DISCOVERY

Potentials of information and communication technology in real estate management and valuation practice

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Citation
Mohammed JK, Bello MZ. Potentials of information and communication technology in real estate management and valuation practice. *Discovery*, 2021, 57(301), 63-73

ABSTRACT

Technological advancement with globalization and increasing urbanization necessitated transition in real estate practice. Consequently, information and communication technology (ICT), including application software, geographic information system, drone technology, wireless sensor networks, cloud computing, artificial intelligence and the Internet of Things (IoT) have become common and emerging tools for estate surveyors and valuers to achieve value addition in real estate practice. These technological innovations are among the most sophisticated in both built and business environments ona global scale. Their adoption affects both employers and employees in both the public and private sectors. The increasing complexity of real estate management and valuation practice requires these technologies to remain competitive in the global economy. Although there are studies on ICT applications in real estate practice they are mostly on software applications, while those on sensor, drone, IoT, big data, and artificial intelligence are industrial based, and motivated by profit maximisation without considering the impact of these technologies on stakeholders and the community. Therefore, there is a scarcity of scholarly studies that evaluate the current trend of technological innovation in real estate practice as it affects employers and employees and also considering privacy issues. This study essentially relies on published data sourced from academic journals, conference papers, thesis, and other secondary sources. The paper explores technological innovations for sustainable real estate practice and therefore recommends what it regards as the most appropriate technologies for various aspects of real estate.

Keywords: Real estate, Information and Communication Technology, Innovation, Employers, Employees, Privacy

1. INTRODUCTION

Advancement in Information and Communication Technology (ICT), globalisation and complexity of the human environment has influenced global industrial sectors including the Real Estate industry (Mohammed et al., 2019). Earlier in the late 1990s, there was

increasing debate over the emergence of a "new economy", built on major structural changes driven by globalisation and ICT (Dixon, 2005). Information technology thereafter becomes a major form of communication in the real estate industry and a tool for marketing and information dispersion (A. K. Oyetunji et al., 2018). Since then, ICT gains prominence by real estate researchers where application software are used in analysing and solving real estate problems(B. O. Oyetunji et al., 2018). For example, a web-based application built on a Fuzzy Object-Relational Database Management System called Soft Data Server which has capabilities for fuzzy data handling (Barranco et al., 2009), using Geographic Information System (GIS) for real estate price spatial assessment (Ajayi, Kemiki, et al., 2015; Mohammed & Sulyman, 2019), property valuation (Hromada, 2016). The adoption of technological innovations has significant positive influences on the real estate profession but negatively affects the social well-being of the real estate professionals and diminishes the demand for the professional estate surveyors and valuers' role (Adama & Michell, 2018).

Consequently, ICT, including application software, geographic information systems, drone technology, wireless sensor networks, cloud computing, artificial intelligence, big data and the Internet of Things (IoT) have become common and emerging tools for estate surveyors and valuers to achieve value addition in real estate practice. These technological innovations are among the most sophisticated in both built and business environments on a global scale. Their adoption affects both employers and employees in both the public and private sectors. Although several studies on ICT applications in real estate are mostly on software applications, while those on sensor, drone, IoT, big data and artificial intelligence are rare. Therefore, there is a scarcity of scholarly studies that evaluate the current trend of technological innovation in real estate practice as it affects employers and employees and also considering privacy issues. It is on that premise this paper intends to explore the potentials of current ICT innovations in real estate taking cognisance of privacy issues.

2. DATA AND METHODS

Published literatures on ICT adoption in real estate management and valuation were systematically reviewed, which were gathered through online search engines such as Google Scholar, Scopus database, Science Direct, Taylor and Francis online, IEEE and others. To search the literature, both keywords and semantic searches were adopted. The method used also comprises of screenings and categorization of literature and all literature selected were written in English. Categorization includes those written on application or potential of software application in real estate, GIS in real estate, Drone technology in real estate, WSN in real estate, Cloud technology in real estate, IoT in real estate, Big data in real estate and AI in real estate respectively. Discussion on the potentials of ICT in real estate was conducted. Also, the implications of these potentials on employers, employees, and privacy issues were discussed. The methodological framework of this process is presented in Figure 1.

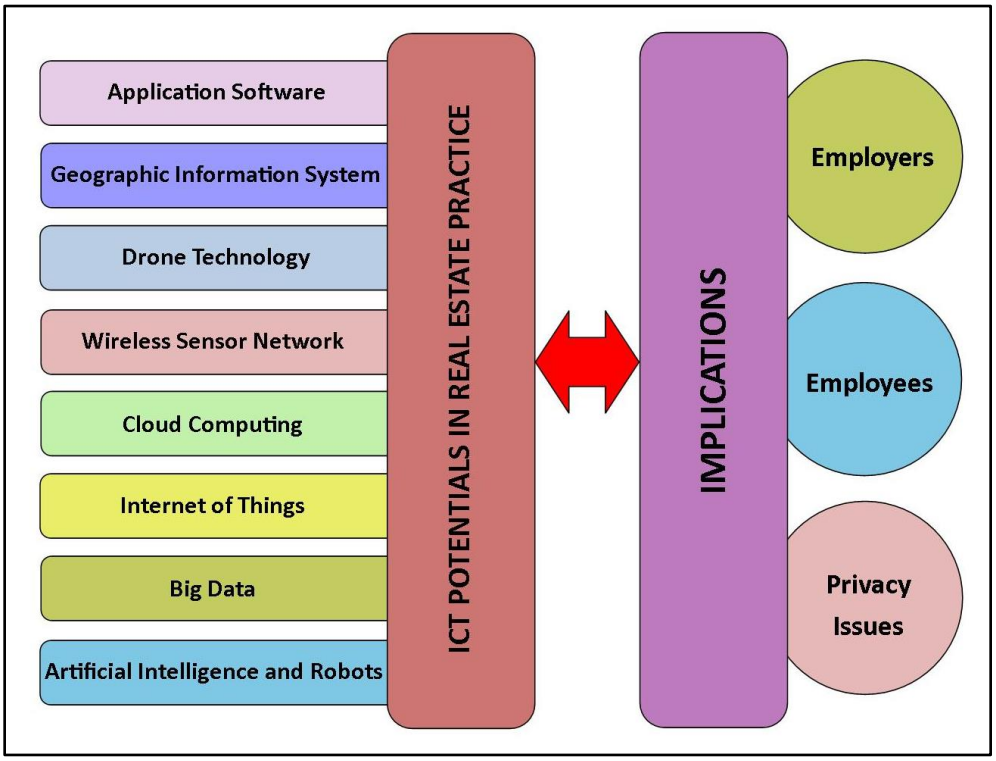

Figure 1: Methodological framework for ICT potentials in real estate and their implications

3. ICT IN REAL ESTATE

3.1. Application software

Application software is used to accomplish a certain task or collection of tasks. In real estate, software are used in information and data management, valuations and appraisals, property management, investment management, agency, and marketing, office procedures, and other several tasks carried out by real estate professionals (Sawyer et al., 1999; Babatunde & Ajayi, 2018). These software are either produced in-house, a tailor-made package from a software house, a general application package marketed by a software house, a general-purpose software package such as a spreadsheet or database generator or/and a multi-purpose software package containing spreadsheet, database, communication and a word processor (Hargitay & Dixon, 1991). For example, Ojo et al. (2018) identified Microsoft Access, Microsoft Excel, Microsoft Word, Microsoft PowerPoint, Microsoft Project, Revit, Microsoft Publisher, Document reader, and Statistical Packages as common general application software used by estate surveyors and valuers.

However, there are several specific applications such as those used in accounting, valuation and appraisal, agency, property management, and several tasks perform by estate surveyors. For instance, there are several packages available for different types of valuation and appraisal, from the individual property level to the portfolio level (Hargitay & Dixon, 1991). For example, FMI- Smart is an application software design for property valuation and appraisal. There are software for property management such as Acumen Property Manager; agency such as Rent Boss; property rating such as Rating Focus; real estate investment analysis such as Crystabol and application software for various real estate activities. These application software has improved real estate practice by increasing efficiency, accuracy, and reduced cost and time spent on the activities (Gacovski et al., 2012).

3.2. Geographic Information System

Geographic Information System (GIS) is a powerful set of tools for capturing, storing, querying, analyzing, and displaying spatial data from the real world for a particular set of purposes (Mohammed, 2020).GIS is a useful tool for nearly every field of knowledge from archaeology to zoology. In the built environment, GIS provides important information including current and past on planned housing, competition in the area, accessibility to the site, traffic counts, gravity models, other sites available, and zoning. This is all incorporated into easy-to-understand reports and map presentations. In real estate, GIS has been applied in several aspects such as property management, spatial property value assessment, property taxation, and several aspects of real estate. For example, Faruk et al. (2016)examine the application of GIS in the administration and management of tenement rate in Bida Local Government Area where it demonstrates how GIS can be used to managed property rating and that GIS can aid policy formulation and decision making (Spatial Decision Support System) in terms of property rating. According to (UN-Habitat, 2013), GIS can be applied in property taxation by identification of ownership data by land plot, analysis of tax revenues by land use within various distances from the city centre and projecting tax revenue changes due to land-use changes. Another application of GIS in real estate is the Land Information System (LIS). LIS is a specialised application of GIS technology that is concerned with issues of land ownership, land planning and land management. The major aspect of LIS is the land titling registration which will not only bring effectiveness in land administration and management but will go a long way in ensuring the reaping of maximum benefit from the land by individual owners and boosting the real estate revenue base of the various tiers of government (Nuhu & Tunde, 2012; Peter & Martin, 2003).

GIS can be used by facility managers for space management, visualization, planning, emergency and disaster planning and response, as well as many other applications (Faruk et al., 2016). GIS can be used throughout the life cycle of a facility – from site selection, design and construction to use, maintenance and adaptation, and ultimately through closing, repurposing, and reclamation (IFMA Foundation, 2010). GIS is also applied in infrastructure assessment (Ajayi, Kemiki, et al., 2015) where areas that need certain infrastructure are easily detected. Spatial assessment of rental price was also conducted using GIS (Ajayi, Nuhu, et al., 2015). Similarly, several spatial and temporal assessment of rental prices were carried out using GIS geospatial techniques (Mohammed & Sulyman, 2019; Cichociński & Dąbrowski, 2013). There are several other studies on housing satisfaction, housing quality, real estate development, and real estate market analysis using GIS applications. GIS has proven to be a good ICT tool for problem-solving in real estate.

3.3. Drone technology

A drone is also referred to as Unmanned Aerial Vehicle (UAV). Drones are rapidly becoming one of the most useful tools for professionals in the built environment (Keilman et al., 2019). In the field of real estate, the benefit of drones includes property management, marketing, and valuation, and a multitude of new uses (Radzali & Tahar, 2018). Recently, real estate agents have started to utilize drone technology to help showcase their sellers' properties and give potential buyers a realistic view of what the home and land look like from an aerial view. In terms of property rating and valuation, Nicholas (2018) argued that drone technology provides great utility for rating purposes and it can ensure fiscal cadastres are up to date, complete and accurate and

also observed that some challenges faced by valuers during field inspections can be solved when UAVs are used to aid property rating. Furthermore, drone usage in rating can save time in the field because the drone through aerial imagery identified large numbers of properties in 10 to 15 minutes where the components of up to datedness, completeness, and accuracy which are essential for a fiscal cadastre were achieved at an affordable cost. Yet, the drone is one of the major innovative technology that is not yet widely adopted by estate surveyors and valuers (Nicholas, 2018).

Similarly, Xifilidou & Kaimaris (2018) argued that drone technology facilitates and improves the valuation process. They also argued that drone can be used in the valuation of rural large properties that demands an inspection of the whole parcel, which sometimes is not possible from the ground. Also, large malls or whole commercial complexes can be inspected by drones more closely, documenting changes within their area and skyscrapers and office buildings with inaccessible parts due to their architectural design may appear to be in a worse condition than observed from the ground. The drone also help appraisers to measure properties precisely especially in the case that a laser scanner is attached to them. Although, drone technology offers a tremendous opportunity for real estate practice, there is no special drone design for estate surveyors yet, this indicates that a lot of estate professionals do not understand what to get with it or drone developers do not understand what estate professionals want. This indicates a significant gap in knowledge of estate professionals and drone technology developers. But significant academic literature that addresses the use of drones in the real estate practice appears to be scanty, whereas those available are industrial based. Therefore, there is an urgent need for collaboration between drone developers and estate surveyors.

3.4. Wireless Sensor Network

A Wireless Sensor Network (WSN) is a self-configuring network of small sensor nodes communicating among themselves using radio signals, and deployed in quantity to sense, monitor, and understand the physical world(M. A. Matin & Islam, 2012). WSN technologies will rise to meet this new challenge, in which information and communication systems are invisibly embedded in the environment around us. This results in the generation of enormous amounts of data that have to be stored, processed, and presented in a seamless, efficient, and easily interpretable form (Gubbi et al., 2013). The WSN monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to the main location or sink where the data can be observed and analysed (M. A. Matin & Islam, 2012). WSN can be applied basically in the monitoring of objects, monitoring of an area, and monitoring of both objects and area. For monitoring an area, this may include; environmental and habitat monitoring, property management, facilities management, land monitoring, precision agriculture, indoor climate control, military surveillance, treaty verification, intelligent alarms(M. A. Matin & Islam, 2012). However, in real estate, the application of WSN for property management is referred to as 'Smart Property Management'(Mohammed et al., 2019). Mohammed et al. (2019) argued that smart property maintenance and management (using WSN) aim at making property management operations more efficient while reducing cost with less energy and time. Also that the information collected from sensors is used to evaluate optimum return, efficiency, and reliability of building components, defaults, and to more accurately predict property yields.

The component sensors (nodes) are microchips that mine information from the components they are attached to and disseminate the information to a super node which collects information from other nodes and linked the information to the server through the antenna. Here, the property manager would be able to monitor remote building components of all the properties under this network without physical contact with the property (Mohammed et al., 2019). Yet, WSN technology is not fully explored by estate professionals.

3.5. Cloud computing

Cloud computing as a concept provides businesses with computer needs (such as software, data storage, etc.) through the Internet. Documents, e-mails, and other data will be stored "in the cloud", i.e. online, thereby accessible from any computer or mobile device (Weber & Weber, 2010; Maggiani, 2009). Cloud computing is a virtual platform where estate surveyors and valuers can store and analyse information (Bölöni & Turgut, 2017). Cloud has large storage capacity which cannot be easily provided by office personal computers (PC), (Gulmez et al., 2015). This allows estate surveyors and valuers to control a large volume of data at low cost (Cervone, 2010; Gupta, 2010). It also allows them to share information and also ensures privacy. Cloud computing offers an increased level of convenience to Estate Surveyors and Valuers and their clients in such a way that users can access physical and virtual resources from wherever they need to work, as long as it is network accessible, using a wide variety of devices such as mobile phones, tablets, laptops, and workstations. Also, with cloud services, Estate Surveyors and Valuers can monitor, control, report, and bill. Its features support directly the functionalities of the real estate registration (Jin et al., 2018). This is an important feature needed to optimize

and validate the delivered services by Estate firms. In another perspective, cloud computing offers the users value by enabling a switch from low efficiency and asset utilization business model to a high-efficiency one (Mohammed et al., 2019).

For the cloud service Real Estate, the physical or virtual resources available for provisioning often appear to be unlimited and can be purchased in any quantity at any time automatically, subject to the constraints of service agreements (Li et al., 2009). For example, the service charge can automatically be paid for without contacting the surveyor. This means that the estate firms and tenants no longer need to worry about limited resources and might not need to worry about capacity planning. Cloud serves as the storage component (Keeping the data for retrieval at convenience) of the entire system in modeling integrated smart estate management (Fang et al., 2017). Another benefit of cloud computing to real estate firms is that usually real estate portfolios are scattered in different locations which is a major challenge but cloud technology has capability of monitoring, controlling and managing all the portfolio from a single location (Mohammed et al., 2019).

According to Mladenow et al. (2015) cloud computing relevance in the real estate sector is determined by three factors which includes; the value of objects in real estate business is relatively high, some phases during their life cycle cover very long time periods, and many different actors are involved along the real estate's value chain. Therefore, cloud computing have a strong impact on the performance of real estate companies (Shenoy, 2019).

3.6. Internet of Things

The Internet of Things (IoT) is an emerging global Internet-based information architecture facilitating the exchange of goods and services. The IoT has the purpose of providing an IT-infrastructure facilitating the exchange of "things" securely and reliably, i.e. its function is to overcome the gap between objects in the physical world and their representation in information systems (Weber & Weber, 2010). The IoT technology establishes a connection between all things and the Internet via sensing devices and implements intelligence for identification and management (Li & Yu, 2011). At its core, innovation in the IoT is characterized by the combination of physical and digital components to create new products and enable novel business models (Wortmann & Flüchter, 2015). Real estate is not an exception of IoT applications. Examples of IoT in real estate include the real-time production logistics synchronization system and Fog computing for wind farms, smart grids and smart cities, domotics home automation device units, and Nest temperature controllers among others (Ullah et al., 2018).

IoT in its dynamic nature can be applied to various aspects of real estate such as; Property Management, Facilities Management, Infrastructure Management, Construction Management, etc. Recently, Smart Home became an important aspect of IoT concerning real estate (Mohammed et al., 2019). In a property maintenance model developed by Mohammed et al. (2019), sensors (microchips) are attached to various components such as a wall, window, door, roof, etc. to mine information from the components and transmit the information via any network (RFID, NFC, Bluetooth, infrared, GPS, etc.) to the remote server and then to the internet. From the internet devices (User interface) the property manager can monitor or control any component of remote building in the network.

3.7. Big data

Big Data is new, novel, and exciting (Winson-Geideman & Krause, 2016). In recent time, it has become a hot topic (Cheng et al., 2016). Big data is a data that is too big, too fast, or too hard for existing tools to process – too big as organisations are now collecting petabytes of data, too fast as processing applications must provide nearly instantaneous results, and too hard when new technologies are required to analyse it (Madden, 2012). According to Cheng et al. (2016), big data is an aggregate of data sets that are large and complicated. Most academic definition of big data comes from describing its characteristics by volume (Big data too big to sit on your hard drive), velocity (Big data is often generated continuously) and variety (Big data can be of any type, consisting of numbers, texts, photos, videos, audio, and other kinds of data (Barkham et al., 2018). This explosive growth of data can be attributed to the rapid development of IoT and cloud computing. Big data has attracted the attention from both academia and industrial areas (Cheng et al., 2016). In the built environment, big data is still in its early stages (Barkham et al., 2018). In real estate, big data can influence the real estate market far beyond pure efficiency improvements – with a disruptive effect also on the nature of property, remodelling, and the way in which real estate is bought, sold and managed (Battisti et al., 2019).

According to Battisti et al. (2019), Big data can favour, on one hand, minimisation of risks (thereby improving efficiency and facilitating cost reduction) and, on the other, an optimisation of the business processes. Du et al. (2014) argued that in the current applications of big data, the estate enterprises including developers, agency, and property management companies all expand multiple comprehensive business domains, also that the estate development operation, intermediary services, and property management are bound together inextricably. Du et al. (2014) also argued that big data has become a type of significant strategic resource for estate enterprises to enhance competitiveness, and is presently achieving success in the Chinese real estate industry. Although, few studies were conducted in China to examine the space-time dynamics of how housing prices fluctuated from a big

data perspective (Li et al., 2017). García-González et al. (2019) opined that big data analytics have been successfully applied in several real estate applications to support the decisions of both buyers and sellers.

Database of real estate assessment based on big data can solve traditional real estate assessment problems due to lacking data, and play advantage of data itself through data mining and knowledge discovery at utmost (Zhou et al., 2015). With the potential of big data in real estate practice, it is yet to be fully exploited in solving real estate problems most especially in the era of massive data generation from different electronic media and devices.

3.8. Artificial intelligence and robotics

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. This includes any machine that exhibits traits associated with a human mind such as learning and problem-solving. AI is conceived in the form of both analytical techniques and robotics. In real estate, according to Conway (2018), AI can be used to facilitate real estate investment in a myriad of ways, spanning all aspects of the real estate profession – from property management to investment decisions, to development processes and thereby transforming real estate into a more efficient and data-driven industry. AI has been adopted by several authors in analysing property values. For example, Abidoye & Chan (2017) argued that AI valuation techniques have proven to be reliable and accurate in property valuation. Also that AI techniques can be used by professional bodies for the regulation of real estate practice. Artificial Neural Network (ANN) an aspect of AI is recommended for mass appraisal of real estate (Zhou et al., 2018). In another perspective, AI techniques such as Machine Learning (ML) into pre-existing data structuring workflows will enable new customer analytics and standards for service that will elevate customer expectations (McGrath et al., 2019).

Another aspect of AI in real estate is robotics. Robotic is one of the most advanced technologies in the area of computer science, electronic and communications, mechanical engineering, and information technology (Madakam et al., 2019). Robotic attracted attention from the real estate industry. For example, Nardelli et al. (2019) explore how automated service interaction offered by telepresence robots (telerobots) impacts the services encountered in real estate. It was argued that the automated experience resulted better compared to physical visits, as telerobots offered an improved experience of the co-working space. Also, robotic furniture systems can enhance the utility of smaller residential units which could alter the landscape of real estate development in urban environments (Pefluela, 2016). However, corporate real estate typically adopts this new technology at a slower pace than other industries (McGrath et al., 2019).

4. IMPLICATIONS

4.1. Employers

Advancement in ICT has several implications for real estate companies/firms. These technologies have made real estate practice fast, accurate, and reliable which are among its tremendous benefits derived. It also reduces the cost incurred in the employment of personnel carrying out various activities, because some of these activities are automated. For instance, robotic technology has many advantages including accuracy of operations, improving employee morale, increasing productivity, making sure low technical barriers, compliance, consistency leading to the reliability, and non-invasive technology (Madakam et al., 2019). Also, there are negative implications for employers. For example, ICT implementation entails additional costs on employee training, licensing, organizational restructuring, and upgrading of existing facilities which also need to be taken into consideration to have adequate investments in ICT that impact organizational productivity significantly (B. O. Oyetunji et al., 2018). Real estate technology and other startups may have trouble hiring from these specialised talent pools when competing with major companies that have great offerings for their employees (Conway, 2018).

4.2. Employees

There are several implications of ICT adoption on real estate employees. For example, ICT applications in real estate firms do not only improve business processes but also improve employee wellbeing and safety, as well as the impact of an environment on employee productivity (Warburton, 2016). Robotic can bring immediate impact to the core business processes including employee payroll and changes in employee status among others (Madakam et al., 2019). With IoT sensors, an employee can enter an apartment and notes what to renovate, which in turn is sent to the partner in the form of a digital checklist. This checklist is sent to someone who packs the goods needed for the renovation and this is then shipped to the renovation object. Where craftsmen start with the renovation and have all the material needed directly on-site (Henningsson & Ljungdahl, 2018). This makes employees' tasks easy, fast, and accurate. An additional implication is that employees with a strong background in machine learning are key to making ML and AI primary and useful components of the various applications (Conway, 2018). Firms with a strong interest in ML and

analytics have benefitted from founders and early employees with a strong background in data science and ML, which are complex areas requiring careful consideration of many variables involved in developing these types of technologies (Conway, 2018). However, inadequate ICT competencies of employees are one of the major negative implications of ICT application in real estate (B. O. Oyetunji et al., 2018).

4.3. Privacy Issues

Privacy is considered a basic human right and should be protected by law (Barkham et al., 2018), and should be a fundamental aspect of new technologies (Parikh et al., 2019). The term data privacy suggests that the data owners do not want their sensitive data set to be disclosed to unauthorised access (Matharu et al., 2014). In this technological advancement era, the managerial issue of privacy is elevated to a level never before realized (Weinberg et al., 2015). This makes it more difficult for real estate agents to retain the privacy of their customers. In real estate organisations employees can use the technology and access customer information (Mani et al., 2015).Several privacy and security issues are generally associated with these technological innovations (Ullah et al., 2018). For example, data leaks from big data generated by IoT could severely impact individual privacy by revealing sensitive personal information such as personal habits or personal financial information (Brous et al., 2020). According to the present ethics and moral concept, we can't ignore the big data containing much personal privacy (Du et al., 2014). For big data statistics and what can be used must be revisited repeatedly to ensure that no citizen's privacy or security rights are violated (Ullah et al., 2018). The use of IoT could have profound social implications. Without safeguards in place, IoT technology also has the potential to compromise consumer privacy and threaten civil liberties. Consumer groups have expressed concern over the privacy invasion that might result in the widespread application of IoT enables devices (Attaran, 2017).

Concerning drones, there is a need to respect the privacy of individuals while flying the drone. Drones are looked at as spying gadgets and no one would love to see it flying over his house or property without permission (Nicholas, 2018). Although such aerial views raise privacy and security concerns, associations such as the Federal Aviation Authority (FAA) of the US have begun to hand out licenses for drones used in real estate (Ullah et al., 2018). To increase the rate of adoption, a broader awareness in tandem with policy change is required while addressing security and privacy concerns (Ullah et al., 2018). Therefore, there are specific measures about privacy and data security (Hammi et al., 2018; Ullah et al., 2019).

5. DISCUSSION

The ever increasing complexity of real estate management and valuation practice requires innovative technologies to remain competitive on a global scale. In this study, we considered application software, GIS, Drone, WSN, Cloud, IoT, Big data, and AI and Robotics application in real estate management and valuation practice and their implications for the companies' employers, employees, and privacy-related issues.

The findings of this paper show that there are several specific and general application software such as those used in accounting, valuation and appraisal, agency, property management, and other several tasks performed by estate surveyors. Real estate management and valuation practice have improved with the use of these software applications by increasing efficiency, accuracy, cost reduction and saving of time (Gacovski et al., 2012). GIS is another aspect of ICT that is widely adopted in the field of real estate management and valuation. Although, much is yet to be done in the application GIS to real estate management and valuation. It has been widely applied in several aspects such as property management, property taxation, mass valuation appraisal, land management, housing, real estate development, facilities management, and spatial and temporal assessment of rental prices.

However, drone technology is new to real estate management and valuation practice, but its potentials have been proven or demonstrated in this paper. Drone technology facilitates and improves valuation processes and makes property inspection easier, most especially in high rise buildings, helps in property measurement, and several other opportunities provided by it. Significantly also, there is an urgent need between drone developers and estate surveyors to understand what to get and what estate surveyors want.

In real estate management and valuation practice, WSN has the potentials for what is referred to as smart property management (Mohammed et al., 2019). Information collected from sensors in WSN can be used to evaluate optimum returns, efficiency, and reliability of building components and predict property yield accurately (Mohammed et al., 2019). With this, remote buildings can be monitored. In the real estate management and valuation also, cloud computing serves as storage components for the increasing data generated from smart technologies in the real estate industry (Mohammed et al., 2019). The real estate portfolio can be managed, monitored, and controlled from a location with the aid of cloud computing.

IoT and its deployed sensors can be used to manage property, facilities, infrastructure, and construction. Recent smart buildings and smart homes are examples of IoT potentials in real estate management and valuation (Mohammed et al., 2019). However, the

explosive growth of data from IoT and cloud computing has made data generation fast, large, and not easy to be handle which is referred to as Big data. Big data can influence the real estate market far beyond efficiency improvement but also transactions in the real estate sector (Battisti et al., 2019). AI and Robotics or the combination of both are making prominence in the real estate sector. It has been conceived to transforming real estate management and valuation profession into a more efficient and data-driven industry. It has potentials in property valuation and management and investment decisions.

These technologies have implications both positive and negative on real estate management and valuation firms/companies and their employees. There is also privacy issues related to these technologies, where certain sensitive data of individuals are disclosed to unauthorised individuals

6. CONCLUSION

Real estate management and valuation practices have been transformed by the current technological innovations. However, the increasing complexity of real estate management and valuation practice and global scale competition necessitate the adoption of innovative technologies. These technological innovations have the potentials of transforming real estate management and valuation profession into a more efficient and data-driven industry. They are the most appropriate technologies for various aspects of real estate presently These technologies have both negative and positive impacts on both employers and employees in the real estate management and valuation sector. Therefore, more is required in the adoption of these technologies in the real estate management and valuation practice, especially the need to consider the privacy of both individuals and companies in the sector.

Funding

This study has not received any external funding.

Conflict of Interest

The authors declare no conflicts of interests any matter related to this paper.

Data and materials availability

All related data have been presented in this paper.

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Peer-review

External peer-review was done through double-blind method.

Article History

Received: 30 October 2020
Reviewed & Revised: 31/October/2020 *to* 07/December/2020
Accepted: 08 December 2020
Prepared: 10 December 2020
Published: January 2021

General Note

We recommended authors to print article as color digital version in recycled paper. Discovery Scientific Society will not provide any prints for subscription.

 ISSN 2278–5469 EISSN 2278–5450 | OPEN ACCESS