The first involved a listing of housing units in the three neighbourhoods to generate a sample frame from which the respondents would be interviewed. The listing exercise was carried out in July and spanned three weeks. A total number of 2295, 1558, and 2654 housing units were listed for Agbogba, Hatso, and Ashaley Botwe, respectively. After generating the list of housing units for each of the three communities, a simple random sampling method was used to select the specific housing units and respondents. In each house, a head of the household or in his/her absence a representative of the head was selected. In multi-habited housing units with more than one household, only one household head was selected, while in owner-occupied housing units which normally has only one household, the head was selected. Consent was sought from respondents and the purpose of the study was explained to them, after which the enumerators proceeded with data collection. The research instrument used for this study was a survey questionnaire, which had questions specifically on the perceived benefits, actual use, and experiential challenges associated with the use of the DPAS. The questionnaire was made up of two main parts. The first part of the questionnaire consisted of an introductory letter to explain the study purpose and collect respondent's-demographic characteristics. The second part contained structured questions to achieve the research aim.

In terms of the analysis, the paper is divided into three sections. The first section presents findings on respondents' perceived benefits of DPAS. Two different analyses were presented in this first section. This includes a chi-square test with Phi and Cramer's V test[5], and Principal Component Analysis (PCA). The chi-square tests were conducted to explore the differences in perceived benefits of the DPAS across the various socio-demographic groups (sex, age, level of education, and level of income), while the Phi and Cramer's V test was conducted to report the strength of these differences. Phi and Cramer's V test is used to measure the strength of nominal associations, and has association values ranging from 0 (no relationship) to 1 (strong relationship) (Agresti, 1996). The PCA on the other hand allowed for defining the broad perceived benefits of the DPAS. The next section presents results on the actual use of the DPAS. Here also, we explored the responses of the various groups within the socio-demographic variables on the actual use of the DPAS. Differences in responses across the groups were ascertained using chi-square test, and Phi and Cramer's V test. The third section presents findings on the challenges encountered by respondents when using the DPAS. Similar to perceived benefits, it examined the distribution of responses by the various groups within the socio-demographic variables to ascertain whether there are significant differences. Following this, the PCA also provided the broad areas of challenges with the use of the DPAS. For questions on perceived benefits and experiential challenges, partici-

[2] Hatso and Agbogba are governed by the Ga East Municipal Assembly, and Ashaley Botwe by the Adentan Municipal Assembly, which are the official names of the administrative local government authorities.

[3] GAMA is the unofficial name given to the larger functional area of Accra, Ghana's capital

[4] This was used in the absence of 2021 population and housing data for the three study neighborhoods which is yet to be published by the Ghana Statistical service.

[5] Authors reported only the Chi-square, Phi and Cramer's V test statistics which was generated together with cross-tabulations between the socio-demographic variables and perceived benefits of DPAS. This was because emphasis was placed on reporting the significant differences within the demographic groups. Same was reported for actual use of DPAS and challenges with the use of DPAS.

Table 1
Test statistics for demographic variables and variables for perceived benefits.

	X^2	df	Cramer's *V*	Phi	*p*-value	Total cases
Receive services from utility companies						
Sex	11.271	4	.106	.106	.024	999
Age	39.881	12	.115	200	.000	999
Level of income	118.614	12	.199	.345	.000	999
Level of education	312.290	12	.323	.559	.000	999
Receive waste management services						
Sex	27.638	4	.166	.166	.000	999
Age	56.859	12	.138	.239	.000	999
Level of income	96.754	12	.180	.311	.000	999
Level of education	275.038	12	.303	.525	.000	999
Quick police response to crime						
Sex	21.663	12	.147	.147	.000	999
Age	28.918	12	.098	.170	.004	999
Level of income	58.584	12	.140	.242	.000	999
Level of education	212.313	12	.266	.461	.000	999
Receive parcels from currier						
Sex	20.312	4	.143	.143	.000	999
Age	19.275	12	.080	.139	.082	999
Level of income	86.119	12	.170	.294	.000	999
Level of education	362.751	12	.348	.603	.000	999
Response to disasters						
Sex	11.412	4	.107	.107	.022	999
Age	35.963	12	.110	.190	.000	999
Level of income	72.283	12	.155	.269	.000	999
Level of education	189.327	12	.251	.435	.000	999
Response to health emergencies						
Sex	8.895	4	.094	.094	.064	999
Age	30.642	12	.101	.175	.002	999
Level of income	98.860	12	.182	.315	.000	999
Level of education	223.742	12	.273	.473	.000	999
Access to credit facilities						
Sex	48.901	4	.221	.221	.000	999
Age	36.444	12	.110	.191	.000	999
Level of income	40.907	12	.117	.202	.000	999
Level of education	85.599	12	.169	.293	.000	999
Locate retail services						
Sex of respondents	20.465	4	.143	.143	.000	999
Age	41.076	12	.117	.203	.000	999
Level of income	131.337	12	.209	.363	.000	999
Level of education	216.146	12	.269	.465	.000	999
Distributing property rates and local government services						
Sex	37.537	4	.194	.194	.000	999
Age	31.525	12	.103	.178	.002	999
Level of income	58.571	12	.140	.242	.000	999
Level of education	187.527	12	.250	.433	.000	999

pants responded to a five-point Likert scale where 1 represents strongly disagree, and 5 represents strongly agree.

7. Study results

7.1. Perceived benefits of DPAS

Table 1 reports on the relationship between selected socio-demographic characteristics and the nine-item variables for perceived benefits of the DPAS. As indicated earlier, we reported only the chi-square test and the Phi and Cramer's V test for the relationship. The result largely shows that differences in residents' perceived benefits by gender, income, age, and level of education were statistically significant. In other words, residents' gender, age, income, and level of education influenced the extent to which they agreed or disagreed on the perceived benefits of the DPAS. Further, the Phi- and Cramer's V test show statistically significant differences of residents' perceived benefits of the DPAS in level of education and level of income.

Specifically, the findings showed that respondents with tertiary level education were more likely to agree or strongly agree that the DPAS will make it easy to receive services from utility companies. Similarly, respondents with high school education and tertiary level education were more likely to agree or strongly agree to the perceived benefits of DPAS: 'it will help in receiving courier deliveries; and help in the distribution of property taxes.' For income, respondents who earned below GHC1000 were more likely to agree that the DPAS will make it easy to receive services from utility companies.

Table 2
Total variance explained.

	Initial Eigenvalues			Extraction sums of squared loadings		
Comp.	Total	% of var	Cumm %	Total	% of var	Cumm %
1	5.158	57.308	57.308	5.158	57.308	57.308
2	1.029	11.437	68.745	1.029	11.437	68.745
3	.701	7.790	76.535			
4	.552	6.131	82.667			
5	.491	5.455	88.122			
6	.350	3.890	92.011			
7	.270	2.995	95.006			
8	.261	2.895	97.902			
9	.189	2.098	100.000			

Table 2 presents the PCA results showing the main items that summarise the perceived benefits of the DPAS. The Kaiser–Meyer–Olkin test shows that the sample was adequate for the PCA as indicated by the score of 0.891, which is above the recommended threshold of 0.6 (Smith, 2002). The Bartlett test of sphericity was also significant (χ

Table 3
Rotated components matrix of perceived benefits.

Variables	Comp 1	Comp 2
Receive services from utility companies	.785	
Receive waste management services	.783	
Quick police response to crime	.830	
Receive parcels from currier	.732	
Response to disasters	.832	
Response to health emergencies	.854	
Distributing property rates and local government services	.680	
Access to credit facilities		.627
Locate retail services		.738

^{2} = 5332.551, df = 36, p = 0.000), suggesting that the correlation between the variables is not identical and, therefore, fit for a PCA. Table 3 explains the variance accounted for by the components. It can be observed that component 1 explains 57.3% of the total variance, while component 2 explains 11.4% of the total variance. Together, the two components account for 68.7% of the total variance, which is above the recommended threshold of 50% as suggested by Samuels (2017) and Streiner (2020).

Table 3 also shows high loadings on the two components. The minimum loading on component 1 was 0.680, while that of component 2 was 0.627. The high loading on the components can be accounted for by the use of the varimax rotation procedure, which essentially maximises the sum of the variances of the square buildings (Smith, 2002). The positive loadings of components means that all variables are in the same direction and appropriately measure the construct. Component 1 includes all variables with the exceptions of 'access to credit facilities' and 'location of retail services, which were the variables found in component 2. Based on the nature of the variables, component 1 is given the label '*service delivery and emergency response*', while component 2 is given the label' *finance and business access'*. The results thus suggest that the potential benefits of the DPAS are for services delivery from government and private service providers. Indeed, high loadings were reported for variables such as response to health emergencies, response to disasters, and police response which are services provided by government. Regarding component 2, it can be suggested that access to finance and retail services or fulfilling economic demands are another important potential benefit for the utilisation of DPAS.

7.2. Residents' use of DPAS

Similar to the results on respondents' perceived benefits, the chi-square test shows a significant difference in the actual use of the DPAS by the different socio-demographic variables. However, level of income and education showed strong significant differences based on the Phi and Cramer's V test. Taking the level of education, as an example, respondents who had tertiary education were more likely to respond that they have digital addresses posted on their walls. Further, the result showed that respondents with tertiary education were more likely to use the digital address for locating a place and have a digital address for their building properties (see Table 4).

7.3. Challenges with the use of DPAS

The result shows the extent of challenges with the use of DPAS were significantly different by demographic characteristics. For instance, different age groups had varied experiences of the challenges in using the DPAS. Similarly, responses on the challenges of using the DPAS varied by levels of education and income. Akin to results on respondents' perceived benefits and use of the DPAS, the significant differences reported for the levels of income and education was strong based on the Phi and Cramer's V test (see Table 5).

Here, respondents with tertiary level of education were more likely to disagree with the statement that the DPAS was complex to use, while those with high school education were more likely to agree with the same statement. Additionally, respondents with tertiary level education, and those with high school education were likely to agree to the statement that the DPAS is not required or barely used for government transactions. With regards to age, respondents in the 21–40 age group agreed with many of the challenges of using the DPAS.

The Kaiser–Meyer–Olkin test shows that the sample was adequate for the PCA with a value of 0.732. Further, the Bartlett test of sphericity was significant (χ 2 = 2294.815, df = 36, p = 0.000), and therefore the variables were appropriate for the PCA. Table 6 shows that the first component accounted for 30.45% of the total percentage variance while the

Table 4
Test statistics for demographic variables and variables for actual use of DPAS.

	X^2	df	Cramer's V	Phi	p-value	Total cases
Does your building property have digital address?						
Sex	1.667	1	.041	.041	.197	999
Age	21.157	3	.146	.146	.000	999
Level of income	73.543	3	.271	.271	.000	999
Level of education	63.436	3	.252	.252	.000	999
Do you have the plate of the address pasted on your wall (in front of your house)?						
Sex	3.926	1	.063	.063	.048	999
Age	19.930	3	.141	.141	.000	999
Level of income	78.398	3	.277	.277	.000	999
Level of education	62.510	3	.250	.250	.000	999
Do you have digital address for your workplace?						
Sex	7.016	1	.084	.084	.008	999
Age	14.715	3	.121	.121	.002	999
Level of income	250.492	3	.501	.501	.000	999
Level of education	291	3	.540	.540	.000	999
Have you benefited from a digital address from your workplace?						
Sex	11.977	1	.109	.109	.003	999
Age	8.841	3	.094	.094	.031	999
Level of income	121.737	3	.349	.349	.000	999
Level of education	222.789	3	.472	.472	.000	999
When locating a place do you make use of the digital address?						
Sex	3.227	1	.057	.057	.072	999
Age	7.356	3	.061	.086	.289	999
Level of income	215.141	3	.328	.464	.000	999
Level of education	221.070	3	.041	.470	.000	999

Table 5
Test statistics for demographic variables and variables for challenges with the use of DPAS.

	X^2	df	Cramer's V	Phi	*p-value*	Total cases
Uncomfortable using because of its complexity						
Sex	15.056	4	.123	.123	.005	999
Age	29.565	12	.099	.172	.003	999
Level of income	137.269	12	.214	.371	.000	999
Level of education	179.723	12	.245	.424	.000	999
Insufficient data to use the application						
Sex	13.802	4	.008	.008	.008	999
Age	9.620	12	.057	.098	.649	999
Level of income	151.355	12	.236	.408	.000	999
Level of education	246.910	12	.287	.497	.000	999
Not required for government and private transaction						
Sex	19.191	4	.139	.139	.001	999
Age	37.252	12	.111	.193	.000	999
Level of income	168.300	12	.237	.410	.000	999
Level of education	155.125	12	.228	.394	.000	999
Difficult to generate address and costly to operate						
Sex	22.900	4	.151	.151	.000	999
Age	25.018	12	.091	.158	.015	999
Level of income	127.416	12	.206	.357	.000	999
Level of education	231.606	12	.278	.481	.000	999
Cumbersome downloading the application						
Sex	11.282	4	.106	.106	.024	999
Age	67.382	12	.150	.260	.000	999
Level of income	208.805	12	.264	.457	.000	999
Level of education	266.350	12	.298	.516	.000	999
Agencies do not use the application and prefer I come over physically						
Sex	32.379	4	.180	.180	.000	999
Age	47.789	12	.126	.219	.000	999
Level of income	119.419	12	.200	.346	.000	999
Level of education	191.722	12	.253	.438	.000	999
Inadequate education on the use of the DPAS						
Sex	14.446	4	.120	.120	.006	999
Age	19.604	12	.081	.140	.075	999
Level of income	30.102	12	.100	.174	.003	999
Level of education	53.750	12	.134	.232	.000	999
High fee charges for pasting the address plate						
Sex	14.446	4	.120	.120	.006	999
Age	15.908	12	.073	.126	.196	999
Level of income	208.633	12	.264	.457	.000	999
Level of education	150.764	12	.224	.388	.000	999
Lack of understanding of the letters and numbers on the address						
Sex	23.073	4	.152	.152	.000	999
Age	35.372	12	.109	.188	.000	999
Level of income	278.516	12	.305	.528	.000	999
Level of education	253.996	12	.291	.504	.000	999

Table 6
Total variance explained.

	Initial eigenvalues			Rotation sums of squared loadings		
Comp	Total	% of var	Cumm %	Total	% of var	Cumm %
1	2.865	31.831	31.831	2.745	30.457	30.457
2	1.807	20.080	51.911	1.931	21.454	51.911
3	.996	11.071	62.982			
4	.923	10.259	73.241			
5	.695	7.726	80.968			
6	.592	6.578	87.546			
7	.419	4.658	92.204			
8	.397	4.410	96.614			
9	.305	3.386	100.00			

Table 7
Rotated components matrix of challenges.

Variables	Comp 1	Comp 2
Uncomfortable using because of its complexity	.701	
Insufficient internet data to use the application	.813	
Difficult to generate address	.817	
Cumbersome downloading the application	.744	
Inadequate education on the use of the DPAS	.526	
High fee charges for pasting the address plate	.776	
Lack of understanding of the letters and numbers on the address	.863	
Agencies do not use the application and prefer I come over physically		.684
Not required for government and private transaction		.712

second component accounted for 21.45%. Together the two components accounted for 51.9% of the total percentage variance, aligning with the recommended cut-off.

Table 7 shows the factor loadings on the two components. Loadings on the two components were positive, suggesting that they appropriately measure the construct that the component represents. The first component contains variables such as 'uncomfortable using the DPAS because of the complexity with its use', 'difficult to generate and costly to operate, and 'cumbersome downloading application', all border on the difficulties in operating the DPAS mobile application. The second component contained two variables: 'not required for government and private services', and 'agencies do not use the application'. Because of this, the first component was labelled as '*operational difficulties*', and the second component was labelled as '*non-use in government agencies'*. In essence, the main challenges with the use of the DPAS mobile application include the operational challenges with the application itself and

the fact that, in actual practice, most agencies do not make it a requirement for the discharge of their services.

8. Discussion

The growing popularity of digital technologies in urban management holds great potential in spearheading economic and social advancement in Global South cities. It has wide-ranging implications that can shape better planning, governance, and sustainable futures in rapidly urbanising cities. In Global South countries such as Ghana, structural weaknesses in planning systems and poor service delivery constrain urban governance. Suggestions are that the deployment of digital technologies presents a good opportunity to improve urban management. A key but rarely considered issue in the ensuing digital turn for urban management concerns residents' perceptions and utilisation of the digital technologies in their everyday life and how challenges thereof can inform better their deployment in urban management. In this study, the DPAS was examined to address these concerns.

The result shows that awareness of the benefits of the DPAS varied with age, education, and income. Taking education, for instance, respondents who agreed with the benefits of the DPAS were likely to have higher levels of education, and were likely to be more informed about the benefits of using the DPAS. This calls for more education about the DPAS, not only to raise awareness, but also for people to appreciate its usefulness in their everyday life. This signifies the need for local government agencies and urban managers to disseminate proper information and sensitise the public about the opportunities that digital technologies offer (Balkaran, 2019).

Beyond residents' knowledge about the benefits of the DPAS, their use of the technology provides an important indicator to concretise its implementation and adoption. The findings on actual use of the DPAS indicate variations across demographic characteristics. The likelihood of usage for locating places, and for daily transaction is dependent on one's level of education which emphasises our earlier point about adequacy of information about the DPAS. While income has a likely impact on the utilisation of the DPAS, the fact that majority of the respondents earned GHC1000 or less necessitates that such relationship should be interpreted with care. These findings illustrate a clear manifestation of hard-soft gaps (*see* Fig. 1), which usually occurs when public authorities assume digital literacy and residents' willingness and capacity to adjust to new digital tools thereby resulting in little effort by public authorities to adapt digital tools to local needs (Heeks, 2003; Odendaal, 2006). Indeed, the utilisation of digital technologies in urban Africa is still in an inchoate state, and many more people are yet to fully embrace the emerging digital culture (Sausen, 2020). This iterates the persistent problem with design-reality gaps which impede the role of digital technologies to improve urban management. Closing this gap invite governing authorities to plan and execute intensive public sensitisation and consultation to allow for regular feedback on utilisation.

The findings of the study also bring to the fore operational challenges that impact the utilisation of the DPAS, which feeds into the notion of country-specific gaps (Fig. 1) in e-governance implementation initiatives (Heeks, 2002; 2003). For example, insufficient internet data and handling complexities in downloading the app impede residents' utilisation of the DPAS. Similar findings have been reported in other Global South cities, where the high cost of internet data, software complexities, insufficient broadband and accessories limit the operationalisation of digital initiatives in public management and urban service delivery (Abebrese, 2019; Baku, 2022). This evokes the notion that local government authorities seeking to deploy digital tools for smart urban management need to get 'smart about smart urbanisms' (Odendaal, 2015: p. 71). Herein lies the call to get back to the first principles: building and maintaining functional digital infrastructure, expanding internet access and penetration, internet affordability, awareness, education and capacity building initiatives to form the basis for the design, and implementation of digital technologies in urban management (Odendaal, 2006; Waller & Genius, 2015). This is especially relevant for countries like Ghana where a significant proportion of the economy is informal and about 20% of the total structures are mobile (Baah-Boateng & Kodwo, 2013; Ghana Statistical Service, 2021).

The study also points to a striking contradiction in the deployment of the DPAS in suburban Accra: that institutions and governing authorities promoting the DPAS were not using it in their everyday service delivery. This is a troubling reality and goes to demonstrate an inherent governance challenge in Ghana, where digital policies are often not accompanied by changes in institutional arrangements to ensure effective policy implementation (Baku, 2022). This creates a discrepancy between digital technologies and institutional functions, leading to the tendency to forcefully promote digitalisation without extensive integration within institutional functions (Giest & Raaphorst, 2018). Clearly, this may potentially serve as a behavioural deterrent to widespread utilisation of the DPAS among the public and an indication that the much-touted digital turn in urban management being championed by the government is a long shot away.

Taken together, the findings reinforce the design-reality gaps in the implementation of the DPAS in Ghana— residents' uncertainties about benefits, operational challenges, and institutional inconsistencies in the use of the DPAS. This situation can mitigate against the potential of the DPAS to enhance urban service delivery and drive progress towards smart urban management. There is, therefore, the need for prioritisation of soft measures that bring residents along with the digitalisation agenda (Jorgenson & Vu, 2016) and hard measures that pay attention to building basic digital infrastructures needed to support digitalisation in urban management.

9. Conclusion and policy implications

Framed within the so-called emerging digital turn in urban management in African cities, this study sought to highlight residents' perceptions and utilisation of Ghana's recently introduced DPAS. At its core, the study revealed how socio-economic characteristics underpin perceived benefits, use and challenges with the DPAS. For the most part, level of education and income account for the differences between different groups. The challenges residents encounter in the use of the DPAS clearly manifest design-reality disconnections as it pertains to technical, social and user adaptations. Within this purview, this paper submits that for broad adoption of the DPAS and other digital technologies, especially for a Global South country like Ghana with a nascent digital culture among its populace, these institutional bottlenecks and infrastructural deficits need to be addressed to ensure residents' benefit.

For practitioners, our study demonstrates the need for better planning and transparency in institutional coordination at multi-scalar levels. For the DPAS to be effective, stakeholders like the Ministry of Local Government and Rural Development, Land Use and Spatial Planning Authority, the Ghana Post Company Limited, local government authorities as well as digital inclusion oriented civil society organisations in Ghana need to work together to reduce user and institutional bottlenecks for broad adoption and utilisation. The findings also imply that strategic visioning of smart urban agenda programs must concretize avenues for bottom-up residents' engagement and user monitoring to improve its design and implementation. Such strategic visioning invites bold steps that transition from top-down politicisation of digital initiatives— often blinded to basic infrastructure and socio-economic realities— to bottom-up strategies. Consequently, engagement platforms should pay attention to urban marginalised groups (e.g., informal settlement dwellers, urban poor) whose adoption and utilisation of digital technologies are often low. This will help improve digital literacy, which is necessary for the broad acceptance and utilisation of digital technologies like the DPAS. As a matter of closing design-use gaps, digital technologies like the DPAS should be made user-friendly—and allow for offline use— by end-users. Given the challenging internet landscape of many parts of the country and difficulty in accessing internet data, particularly for the poor, im-

proving the design interface and offline use will contribute to expanded use and ensure inclusiveness in the use of digital technologies in urban management.

Despite the usefulness of this paper's findings for addressing emerging challenges in the so-called digital turn for urban management, there are three limitations that warrant a carefully application of results. First, the study did not integrate qualitative interviews which could have yielded additional views and insights on the perceived benefits and challenges, as well as the experiences with the actual use of the DPAS. Future studies can employ mixed methods across broad range of actors to improve understanding of current challenges including the security risk fuelling perceptions of DPAS. Second, this study only uses perception data to assess the benefits of the DPAS, hence future studies may explore other approaches to evaluate the benefits of digitalisation in urban management. Third, the study design did not consider the type of property—formal or informal—on which digital address plates were embossed; this may be considered in future studies in highly informal urban contexts.

Overall, the low utilisation of the DPAS and the challenges associated with the digital technology in urban Ghana and other Global South cities call for appropriate actions to improve broad adoption and utilisation. For Global South cities with low digital cultures, such actions are necessary to place residents on sustainable, and inclusive development trajectories.

Declaration of Competing Interest

The authors declare no conflict of interest.

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References

Abebrese, K. (2019). *Implementing street addressing system in an evolving urban center. A case study of the Kumasi metropolitan area in Ghana*. Iowa State University.

AbouKorin, A. A. (2018). Technology and the urban future in developing countries: The case of Africa. In *E-planning and collaboration: Concepts, methodologies, tools, and applications* (pp. 1617–1646). IGI Global.

Adjei, J. (2017). *Digital address system: Waakye, Koko sellers will have address – Akufo-Addo* Retrieved May 24, 2022 from https://kasapafmonline.com/2017/10/digital-address-system-waakye-koko-sellers-will-have-address-akufo-addo/.

Adogla-Bessa, D. (2017). *Nana Addo launches Ghana's digital property address system* Retrieved May 24, 2022 from https://citifmonline.com/2017/10/nana-addo-launches-ghanas-digital-property-address-system/.

Adogla-Bessa, D. (2018). *GhanaPost GPS charging GHc50, GHc100 to tag properties* Retrieved May 24, 2022 from https://citinewsroom.com/2018/08/ghanapost-gps-charging-ghc50-ghc100-to-tag-properties/.

Agbozo, G. E. (2021). *Spatial technologies, (Geo) epistemology, & the Global South: addressing the discursive materiality of GhanaPostGPS through technical communication*.

Agresti, Alan (1996). *Introduction to categorical data analysis*. NY: John Wiley and Sons.

Andorful, F. (2021a). *May I have your attention please; The Ghana post GPS data is outdated*. Retrieved April 30, 2022 from https://blog.wheregeospatial.com/2021/07/05/may-i-have-your-attention-please-the-ghana-post-gps-data-is-outdated/.

Andorful, F. (2021b). *The census structure listing is our only hope to get back the Ghana post GPS data back to life* Retrieved April 30, 2022 from: https://blog.wheregeospatial.com/2021/08/17/the-census-structure-listing-is-our-only.

Angelidou, M. (2017). Smart city planning and development shortcomings. *TeMA-Journal of Land use, Mobility and Environment, 10*(1), 77–94.

Ansah, M., & Longdon, B. (2021). *Every house to get digital address by 2022 -Bawumia* https://citinewsroom.com/2021/07/every-house-to-get-digital-address-by-2022-bawumia/.

Arnardu, A. N., & Francke, E. (2021). Cape Town: A smart city for African socio-economic development. *Suid-Afrikaanse Tydskrif Vir Natuurwetenskap En Tegnologie, 40*(1), 140–148.

Ayakwah, A., Damoah, I. S., & Osabutey, E. L. C. (2021). Digitalisation in Africa: The case of public programs in Ghana. In *Business in Africa in the era of digital technology* (pp. 7–25). Springer.

Azevedo Guedes, A. L., Carvalho Alvarenga, J., Dos Santos Sgarbi Goulart, Maurício, Rodriguez y Rodriguez, Martius Vicente, & Pereira Soares, C. A. (2018). Smart cities: The main drivers for increasing the intelligence of cities. *Sustainability, 10*(9), 3121.

Baah-Boateng, W., & Kodwo, E. (2013). Employment: Policies and options. In K. Ewusi (Ed.), *Policies and options for Ghana's economic development (3 ed., chapter. 8)*. Accra: Institute of Statistical, Social and Economic Research, University of Ghana.

Baku, A. A. (2022). *Digitalisation and new public management in Africa. New public management in Africa* (pp. 299–316). Springer.

Balkaran, S. (2019). Smart cities as misplaced priorities in South Africa: A complex balance of conflicting societal needs. *Journal of Management & Administration, 2019*(2), 1–30.

Ballon, P., Glidden, J., Kranas, P., Menychtas, A., Ruston, S., & Van Der Graaf, S (2011). *Is there a need for a cloud platform for European smart cities?* (pp. 1–7) Paper presented at the.

Banga, K., & te Velde, D. W. (2018). *Digitalisation and the future of manufacturing in Africa*. ODI.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., & Portugali, Y. (2012). Smart cities of the future. *The European Physical Journal Special Topics, 214*(1), 481–518.

Baud, I., Scott, D., Pfeffer, K., Sydenstricker-Neto, J., & Denis, E. (2014). Digital and spatial knowledge management in urban governance: Emerging issues in India, Brazil, South Africa, and Peru. *Habitat International, 44*, 501–509.

Bernardo, M. R. M (2017). Smart city governance: From E-government to smart governance. In L. C. Carvalho (Ed.), *Handbook of research on entrepreneurial development and innovation within smart cities* (pp. 290–326). IGI Global. 10.4018/978-1-5225-1978-2.ch014.

Bibri, S. E., & Krogstie, J. (2019). Towards a novel model for smart sustainable city planning and development: A scholarly backcasting approach. *Journal of Futures Studies, 24*(1), 45–62.

Bokpe, S. J. (2017). *How the national digital property address system works*. Graphic Online Oct - 19 - 2017 https://www.graphic.com.gh/news/general-news/how-the-national-digital-property-address-system-works.html.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Dano, U. L., Balogun, A., Abubakar, I. R., & Aina, Y. A. (2020). Transformative urban governance: Confronting urbanisation challenges with geospatial technologies in Lagos, Nigeria. *GeoJournal, 85*(4), 1039–1056.

Decardi-Nelson, I., Asamoah, O. R., Solomon-Ayeh, B., & Nduro, K. A. (2012). The informal sector and mortgage financing in Ghana. *Ghana Journal of Development Studies, 9*(2), 136–152.

Demuyakor, J. (2021). Ghana's digitization initiatives: A survey of citizens perceptions on the benefits and challenges to the utilization of digital governance services. *International Journal of Publication and Social Studies, 6*(1), 42–55.

Ecklu, G. A. (2011). *Implementing a street and property identification system: A case study of Accra, Ghana*. Western Michigan University.

Effah, S. K. (2019). *Gov't to issue number plates to every house in Ghana* Retrieved May 24, 2022 from: https://3news.com/govt-to-issue-number-plates-to-every-house-in-ghana/.

Frimpong, L. K., Mensah, S. L., Okyere, S. A., Abunyewah, M., Diko, S. K., Enning, S. B., & Attigah, J. M. (2022). Digitalisation for whom: the determinants of residents' use of the digital property address system in Accra, Ghana. *Smart and Sustainable Built Environment* ahead-of-print. 10.1108/SASBE-06-2022-0121.

Froehlich, A., Ringas, N., & Wilson, J. (2020). E-Governance in Africa and the world. *Space supporting Africa. Studies in space policy*: 28. Cham: Springer. 10.1007/978-3-030-52260-5_2.

Gah, S. K., Katsriku, F., & Gyamfi, N. K. (2018). Using GPS and Google maps for mapping digital postal address (GhanaPostGPS). *Communications on Applied Electronics, 7*(13), 15–20.

Ghana Statistical Service. (2014a). *2010 Population and housing census. Adenta municipal assembly. District analytical report*. Accra: Ghana Statistical Service https://www2.statsghana.gov.gh/docfiles/2010_District_Report/Greater%20Accra/Adentan.pdf.

Ghana Statistical Service. (2014b). *2010 Population and housing census. Ga East Municipal assembly. District analytical report*. Accra: Ghana Statistical Service https://www2.statsghana.gov.gh/docfiles/2010_District_Report/Greater%20Accra/GA%20EAST.pdf.

Ghana Statistical Service. (2021). *Ghana population and housing census*. Accra: Ghana Statistical Service.

Giest, S., & Raaphorst, N. (2018). Unraveling the hindering factors of digital public service delivery at street-level: the case of electronic health records. *Policy Design and Practice, 1*(2), 141–154.

Hatsu, S. (2018). *A framework for benchmarking e-governance projects in developing countries*.

Heeks, R. (2002). e-Government in Africa: Promise and practice. *Information polity, 7*(2–3), 97–114. 10.3233/IP-2002-0008.

Heeks, R. (2003) Most eGovernment-for-development projects fail: how can risks be reduced?, iGovernment Working Paper no. 14, Available at: 10.2139/ssrn.3540052.

Jorgenson, D. W., & Vu, K. M. (2016). The ICT revolution, world economic growth, and policy issues. *Telecommunications Policy, 40*(5), 383–397.

Kuuire, J. A. (2017). *Ghana's digital addressing system is officially launched; GhanaPostGPS Is Live* https://technovagh.com/ghanas-digital-addressing-system-officially-launched-ghanapostgps-live/.

Lall, S. V., Henderson, J. V., & Venables, A. J. (2017). *Africa's cities: Opening doors to the world*. World Bank Publications.

Lyons, A., Kass-Hanna, J., & Greenlee, A. (2020). *Impacts of financial and digital inclusion on poverty in South Asia and Sub-Saharan Africa* (August 28, 2020) Available at SSRN. 10.2139/ssrn.3684265.

Makara, S. (2018). Decentralisation and good governance in Africa: A critical review. *African Journal of Political Science and International Relations, 12*(2), 22–32.

Menychtas, A., Kranas, P., van der Graaf, S., Vanobberghen, W., Schade, U., Coote, R., & Dirkx, M. (2013). EPIC: A holistic approach for smart city services. In *Proceedings from*

the CMI's 6th Annual International Conference: Developing the Future ICT Infrastructure Technologies, Markets, and Policies.

Ministry of Local Government and Rural Development. (2011). *Operational guide national: National street naming and property addressing*. Accra: Ministry of Local Government and Rural Development https://new-ndpcstatic1.s3.amazonaws.com/pubication/Street+Naming&Property+Addressing+Policy_Nov2011.pdf.

Nam, T., & Pardo, T. A. (2011a). *Conceptualising smart city with dimensions of technology, people, and institutions* (pp. 282–291) Paper presented at the.

Nam, T., & Pardo, T. A. (2011b). *Smart city as urban innovation: Focusing on management, policy, and context* (pp. 185–194) Paper presented at the.

Niebel, T. (2018). ICT and economic growth–Comparing developing, emerging and developed countries. *World Development, 104*, 197–211.

Odendaal, N. (2006). Towards the digital city in South Africa: Issues and constraints. *Journal of Urban Technology, 13*(3), 29–48.

Odendaal, N. (2015). Getting smart about smart cities in Cape Town: Beyond the rhetoric. In *Smart urbanism* (pp. 71–87). Routledge.

Okyere, S. A., Frimpong, L. K., Diko, S. K., Abunyewah, M., & Kita, M. (2021). Situating Everyday Urban Struggles Within the Context of the SDGs in an Informal Settlement in Accra, Ghana. In *Sustainable Urban Futures in Africa* (pp. 265–287). Routledge.

Onyango, G. (2017). *One-step shop in service delivery in Kenya*. Global Encyclopaedia of Public Administration, Public Policy, and Governance.

Ratti, C., Frenchman, D., Pulselli, R. M., & Williams, S. (2006). Mobile landscapes: using location data from cell phones for urban analysis. *Environment and Planning B: Planning and Design, 33*(5), 727–748.

Roser, M., Ritchie, H., & Ortiz-Ospina, E. (2018). *Internet* https://ourworldindata.org/internet.

Samuels, P. (2017). *Advice on exploratory factor analysis*. Centre for Academic Success, Birmingham City University ResearchGate https://www.researchgate.net/publication/319165677_Advice_on_Exploratory_Factor_Analysis.

Sausen, H. (2020). *What is digitalization? Opportunities and challenges in East-Africa*. Rwanda: Friedrich-Ebert-Stiftung http://library.fes.de/pdf-files/bueros/ruanda/16158.pdf.

Shoval, N. (2008). Tracking technologies and urban analysis. *Cities, 25*(1), 21–28.

Siba, E., & Sow, M. (2017). *Africa in focus: Smart city initiatives in Africa*.

Simons, B. (2021). *Bright Simons: My little beef with Bawumia's digitisation agenda* Retrieved April 24, 2022 from: https://www.myjoyonline.com/bright-simons-my-little-beef-with-bawumias-digitisation-agenda/.

Singh, R. M., & Said, J. (2020). *Harnessing Digital Technology for Africa's Economic Recovery and Transformation*. London: Tony Blair Institute for Global Change https://institute.global/sites/default/files/inline-files/Tony%20Blair%20Institute%20for%20Global%20Change%2C%20Harnessing%20Digital%20Technology%20for%20Africa%27s%20Economic%20Recovery%20and%20Transformation%2C%20November%202020.pdf.

Smith, L. I. (2002). *A tutorial on principal components analysis*.

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy, 67*, Article 101104.

Streiner, D. L. (2020). *10 Figuring out factors: The use and misuse of factor analysis. A guide for the statistically perplexed* (pp. 110–122). University of Toronto Press.

The World Bank Group. (2019). *Ghana digital economy diagnostic*. World Bank.

Tshiani, V., & Tanner, M. (2018). South Africa's quest for smart cities: Privacy concerns of digital natives of Cape Town, South Africa. *Interdisciplinary Journal of E-Learning & Learning Objects, 14*.

United Nations Human Settlements Programme. (2020a). *Digitalisation for inclusive, safe, resilient and sustainable cities and human settlements* https://unhabitat.org/digitalisation-for-inclusive-safe-resilient-and-sustainble-cities-and-human-settlements.

United Nations Human Settlements Programme. (2020b). *People-centered smart cities* https://unhabitat.org/programme/people-centered-smart-cities.

Waller, L., & Genius, A. (2015). Barriers to transforming government in Jamaica: Challenges to implementing initiatives to enhance the efficiency, effectiveness and service delivery of government through ICTs (e-Government). *Transforming Government: People, Process and Policy*.

Yildirim, V., Yomralioglu, T., Nisanci, R., & Inan, H. (2014). Turkish street addressing system and geocoding challenges. *Proceedings of the Institution of Civil Engineers - Municipal Engineer, 167*(2), 99–107.

Yoon, C. (2020). Digital Africa: An analysis of digital trends in Africa and their driving factors. In *Space fostering African societies* (pp. 109–133). Springer.