

DESIGN AND IMPLEMENTATION OF AN INTELLIGENT ESTATE VALUATION MODELLING SYSTEM FOR AUTOMATED PROPERTY ASSESSMENT

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Abstract: Traditional approaches to estate valuation rely heavily on the manual judgment of professional valuers applying the comparative, investment, residual, cost, and profits methods to sparse and often outdated transaction records. This dependence introduces subjectivity, slows turnaround time, and limits reproducibility, particularly in property markets where sales data is fragmented across registries, agencies, and informal records. An accurate, dependable, and efficient valuation system would result from a well-managed estate valuation model. It also aids in re-establishing property owners' privacy. The goal of this study, which focuses specifically on estate valuation in the context of a property and investment company, is to determine how different classes of properties are valued in order to create a computerized model that will solve the issues encountered throughout the valuation process. Additionally, it aims to reduce operational bottlenecks by providing computer-assisted alternatives to the establishment's manual property valuation process. In light of this, we made the decision to create an Estate Valuation Modeling System (EVMS), understanding that doing so would essentially solve a number of issues related to the establishment's current manual operating system. Java 8.0 was the programming language utilized to create this system. Results indicate that the model's estimates fell within an acceptable margin of the manually derived values for the majority of test properties, with a coefficient of dispersion within the range recommended by international mass appraisal standards.

Keywords: Design, Implementation, Estate, Automated, Valuation, Modelling, System, Property Appraisal

Introduction

Valuation and estate surveying have existed since the beginning of time. God created the first estate in the Garden of Eden, and Adam and Eve were given responsibility for it (KJV Jude 1:6). Therefore, the first estate surveyors and valuers in human history were Adam and Eve. However, the growing difficulty of record keeping, booking, accounting, and statistical data analysis resulted from the development of estate surveying and valuation as a separate and

acknowledged profession. Therefore, in order to overcome the difficulties presented by the current manual approach used in the esteem profession, we are concerned with creating a computerized system that will be utilized in the estate valuation practice. An item must be rare in relation to demand in order to have value. Put another way, the supply must be restricted in proportion to the demand (Adegoke, 2016). In the economic sense, an item has no value if there is an abundance of it and little to no demand for it. An increase in demand or a commensurate decrease in supply are necessary for an object's value to rise. Therefore, valuation is the art, science, and practice of figuring out the worth of every type of property and every stake in it. Estate development and management, as well as other land-related businesses.

According to Babawale & Omirin (2012), securing the best use of land and its related resources to satisfy social and economic demands is the goal of valuation. Assessing a building's structure, state, and services and offering maintenance, modification, and improvement recommendations. Determining the economic use of land resources through financial evaluation for the construction of industries is the process of valuation. Every estate firm searches for an efficient, accurate, and successful method of valuation. As difficulties get more complex due to rapid technology advancements, the growing state of data, record generation, and the implications of such are becoming more apparent. The process of valuing real estate is known as estate valuation. The market value of the property is typically sought after. Purchasing or renting (as an agent) real and personal property as well as the interest in it, and selling (whether through auction or another method).

In the process of valuing a property, the effects of sociological, economic, political, and physical factors are examined. One of the biggest issues facing the most of our estate valuation firms is having an efficient valuation calculation system, which the majority of the firms freely acknowledge they struggle with. The computational approach to estate valuation has received a lot of attention lately. These can be achieved by learning some specific abilities that anyone working in the estate management industry can acquire. Regardless of how complicated or straightforward the subject is in valuation, the answer necessitates the

interpretation in monetary terms of the impact of economic, sociological, physical, and governmental influences on the given item. An automated valuation technique crystallizes the scientific solution to valuation issues (Kontrimas & Verikas, 2011). Valuation is the art of estimating the value for a specific purpose of a particular interest in a property at a particular moment in time, taking into account all the features of the property and also taking into consideration all the underlying economic factors of the market, including the range of alternative investments. A change in these valuable tools will require a conscious departure from the traditional practice, especially the use of a computerized method in place of the manual method. It goes without saying that the valuation process should be examined on a regular basis. If expectations differ significantly from the prior projections, the valuation charges for the present and the future should be modified using the standard valuation values for the specified time. Investors and practitioners can obtain a better understanding and a specific purpose on which to base a more persuasive decision on investment action by researching and detailing the many methods that can be utilized for property valuation and examining the extent to which they are used in Nigeria. However, estate surveying and valuation firms will use the automated approach of estate valuation as a means of enhancing their contributions (Wyatt, 2007). Nonetheless, valuation ought to be viewed as a service provided by estate valuers known as stewards or agents who represent investors or owners. The sobriquet associated with the profession of estate valuation can be explained by the fact that the valuers should be men of honor who are trusted in various fiduciary relationships.

Aim and Objectives of the study

The aim of this study is to design and implement an intelligent estate valuation modelling system that automates property assessment and provides accurate, consistent, and efficient property valuation estimates using relevant property and market data. The specific objectives are to:

1. Create an intelligent computerized model that is capable of collecting, processing and analyzing relevant property attributes such as location, property type, size, age, condition and prevailing market factors to automate property assessment.

2. Develop an intelligent property valuation system that can produce reliable estimated property values while reducing the time, subjectivity and errors of the traditional manual valuation methods.
3. Test the system's performance and efficiency by contrasting the valuation results obtained with the system to those of traditional estate valuation methods and assess its accuracy, efficiency, usability, and reliability.

Literature Review

Nowadays real estate appraisers have been appraised real estate based on their intuition or experiences. Now that the concern with securitization of real estate is brought to attention, the technique of appraising the real estate more logically, quantitatively and accurately is required (Shibasaki, 2011). The pricing of real estate has been studied extensively since the early 1980s using a variety of methods (Tanaka, 2011). Since people being sedentary earth, economy, law and society is constantly on the agenda. Territory became subject of urban usage, will be installed within the boundaries of the zoning by function and this function by function in the real estate market gains value. There are many uses for that value (Nisanci, 2015).

Immovable property of the economy that are subject to lease, purchase, sale, barter, easement to be, at the land-kind and limited rights establishment, immovable partially or completely expropriation, nationalization, partnership capital in kind, such as almost all transactions with the real estate tax the income can be received real value of known depends. Objective of immovable property (objective), to determine the correct and safe way; immovable property owners, sellers, buyers as their interests, are also important in terms of social economy. Immovable property constitutes a large part of social wealth. Everyone wants to know the correct value of real estate owned (Aclar 2012).

Faison and associates (2013) added that “in Estate Management there is a liaison between the landlord and/ or the management firm operating on the landlord’s behalf and tenant”. The Estate manager’s duties include accepting rents, responding to and addressing maintenance issues, and providing a buffer for those landlords to desiring to distance themselves from

their tenant constituency, they should also manage the account and finances of the real estate properties, participate in or initiating litigations with tenants, contractors and insurance agencies and the Estate Management company should be a licensed real estate broker for security reasons amongst other things.

Categories of Estate

Chris Joseph (2008) in his book “fundamentals of property management” stated that there are four basic categories of Estate which are:

1. **Equitable Estates:** neither ownership nor possession e.g. Lien, easement.
2. **Statutory Estate:** They are the estates created by law e.g. Community property, homestead, tenancy by entirety etc.
3. **Leasehold Estates:** right of possession and use but not ownership. The lesser (owner/ landlord) gives this right to the lessee (tenant). These are also four categories of leasehold estates.
4. **Free-Hold Estate:** Here there are types of rights of ownership of the estate i.e.
 - a) *Life Estate:* Ownership for duration of someone's life.
 - b) *Fee simple:* Absolute ownership of real property but it is limited by the four basic government powers of taxation, eminent domain, police power and escheat and could also be limited by certain encumbrances or a condition in the deed.
 - c) *Fee tail:* inalienable rights of inheritance.
 - d) *Defensible or determinable fee:* Void able ownership.

Estate Valuation

This is a combination of two words – “Estate” and “Valuation”. Estate means an interest in landed property; an estate denotes the character and quality of rights of ownership. In other words, an Estate is a legal concept, whereas valuation means the act of estimating value at a particular date. So when we talk of Estate valuation, we are thinking of the value of an

interest, such value is normally expressed in monetary terms. Estate values changes with time and as such one must never forget to indicate the date of valuation in any Estate Valuation assignment carried out (Nwajikwa and Chigbo, 2025)

Importance of Estate Valuation

Valuation is important because so many people require valuation, individual as well as corporations requires valuation for various purposes. An insurance company, for example needs to know a replacement cost of a building in order to determine the premium which a policy holder will pay (Nwajikwa and Chigbo, 2025). A lending bank may require a mortgage valuation in order to ascertain the amount of loan to advance to a borrower for a property deposited as collateral. An individual may need to know the value of his property for the purpose of sale. Government may want to know how much compensation to pay to individuals whose properties are affected by a road widening scheme or an oil pipe line.

Various Purposes of Estate Valuation

According to Nwajikwa and Chigbo, (2025), there are various purposes of estate valuation namely:

- a. **Mortgage:** a mortgage valuation is required for those who want to borrow from any financial institution such as an insurance company. Mortgage finance is a debt finance. A mortgage is created when there is a dead of mortgage, in this case, could be a chattel (movable) or immovable like property. The object of the loan may be to engage in building project or for the borrower to import some goods with the loan.
- b. **Insurance:** An insurance valuation is required when we want to insure a chattel or property against fire or other losses. In such a case, a value concept sort is one of replacement cost value concept from which the premium is determined.
- c. **Probate:** valuation for probate is carried out when an individual dies. The object of the exercise is to determine the amount to be paid to the government by those inheriting the deceased property. In such cases, the will of the deceased is scrutinized.
- d. **Going Concern:** going concern valuation is required to appraise a business enterprise current position with emphasis on its ability to generate profit. Going concern

valuation is required when firms, e.g PZ, UAC, GUINNESS NIG, PLC wants to merge or for takeover, that is in the case of liquidation.

- e. **Rating and Taxation:** Government usually undertakes the levying of taxes and rates on both chattels and property. Its objective may be for revenue generation, the relief of the poor.
- f. **Compensation:** Valuation for this purpose is normally required by the government when there is an injurious affection caused by the act of government. It may be that in trying to lay an oil pipeline from Port Harcourt to Kaduna, some buildings and crops were destroyed; government calls valuers to assess compensation payable to such owners.
- g. **Capital Gains and Capital Transfer Taxes:** Valuation for capital gains is required when an individual and group of individuals buy a property at a lower rate and sell it at a higher rate in future; the excess revenue generated is valued and taxed. In capital transfer, a property owned by a dead person and inherited by his child.
- h. **Feasibility Study:** most people who want to engage in investment projects usually require a feasibility report in the project. This will give the investor a clear cost, the payback period of the investment, and the tax structure in the investment.
- i. **Balance Sheet:** Plants, machinery and buildings owned by a firm is usually valued for purpose of use in the balance sheet of revenue account at the end of each financial year. Valuation for balance sheet is a going concern valuation.
- j. **Sale:** Valuation can be required when an investor wants to sell his property or the owner of a work of art wants to sell his art work. In this case, the value concept cost is one of present value.

Methodology

A methodology for project is a combination of step by step methods and techniques for successful planning and delivery of project. The following are concepts of methodology.

Structured System Analysis and Design Methodology (SSADM)

This is a set of standard for system analysis and application design. It was a formal methodical approach to the analysis and design of information system software. The SSADM

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is an open methodology based on the water fall model, can be thought to represent a pinnacle of the rigorous documented approach to the design. Stages of SSADM are Determining feasibility, Investigating the current environment, Determining business system options, Defining requirement, Determining technical system options, Creating the logical design and Creating the physical design. The three most important techniques that are used in SSADM are as follows:

1. *Logical Data Modeling*: The process of identifying modeling and documenting the data requirement of the system being designed. The result is a data model containing entities (thing about which a school need to record information of a student) Attributes (facts about the entities and relationships) association between the entities.
2. *Data Flow Modeling*: This involves tracking the data flow in an information system. It clearly analyzes the process, data stores, data movement and external entities.
3. *Entity Behaviour Modeling*: This involve identifying and documenting the events in fluency each entities and the sequence in which these event happen.

Object Oriented Analysis and Design Methodology (OOADM)

This is a popular technical approach to analysis, designing of an application, system or business by applying the object oriented paradigm and usual modeling throughout the development life cycle to foster better stake holder communication and product quality. According to the popular guide unified process, OOAD in modern software engineering is best conducted in a literature and incremented way iteration by iteration, the output of OOAD activities design model for OOD/object oriented design and Analysis model for OOA (object oriented Analysis, respectively, we'll be refund and evolve continuously driven by key factor like risk and business value:

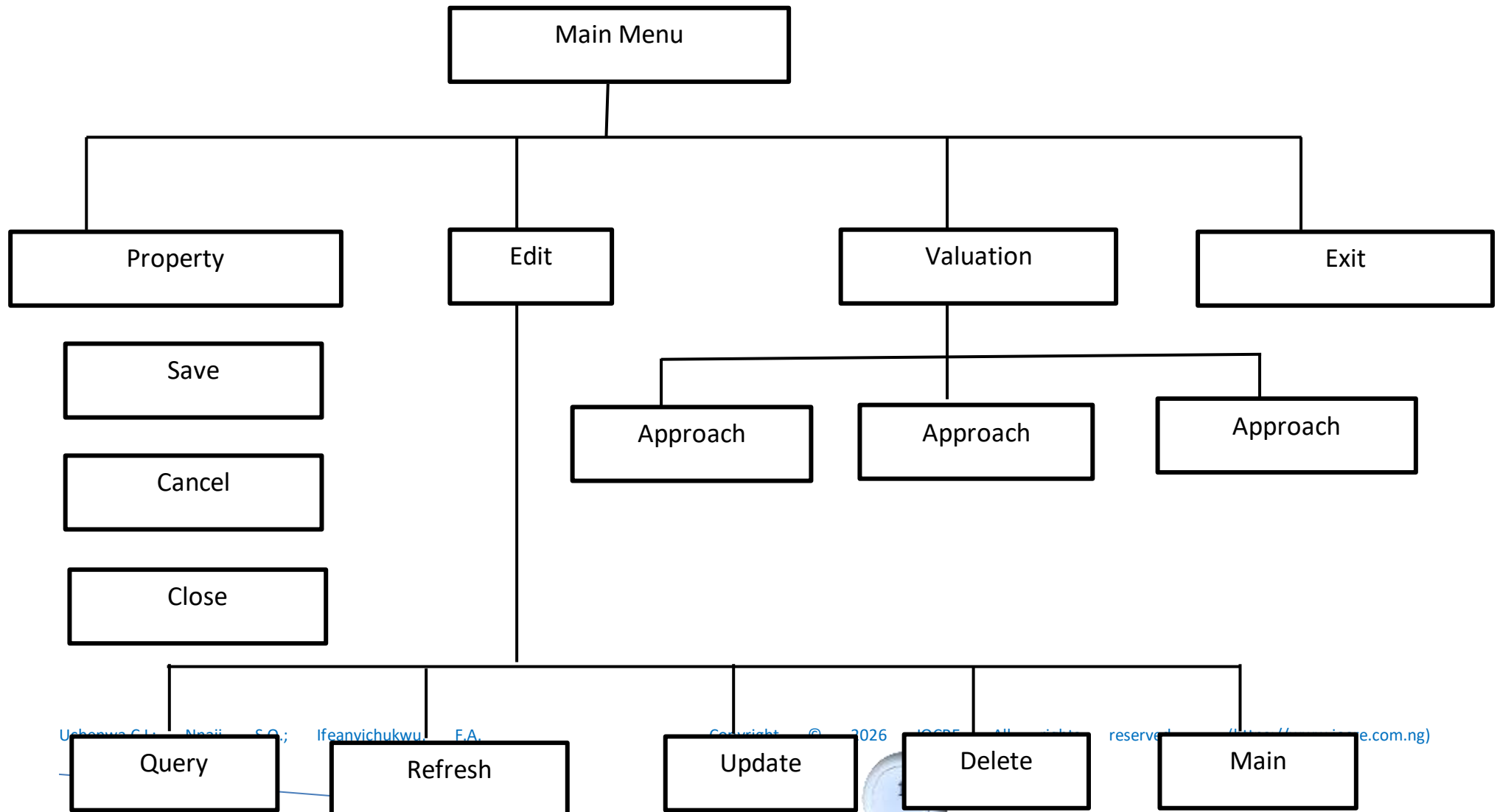
1. *Object – Oriented Analysis (OOA)*: It deals with the design requirement and overall architecture of a system and is focused on describing what the system should do in terms of key object in the problem domain. The primary task in objects – oriented analysis (OOA):
 - a. Find the object
 - b. Organize the object

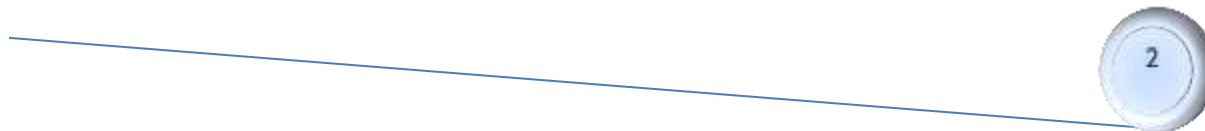
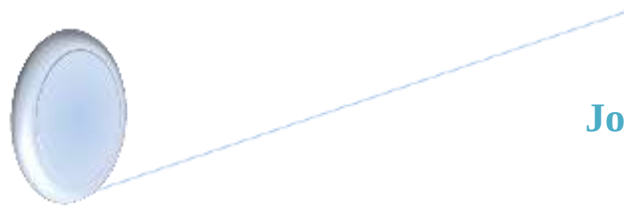
- c. Describe how the objects interact
 - d. Define the behaviour of the objects
 - e. Define the internal of the objects.
2. *Object Oriented Design (OOD)*: This translates system architecture into programming constructs, such as interface classes and method descriptions.
3. *Object Oriented Programming (OOP)*: These implements the programming constructs. The software life cycles typically divided up into stage going from abstract descriptions of the problem to design then to code and testing and finally to deployment. The earliest stages of this process are analysis and design. The analysis phase is also often call requirements.

System Design

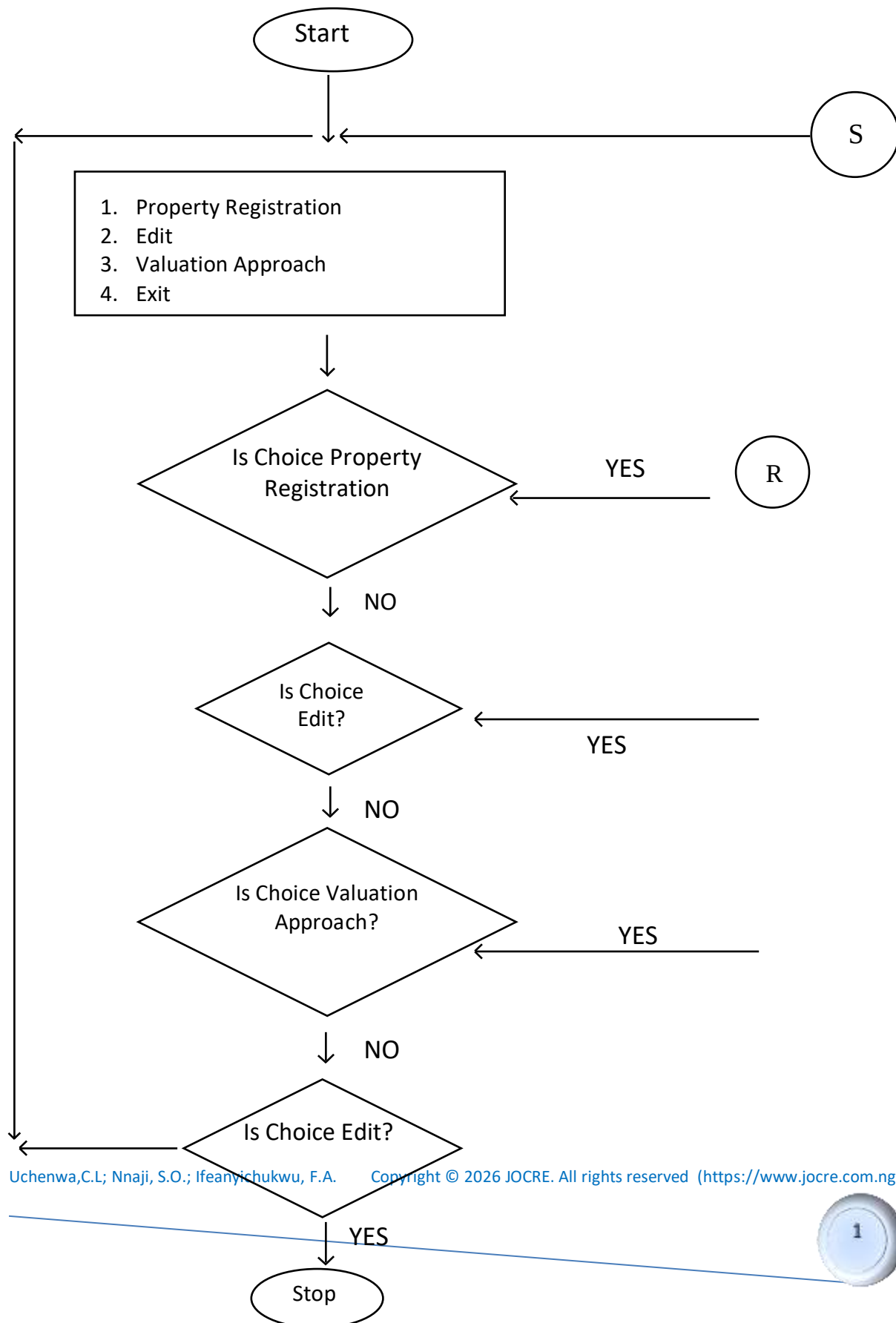
The fundamental process of organizing the new system's logical processes is called system design. It entails the following procedures:

- a. Input design
- b. Output design
- c. Program flowchart.





PROGRAM FLOWCHART



System Analysis

System Analysis is the process of collecting analyzing facts in respect to the existing operations, procedures and system in order to obtain a full picture of the situation system in order to obtain a full picture of the situation prevailing so that an efficient computerized system may be designed and implemented if proved feasible. It can also be defined as the critical examination of an activity, procedure, method or technique to determine its purpose and how the necessary operations can best be achieved. A system is a collection of mechanisms that together to achieve a purpose(s). A research methodology is defined as a series of well-defined sequence or steps that should be followed in carrying out a research analysis Tom (2001).

The analysis of the present system in this chapter is with the aim of identifying and correcting the weaknesses and shortcomings within the existing system. The analysis of the present system in this chapter is with the aim of identifying and correcting the weaknesses and shortcomings within the existing system.

Data Collection

During the research work, data needed for the project was gathered from various sources. In gathering and collecting necessary data and information needed for system analysis, two major fact-finding techniques were used in this work and they are:

- a. *Primary Source*: This refers to the sources of collecting original data in which the researcher made use of empirical approach such as personal interview and questionnaires.
- b. *Secondary Source*: The secondary data were obtained by the researcher from magazines, Journal, Newspapers, Library source and Internet downloads. The data collected from this means have been covered in literature review in the chapter two of the project.

The researcher also was able to accomplish these tasks by applying interview method and evaluation of forms etc.

- i. *Review of Information Available:* The researcher upon an evaluation of some official forms used in the processing of Estate Management transaction was able to retrieve a lot of useful information, e.g. each occupant has an ID number, Name, Block number, signature etc.
- ii. *Interview:* The researcher found it necessary to get authentic and reliable information pertaining to the procedure to the procedures the estate management companies' use, by embarking on a face to face conversation with high-designated personnel in the company. This method assisted the researcher in understanding their procedures.
- iii. Surfing and downloading of information and materials from the internet.
- iv. Review of related material, journals, articles and magazines

Discussion

Java is the programming language that was utilized for this study. It is appropriate since it offers a robust library of language diagnostics that informs a programmer of any errors that may have occurred during the writing of the program. Additionally, it features a library of common mathematical functions that can be utilized in tabulation, as well as an editing capability. People from a variety of backgrounds, including engineers, accountants, students, and others, can utilize this language. Secondly, the algorithm design used demonstrate super accuracy and efficiency over manual or traditional designs. It has a predicted monetary value, confidence/accuracy as well as comparable market data. Areas for further research will be the automation and inclusion of Artificial intelligence and Machine learning.

Programming Environment: This program operates in the programming environment. The Windows environment is used by the Java programming language.

System Implementation: A number of tasks must be completed in order to implement the suggested system. The detailed design step is followed by the implementation. This entails coordinating the information and technology department's and the user's department's efforts

to implement the new system. The managers of the relevant departments and a representative from the computer department must form a coordinating department for this purpose.

Task **in** **System**

Implementation The following areas are covered by the tasks to be completed:

- a. **Staff Training:** A system analyst would need to make sure that everyone working on the new system is capable of making it an operational success using the following resources —handbooks, seminars, and courses.
- b. **Programming** The programmer's job is to make it possible for him to create programs that meet the requirements outlined in the system specification.
- c. **System Testing:** This is to guarantee that the system will operate properly overall and that each program has been developed correctly. There are two stages to this.
- d. Program testing is necessary to make sure that the programmer has accounted for all potential outcomes and that the tests anticipated outcome has been determined in advance.
- e. **Procedure Testing:** this is done to make sure the system functions as intended.

System Installation and Testing: This is the process of actually assembling the computer's physical components, putting up the equipment for the computer system on the site, and turning it on. As a result, it is necessary to make sure that the existing system's individual programs have been developed appropriately and that the system as a whole—that is, the connections between the programs in the suite—will function. Coordination with the relevant clerical procedure is also necessary.

Procedure for installation: The seamless integration of the entire system will be guaranteed. This would include the actual machine operation, the output process that follows, and the clerical procedure that comes before the inputs. To start the installation, insert the installation disk into the CD drive, click Start, choose Run, hit Enter on the keyboard, and wait for the installation to finish.

Figure 4.1: Shows the Home Page (Welcome Screen) of an Estate Evaluation Modelling System.

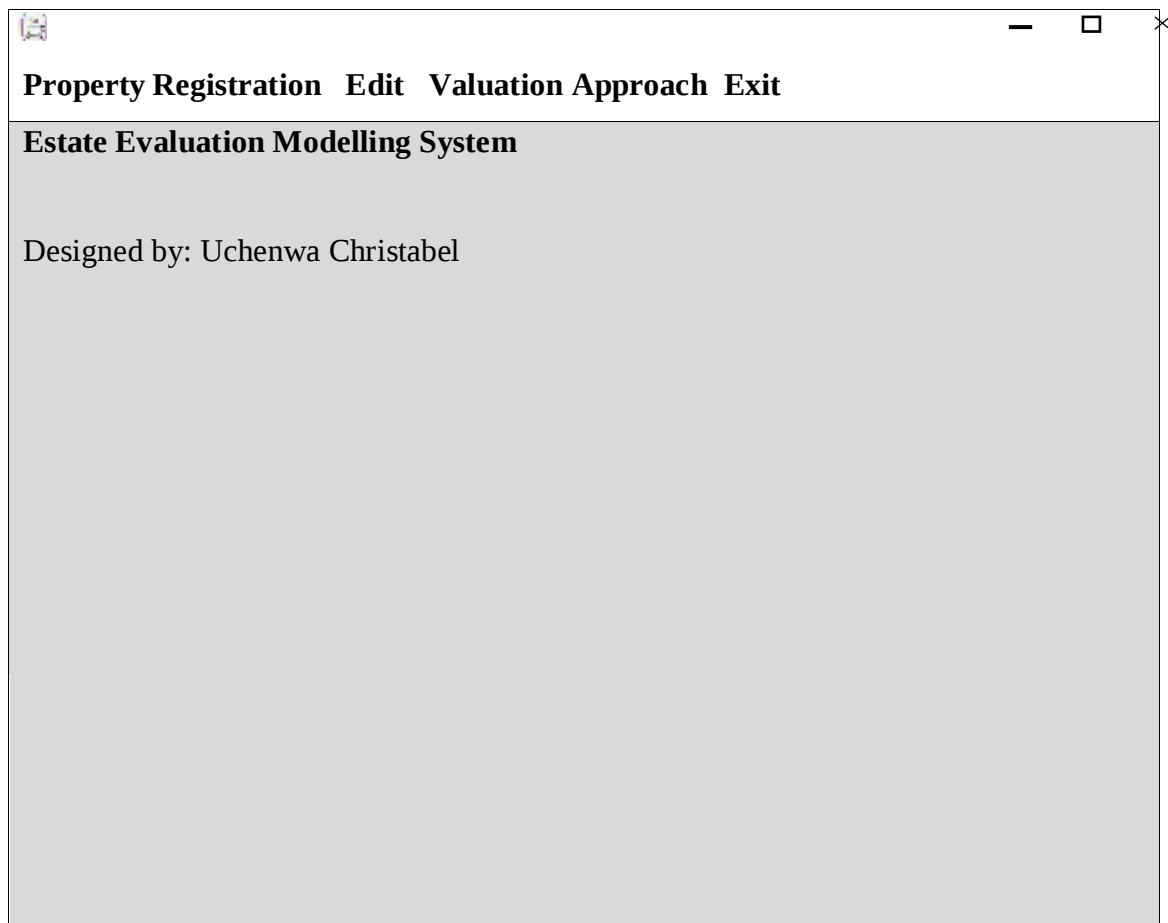


Figure 4.1: Home Page (Welcome Screen)

Figure 4.2: Shows a Property Registration Form (or a simple property record entry form) used to capture information about a property owner and their property details

A screenshot of a software application window displaying a property registration form. The window has a title bar with a minimize button, a maximize button, and a close button. The form contains three input fields: 'Owners Name', 'Phone number:', and 'Location:'. The 'Owners Name' field is filled with a white box. The 'Phone number:' field is also filled with a white box. The 'Location:' field is empty. Below the form, there is a footer containing the text 'Udochukwu, S.O.; Ifeanyichukwu, F.A. Copyright © 2026 JOCRE. All rights reserved (https://www.jocre.com.ng)'. The text 'Description' is also visible on the left side of the footer.

Date

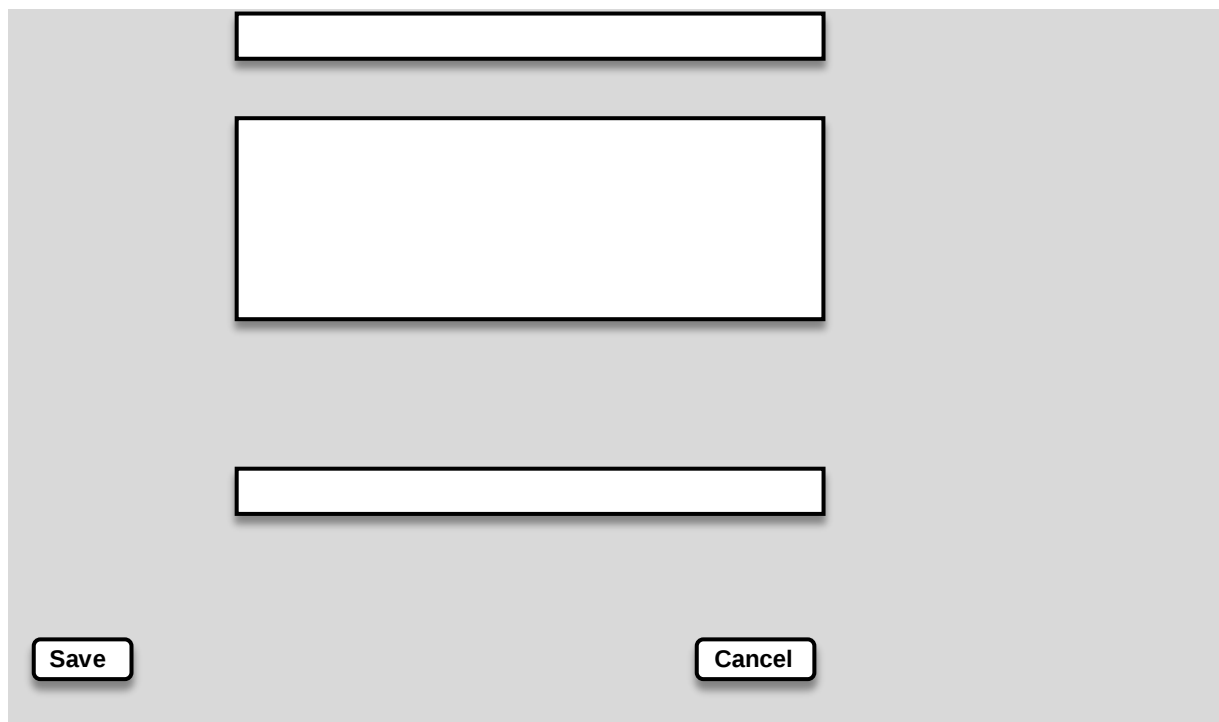
A screenshot of a web-based property registration form. The form is set against a light gray background. It features three white rectangular input fields with black borders, arranged vertically. The top field is the shortest, the middle field is the tallest, and the bottom field is of medium height. At the bottom left of the form is a 'Save' button, and at the bottom right is a 'Cancel' button. Both buttons are white with black text and rounded corners.

Figure 4.2: Property Registration Form

Figure 4.3 shows the Property Records Management Page of the Estate Evaluation Modelling System. It is used to view, search, update, and manage registered property records stored in the database.

Reg ID	Owner's name	Phone number	Property Location	Description	Date registered	Valuation month	Valuation month	Last modified
4000	James		Uyo	Welcome				
00	Okon A..	08087074329		Okon	31/23/2017			
6000	Miriam			You are				
00	Bassey.	08125189260	miriam@ya ho...	welco...	31/24/2017			

Search

Figure 4.3: Property Records Management Page

Figure 4.4: Shows the Cost Approach Valuation Module of the Estate Evaluation Modelling System. Unlike the Income Approach, this method estimates property value based on the cost of acquiring land and constructing the property, adjusted for depreciation.


— □ ×

Valuation with Cost Approach

Search

Owners Name:

Phone numbers:

Location:

Description:

Date:

Welcome Okon

11/23/2025

Land acquisition cost

Building Cost

Labour allowance

Site improvement cost

Depreciation rate (%)

72.0

Let Land acquisition cost = L

Let Building Cost = B

Let Labour Allowance = A

Let Site Improvement = S

Let Depreciation Rate = D

Using R to represent Deducted depreciated Rate from estimated Construction Cost.

$$R = (B + A) - ((D/100) * (B+A))$$

Therefore the Total Property Value (V) = R + L + S

Figure 4.4: Valuation with Cost Approach Module

Figure 4.5: Shows the Income Approach Valuation Module of the Estate Evaluation Modelling System. The purpose of this screen is to estimate the value of a property based on the income it generates.


— □ ×

Valuation with Income Approach

Search

Owners Name:

Phone numbers:

Location:

Description:

Date:

Welcome Okon

Gross Income	30000
Estimated Vacancy	
Expenses	2000
Property Cost	1000
	500

Let Gross Income = L

Let Estimated Vacancy = B

Let Expenses = A

Let Property Cost = S

Using R to represent the total cost

$$R = B + A + S$$

Therefore, the Total Property Value (V) = L – R

Figure 4.5: Valuation with Income Approach Module

Figure 4.6: Shows the Discounted Cash Flow (DCF) Valuation Module of the Estate Evaluation Modelling System. The DCF method is a financial valuation technique that estimates a property's value based on the future income it is expected to generate.

Valuation with Discount Cash Flow

Search

Owners Name:

Phone numbers:

Location:

Description:

Date:

Welcome Okon

Investment

Estimated Income (%)

No. of Years

Let Investment = I

Let Estimated Income = Ei

Let No. of Years = Y

Let Annual Profit = Ap

Annual Profit (AP) = $(Ei/100) * I$

Total Property Value (V) will now be the annual profit multiply by the number of years.

Therefore the Total Property Value (V) = $Ap * Y$

Figure 4.6: Discounted Cash Flow (DCF) Valuation Module

Post System Implementation

- a. **System Evaluation:** This development's primary goal is to collaborate with users to improve the original system from the first described specification. Here, the user-proposed requirements for the new system will be taken into account. At this stage, the software prototype could be created.

b. **System Maintenance:** After the system is implemented, this is a continuous procedure to make sure it is delivering the needed services. Because there is typically room to make adjustments anytime a system fault occurs, the significance of system maintenance cannot be overstated. The following are the requirements for system maintenance:

- i. Programs may need to be modified to handle unanticipated events that arise during operations.
- ii. To verify that the intended goals are being achieved and, if not, to take appropriate action.
- iii. To guarantee that the system can adapt to the organization's evolving needs.

Adjustments are required when the systems fail to meet expectations, which may be the result of user error or ignorance. Therefore, maintenance guarantees that the design and operational control achieve the user's ultimate goals. The outcome of the system review will be utilized in subsequent system analysis because of these factors.

Data Security

Controlling data to avoid loss, misuse, or disclosure is a crucial component of control. Preventing data loss, misuse, or unauthorized changes is the focus of data security. The following criteria must be applied to guarantee data security:

- i. Make backup copies.
- ii. Physical prevention, such as writing permits and limiting staff access.
- iii. Keep data secure.
- iv. Using a password to stop illegal users from accessing online files or using computer terminals.

Objectives:

1. **Accurate and Dependable Database:** The system includes a robust Property Registration Form (Fig. 4.2) and Property Records Management Page (Fig. 4.3) with fields for Reg ID, Owner's name, Phone, Location, Description, Dates, and Valuation methods. This centralizes data, enables search/update/delete, and supports querying for reliable valuation records, addressing manual record-keeping issues.

2. **Sustainable IT System for Records:** Implemented in Java on Windows with database integration (implied via forms and management interface). Features like backups, password protection, and maintenance procedures (Section 4.5) ensure sustainability, currency, and security of valued property records.
3. **Reduce Calculation Stress:** Dedicated modules for valuation approaches (Figs. 4.4–4.6) automate calculations:
 - a. **Cost Approach:** $V = R + L + S$ where $R = (B + A) - ((D/100) * (B + A))$.
 - b. **Income Approach:** $V = L - R$ ($R = B + A + S$).
 - c. **DCF:** $AP = (E_i/100) * I$; $V = AP * Y$.

These provide instant, parameter-driven results, minimizing manual errors and effort. Post-implementation evaluation and maintenance ensure ongoing alignment with user needs.

Conclusion

This study's primary goal was to create an automated model for valuation procedures. There isn't a thorough study outlining the numerous valuation methods used in the real estate sector and how they might be applied in various economic contexts. Every valuation method has distinct advantages and disadvantages depending on the state of the economy. Nonetheless, there is a more effective method for achieving accuracy in the organization's offerings. Because it is dependable and ensures that properties are valued correctly and accurately, estate valuation modeling is the key to the future and a preferred instrument for record keeping and processing. Therefore, the organization's management views computerizing its operations as a tool that will improve growth, speed, accuracy, and efficiency in their services rather than as a way to disrupt their business.

Recommendations

In light of the constraints experienced during the implementation and completion of the research work, the scope of study was limited to the management of housing estate with only tenants, landlords and Estate Managers. According to the researcher, enough time should be given, constant power supply should be provided for researchers, adequate finance and

logistics should be provided, provision of covering letters from the school to related firms of research topic for proper collaboration.

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