

Improving online Real Estate Management System using data analytics

Wisdom Kelechi Obinna^{1*}, Mfoniso James Udo^{2*}

¹Department of Computer Science, University of Port Harcourt, Nigeria. kcwisdom@gmail.com

²Civil Engineering, University of Agriculture, Benue, Nigeria. udomfoniso3@gmail.com

*Corresponding author: kcwisdom@gmail.com



Abstract: As technology advances, every industrial sector has continued to innovate and scale. Several property technologies have fast-tracked nominal developments and accelerated growth in the Real Estate market. Real Estate markets in developing countries have endured challenges and issues emanating from various areas such as management, trust, sales, and infotech, many more. This paper aims to implement a model of the online Real Estate Service system via a responsive web application using data analytics and visualization techniques that show insights and improve decision making based on user data. This implementation includes backend clustering and Regression algorithms to produce insights based on available test data of over 62 PropTech firms in Nigeria, thus helping clients, managers, and agents make critical decisions to accelerate organizational growth. The model was developed by analyzing the impact of data growth in the online Real Estate service system, hinging on the study of earlier literature and data from over 7000 PropTech firms. The research adopted a questionnaire and validation method to understand the main domains to focus on, including property search, Agent trustworthiness, and capabilities. The findings presented here include use cases of the application that provides comprehensive solutions with the system feature providing solutions for deeper property search, minimizing the danger of being scammed and making it easier to acquire properties with specific criteria and to easily contact verified agent based on individual needs of the client and agents track record. Test findings reveal that more data introduced to the system will make it more efficient since the threshold of each level adapts based on data inputted in a dynamic cluster.

Keywords: Data analytics, Data, PropTech, Real estate services, Realtors, Web-based

1. Introduction

The key responsibilities of a manager include organizing and directing a system to attain its objectives. Well-being issues, including housing, are vital to human survival. Organizations in practically every sector are deliberate about using data to gain insights, given the massive amounts of data available (Provost et al., 2013). With the help of an online Real Estate Service system, these issues have been reduced comparatively. Initially, online Real Estate Service systems were viewed as software where property details such as available house details, schedules, addresses, and others are set up by an administrator. However, online Real Estate Service has become a pretty broad term for several areas in the last decade, including Real Estate

Research Article: This article is published by *Jozac Publishers* in the *Journal of Emerging Technologies (JET)*. This article is distributed under a Creative Common [Attribution International License \(CC BY-SA 4.0\)](https://creativecommons.org/licenses/by-sa/4.0/). **Conflict of Interest:** The author/s declared no conflict of interest.



Service, surveying, business, finance, and the built environment. Real estate managers are often in charge of setting the service models and employing and managing the workforce required to achieve those needs. With the emergence of tones of data, this is gradually changing; more than 2.5 quintillion bytes of data are generated every day; with the growing popularity of the internet of things (IoT), this data creation rate will become even more significant (Vuleta, 2021) and it is expected that 2.7MB will be created every second by 2023 (Ahmad, 2020).

Housing is still an essential requirement for human existence. Monthly housing data tones are rising due to factors like the growth in population and income, which has further resulted in an equal increase in home demand over the years. Managing these demands offline posed significant challenges and difficulties, leading to the involvement of technology. Globally, industrial sectors, including the Real Estate industry, have been influenced by the innovative dynamism in the Information Technology space, globalization, and the complexity of the human environment. (Mohammed et al., 2019). As human involvement with data grows exponentially, it has become imperative to upscale the method of administration. Keeping real estate records involving components like land, houses, and homeowners have also metamorphosed into a data-driven system, so much so that trends and patterns can be noticed from these records by the government and can be used to make future predictions on population growth, budgets, town mapping, metropolitan management as well as make key decisions on communal development. Despite the growth rate, data on property sectors in most developing countries inclines to be insufficient and out of reach. While the government generates statistics for its own activities, such as GDP and inflation rates, other industries operate with incomplete data. (Onwuanyi, 2020). In most developing nations getting access to real estate data is complex; people lose funds due to a lack of property information. Illegal land and house sales without the agreement of the owner are common also, the estates are most times not valued in order to pay taxes to the government, necessitating a high level of data reception and analytics-based online Real Estate systems involvement; Because emerging countries are adopting web-based solutions, it is critical and intelligent to use data analytics tools to collect and generate insights from daily procedures in the online Real Estate market. Consequently, this article focuses on combining online real estate management, data gathering, visualization, and analytics, leveraging machine learning algorithms to implement further solutions based on the study of earlier literature and implementations.

2. Literature review

Mohammed et al. (2021) reported a study that aimed to ascertain Information and communication technology's potential in real estate management, adopting a systematic review of existing technologies, which includes real-time applications, Artificial intelligence, robotics, cloud computing, Geographic Information Systems, Drones, and Internet of things application, noting their implications for the companies' employers, employees, and privacy-related issues. They further opined that the current technological developments had changed real estate management and valuation procedures. However, their findings noted that the growing complexity of real estate management and valuation practices and competition on an international scale demands the implementation of cutting-edge technological innovations. These technological advancements, such as data analytics and visualization, have the potential to revolutionize property management and valuation.

Mohammed, Zeebaree and Tiryaki (2021) adopted an E-Land-Registration system for Duhok land registration in Malaysia. The services of the database management system covered the employee registration module, estates registration module, operation type module, estate owner's module, estate status module, view Information module, and login employee module. Web development and Database tools were used for the design and implementation stages of the proposed ELR. This implementation plausibly created a solution for the system and eliminated the challenge directorates suffer from the classical hardcopy-based approaches in the country, so building this ELR system created a structured system for data

while reducing time consumption and paper waste.

In a study, Norizan et al. (2020) employed activity theory to provide an analytic perspective in a Malaysian environment. They discussed potential improvements in the real estate business as a result of advances in Internet and mobile technologies and the prospects for the application of IoT in the industry. IoT devices provide real estate brokers with practical and helpful property analytics that they can use to increase sales. To boost buyer confidence, agents might disclose this information; buyers can make speedy selections using readily available, well-informed analytics. It can give lenders and investors in-depth research of homes before buying them. Prospective buyers have the knowledge they need to understand house appraisals. (Dahl, 2018). This study can move further to create an open-source application with its environment including agents, owners, and buyers with all having equal user interface privileges as determined by the admin.

While being the world's largest asset class and a vital part of the global economy over the years (Saul et al., 2020), real estate is traditionally a slow-moving sector and has been slower in adapting to data resourcefulness in developing nations. The focus on personal connections and the sluggish acceptance of novel technologies have long been seen to shape the industry (Fields, 2019b). However, PropTech is becoming a more prominent, global phenomenon, with data-driven tools at the heart of the property technology frameworks. Braesemann and Baum (2020) conducted an extensive study to ascertain whether Property Technology is converting the property market into a data-enhanced industry in developed nations. Such tendencies are evident in the quantitative findings of an analysis derived from over 7000 property technology companies.

Garcia-Gonzalez et al. (2019) highlighted the rising issues in connections with the data generated, particularly around the real estate industry. Real-time data is one of them. Data in real-time has the property of changing over short periods, which implies that data is delivered immediately after collection. This type of data is also increasing due to advancements in IoT (Wingerath et al., 2016), where a large number of sensors capture environmental data and publish it over the Internet.

As seen in the case studies mentioned above, Big Data is unique and can become a stimulant to enhance the real estate industry when applied (Winson-Geideman & Krause, 2016). The real estate market is rapidly becoming a data-driven sector with unusual amounts of data generated daily. Most other industries have embraced and adopted technological tools like Google Analytics to manage data and develop insights. However, the real estate industry's tailor-made data collection and analytic algorithms are yet to gain the needed attention, particularly in core integration with web-based management systems. The fractious relationship between the insights that can be generated from data and the Realtors is frightening. Web-based systems have been adopted in developed nations, with the number growing considerably in the previous decade, albeit data visualization functions have only been implemented in knowing web clicks and analytics rather than generating insights from sellers, agents, and buyers' activity on the web page. It remains to be seen the level of managerial correctness that will be revealed if data in online real-estate management systems are maximized.

3. Methodology

The proposed research model of the online RES system consists of three phases: a literature review of the impacts of data generation and growth in the real estate industry, web model design using the agile development method, and model testing using real-life datasets. Here is a brief outline of the data sources and the methodologies employed before giving the quantitative results.

3.1. Data sources

With Over 7000 Property technology firms listed on Unissu having a plethora of data on real estate, including regular updates, it consequently provides tones of property details that represent the industry's

average reality. The platform aims to inform real estate as an industry. It showcases technologies that are tailored for the real estate market. Thus, providing a rich vein of data for testing a model such as these. Furthermore, it matches identifiers of a similar platform in Crunchbase with over 90,000 datasets, with data from both platforms complementing each other. Hence, the model leverages the comprehensiveness of the dataset available to test and build, test for efficiency, and train using real-life data.

3.2. Questionnaire and validation

Having analyzed the challenging factors from the literature review of data growth impacts in the online RES industry. An online questionnaire-based survey is conducted for property managers in three developing countries (Nigeria, Peru, and Tahiti). Iteratively validating the questionnaires, academic experts in civil engineering grouped the major challenge factors in three domain areas, thus, aiding the choice of tools for data visualization and the focus domains.

3.3. Design and structure of proposed web-based System

Figure 1 depicts the system architecture, which illustrates how communication happens between the Clients, Seller/Agent, and the system. The system architecture implemented in this project would be client-server architecture. Client-server architecture is the system architecture used in this project. Clients must connect to the server, housed in a centralized database and web services, to ask the server to do a task and receive a response. The server sends the feedback to the client. It then stores the data increasingly in its database, which can be visualized daily and weekly as charts and insight-driven visualizations with analytical suggestions.

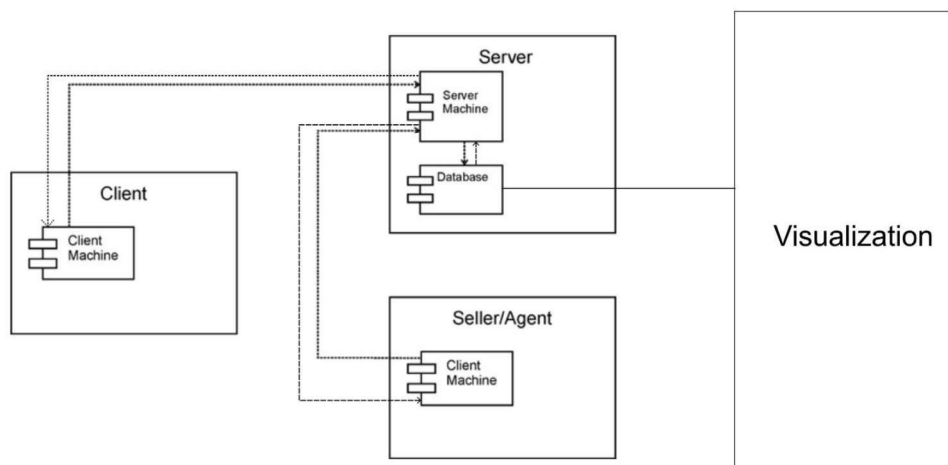


Figure 1: General system architecture

3.4. Web architecture

The web architecture is represented in figure 2. For technical implementation, a web application's infrastructure is dependent on this system. Three basic layers in down-up architecture represent this system: Presentation Layer: These layers are made up of a variety of tools, including the ones listed below.

- ⊙ HyperText Markup Language
- ⊙ CSS
- ⊙ JavaScript
- ⊙ Bootstrap

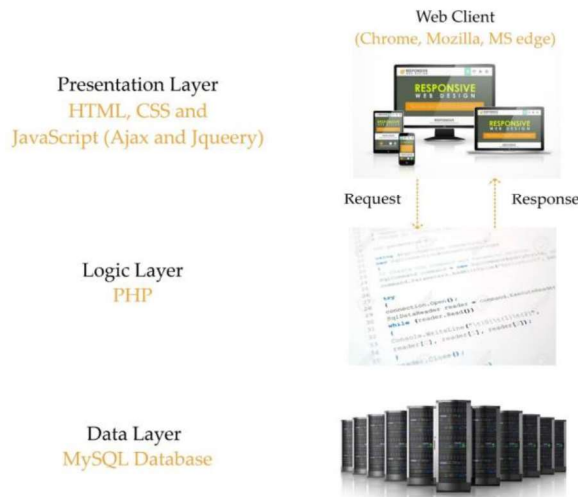


Figure 2: Web Architecture

3.5. Application Evolution Life-Cycle

This model of development will go through the following phases.

A. Requirement Phase

This consists of the Users' requirements and developmental needs; practical and Non-practical requirements are part of deliverables in this phase.

B. Analysis Phase

The RES System should give property details of properties for sale or rent with comparative data analytics of similar properties as well as afford users the ability to contact an agent or property owner, negotiate conditions, and examine contracts while handing Property owner/Agent the ability to view daily data reports as well compare dynamically with previous days or months.

i. Use case diagram

The landlord/agent and customer functionalities are represented by the use cases in Figure 3.

Landlords/Agents will be able to add or amend properties and property details in addition to logging in and registering. Tenants will be able to check property lists, payment options, and book appointments at the same time.

ii. Activity Diagram

Figure 4 shows the basic activities carried out in the system and the linkages among the processes.

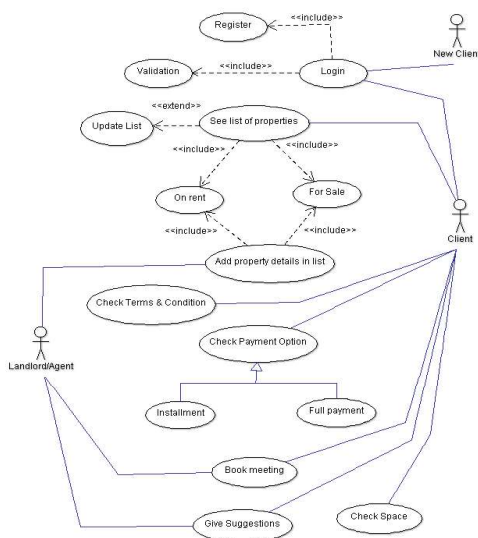


Figure 3: Use case diagram

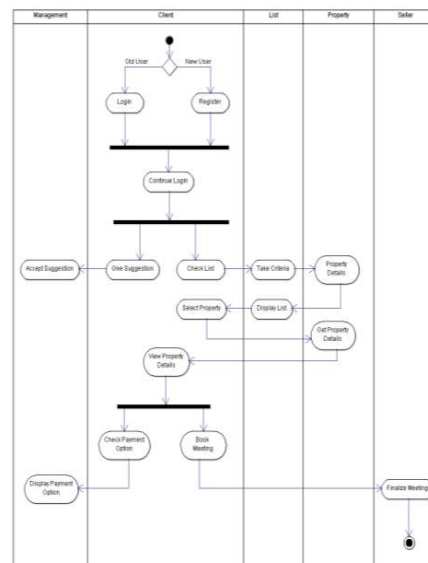


Figure 4: Activity diagram

C. Design phase

During the design phase, the rational model created during the analytical stage is utilized to produce a visible system representation. The physical model includes encapsulation of system logic, a logical view of the database that indicates connectivity, user experience design, report calculations and processing, and security object definition.

i. Class Diagram

Interfaces, methods, variables, and their relationships are all shown in a class diagram. The primary capabilities of the landlord/agent interface are described in Figure 5, which is a class diagram for the Online Real Estate Service System.

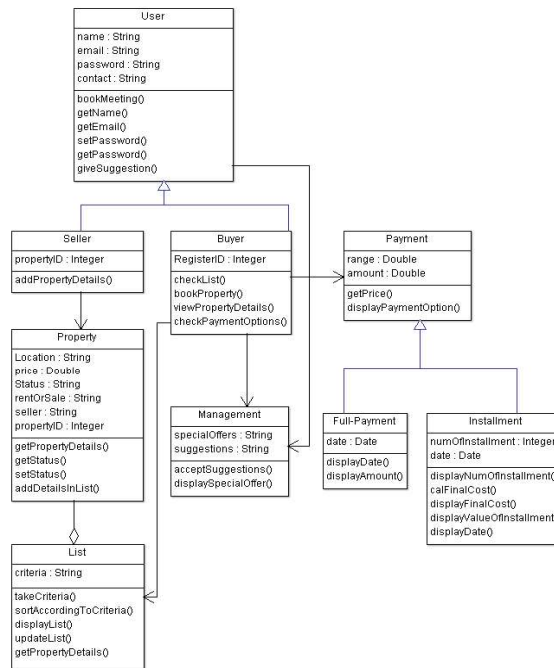


Figure 6: Class diagram

ii. Database Design

Figure 7 is the database design of the system with four table (Property, Seller/Agent, Client and Seller_client)

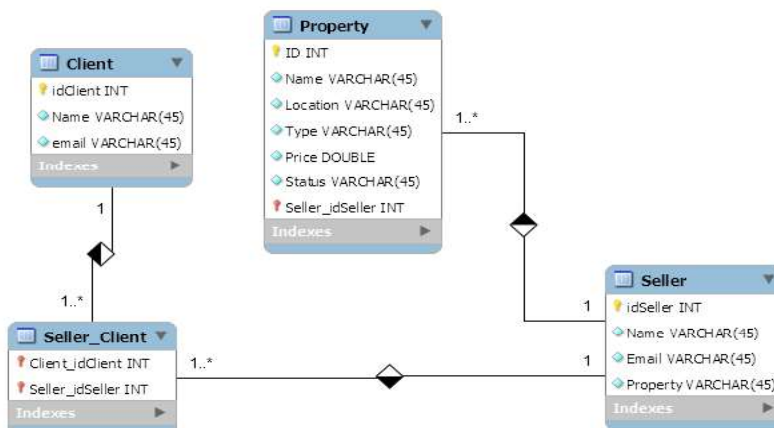


Figure 7: Database design

4. Result and discussion

This section deals with the implemented web-based real estate service application mentioned in previous chapters. The application was developed as both a mobile and web application with responsiveness a

primary component of the design to create an easy-to-use, real-time, adaptive management and service tool to enhance the quality of decision making, data management, and monitoring the continuous improvement of online services in real estate organizations.

The models for each web application domain were developed by considering the ease of use, no installation requirement, and accessibility from any device. This allows property agents, buyers, and owners to access and check property status and data generated, including visualizations. The landing page, illustrated in Figures 8a and 8b, is the first page users see when they log on to the website. It is designed with a log-in feature that helps the system separate an agent from a regular buyer or property owner; this aids data collection as activities are monitored to create key data insights for all parties. This homepage features a banner as a background and a search with two parameters (property type and location); figure 8a shows a search already conducted. The implemented clustering and regression learning algorithms help the system suggest property types for regular users looking to secure particular properties Using previous client demand data, such as search keywords and clicks. A further selection of any searched property displays the data surrounding that property with analytics that show

- (i) the number of occupants to the specific number of years,
- (ii) frequency of renovation against years, and
- (iii) the number and types of rooms with features.

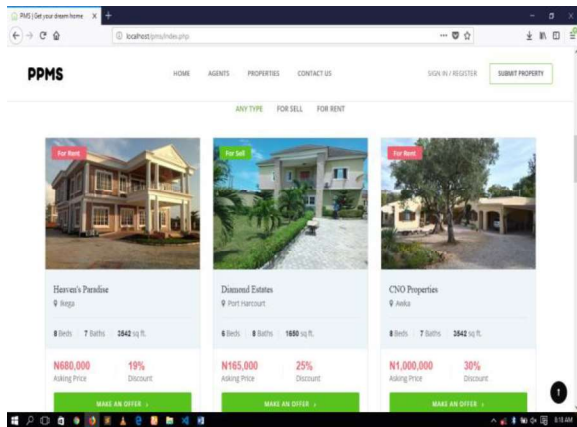


Figure 8a: Landing page with search result

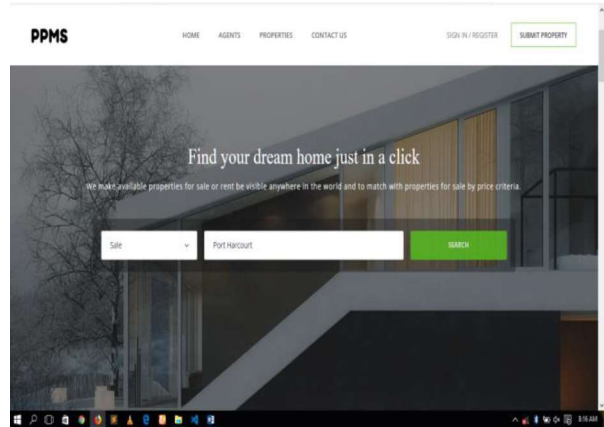


Figure 8b: Landing page

4.1. Agent page

The user interface of Agent's Page, as shown in Figure 9a, is data-driven. Its development enhances interactivity, with a face and location attached to each name. Upon log-in, a unique, easy-to-use dashboard for each agent enables the real-time input of data such as property upload and description, ticking out sold properties, listing achievements and challenges, and many more. This data collected improves the agent's profile and provides valuable insights into areas of interests, specialization, certifications, and critical domains of comparative advantage, thus helping buyers and owners make the best decisions in hiring or working with an agent. There is a list of top agents in different regions based on results in each agent's area of interest. Figure 9b further shows the agent's details, including properties sold, years of active experience, short bio, and clients feedback which the backend algorithm separates happy and unhappy clients. This number of happy clients is turned into valuable data to help buyers determine the choice of an agent. This system generates data based on houses sold, costs, and fluidity to determine individual agents' comparative advantage and experience in an area and their most frequent clientele. On the part of the buyers and page visitors, there is a search bar with two fields (Location and Agent Name). A user can easily search for an agent in a given location; there is also a chance for adding a few other specific criteria like property type.

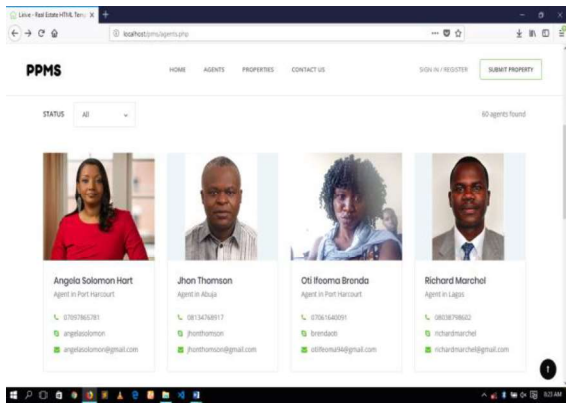


Figure 9a: Agent page

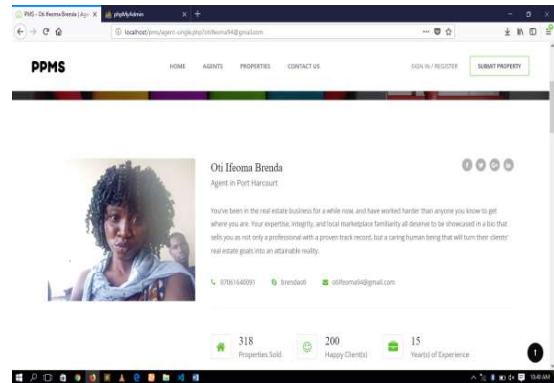


Figure 9b: Individual agent page with data details

4.2. Visualizations

Data visualization was implemented in various parts of the application and serves as a guide for decision-making. Figure 10a shows the price per square foot pitched against the total square foot area; this can be found with a click on any property of choice. An extensive form for various details is displayed during property upload for the agent to input a wide range of data about a particular property and its features. This analytics is generated from the data gained in uploading, during which elements like prices, area, and square feet are inputted. JavaScript python module embedded in the program generates these visualizations using the amount of data available on the property. Below is a sample of a comparative analysis of price per square foot against total square feet area and bathrooms in the building against count. Figure 10a compares the unit price per square foot with the square feet area of the building; this can help the buyer understand the price differences in properties even without seeing these properties physically or measuring with tape. It reduces the concern of property size to enhance property value in the view of the client while building a healthy comparison with other available properties on the platform. This insight is also similar to what can be generated from figure 10b and any other visualization choice on the application, thus improving decision making, enhancing property value, and building credibility.

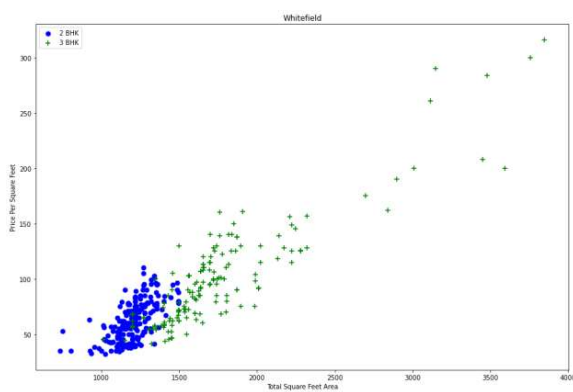


Figure 10a: Price per Sqft against Total Sqft area

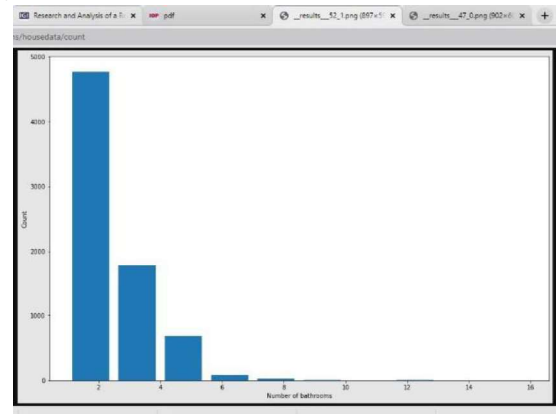


Figure 10b; Bathrooms in building against count

4.3. Contribution of Study

The study highlights the importance of a data-driven online web management system for real estate firms and agents as the volume of data grows globally, with several property firms already established online with little interest in data analytics around the property and interest of clients. Property Tech app solutions rose in the last decade with several options online depending on location and client needs; however, web applications have remained the top choice for realtors looking to build online in most countries. Real estate

firms in developing countries have extensively adopted this system as the digital age changes the world and its significance in service. However, the rise of data has left too many questions, with several solutions quickly rising using technology. The results of this study have contributed to solving one of such questions, which is

- A. how to make decisions on the property to buy,
- B. Choosing the right agent to work with based on needs
- C. How to bring the agents closer to the clients
- D. Understanding key property elements

Furthermore, it exposes the value derived from data mining and the active involvement of concepts like the Internet of things and ML algorithms in application development, advancing the course for datalogy and its implementation in emerging applications. It enhances conceptual understanding with visual representations that explain the property involved, the agent's track record, and trends around the industry.

4.4. Implications and Recommendation

The major finding of the research is that data analytics can be integrated into a real estate service system with easy methods that employ a focus on quality user experience, and visualizes data with understandable technical details while bridging the fractious relationship between the insights that can be generated from data, clients and the Realtors.

The other findings are inferences drawn from the review. This includes the notion that the growing complexity of real estate management and valuation practices and competition on an international scale demands the implementation of cutting-edge technological innovations. Also, previous implementations can be moved further to create open access applications within its environment, including agents, owners, and buyers, all having equal user interface privileges as determined by the admin. In the future, more innovations will be implemented around data and the web in all sectors, including the real estate industry, in furtherance of improving decision-making and client-agent relationships.

The main recommendation of the study is the establishment of a property databank for developing countries, with developed countries like the USA ranking high on the real estate transparency index with data accessibility as a significant factor for classification (JLL, 2018). Stakeholders in the real estate industry should drive this objective by encouraging the active integration of data analytics and visualization in real estate web and mobile application development. Furthermore, hands-on tools like schedule management, appointments, time calculator, and price monitoring can be added to enhance managerial decisions of agents and owners as the growth of data means more to handle for realtors. Additionally, the user experience of this application can be improved upon and new features added to extensively cover the details in property acquisition and management, including the documents of each selling or renting property as well as neighborhood needs, thereby upscaling the knowledge of clients and improving active decision making based on true choices of clients.

5. Conclusion

In this study, a model of a web-based approach with an analytic data feature for online Real Estate Management was proposed based on previous models and literature review to provide practice questions, domains, and results of assessment for RES. The model consists of four domains a User interface (front-end), Database (MySQL), back-end (PHP) as well a clustering algorithm with an analytics module. Our model, which was developed with an agile model, could identify subgroups and provide an insight into the multiple ideas that can accelerate Real estate online. The model provides comprehensive solutions based on local issues; the system feature can solve the problem and difficulties in acquiring an accommodation, minimizing the danger of being scammed and making it easier to acquire properties anywhere in the country with certain criteria and to easily contact verified agent based on individual needs of the client and

agents track record. More data introduced to the system will make it more efficient and credible based on the data learning features. The threshold of each level adapts based on data inputted in a dynamic cluster. The RES system of the online Real Estate industry in terms of the web application was developed considering the ease of use and ability to access from any device. This allows Real Estate companies to cover clients of all levels since the system is less sophisticated and easily understandable.

6. Funding

This research paper received no internal or external funding

ORCID

Wisdom Kelechi Obinna  <https://orcid.org/0000-0003-1940-8754>

Mfoniso James Udo  <https://orcid.org/0000-0001-8464-2876>

References

1. Ahmad, I. (2021). How Much Data is Generated Every Minute?. Social Media today. Retrieved from: <https://www.socialmediatoday.com/news/how-much-data-is-generated-infographic-1/525692>
2. Dahl, J., & Lingius Cerda, B. (2019). Assessing Performance Gains of a P2P System Based on User Acceptance: A Case Study on National Real-Estate Companies.
3. Foster, P., & Tom, F. (2013), Data Science, its relationship to Big-Data and Data-Driven Decision Making, *Mary Ann Liebert, Inc., Publishers*. 1(1), 2-5.
4. Fields, D. (2019). The Politics of Digital Transformations of Housing. *Planning Theory & Practice*, Taylor & Francis, 20(4), 578–582.
5. García-González, H., Fernández-Álvarez, D., Labra-Gayo, J. E., & Ordóñez de Pablos, P. (2019). Applying big data and stream processing to the real estate domain. *Behaviour & Information Technology*, 38(9), 950-958.
6. Gibson, V., & Orchard-Lisle, A. (1994). Strategic Real Estate Service. *Journal of Real Estate Service*. Vol. 12, No. 3. pp 9-14.
7. Mohammed, H. A., Zeebaree, S., Tiryaki, V. M., & Sadeeq, M. M. (2021). Web-Based Land Registration Management System: Iraq/Duhok Case Study. *Journal of Applied Science and Technology Trends*, 2(04), 113-119.
8. Mohammed, J. K., Bello, M. Z., Saidu, A. U., & Maikudi, M. (2019). A Model for Integrated Smart Real Estate Management. *Smart City Development Issues in Nigeria* (pp. 1–10). *Unilag Press*.
9. Mohammed, J. K., & Bello, M. Z. (2021) Potentials of ICT in real estate management and valuation practice. *Discovery*, 57(301), 63-73.
10. Onwuanyi, N. (2020). Review of the Property Data Challenge in Nigeria. *Journal of African Real Estate Research*, 5(2), pp.15-40.
11. Saull, A., Baum, A., & Braesemann, F. (2020). Can Digital Technologies Speed-up Real Estate Transactions? *Journal of Property Investment & Finance*.
12. Vuleta, B. (2021). How much data is created every day?[27 Staggering Stats]. Retrieved from: <https://www.seedscientific.com/how-much-data-is-created-every-day/#>
13. Wingerath, W., Gessert, F., Friedrich, S., & Ritter, N. (2016). Real-time stream processing for Big Data. *Information Technology*, 58(4), 186-194.
14. Winson-Geideman, K., & Krause, A. (2016, January). Transformations in real estate research: The big data revolution. In *Proceedings of the 22nd Annual Pacific-Rim Real Estate Society Conference, Queensland, Australia* (pp. 17-20).
15. Kopp, A., & Orlovskiy, D. (2022). Guidelines and a software tool for quality assessment of BPMN business process models. *Journal of Emerging Technologies*, 2(2), 55-65.