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The Potential of a Blockchain-Driven Fractional Ownership System in Addressing the Housing Financing needs of Nigeria

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Abstract

The staggering amount of housing deficit in Nigeria is a well-known issue to stakeholders in the country's building industry. For more than five decades after independence, the Nigerian government, corporate real estate practitioners and individuals have grappled with the task of addressing this issue but have met various challenges. A paucity of funding realized through the traditional property financing methods has been identified as a major reason why this issue persists. Fractional property ownership - a real estate crowdfunding financing model– that raises funds through the syndicated investments of several investors, who agree to share both the costs and benefits of a property, is an emerging trend and financing option in the Nigerian real estate sector. Though this method has shown a great promise in tackling the housing financing challenge and in bridging the housing gap, the heavy reliance on intermediaries, high transaction cost, time-consuming processes, and the lack of transparency in the transaction process are major setbacks of the model. This research introduces blockchain as a novel approach, to property fractionalization and syndicated real estate financing in Nigeria. Blockchain is an immutable public repository or database that stores records through peer-to-peer transactions without the need for intermediation (H L, Gururaj, 2020). The technology can fragment assets and represent them with digital tokens. These "tokens" represent an underlying property with all its rights and obligations.

The purpose of the thesis is to investigate the possibility of making the fractional property process more efficient and transparent by incorporating blockchain technology. The paper includes the exploration of issues surrounding traditional fractional funding and a discussion of the capabilities of the new blockchain technology to address these issues. Using multi-party interviews, the main pain points of the current process are identified, analyzed, and ranked statistically using the Kruskal-Wallis to develop a conceptual model which will provide the framework for an acceptable blockchain-driven fractional property ownership process. It is hoped that the proposed model will improve current fractional property financing transaction processes, drive adoption of the system and remedy the Nigerian housing crisis.

Keywords: Fractional Property Ownership, House ownership, Real estate, Blockchain technology, Transaction process, Housing Deficit, Tokenization, Crowdfunding.

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List of Abbreviations

Fig.	Figure
NBS	Nigerian Bureau of Statistic
NFT	Non Fungible Tokens
Tab.	Table
UN	United Nations
HDPP	Housing Deficit Per Person
SEC	Securities and Exchange Commission of Nigeria
PPP	Public Private Partnership
FESTAC	Festival for Arts and Culture

1. Introduction

Adequate and affordable housing has been referred to as a ‘minimum irreducible of all human wants’ (Ifesanya, Kunle 2012, P.S. Ogedengbe, 2003). It is so basic and important to humanity that it is usually a focus of the world’s governments in their infrastructural development agendas and to the United Nations in the formulation of its periodic development goals. In many developed countries, a large share of residential properties is owned and maintained by the government through its social or low-cost housing schemes, otherwise known as public housing. For instance, there was less than 45% of owner-occupied housing in Germany in the year 2020, and both Austria and Switzerland had more than 44.8% and 58.4% of public housing respectively in the same year (Leo Kaas et al, 2020; Statista, 2020). The same cannot be said of property ownership in developing countries like Nigeria where private property ownership far exceeds public property ownership. The primary cause of the problem is that, despite several housing construction plans, governments in emerging nations are unable to successfully meet their citizens' housing needs. In Nigeria, for instance, none of the several housing development plans, policies, and programs implemented since independence in 1960, have been able to sufficiently supply enough housing to meet the national demand or to perform above 25% of expectation. The Nigerian Housing Policy (NHP) of 1990 identified a paucity of funding as the most critical factor responsible for non-attainment of the goals of previous public housing efforts (Ocholi Samuel et al., 2015). Indeed, the unsatisfactory performance of government budgetary allocations for housing is also directly linked to the mediocre performance of subsequent housing plans. The result? An alarming and increasing national housing deficit have existed in Nigeria for the past five decades! In 2018 for instance, this housing deficit was estimated to be between 19- 21 million units, with a minimum of about 900,000 apartments required to be constructed annually in the next three decades to correct this shortage (Emmanuel Moore, 2019).

The failure of the Nigerian government to adequately address the national housing crisis has led to the concentration of homeownership in the hands of individuals and real estate companies. Upon the realization that government is unreliable in their ability to meet up the national housing demands, Nigerians, since the mid-1970s, have begun to look inwards and seek alternatives to their housing needs. More than 70%-96% of

new homes in Nigeria are owned by either individuals or private real estate firms (Dimuna. 2016; Ogu, 1996), and funding for these buildings is often provided from personal savings, loans from cooperative societies or other informal financing houses, and in few cases structured mortgage loans. Although this pattern of homeownership has proven to be relatively more effective than public homeownership, and most of the commercial and residential real estate in Nigeria have private ownership; the method has unfortunately not been able to largely impart the housing shortage challenge in the country. This is because, many of the financing issues private investors in the Nigerian real estate must surmount, during housing development projects are no different from those that hindered the efforts of government over the decades.

1.1 Research Motivation

Construction of private property in Nigeria was initially financed by individual savings. (Ogedengbe and Adesopo, 2003). Landowners, painstakingly, save monies from their monthly incomes over several years, and at often extremely low interest rates, to raise the funds required to develop their lands. Very often building projects were executed simultaneously with periodic tranches of savings to check the negative effect of inflation and foreign exchange devaluation that normally happen when savings are kept for too long. Painfully, the low national minimum wages, low per capita income, and inequity in wealth distribution in the country create a comparatively low amount of disposable income, which makes this method of financing real estate highly ineffective. The long time required for building such savings makes investors subject to undesirable macro-economic factors like double-digit inflation and local currency devaluation which further compound the issues of relying on personal savings for property financing. To speed up construction schedules, many Nigerians now consider the combination of equity capital and debt capital as a better way of property financing (Ogendengbe et al, 2003). The success of a private property development project in the country is therefore a factor of how much access a landowner has to the debt financing he requires to add up to his equity contribution.

The common methods of debt financing in Nigeria can be broadly classified, according to the loan term or tenure, into short-term loans, medium-term loans and long-term loans (Atterberry W, 1980). The main differences between the three methods lie not only in the length of time required to pay back the loan but also, the documentation

required, interest rates, the type of creditor, the amount of security demanded by the creditor and the available amount of capital loaned out in each of the variants. Short-term loans dominate the property debt financing arena in Nigeria because of the ease of processing such loans. These loans are often issued by commercial and merchant banks for two to three years and at rates of 2% to 6 % above basic interest rates (Atterberry W, 1980). Many Nigerians find it difficult to access this form of capital because of the very stringent terms upon which they are provided, and the collateral often required to secure them. In addition, many low-income earners in Nigeria earn their living in the informal economy and have neither the means nor the requirements to obtain bank loans. A special type of short-term loan with a very informal source, low interest rate, no collateral security and very friendly repayment terms are short-term loans issued by building and general-purpose cooperative societies (Nubi, 2000, Olukayode et al, 2017). Due to the specific characteristics mentioned above, these loans have grown to be the most common way to finance real estate in Nigeria. Cooperative loans, however, have certain rules and controls by which they regulate compliance and avoid defaults. These rules have made this financing option difficult to access for some low-income earners. For instance, most societies require members to fulfil a prequalification requirement of six months to one-year of uninterrupted thrift savings and an equity of up to one-third of the total project cost (Olukayode et al, 2017). Although a combination of funding from personal savings and loans from cooperative societies remain the most popular method of financing private real estate in Nigeria, and accounts for more than one-third of property financing in the country, the increasing checks and control measures instituted by the societies to improve loan performance is gradually making the system too restrictive for many Nigerians, and the expected impact the financing method should have on housing supply is steadily declining (Oluyombo, 2010). Other sources of property financing available to Nigerians such as medium-term loans of up to ten years, issued by commercial banks or long-term loans of 20 to 30 years issued by mortgage institutions have been known to have a plethora of problems like high interest rates, excessive bureaucracy and protocol in the application process, high loan ceiling, the undercapitalization of Nigerian mortgage banks, high equity contribution and very often the non-allocation of funds for this purpose by the banks because they consider the sector unattractive (Lucy Ogbenjuwa et al, 2021).

The concept of fractional ownership or crowdfunding in real estate was introduced in Nigeria in the last decade (Aladejebi O, 2020). The term fractional ownership refers to a form of property ownership where the costs and profits of owning a building are shared among a group of individuals who are organized exactly for that purpose (Lowies et al, 2018). Like most sharing economies, mediation is usually provided by an intermediary who manages a digital platform upon which the organization takes place and where potential participants are matched according to pre-established guidelines. This system of property ownership grew rapidly in Nigeria in a few years and noticeably displayed the potential to massively disrupt real estate financing in the housing industry. Indeed, in the early days, fractional property ownership showed a tendency to correct the Nigerian housing shortage. Certain drawbacks of the transaction process of fractional property financing, however, limited its potential and led to a decline in its patronage in a short time. Firstly, the system relies heavily on the trust economy. The investor owners were often at the mercy of the "sponsors" or intermediaries in charge of holding and disbursing aggregated funds to trade real estate developers and providing mediation among the parties. Some dubious sponsors took advantage of the weak regulatory systems and began promising higher than normal returns on investment to lure unsuspecting investors, with the intention to defraud them. (Olufemi, 2020) ranks fraudulent practices among some sponsors as the most significant risk factors of fractional property ownership in Nigeria. In addition, the traditional fractional property ownership transaction process, despite its reliance on internet and web technology is highly inefficient, time consuming, costly, and often ridden with inconsistencies in fragmenting the piece of real estate into fractions (Wouda Peter et al, 2019). These challenges have resulted in overwhelming disinterest in the system, especially among low-income earners, posing a barrier to an otherwise promising alternative to property financing in Nigeria. The need for a system or technology that can radically overcome the weaknesses of traditional fractional property ownership has thus prompted this researcher to look in the direction of the novel blockchain technology. Blockchain technology is said to have characteristics that make it potentially able to perform tokenization a better and more efficient way.

Blockchain, the underlying technology that supports cryptocurrencies "is a protocol that allows a secured transfer of unique instances of value (like money, property, contracts, and identity credentials) via the internet without requiring the third-party intermediation

of companies, and banks, or governments (Hileman and Rauchs, 2017). In simple terms, “a blockchain is a type of database with transactions (inputs and outputs) done over a Peer-to-Peer network”. What sets the technology apart is the fundamental trustlessness, decentralized infrastructure, open-source capabilities and enhanced security that govern its functionality. These features have created several use cases for the technology since its discovery, and it has found interesting applications in many fields. Any industry that struggles because of the need for intermediation, that is illiquid and non-transparent, that relies enormously on the principles of trusts, that needs regular system audits, or an enhanced regulation and internal control is capable of being disrupted by the blockchain technology. A specific application of the technology in the real estate industry is the concept of blockchain tokenization. Blockchain tokenization in real estate “is the process of fractionalizing or breaking down a property efficiently into tokens stored on a blockchain. Investors can secure direct ownership of a piece of the broken asset without buying or managing the property themselves – management duties primarily lie with property developers and managers” (Baum A, 2002). Blockchain tokenization addresses the drawbacks of traditional fractional property ownership transactions by, reducing market barriers, removing inefficiencies, removing the need for go-betweens, breaking down the high investment and transaction costs, increasing liquidity, improving transparency, and streamlining processes. Although recent studies have examined the possibilities of applying blockchain technology to property tokenization, the specifics and applications remain unclear and only a few experimentations have taken place in some European countries like the Netherland and Switzerland, Canada, Australia, and the USA. In Nigeria interest in blockchain came into focus in 2017, when the country was ranked second globally in cryptocurrency transactions volume, outpacing major developed countries where one would expect higher volumes. The popularity of blockchain technology in Nigeria is an indication of its high acceptance and could open the way for seamless application in other areas of the economy. Therefore, the motivation for this research is to investigate the possibility of combining the technology with traditional fractional property ownership system in a way that will drive the adoption of the system and ultimately address the decade long housing deficit problem.

1.2 Research Aim

The aim of this thesis, therefore, is to improve the traditional fractional property transaction process in Nigeria by the application of the blockchain technology to make the system more efficient and transparent. The research includes the exploration of issues in the fractional property transaction process with the aim of identifying of the most pressing concerns inherent in the process. The goal of the research is to present a conceptual blockchain transaction model for fractional property financing, based on the highest ranked weaknesses of the existing system, including basic aspects of prototype architecture and implementation. The concept proposes a redesign of the existing transaction flow in favor of a distributed ledgers technology (DLT) driven transaction, with an objective of enhancing real estate financing and property construction in Nigeria.

1.3 Research Objective

The aims and goal of this research are accomplished by:

- Identifying the critical challenges of the traditional fractional property financing transaction process through multi party interviews.
- Exploring literatures to determine the characteristics of the blockchain technology, verify its capacity to transform the tokenization process of traditional property crowdfunding in Nigeria, by getting selected practitioners in the Nigeria Real Estate industry to provide answers to survey questions.
- Ranking the identified issues through statistical analysis to determine their order of importance.
- Combining the reports of literature reviews and the results of the statistical analysis to develop a blockchain driven transaction model for fractional property financing, that can overcome the challenges of homeownership in Nigeria.

1.4 Research scope

This research is part of the requirements of the joint master's degree in Construction and Real Estate Management from The Helsinki Metropolia University of Applied Science and the Berlin Hochschule fur Technik und Wirtschaft (HTW Berlin). Since this is a management program, the study shall maintain a managerial and economic approach and findings shall not be viewed from a technical perspective. Therefore, the

model developed at the end of the study is not a ready to use prototype or practical implementation model but merely a theoretical conception of a better transaction process. However, from a computer programming point of view, the development of algorithms based on the conceptualization should be relatively easy to do. The model is a proposed improved blockchain-driven workflow of the transaction process between investors, sponsors, and developers in a fractional homeownership system. The study shall concentrate on the use of blockchain technology for tokenization rather than a general overview of all the use cases of the technology in global real estate economics. Although the scope of the research is limited to the Nigerian real estate environment, which admittedly has some unique characteristics, Nigeria being an important representative of emerging economies; makes the findings of this research easy to apply in many developing countries. This thesis does not cover detailed aspects of transaction regulation or legal and financial compliance, but it is hoped that the concept of smart contracts and digital democracy that the new process advocates shall eliminate the need for a lot of these regulations, audits, and controls.

1.5 Research questions

The core question that this thesis seeks to answer is the possibility of improving the transaction process of real estate syndicated funding using the blockchain technology; in a manner that investors will still find appealing and safe. The most important challenge the traditional process of real estate crowdfunding is the presence and need for intermediaries. This intermediation often introduces issues related to trust and accountability, efficiency, slows down the transaction process, increases transaction costs, is prone to corruption and malpractices; and constrains the ease of fragmentation. Blockchain, being a decentralized and immutable system, explicitly eradicates the need for a middleman and automate the process without the risk of loss or counterfeiting. The critical questions to be answered are therefore:

1. What are the most important challenges currently facing the existing fractional funding system, which has made it unable to address Nigeria’s housing financing and housing deficit problems?
2. What features of blockchain technology makes it a unique solution for the issues of fractional property financing?

3. What is the best framework for the implementation of the blockchain technology in fractional property ownership?
4. What are the limitations of this initiative?

Finding answers to these will require the following methodology:

1.6 Research Methodology

There are two main disciplinary approach to this subject: management and computer science or software engineering. An interdisciplinary subject of this nature usually requires more than one research approach. This research therefore applies two basic methodologies: a modified action research, an approach commonly used for improving conditions and practices (Meyer, 2000) and a survey using a quantitative approach towards a design science. The literature analysis includes an examination of the characteristics and state of knowledge of the blockchain tokenization process for the purpose of obtaining a theoretical framework for comparing the current transaction process of fractional property funding with the blockchain tokenization process. Subsequently, multiple parties are interviewed to determine the major challenges within the traditional property fractionalization process on the one hand and verify previously held biases about blockchain tokenization on the other hand. The interview findings are analyzed, ranked, and synthesized with the result of the literature analysis to design a blockchain property tokenization prototype that can overcome established challenges in a fractional property financing transaction process in Nigeria. The design science research aspect, therefore, presents an architecture, models, prototypes, or methods that can be useful for a blockchain fractional property funding transaction workflow unique to the Nigerian environment. Conclusions are drawn from the analysis, the technology, and the concept, and recommendations given for further steps required in typical action-based research.

1.7 Research Structure

Chapter one introduces the study and discusses the research motive, aim, objectives, methodology, scope and provides a list of the research questions. In the next two chapters, various pieces of literature that discuss the issues of financing in Nigeria's housing industry and the fractional property financing concept are reviewed to provide insight into the problem. The fourth chapter throws light into the blockchain ecosystem with

special focus given to blockchain real estate tokenization and its capacity to correct the limitations of traditional fractionalization in real estate financing. In chapter five, the method adopted in providing answers to the research questions is discussed, and chapter six provides a statistically analysis of data obtained from surveys carried out to test the validity of the research hypothesis and justify the conclusion of the research. Chapter six also presents a conceptual model of a blockchain fractional ownership transaction system. Finally, chapter seven gives the researcher's conclusion and recommendations for future study.

2. The Property Financing Situation in Nigeria

‘National housing deficit’ is perhaps the most discussed subject within the Nigerian housing sector. The term is often used loosely, to describe the supply lag of housing units against the demand for houses in a country. Rated as one of the worst in the world, Nigeria’s current housing deficit is speculated to be between 17 million to 22 million housing units, and it requires approximately one million new units annually in ten years to bridge the gap. (CAHF, 2018; Aliyu Sanusi, 2019). The issue of housing shortage in Nigeria is compounded by decades-long population growth and the current population demographic spread. Nigeria is Africa’s most populous nation with an estimated population of 206.1 million people (World Bank, 2020). Its current annual average population growth rate of 2.54%, which has been steady for over a decade, means this population is likely to exceed 400 million people by 2050; and in fifty years, there could be more people in Nigeria than the entire European continent (BBC 2022). Nigeria also has one of the youngest populations globally, with an estimated 86.4% of the population being below the age of 45, and 33% being young adults between the ages of 15 to 35 years old. This demography of young adults has been identified as the most mobile and the most likely to seek new homes for rent in most countries (Anthony Cilluffo et al 2017). While the pressure for new home occupancy is highest among the under 35 years old in Nigeria, (O. Adewunmi, 2020) noted that the home-ownership pattern in the country is rare within this age bracket and that most outright purchases of homes or mortgage patronage are done by citizens between age 50 and 60. Nigerians within the 50 to 60 years age bracket constitute less than 6% of the total national population (NPC, 2021). The implication of this demographic spread around homeownership in Nigeria is a higher demand than supply for residential and commercial housing in the country and a noteworthy national housing deficit.

2.1 The Nigerian Housing Deficit Question

Since the last decade, most publications have suggested that Nigeria requires 17 million new housing units to adequately meet the population's housing needs (CAHF, 2018). Surprisingly, this figure is cited year after year by various researchers, including reputable organizations such as the United Nations, World Bank, African Development Bank (ADB), Price Waterhouse Coopers (PWC), and the International Monetary Fund (IMF), with little or no adjustments made to account for the number of new buildings

built each year or rapid national population growth. The lack of accurate statistics from government departments in most developing nations or the bottlenecks one has to surmount to access these data where they exist, is often the reason why many researchers cling to the one source of verifiable data they can get, and repeatedly rely on such information in all their publications. (Behr et al., 2021) The official document from which most of these publications refer is a 2012 policy document from the Nigeria Federal Ministry of Housing, which projected the national housing deficit to be about 17 million units in that year. This mere projection, added as a footnote to the document, was later updated by some other publications to reflect population growth before and after the projection. The numbers given in Table 1 below, give a picture of the estimated housing deficit in Nigeria, using the same data source, with projections done over selected years in the past three decades.

Year	**National Population**	**Population Growth Rate**	**Housing Deficit**	**Annual Units** Required to **Plug Deficit within a Decade**
1993	c. 103 million	2.5%	4 million	≈ 700,000
2007	c. 146 million	2.6%	10 million	-
2013	c. 172 million	2.7%	17 million	-
2017	c. 191 million	2.6%	19 million	≈ 900,000
2022	c. 216 million	2.53%	22 million	≈ 1,000,000

Tab 1: Yearly Projections of Nigeria Housing Deficits[1]

While these figures have become generally accepted, it is important to point out that many scholars, and even the Nigerian Ministry of Housing from which the data emanated, have expressed certain qualifications about the accuracy of the data. At a national conference in 2021, the Nigerian Minister of Housing strongly debunked the claims established by the data, stating that “the figures are much too high and that it is highly unlikely for Nigeria to have one of the highest national housing deficits in the world, given the physical evidence, the cultural taboos surrounding homelessness in the country, the known statistics on household population, and the absence of statistical evidence to support the information on Table 1 (Thisday Aug. 21, 2021). To buttress

[1] In conformity with Oyo-ita 2017 p 5, Aliyu Sanusi p 5.

his point further, a comparison of similar data on housing shortages in other developing countries is shown below in Table 2. The countries selected are developing nations with similar cultural experiences, similar economic indices, or comparable population/population growth rates. The result on the Table strangely ranks Nigeria's housing lag close to India, a country with seven times its population and a similar political and economic climate, and places it far worse than that of several less economically prosperous African countries or those of similarly populated Asian and South American countries, like Pakistan and Brazil. This naturally raises questions and doubts about the accuracy of the initial data that specified 17 million as Nigeria's national housing deficit.

SN	Country	Year	Estimated Population (people)	Estimated Housing Deficit (Housing units lag)	Housing Deficit to Population Ratio (housing unit lag per person)
1	**Nigeria**	**2019**	**201,000,000**	**21,000,000**	**0.1045**
2	Ghana	2019	30,000,000	2,000,000	0.0667
3	Kenya	2019	52,000,000	2,000,000	0.0385
4	Uganda	2019	44,000,000	1.700,000	0.0386
5	South Africa	2019	58,000,000	2,500,000	0.0431
6	Ethiopia	2019	112,000,000	1,200,000	0.0107
7	Egypt	2019	100,000,000	3,500,000	0.0350
8	Brazil	2019	211,000,000	7,000,000	0.0332
9	Pakistan	2019	216,000,000	7,500,000	0.0347
10	Philippines	2019	108,000,000	3,750,000	0.0347
11	India	2019	1,370,000,000	73,600,000	0.0537

Tab 2: Estimated Housing Deficit across Several Developing Nations[2]

The housing deficit per person (HDPP) ratio is introduced in Table 2 to expatiate on this argument. The HDPP ratio is the housing deficit in a country per the total national population. The value which ranges between zero and one, one being the worst case, is indicative of the weight or the impact of the housing shortage in a country on each citizen. The higher this ratio, the more the need or lack is felt in the selected country. Again at 0.1045, Nigeria ranks as the worst country among its peers in Table 2, and it

[2] In conformity with Mojale et al, 2011 p. 11 and Moore 2019 p. 205.

is quite surprising to imagine that, according to the report on the Table, an average Nigerian is expected to feel the housing lag more than any of the listed countries. The question of whether the burden of the housing shortage is more intensely felt by Nigerians than the other countries, is difficult to answer even where one has spent considerable time in all the countries. Only actual statistical data obtained in a census can make us certain of the true extent of the housing shortage in Nigeria. Unfortunately, none of the five national censuses conducted in Nigeria since 1952 captured the relevant data for housing statistics. In the last census of 2006, this data was deliberately omitted to avoid the politicization of the entire census project. Politicians can be trusted to give priority to manipulating the population and number of houses in their electoral constituencies to easily rig elections than to obtain the necessary data required to solve a serious social problem. Fortunately, the proposed 2022 census, yet to be conducted, presents another opportunity to obtain this particularly important statistics.

As mentioned in the preceding paragraph, the most reliable official statistic pointing to information on the available housing in Nigeria is provided by the Nigeria Bureau of Statistics (NBS). The Bureau periodically does a count of household population and household size. A household as defined by the NBS is “a group of persons living together and maintaining a unique eating arrangement. It can also be a person living and eating alone.” The report from the NBS showed that the average household size in Nigeria ranged from 5.2 people per household in 2012 to 4.7 people in 2020 and the total number of households ranged from about 35 million households in 2012 to about 43 million households in 2020 (NBS, 2006). Juxtaposing the data above, and the projections from Table 1 would indicate that more than half of Nigeria's total households were homeless for the various years those projections were made. This is certainly not the case in real life, making the points raised by the Nigerian Minister and those on the other side of the argument, justifiable to a certain extent.

While the argument about the actual figure for the housing shortage in Nigeria persists, there are no objections to the alarming statistics on the poor quality of the housing, millions of Nigerians occupy, both in the big cities and in the rural areas. More than half of Nigeria’s population lack the means to acquire adequate housing or pay the rent for such a service. Regarding the supply of suitable housing and the lack of demand due to low national income of the population, (Oloke et al, 2017) reported that between 2014 to 2016 alone, vacancy rate for standard housing in the Lekki, high-brow, area of

Lagos Island rose by almost 72%. This vacancy exists even as more Nigerians desperately seek for housing in the mainland area of Lagos. Perhaps then, the cross of the argument is what the term “housing deficit” actually means. The term, as used by many authors, is rather ambiguous and often loosely quantifies the housing backlog, shortfall in housing units or the number of houses required to bridge the housing gap. What is often neglected is the fact that a house is not a rubber stamp. The qualitative housing deficit that estimates how many households live in sub-standard houses with little or no access to basic services is often left unaccounted for (Bah et al. 2018; Bouillon 2012). In this regard, therefore, Nigeria’s quantitative housing deficit which is often termed an urban phenomenon (Aliyu Sanusi 2019) may have been grossly overestimated in the report, but when the estimates are used to judge the national qualitative housing deficit- an issue which is more than merely an urban phenomenon, the numbers will be just adequate if not slightly underestimated. A better definition of the term ‘housing deficit’ as it applies to the Nigerian situation will then be: “the number of shelters which do not have adequate conditions to be habitable, plus the number of housing units that need to be built to shelter all families who currently lack one and as a result, share a shelter with another household in overcrowded conditions” (Carols, 2012). Again, the distinction that exists between housing demand and housing need also have a clear impact on all previous estimates of housing deficit. While the former is the quantity and quality of available housing, the latter, which is more indicative of the figures, applies to a lag or excess from a given normative standard that applies to a group or subgroup of nationalities (Glen, et. al., 2010:25). Using such an ambiguous parameter to judge countries often result in a misconstruction of real situations, as countries with uneven demographics are often peered together with similar expectations.

2.2 The Nigerian Housing Crisis: A Financing Problem

A real estate development process usually starts with one or several of three perspectives: Concept, Property or Finance. These perspectives also determine the main actors at the start of the development process. Although these perspectives are independent and of equal importance, a single stakeholder can be responsible for the provision of the three. Also as indicated in figure 1 below, it can be argued that the financial or money aspect overlap with any the other two the process begins with. For instance, formulating an idea usually involves research and a feasibility study with contributions

from different professionals and the process cannot be completed without the investment of some money.

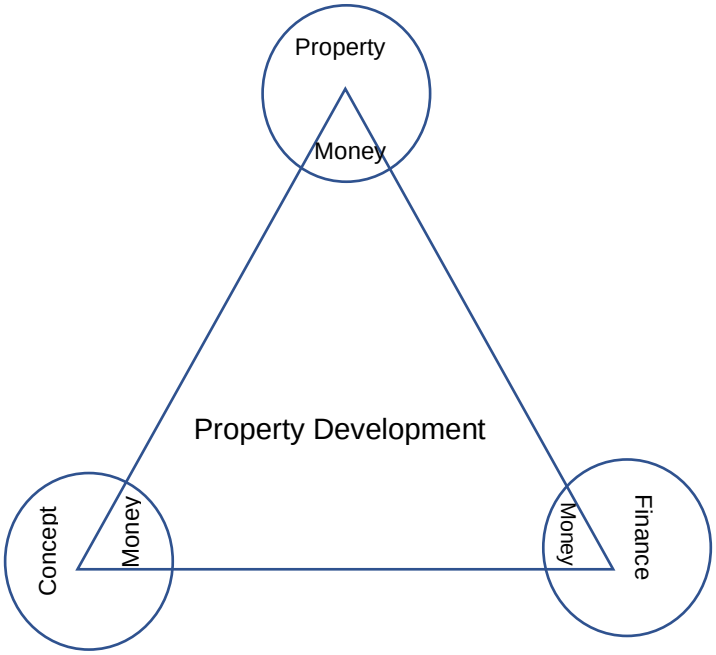

Fig 1: Perspectives of Commencing a Property Development[3]

The same can be said of a development process that began with the sale or purchase of a property, monies must have been spent to acquire the asset in the first place. This argument makes the influence of adequate financing very strong at the beginning of a property development process. To understand the Nigerian housing deficit challenge, therefore, one would need to understand the challenges owner and investors undergo as they try to source for funds at the beginning of their building projects. This is not without acknowledging the presence and the diverse and multifaceted nature of other factors or acknowledging that providing solutions to the Nigerian housing crisis requires a multipronged approach. The next sections of this thesis shall review the two basic sources of property financing in Nigeria: public property financing and private property financing. The goal will be to identify the challenges of both financing source with the aim of establishing the lack of adequate funding for property development as the most critical factor responsible for housing deficit in the country.

[3] In conformity with N Riediger (CONREM lecture note, 2022).

2.2.1 Public Property Ownership: Nigerian Government Interventions in Housing Financing Since 1960

So far, they have been six attempts by the Nigerian government to embark on nationwide housing programs, meant to address the escalating housing shortage. Painfully, none of these programs has been very impactful or has sufficiently provided low-cost housing for most people. Four of these initiatives were housing plans that formed part of a broader national development plan initiated by various military governments and one civilian government between 1962 and 1985. With the return to democracy in 1999, the three democratic governments Nigeria has had, also set up different national housing projects to bridge the housing gap in the nation. From time to time, state and regional governments execute affordable housing schemes within their jurisdiction. While some of these attempts are laudable and often well-thought-out, it is sad to say, that none of them has truly been felt by a large section of the ordinary Nigerian population. Table 3 below gives a list of these efforts with a special emphasis on the monetary allocation and the budgetary performance of the program; to highlights the point that poor financing is the possible reason why most of these plans failed.

2.2.1.1 The First National Housing Development Plan 1960-1968

As typical of most infrastructures in colonial Nigeria, the focus of any public housing effort in Nigeria before independence in 1960 was primarily to provide shelter for the staff of the European colonial administration and in some cases to their native subordinates. The prevailing colonial housing policies were meant to provide living quarters and to maintain the apartments in government reservation areas (GRA) (Onibokun, 1975; Oni, 1989). The bias between the provision of accommodation and facilities for colonial officers and the natives was obvious for everyone to see and the general population didn’t expect much from the colonialists. Some efforts at housing development that were made arose from critical situations in which the hands of the colonial government were forced to act. When Nigeria gained independence in 1960, the situation for indigenous peoples improved marginally, and a few Nigerians were able to obtain decent accommodation in the main towns. However, this was only a reflection of the growing number of Nigerians who could now find work in government offices and take over the apartments and homes that the British colonialists had left behind. According to (Arigbola, 2020), the first Nigerian government officials simply carried on the policies

of the departing British officer, and they were far more interested in taking over homes and apartments left by the British in Government quarters as a mark of distinction than to providing access to housing for the rest of the population.

As soon as the demand for such government staff housing outstripped the supply due to the increasing government labor force, attention turned to improving the virgin areas of government quarters. This of course raised the expectations of the public who began to make demands that quickly stimulated government response. Though the government responded to these demands, the national housing plan contained in the first national development plan was somewhat inadequate to cater for the needs of the teeming population. This inadequacy was mostly brought about by poor planning and the lean purse of the treasury. In Nigeria's first national housing plan, some 84 million naira were budgeted to construct 24,000 housing units to accommodate low, medium, and high-income earners. Prior to 1960, the majority of Nigeria's 45 million people in Nigeria lived communally in villages and towns. Most homes were either cottages or huts, scattered about in family plots and cannot really be described as proper housing. Thus, the 24,000 houses planned for, were certainly inadequate to meet the demands of the nation and a sign of poor planning and financial inadequacy. The performance at the completion of the period further highlighted the financing problems the government must have encountered in the early days of independence. Only 500 units of the targeted 24,000 housing units could be commissioned by the ministry of housing (Ekpo, Akpan 2019). Besides the financial issues, though, the outbreak of the Nigerian civil war in 1967 contributed to the abandonment of the plan.

2.2.1.2 The Second National Housing Development Plan (1970 -1974)

The second national development housing plan was part of a nationwide reconstruction effort at the end of the Nigerian civil war in 1970. It was the first all-inclusive housing plan that had the involvement of both the Nigerian central government and the federating units. The program was brought into focus by the formation of the National

SN	Plan/Policy	Period	National Population (million)	Target (units)	Budget	Actual (units)	Budget Performance
1	First National Housing Plan	1962-1968	46.1 - 53.5	24,000	₦84,000,000 ($127,272,000)	500	2.08%
2	Second National Housing Plan	1970-1974	56– 61.7	59,000 including 5,000 for FESTAC	-	7,080	12%
3	Third National Housing Plan	1975-1980	63.4 – 73.4	202,000 per year	₦1,830,000,000 ($297,080,000)	28,500	14.1%
4	Fourth National Housing Plan	1981-1985	75.4 – 83.6	About 200,000	₦1,900,000,000 ($3,114,754,098)	47,234	23.6%
5	National Housing Policy	1986-1999	97.7 – 119.4	121,000	-	1,114	0.9%
6	Post Fourth Republic Housing Schemes	2000-2007	121,3 – 216.3	• 10,271-PPP • 18,500 in all states • 40,000 in other cities annually		• 6,640 - PPP • 100 • -	• 2%

Tab 3: Public Housing Financing in Nigeria since 1960[4]

Council of Housing by government decree. A target of 59, 000 new homes nationwide was put forward by the council in 1972 with, 15,000 units planned for Lagos, the capital city, while 4,000 units were decided for each of the other existing eleven states or regions and 5,000 units for Olympic-village style residences to host the 2nd Festival of African Arts and Culture (FESTAC) in 1975. Realizing that a mere 59,000 units of

[4] In conformity with Ajayi,2019

houses was grossly inadequate for a population of over 55 million people, the government created a Staff Housing Board (SBH) to cater for the housing needs of federal civil servants, in collaboration with the Nigerian Building Society of 1956 (NBS). This was followed by the establishment of the Federal Housing Authority (FHA) in 1973, which together with the FMBH and the SBH provided mortgage loans to government workers to finance their private residences. Loans were given out at a rate of 3% and with an equity contribution of 10 to 20% of the total cost of the building. This contributory requirement ended up as a major drawback of the entire scheme because the lower class of the society did not earn enough to raise the initial 10% down payment required to commence the loan (Onibokun,1975). The plan was seen basically as a scheme for the rich and middle class who constituted a smaller percentage of the population. Although, (Akpan Ekpo, 2019) insisted that the delay in kickstarting the FHA, which did not commence operation till 1976, was the crippling factor of the entire scheme, (Lekwot et al, 2012) argued the negligible funding for the federal and state projects were the reasons the scheme wasn't so successful. Monies budgeted for the project were supposed to be generated by both the federal and state treasuries, however, by the end of the scheme, the federal government could only manage to raise less than 20% of its share while most states did not allocate any monies at all. Disappointingly, only 7,000 units of houses could be built by 1975, with 5,000 of the houses built because Lagos city hosted the Festival of African Arts in 1975. (Olotuah O. et al, 2015). The project became a monumental failure, mostly due to funding gaps.

2.2.1.3 The Third National Housing Development Plan (1975 -1980)

The third national housing plan tried to correct the failures of the previous plans by increasing the monies allocated for funding housing projects in the national budget. This was easy to do since Nigeria became particularly wealthy in the 1970s after global crude oil prices skyrocketed due to the Arab embargo on crude oil, which sent the price of the mineral four times above normal prices. The basic objectives of the fourth national housing plan were to directly construct 202,000 housing units nationwide (46,000 in Lagos, 12,000 in Kaduna and 8,000 in other state capitals), every year for five years. This was meant to address the estimated 865,000 housing deficit calculated in 1975. The plan also ensured that working-class people do not spend more than 20% of their monthly income on rent. A total of ₦1.83 billion was budgeted for the project. The Federal Housing Authority provided the plan and infrastructure for the development while

a new Ministry of Housing was created to facilitate the project and to reduce bureaucracy in title registration. The transformation of the Nigeria building society to the Federal Mortgage bank and the enactment of the Land Use Act in 1978, an Act which is still in use to this day, were additional attempts to consolidate government resolve to finally address Nigeria's housing concerns in 1975 (Omange and Udegbe, 2000).
The enactment of the Land Use Act as a first step to encourage private participation in housing development is remarkable because of the issues surrounding land acquisition prior to the enactment of the law. However, while the law streamlined the process of land acquisition and registration; and provided a framework for land authentication, it was unable to effectively remove all the barriers Nigerians go through in the land procurement process. The Nigeria Land Use Act vested land in the hand of state governors who hold lands in trust for communities. As a result, state governors exercise the right to give consent and certificates of occupancies or to revoke the ownership of any land under their jurisdiction. Although this arrangement appears perfect on paper, the absence of other structures of effective governance and weak law enforcement have opened the way for a lot of abnormalities within the system. They have been incidences where politicians and governors forcibly acquire land in prime locations to the detriment of the aboriginal occupants of the community. (Aluko et al, 2004) lambast the 1973 Land Use Act, lamenting that the elimination of the traditional authority of land delivery and the absence of an official role for community stakeholder engagement in the Act has led to the distrust that invited the participation of unofficial and parallel actors like community tout popularly called 'omo onile' (loosely translated: sons of the land) who cause serious confusion within the system.

What is more relevant to this research, however, is the additional cost now associated with title ownership because of gaps in the land use act. Taxes, bribes, and levies never heard of before were introduced into the land conveyance process, thereby driving up the cost of property development. (Aluko et al, 2004) mentioned that some of these government levies include: the cost of perfecting land titles, tax clearance certificates, application fees, tenement rates, obtaining and transfer of governor's consent, agency fees, legal fees, stamp duty, capital tax gains community development levies etc. The total cost of dues required just to obtain a certificate of occupancy from the governor may amount to 46 to 60% of the cost of acquiring the land. In practice, many Nigerians avoid these registration processes and would choose instead to buy land

from community stakeholders who lay claim to lands based on inheritance and often sell their lands without a governor's consent. This however is not without consequences, as many investors fall into the hands of dubious characters and powerful people in society who either sold land to multiple parties or sold lands that they did not own.

The third national housing plan recorded some success stories when compared with previous plans. By 1980, when the plan was scrapped, “the first ever low-cost housing estates had been built in the capitals of the eleven states of the Federation. This was the first-ever attempt by the Federal government to provide affordable accommodation on long-term repayment arrangements” (Ibi Ajayi, 2019). Despite its accomplishments, the success of the program also fell below average, as only 28,500 housing units were eventually completed at the termination of the plan. Again, the limited success of this plan can be traced to the increased revenue of the Nigerian federal government at the beginning of the 1970s, thus, corroborating the point that the lack of adequate budgetary provision for housing by the Nigerian government is responsible for the dismal performance of the early public housing development plans.

2.2.1.4 The Fourth National Housing Development Plan (National Low-Cost Housing Scheme) (1981 -1985)

Nigeria’s successful transition to civilian rule in the 1980s resulted in increased government interest in infrastructural spending. The new civilian government attempted to increase spending on infrastructural projects to a scale larger than ever before. About 1.9 billion naira was allocated to housing construction nationwide. The fourth nation development plan was set up to construct 350 units of housing for middle and high-income groups in each state. Additionally, 40,000 low-cost housing will be constructed nationwide at 2,000 units per state. This was to be done continuously every year for four years. If successfully implemented, about 200,000 apartments were expected at the end of the period. (Olotuah 2000). The fourth national housing plan is celebrated for making provisions for low-income earners whose annual income did not exceed N8,000, and for promoting the growth of mortgage finance through the Federal Mortgage Bank of Nigeria (FMBN) and the Primary Mortgage Institutions (PMIs). The program also encouraged the development of indigenous contractors and promoted the consumption of local raw materials – making more monies available for actual

construction, conceptualizing affordability, improving citizen participation, and allocating more funds to the housing agenda.

The fourth NDP is by far the most successful of all national housing. However, by June 1983, two years before the target delivery date, only 600 million naira (37 per cent) had been spent to complete 32,000 units or 20% of the target. Though an additional 15,200 units were commissioned subsequently; the program is generally regarded as a failure and could not even take off in many states (Ajayi I, 2019). An important limitation of the program was its politicization. In many regions of the country, the program was used for political patronage. Uniform housing was erected in every state of the ruling political party with no consideration given to differences in socio-cultural values and climatic conditions. Northern Nigeria has remarkably different cultural manifestations and building requirements from southern Nigeria. In states with opposition parties, the program got a poor reception from local politicians who fear that the love the scheme engendered in the minds of people could make them shift political alliances. The uncooperative attitude of the state governments who were supposed to contribute 20,000 housing units in total further limited the overall performance of the fourth public housing plan. The most bickering challenge, however, is evident in the financials and total funds disbursed to implement the program. The lingering stagflation that resulted from the oil crisis of the late 1970s led to reduces government revenue and a lengthy period of economic recession. Government could barely pay salaries in some months let alone invest in capital projects.

2.2.1.5 The National Housing Policy (1991-1999)

In 1991, after a retrospective assessment of all previous national housing programs, the Nigerian government shifted focus from merely erecting social housing to addressing issues around land acquisition, property financing and housing delivery. In 1991, a new housing policy to springboard the housing for all agenda of the year 2000 was formulated by the housing ministry. To achieve this goal, 8 million apartments had to be built before the year 2000 to cater for existing and future needs. Three million of the new buildings were especially targeted for construction in rural areas (Oluotua et al, 2015). The new Housing Policy was launched in February 1991, and it had three components: land acquisition, housing finance and housing construction and delivery. As regards housing delivery, efforts were made to intensify the delivery of serviced plots

through the “sites and service scheme” with over 2,800 such plots delivered nationwide (Ademiluyi, 2010).

An important aspect of the policy was to ensure the continuous flow of funds for private properties and reduce reliance on government for property financing. The National Housing Fund Decree of 1992 was promulgated, and Primary Mortgage Institutions (PMIs) were licensed to provide funds for this purpose. Every Nigerian worker earning 3,000 naira or more was expected to contribute 2.5% of their monthly income to the fund. Additional sources of financing for the fund were a 10% contribution from commercial bank loans and advances, and a minimum of 20 to 40% contribution from life funds of insurance companies. The central government provided the rest. (Akpan 2019). “The NHF was established primarily to address the constraint of the mobilization of long-term funds for housing development, and to nurture and maintain a stable base for affordable housing finance.” (Olotuah, 2001). For the first time active private sector participation was encouraged to meet the target of 700,000 houses a year necessary to actualize eight million apartment homes by 2020.

The National Housing Program of 1994 to 1995 was a development that arose from the national housing policy of 1991. It was a further attempt by the federal government to augment the efforts of the private sector partnership, which was beginning to slow down at the time. The program attempted the direct construction of 121,000 units of housing in all state capitals where housing shortage was most acute. Like the attempts of the previous years, housing situation in Nigeria remained inadequate in quantity, quality, and affordability because the program failed to take off in most states. The shelter policy ended abruptly in December 1983 as no significant allocations was made for it in the national budget. Only 1,114 housing units were completed (Kado Estate in Abuja) and commissioned on 15 December 1994 (Benjamin, 2000).

In general, very little was achieved in terms of meeting specified targets in housing construction with these housing plans (Muoghalu, 1987; Jiboye, 1997). This is especially true for direct house construction programs. Besides the poor funding of these projects, “a wrong perception of the housing needs of the low-income earners, who incidentally constitute the vast majority of urban dwellers; the proposal of typical housing that is not rooted in the different Nigeria’s climatic, cultural and socio-economic environments; improper planning and poor execution of housing policies and programs; undue politicizing of government housing programs, the lack of the political will

and astuteness to carry out government housing programs to logical conclusions; unrealistically high cost of houses built for the low-income people, and the insensitivity of government to the operations of the private sector in housing delivery", are major factors responsible for the failed public housing projects of Nigeria, in the past decades (Olotuah and Ajayi, 2008).

2.2.1.6 Post Fourth Republic Housing Schemes(1999-Date)

With the return of Nigeria to democratic rule at the beginning of the millennia, the housing policy focus was essentially on private sector driven housing delivery. Government only focused on providing the fundamental infrastructures required for the success of private sector housing delivery. Due to this, financial institutions like the Federal Mortgage Bank of Nigeria (FMBN) were reviewed, and private developers were given a 5-year tax exemption. In 2006, a fresh national policy was also released. In accordance with the new policy, the amortization period—which was previously 25 years—was extended to 30 years, the interest rate was lowered from 5% to 4%, and the lending rate for National Housing Fund donors was lowered from 9% to 6%. The government started a program to build 1 million affordable housing units annually to help with the housing shortage. Additional changes to the National Housing Fund (NHF) mandated that every employee making more than N30,000 per month pay 2.5% into a fund that is maintained by the FMBN. The FMBN was supposed to offer customers loans of up to N15 million through the Primary Mortgage Institutions for the purchase of homes. (Aminu Bello, 2019). In 2004, the Federal Government once more proposed the construction of 18,500 housing units across the federation, with over 10,000 of those units being built through public-private partnerships. Needless to say, except for the PPP project which managed 6,440 out of 10,271 proposed, the effort was underfunded and a monumental failure.

The housing policy between 2000-2007 was well articulated and well intentioned, but a change in government after the 2007 general election slowed down the implementation. Due to the lack of institutionalization of policies, it was not carried out like most policies in Nigeria. The new government of 2007-2015 validated the effectiveness of the new housing policy and did not bother initiating any amendments. Instead, the focus was on amending the land use act to remove any impediment in the title ownership process. The agenda of the new government also included the reorganization of the

Federal Housing Authority (FHA) to provide mortgage insurance for affordable housing and the expansion of the Federal Mortgage Bank of Nigeria (FMBN) to become a secondary mortgage institution refinancing mortgage loans through the capital market, and the provision of legal protection of lenders against bankruptcy with the aim of attracting private investors into housing financing. In 2014, the Federal government launched the Nigerian Mortgage Refinancing Company (NMRC), and the first 10,000 mortgages for affordable home scheme; with a view to making mortgage accessible to Nigerians to enable them to purchase and own their own houses.

Between 2015 and the present, the Nigerian government promised to revise the 1978 Land Use Act, create freehold and leasehold interests in land, and establish a statewide computerized land title registration. Additionally, plans were for the construction of two million new dwellings in 2015 and one million each year after. This was to be accomplished through the national mortgage system, which would provide loans with interest rates in the single digits to Nigerian workers for the purpose of buying owner-occupied homes. These objectives appear unattainable when considering the results of prior government initiatives, and they were established at a time when the price of crude oil had fallen by half from its pre-2015 value. Over 80% of the Nigerian government's revenue comes from the sale of oil. The Mohammed Buhari administration was greeted with a general economic slump in 2015 that persisted into 2018. As a result, several developers had to reevaluate their investment strategy, which negatively impacted the plan's performance. To be fair to the administration, there were a number of public housing development programs during this time. For instance, the FMBM launched a national program to supply affordable housing for Nigerians in collaboration with the Nigerian Labor Congress (NLC) and other labor unions. The program is expected to construct 2,800 units over fourteen sites across Nigeria. In addition to houses to be built in Lagos and Abuja, it comprised 200 homes in each of the six geopolitical zones. The Family Houses Funds, a social housing initiative launched by the Federal Government to provide affordable mortgages for low-income individuals and families across the nation, is one of the other housing projects financed by the government between 2015 and the present. Under the program, civil officials with salaries of N30,000 or more are eligible for a mortgage to purchase a home. Another option is the FISH (Federal Integrated Staff Housing) program, a public-private partnership project that was started in 2016 with substantial participation from state and federal

governments. Sadly, none of these projects received the motivation or finance they needed. At the end of December 2018, only 32 of the 55,000 public officials who enrolled to the FISH have got their keys. Because of political unpredictability and an overly centralized system of decision-making, mass housing projects suffer from inconsistent planning, inadequate organizational structures, and inconsistent programming (Jiboye, 2011). Another complaint is that most of the properties classified as low-income housing are out of the price range of the intended audience due to their high cost. The biggest criticism in all government attempts to resolve the intractable housing problem of the country has been inconsistent approach and ever-changing strategies. Housing-related issues are frequently moved between several government ministries because of changing political regimes. It appears no lessons are ever learnt from the failure of a previous plan. Rarely was anything done to address the funding problem which is easily observed from all the plans in Table 3 above. For instance, the Federal Ministry of Housing and Urban Development was established as part of the housing reforms the Federal Government undertook (1999–2007). The Federal Mortgage Bank of Nigeria was under the ministry's supervision, particularly when loans were disbursed using donations to the National Housing Trust Fund. The ministry has since been abolished, and the current Federal Government merely established a new Federal Ministry of Works and Housing in its place. Such inconsistency is the bane behind the poor appraisal of the plans, the cases of corruption and misappropriation recorded now and again and the general unaccountability of the government departments in charge of executing these policies. Unfortunately, it is the ordinary Nigerian that bear the brunt of this failed policies and is left with no choice than to look elsewhere for housing supply or housing finance.

2.2.2 Private ownership: Equity Property Financing in Nigeria

It can be said that the failure of government to provide adequate housing or to provide the needed mortgage laws to drive property financing made the Nigerian population to start seeking other alternative sources of property finance. Equity financing or self-funding is one of such alternatives. Equity property financing refers to the funds realized from personal or family savings and used for property development. In commercial real estate practice, it is the sum of monies, a Trade developer must contribute before he can get reasonable interests from an investor. Equity financing the most common source of property financing in Nigeria. Usually, the trade developer or landowner save

monies overtime in a bank until the sum is large enough to complete phases of a building project. While this method of funding has proven effective in many ways and currently accounts for the financing of nearly 95% of new owner-occupant buildings in Nigeria, it is not without its challenges.

The state of the national economy makes it difficult especially for individuals to save the substantial amount of money that real estate demands. Nigeria is often categorized as a middle-income mixed economy and an emerging market with per capital income suitable for the general standard of living. In reality, though, only a few Nigerians enjoy a stable and fair income, and a massive income inequity exists within the population. Approximately 60% of the Nigerians occupy the lowest two of the six social-economic groups and earn between 570 euros to 1,300 euros per annum. These two groups make their living within the informal economy, are mostly unbanked and have no access to even microfinance loans. The rising cost of food and transportation means these low-income earners have little or no disposable income after taking care of their rents and upkeep. When they manage to save any monies, manifestations in the macro-economy like, a low bank savings interest rates that is usually less than 3%, a double-digit inflation, discourages individuals from saving. Also, even when people eventually gather the courage to save, periodic devaluation of the local currency due to falling crude oil prices will send the cost of imported building materials across the roof and raise the financial requirements to build a home. For instance, the estimated cost of building a 4-bedroom bungalow in the Nigerian city of Kaduna moved from about 8,000 euros in 1998 to 14,800 euros in 2002. A whopping 45% increase within five years! (Nwuba, 2004). This explains why it sometimes take an average time of five to fifteen years to complete a private residential building from equity savings (Alagbe et al 2013). Sometimes, even middle to high-income earners struggle to meet these requirements, and the only option left is to have a combination of equity financing with some form of debt financing. Similar to standard institutional real estate development projects, the goal of the combination is to not only ensure the maximum return but also maintain the development's viability. The amount of equity capital at a developer's disposal therefore increases his capacity to borrow.

2.2.3 Private ownership: Debt Property Financing in Nigeria

These are basically loans gotten from various sources like commercial banks, mortgage institutions, financing houses, corporative societies etc., and used specifically to

finance real estate projects. These loans are structured specially for building projects; thus, they have tenures, terms, and conditions unique to them and different form other loans. Short-term, medium-term, and long-term loans are the three categories into which debt property finance can be divided.

2.2.3.1 Short Term Loans

Short Term Loans: These are not different from regular loans issued by banks or other financial house, except that they are meant specifically for real estate projects. Short term loans have tenures of 1 to 5 years and are issued at between 3 to 6 percent above monetary policy rates (MPR). Most times, a form of collateral security is required for these loans, by the banks as an insurance against default or diversion. Nigerian banks generally do not have appetite for financing real estate projects. They consider the risk too high or the returns too low in comparison to other sectors like oil and gas. The central bank of Nigeria has ordered commercial banks to set aside 7% of their loanable funds for real estate to mobilize capital for the residential housing sector. The penalty for refusing to do so, is the withholding of any deviation from the stipulated minimum and depositing the difference in the Federal Mortgage Bank. Enforcement of this mandate, though, is low, and compliance is also expectedly low. The large population of the unbanked in Nigeria also makes short-term property debt financing unpopular in Nigeria.

The emergence and growth of building and multipurpose cooperative societies after the 1970s provided an interesting solution to the underlying problems of obtaining short-term property loans from commercial banks. These cooperatives operate like mortgage banks and help where the banks have failed. A typical cooperative society offers loans of up to three to four times the equity contributions of their members for construction purposes. Additionally, some societies buy building materials in bulk to enjoy the benefits of scale and wholesale prices in purchases. Such items are then sold to their members at less than retail market prices. The ease of entry into cooperative societies, seamless loan application processes, low-interest rates, subsidized cost of building materials and friendly payback terms easily made them the first point of call to low-income earners seeking funding for building construction (Olukayode et al, 2017).

However, there are certain requirements to enjoying the benefits of membership in such societies that eventually became a hindrance to the loan acquisition process. Firstly, these societies usually require a form of weekly thrift savings from their members. Such contributions must be made consistently for a period of six to twelve months as a form of equity contribution to the total project cost. While this is relatively easier to do than saving religiously for several years, many people still find it a challenge to maintain the discipline and self-control required to keep up with a thrift. Additionally, some members find the equity contributions required to finance standard buildings much too high compared to their income. A member of a building society that intends to build a typical 3-bedroom residential apartment of say 15,000 euro, will be required to have made savings of up to 5,000 euro before he is granted a facility of the full amount. Many middle-class Nigerians still cannot afford this amount of equity, which causes these organizations' borrowing procedures to skew more toward those of commercial banks. Collateral security and guarantors which later became additional requirements of some cooperative societies as a check against funds diversion or payment defaults, also made the medium too bureaucratic for many interested parties. Although a combination of funding from personal savings and loans from cooperative societies is still the most popular method of financing private homeownership in Nigeria, the increasing checks and control measures instituted by the societies to improve loan performance have altogether made the system too restrictive to some people and the expected impact on housing supply is gradually declining (Olujimi et al., 2021).

2.2.3.2 Medium Term Loans

Medium-term loans are comparable to short-term loans, with the exception that their terms can last up to 10 years. They are meant to finance multiple building projects or phases of multiple building projects that require long-term loans. Some developers process this type of loans to avoid paying a heavy interest for a long-term loan required in a large-scale building project with multiple phases. In this way only a middle-term loan required to complete a phase is taken at a time. Breaking the financing into tranches of medium tenure however increases the effort in processing loans and may lead to delays in executing the project.

2.2.3.3 Long Term Loans

Long Term Financing: Long-term debt financing last between 20 to 30 years and are usually given at lower interest rates compared to the previous two variants. These loans are usually issued by mainly by mortgage institutions. In Nigeria, the Federal Mortgage bank (FMBN) regulates the activities of primary mortgage institutions who provide long term financing for real estates. Although mortgage banks occasionally provide finance to real estate developers for commercial, industrial, and special projects in real estate, their lending activities are mostly focused on the residential housing sector. The FMBN's principal objective is to create a housing financing system that relies mostly on the private sector. By government Decree No. 3 of 1992, the National Housing Fund (NHF) was formed to help achieve this goal. The primary goal of the NHF is to alleviate the difficulty in raising long-term capital for construction projects by simplifying the access to low-cost capital in the form of long-term loans for the purpose of constructing, acquiring, and improving homes (Olotuah, 2001). The 2004 Housing and Urban Development Policy was created because of a 2002 review of the National Housing Policy. To provide Nigerians with the quantitative housing demands they require, the new National Housing Policy that was introduced in 2002 utilized mortgage financing. The Federal Mortgage Bank of Nigeria (FMBN), Federal Mortgage Finance Limited (FMFL), Federal Housing Authority (FHA), and Urban Development Bank of Nigeria (UDBN) are among the organizations that must be reorganized, strengthened, and recapitalized to achieve this (Ebie, 2004). The NHF changed into a trust fund with a board of trustees, the FMBN serving as the fund manager under the trustees' control. Now that the Fund has been renamed the National Housing Trust Fund, the private sector and housing organizations are permitted to use it for estate development. According to § 2.2.1.6, the NHF is supported by contributions from the government, banks, insurance firms, and workers. On application, mortgage banks receive long-term loans that are disbursed. Ordinary Nigerians who contribute to the fund can thus apply for loans of up to fifteen million naira under certain conditions.

The limitations if the NHF are easily evident from its design. Firstly, the reliance on contributions from the same government who have defaulted in the funding arrangement of all housing plans is questionable. Government funding for operational support was erratic and the government's equitable share was only partially delivered. Due to widespread skepticism about the program's value among Nigerians, the contributions

of self-employed people were also insignificant. With a high unemployment rate and with a large portion of employed people engaged in the informal economy, only a few Nigerians could contribute or access the fund. In some cases, the issue is a lack of awareness or discouragement brought about by the extremely bureaucratic process required to access the fund. Only 1.3 million people took part in its first five years of operation. Contributions to the Fund had only reached an equivalent of 4.7 million euros by December 1997. (FMBN, 1998). Additionally, there were issues with land acquisition, title issuance, registration, and transfer, all of which led to new requirements from mortgage lenders. Thus, in the year 2000, only 631 contributors out of 1.8 million people could access funds totaling about 818 thousand euro out of about 12 million euro contributed to the NHF so far (Bichi, 2000). And by 2018, only 73,676 people out of 3,772,031 contributors have benefited from the loans of up to 90 million euro even though the total contribution has grown to about 240 million euro by 2018 (Ayotamuno, 2018). In the end, what could have been the perfect solution to housing finance and the housing deficit debacle ended up as a problem of its own.

3 The Fractional Property Ownership Alternative to Real Estate Financing in Nigeria

The idea of fractional ownership in real estate was introduced in Nigeria in the last decade. Often closely associated with crowdfunding, the term fractional property ownership refers to a form of property ownership in which costs and benefits are “divided among a group of individual investors who are who are organized, specifically for the purpose of sharing the costs and the proceeds of investing in an asset. Though sometimes used as a synonym, of ‘timeshare’- sharing ownership of a vacation or resort property in an agreement that divides usage rights based on time - the phrase fractional property ownership in this thesis is not to be confused with timesharing in vacation home partnerships. In this literature, fractional property ownership is used to describe the pulling of resources for real estate development from multiple parties or the process of crowdfunding in property development. Preference has been given to the use of the term “fractional ownership” instead of “crowdfunding” to differentiate the practice from other popular crowdfunding systems which are often non-profit initiatives. The fractional property financing system usually involves raising small amounts of monies, over the internet, from different investors to fund a real estate project. The idea is to invest in properties or portfolios much bigger than each investor can afford or is willing to risk. Each investor will be expected to contribute a fraction of the total cost required for executing the project, subject to pre-established minimums (Lowies et al., 2018). The fractions need not be uniform, and the total cost is the sum of all costs relevant to the process of acquiring a residential or commercial estate and putting it to use. This may include the cost of purchasing land, securing titles, deed or official consent, the cost of design, planning and constructing building properties on the land; or the cost of purchasing, renovating, operating, and maintaining an existing building. Fractional ownership financing makes real estate more accessible, lowers investment thresholds and makes more project data available to potential investors than they would normally in conventional methods.

The concept of fractional ownership in real estate is not new. It used to be a form of asset syndication that was exclusively accessible to institutional investors with millions of euros and ultra-high net worth individuals in developed economies. These investors operate within the same circle and know themselves well enough to control the risks

investing with unknown parties (Pasimeni, 2020). With the advent of internet technology, however, the entry requirements were lowered, and the organization of investors with smaller and staggered amount of monies became possible and easy to do-thereby making real estate syndication more accessible to all. The modern fractional property ownership system is organized on digital platforms owned, organized, and mediated by third parties called 'Sponsors' who connect the investors to developers or to a property. These sponsors organize the administrative, legal, and accounting side of the investment on behalf of the investors. They receive the fractionalized investments on the one hand and disburse the lumpsum fund to trade developers or to the construction and project management team, who plan and execute the project on everyone's behalf. On the reverse side, the sponsors also organized the facility management aspects of the property during the utilization phase, obtain rent or leases as revenues and disburse profits back to the investors. (Lowies et al, 2018). The sponsors stay in business from the reward they get in having an equity contribution to the investment or from the fees they receive for their effort. This fee is often a percentage of the profit realized from selling or renting the properties or from a fixed transaction cost or management fee applied to the transaction of each investor and fixed from the inception. Globally, in 2020, over 60,000 investors participated in various forms of fractional property financing, with an average of 2.2 million euros spent for each object of investment. The average ratio of sponsor's equity to investor contribution was 20:80 and return on investment ranged between 5% to 20%. In cases where the sponsors existed as just intermediaries and made no contribution to the investment, an average of 0.5% to 2% was netted as a management fee for the transactions Some popular sponsors platforms in the period include Crowdhouse, Crowdli, Foxstone, Mybrick, Fundrise, Crowdstreet etc(Vogel and Moll, 2014)..

3.1 The Fractional Property Ownership Transaction Process

The fractional ownership transaction process can be summarized in the following steps:

1. The process begins with a trade real estate development company coming up with an idea and preparing a feasibility report to determine the possibilities to actualize the idea.

2. Next, the Sponsor or fractional ownership company receive the submission of the conception, screen and perform due diligence to ensure it meets their standards. The sponsors then set up the management and accounting strategy for the concept. In some cases, both the developer and the sponsor exist as a single entity. The sponsor's business is often organized as a Limited Liability Company or a Limited Partnership. Investors participate in the limited liability company as passive members or limited partners, with the Sponsor's role being similar to that of a general partner or manager. Except a special contract was entered, the investors' claims on the limited liability company are limited to the company's limits or to the amount they invested (Vogel and Moll, 2014).
3. Details of the selected project are prepared and made available on the internet. A typical fractional property ownership documentation that will contain most of the information one would expect to find in an institutional investment document: the location of the assets, financials, market data, insurance requirements, legal agreements, track records of the sponsor and exit details of the investment, economic, legal and technical aspects of the feasibility report: asset development costs, estimated revenue, yield, payback time, minimum investment required, estimated maturity, type and structure of the contract, and other legal contracture details.
4. The system is then opened for a pool of investors to confirm their interest by subscribing to singular or multiple units of the fractions. Most sponsors invest some of their monies as equity contributions. When this is done, the motivation is not only to assure the other investors, especially those with a low-risk appetite, of the safety of their investments but also to increase the returns accruable to the sponsors. In some cases, the sponsor contributes a larger share to instill a greater confidence in the scheme, and the remainder is shared among several investors. For example, if it requires 100,000 euros of capital to fund a property development, the sponsor may provide 50,000 euros of the sum and have twenty investors share the remaining 50,000-euro costs in minimum units of 1,000 euros. While this is often advisable, it is not exactly a requirement of the system. However, where the sponsor chooses not to invest any equity, only transaction or management fee of between 0.5% to 2% comes to them for their efforts.
5. Once the target investment required is realized, funds are disbursed to the developers and project management team where third parties are assigned these roles.

6. In cases where the invested total is less than the project cost, the process is terminated, and the monies are returned to the investors.
7. At the project's utilization stage, each investor receives a proportionate share of the sponsor's rental, lease, or sale income from the asset in accordance with the contractual terms. "This is normally on a monthly or quarterly basis." Real estate increases in value over time, allowing investors to generate bigger returns and increase their profits if market conditions are good. Payment depends on how long the investment needs to mature; some fractionalizations take 6–12 months to complete, while others can take 7–10 years. Typical yield for fractional property investments is between 5-10% depending of course on how risky the venture is.

The yield or profit from a fractional property investment is not always guaranteed by the sponsors. Sometimes a high vacancy may lead to significant losses which both the sponsor and investors have to bear. This is not always a pleasant scenario for investors who till this time have maintained a very passive involvement in the whole process and have not entertained such a possibility for their investments. Incidences of this nature create the need to allocate the risk investors are required to bear from the initial contracts, and the necessity to distinguish the difference between two main types of fractional property ownership.

3.2 Types of Fractional Property Ownership

There are two common variants of fractional property ownership. The most popular which is described above and illustrated in figure 2 below, is called Equity Fractional Ownership. With equity fractional ownership, the investors act as shareholders or co-owners of the property. Their rights are however limited to decision making as they cannot use the buildings as in the case of timesharing. They share in the profit and risk of owning the real estate and often enjoy higher returns because of the risks that they share. The investment tenure is also quite long under equity fractional property ownership, and could last for ten, fifteen or even twenty years. The investors get an annual yield of their investments plus profit over the payback period of the property. c However, the fact that such investors bear an owner’s risk means they may suffer periods of losses or outright loss of their entire investment if a dramatic downturn in the real estate market occurs during the investing period.

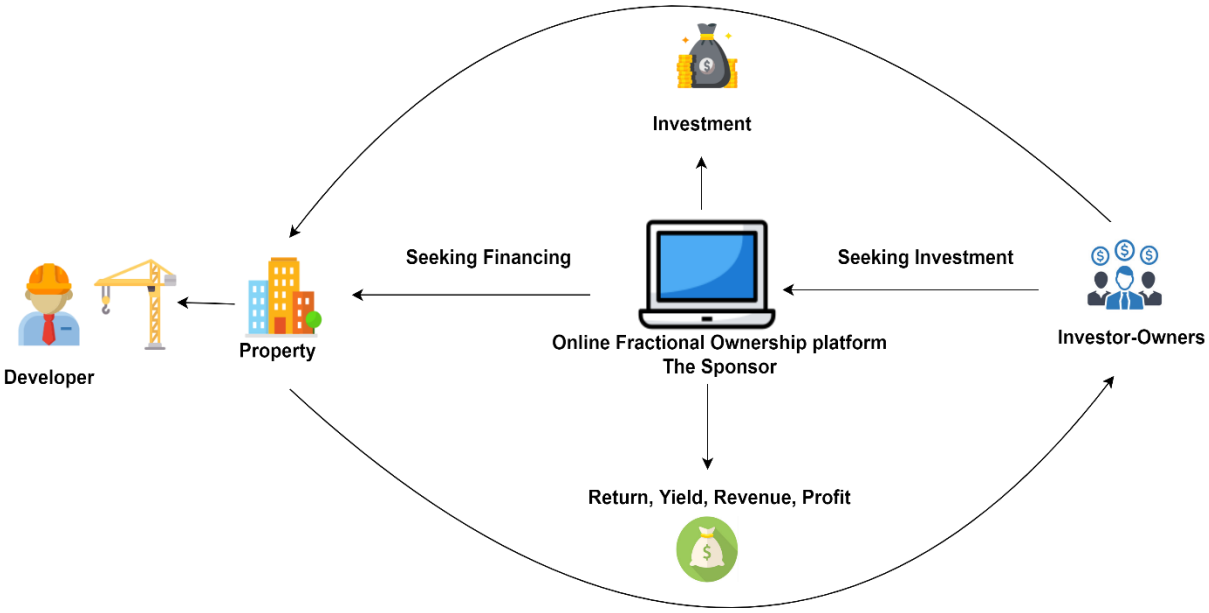

Fig 2: The Equity Fractional Property Ownership Cycle[5]

In the second variant called Debt Fractional Property Ownership, individual investors fund a Limited Liability Company which was set up to receive such funds, as loans, and have them disbursed to an experienced real estate developer, who construct or purchase and renovate properties on their behalf. In Debt Fractional Property Ownership, the investor's principal is treated as a loan given to the sponsor, at a specific interest rate and tenure. The loans are like mortgages, backed by an asset and having a maturity of six to twenty-four months (Vogel et al, 2014). The investors do not share in the risk of developing or operating the property. The only risk that they bear is the chance that the sponsor will default on the loan repayment. Figure 3 below is a diagram showing the cycle of a typical debt fractional property ownership cycle. As would be expected, the yield of the investment accruing to individual investors in a debt fractional property finance is much lower when compared with equity fractional ownership. This is because the lower the risk investors are willing to bear, the lower the returns accruing to them. However, the investors in this variant, enjoy the benefit of having first preference in the disbursement of profits realized from operating the property. In addition, the maturity of the yield also has a shorter tenure compared to equity fractional property ownership and so investors are free from the burden of a bearish property market which could happen over a lengthy cycle.

[5] In conformity with lebijou.io c, 2022

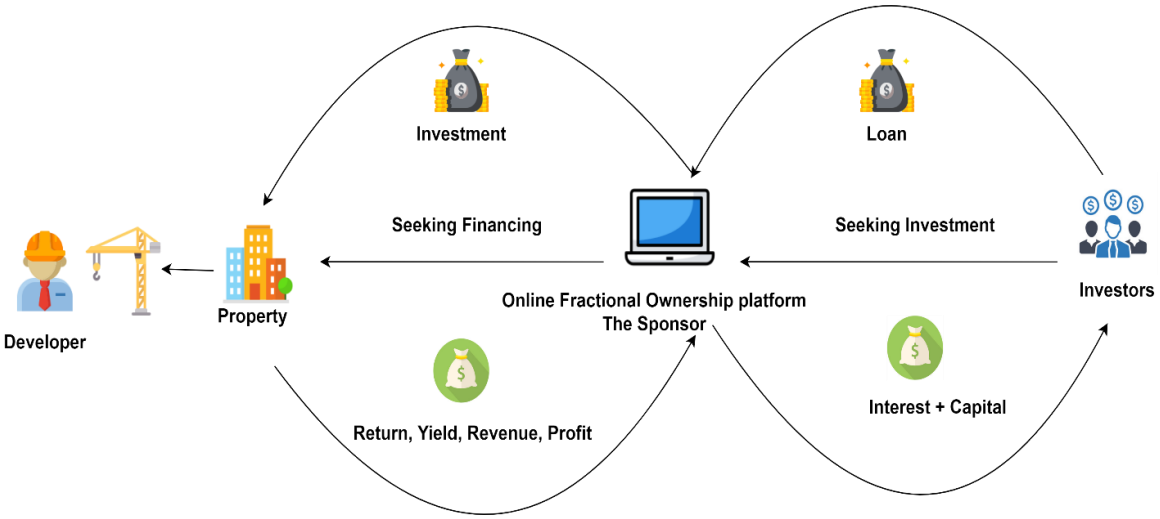

Fig 3: The Debt Fractional Property Ownership Cycle

In Table 4 below, a comparison of the characteristics of the two popular types of fractional property ownership is given to further highlights the differences between them.

Characteristics	**Debt Fractional Property Ownership**	**Equity Fractional Property Ownership**
Type of investment	Lender to the Sponsor	Co-owner of the Property (shareholder) with the sponsor
Type of Return	Interest (Fixed)	Variable share of net profits (Varies)
Potential of Return	Capped, limited to the loan interest rate	Uncapped, can be in the double-digits
Investor Risk	Lower (usually less than 10%)	Higher (up to 20%)
Secured by	Payback of loan is sometimes secured by the property or at other times loans are unsecured promissory note	Unsecured-investor own real estate value after debt
Seniority Default	Receives payout before anyone, but may have to pay some of the foreclosure costs if a loan goes into default	Receive payout after all liabilities are settled
Distributions	Monthly or quarterly interest payouts	Varies, sometimes quarterly distributions are paid
Fees	Typically, 2% + possible loan origination fee	Typically, 1%–2%, no upfront or service fees
Holding period	Varies: 6–24 months	Varies: 1–10 years
Tax benefits	No	Investors can take the depreciation deduction without owning the property directly

Tab 4: Comparison between Equity and Debt Property Ownership

3.3 Flow Diagram for a Traditional Fractional Property Transaction Model

As was covered in the previous section, the sponsors disclose the anticipated cost of a project and the developer's proposal to the investors in order to secure funds for the project, at the start of the standard fractional property finance transaction process. The sponsors' electronic platform, as depicted in figure 4 below, keeps the investors' expectations about time, cost, support duration, ownership rights, return on investments (ROI), yield, and votes open for all investors to see.

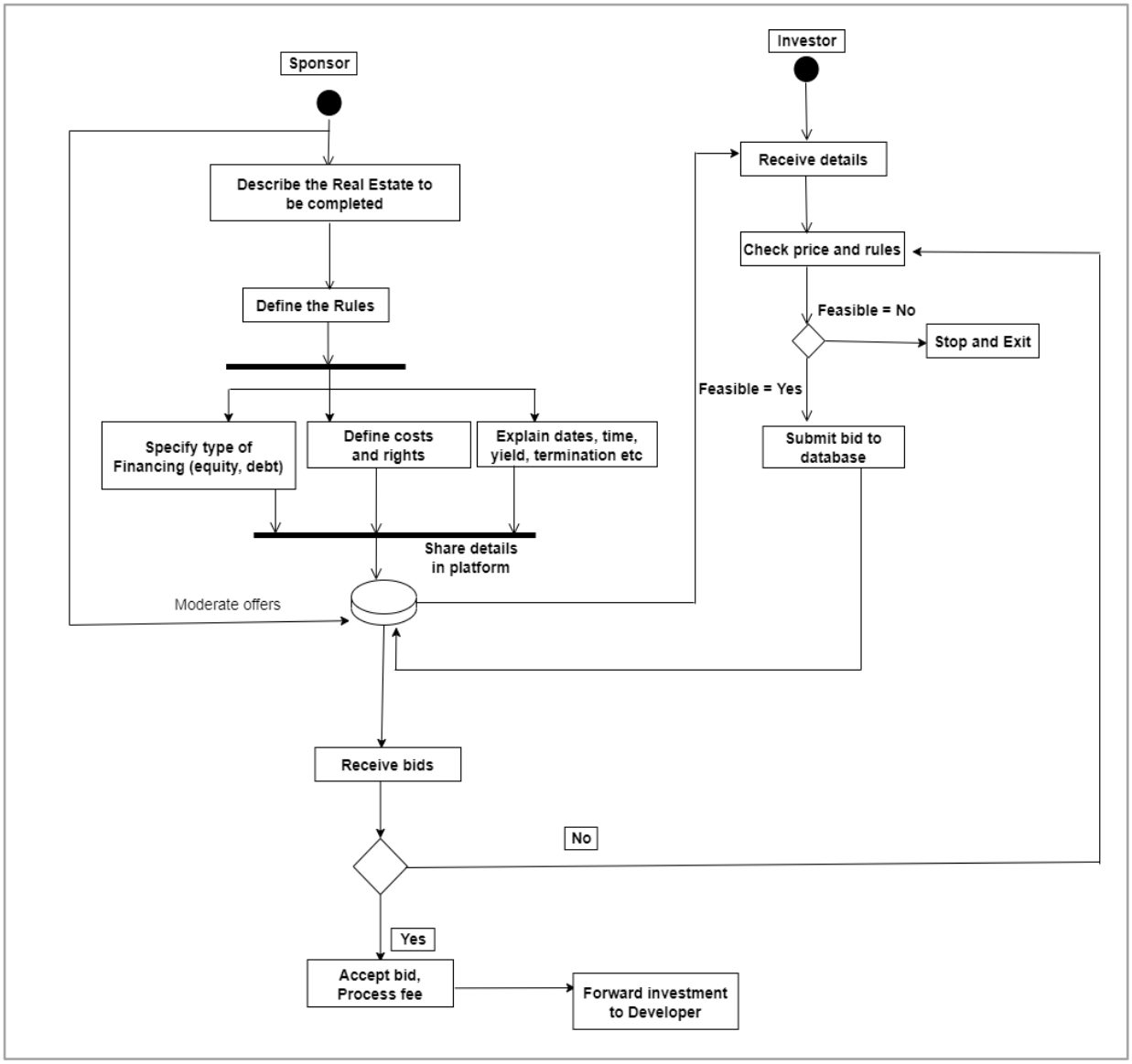

Fig 4 Flow Diagram for Traditional Fractional Property Transaction[6]

[6] Inconformity with (Hassija, et al, 2020 pg 9)

The buy process is perfected when an investor initiates a bid in accordance with the sponsor requirements. Once accepted, the bid becomes an investment and each investor's fund is forwarded to the sponsor's purse, until the required property cost is completely aggregated from several investors. If rejected however, the investors is alerted to begin the cycle all over. Specific areas of inefficiency within this transaction initiation model are evident from the diagram. Firstly, sponsors seem to have an enormous control and access to the database. This allows for deliberate or mistaken alterations of asset parameters or investors inputs and could led to fraud. Additionally, the back-and-forth movement of the transaction makes the process very time consuming and increases the transaction cost. Despite these challenges, however, the fractional property financing method have significant advantages over the common methods of financing private residential real estate in Nigeria. The next section discusses some of these advantages.

3.4 Some Benefits of Fractional Property Ownership in Nigeria

The modern fractional property ownership sprang from crowdfunding initiatives used to fund non-profit projects in the USA from the later part of the last two decades. As crowdfunding startup companies like Indigogo, Kickstarter, and Gofundme became popular internationally, small firms, in different economic sectors, began to use the same model to achieve their corporate objectives, in many countries. The total amount raised through crowdfunding in the world in 2014 was $16.2 billion, representing a 167 percent annual growth rate (The Crowdfunding Industry Report, 2015). African crowdfunding totaled $181.27 million in 2016, an increase of 118 percent from 2015. The majority of Western African crowdfunding platforms were located in Nigeria and Côte d'Ivoire. However, a sizeable portion of the investment volume (88 percent of the volumes in 2016 and 89 percent of the volumes in 2015) was raised through overseas platforms with headquarters in Europe and the US. Of this contribution from Nigeria, were several real estate crowdfunding firms that emerged in Lagos, Nigeria, at the beginning of the last decade (Emmanuel Chao et al, 2020). Interest in social media, the unprecedented growth of smartphone ownership and increasing access to the internet were enabling factors that promoted the growth of these platforms.

The technology upon which many of the fractional property ownership platforms rely offered enhanced reporting, and seamless transaction processes. Management fees were either non-existent or insignificant and investors were encouraged by the small

minimums required for a unit investment. In general, early real estate crowdfunding in Nigeria showed signs of disrupting the sector and could have addressed the inefficiencies of traditional property financing (Vogel, 2014). Additionally, the level of development of the capital or real estate market in a country has been identified as a factor that attracts the speedy growth of a new market like the fractional property ownership market. This factor explains why Columbia recorded some of the largest crowdfunding investments at some point. Small-scale investors in emerging markets like Nigeria and Columbia have very few options to put money into commercial real estate, thus, fractional funding partnerships become an easy bet for investors in such economies (Max, 2013).

Table 5 below is a comparison between Traditional real estate investments and Fractional property ownership. The comparison adopted from the commercial real estate crowdfunding company prospectus of Le bijou in Switzerland is meant to highlight the fundamental advantages fractional property financing have over traditional real estate financing options in Nigeria. Some specific advantages of fractional property financing to the Nigerian real estate environment are explained below. These advantages made the system a more attractive way of financing real estate to developers and a less bureaucratic way of acquiring real estate to investors. The expected outcome of this effect is that more Nigerian will became involved in the real estate business and more properties will get constructed every year. Thus, fractional property financing was quickly tagged as the solution to Nigeria's housing deficit challenge.

1. **Availability of Funds:** Arguably, the money related challenges of property development in Nigeria can be overcome if developers have full access to the budgeted funds required to complete the project on time. Increased cost of building materials and labor charges that occur due to the inflation or currency devaluation is often the reason many developers run short on their budget finances. The possibility of this happening is increased when there are time lags between rounds of fundraising. Such lag occurs because of the bureaucracy involved in raising finances for building phases. Fractional property financing is able to overcome this challenge since the full expected cost of a housing project is raised before the project even commences. This is made possible because the small minimums requested by sponsors attract multiple investors and all project cost is raised and handed to the developer before construction begins. This design makes it easy to avoid the time

wasted for inspections or for preparing and presenting completion certificates to banks and cooperative societies - a requirement for seeking new loan approvals. In the end, projects financed with the fractional property system are completed on time and annual rounds of rising inflation is avoided.

Factor	Traditional Real Estate Investment	Fractional Property Ownership
Initial Capital Expense	At least 100,000 euro	Often less than 500 euro
Geographic range	Most investors buy or build or invest in properties located in areas they know well (i.e., local)	Platforms offer properties from all over the country
Transaction costs	2-12% of the purchase amount (purchase)	Around 1-2% of the purchase amount
Income potential	Yield 3-10% depending on leverage	Yield 5-20% depending on leverage
Risk	Subject to market performance	Subject to market performance. Debtors may suffer from a risk of default.
Liquidity	Low as selling real estate takes time	Low to medium. Some platforms offer a secondary market for trading. Other platforms encourage buy-back schemes after a specified period of time.
Leverage	Up to 60% loan-to-value ratio	Indirect - the investor could invest in the equity tranche of the project.

Tab 5: Comparison between Traditional Real Estate and Fractional Property Ownership[7]

2. **Low Transaction Fees:** For an individual investor who can raise the full amount required to purchase a property, in a traditional real estate setting; as much as 10% of that cost is usually paid out, as management and transaction fees or in the form of value added taxes. Fractional property financing, on the other hand, allocates most, if not all the monies from an investor directly into the property. As a result,

[7] In conformity with lebijou.io company prospectus, 2022

considerably higher return on investment (ROI) than what is obtainable from traditional real estate investments can be realized through fractional ownership. Even more remarkable is that any fees associated with a fractional ownership transaction are often declared and known beforehand unlike typical real estate deals which may contain a lot of hidden fees.

3. **Certainty about Investment Returns:** For investor-type private property owners, estimating the returns of any investment can be very tricky. Proceeds from rent, lease or outright sales are subject to a multitude of factors. The general economy, local population, vacancy rate, quality of finishing materials could increase or reduce the profitability beyond normal. Using a hedonic pricing specification (Oluseyi et al, 2017) showed that the number of toilets, the existence of burglary alarms and other conditions can influence the valuation or worth of a real estate in addition to other basic conditions. Even with advanced statistics, predicting the exact impact of these factors is an impossible task. With fractional ownership, however, sponsors are obligated to define an expected range of profit for each project based on previous marketing experience. Preferred return ranges from 7% to 12% and an average of 8.35%. Though this is not always achievable, it serves as a guarantee and places a responsibility on sponsors to deliver returns (Realty Mogul survey 2012).

3.4 Challenges with the Fractional Property Ownership Process in Nigeria

As mentioned in section 3.3, despite the enormous benefits that fractional ownership has over traditional property financing, in Nigeria, there still exist some challenges which has altogether make the system unattractive to Nigerian investors. After more than a decade of its existence in the Nigerian real estate financing market, the expected impact of the system on the housing shortage is yet to be fully realized in the sector. Sadly, the observed challenges listed below has shifted attention form the system of property financing and more and more Nigerians now look towards the traditional systems for financing their properties. Between 2010 and the present time many fractional funding real estate firms in Nigeria have either liquidated or are currently struggling to survive. The challenges of Crowdyvest a renowned real estate fractional property financing firm in Lagos is perhaps the most popular. Crowdyvest had serious challenges meeting up with its debt obligations to investors in 2021, creating so much panic within the sector. Crowdyvest is not the only fractional property ownership startup in Nigeria that have had difficult times or even went bankrupt. By the summer of 2021,

nearly half of the crowdfunding real estate startups of the early 2010s simply vanished from the scene. This occurrence prompted many columnists to argue that perhaps the fractional property ownership model is faulty. Arguments on the other side, however, insists that these failure incidences are typical of startups in a new sector; and that as a new business model stabilizes and matures many small players are expected to give way for the big ones. Again, it is arguable that incidences like this are the result of unforeseen macroeconomic downturns and no fault of the firms. However, the highly inefficient processes and lack of transparency that is a hallmark of many of these startups did not help at all to reassure investors and instill confidence. The poor and reckless management or the fraudulent intent of some sponsors companies was also a reason for the instability that greeted the sector post 2020. Unfortunately, this has dampened the confidence of many Nigerians in an otherwise amazing solution to the national housing financing crisis. In general, the challenges in the Nigerian fractional ownership process can be grouped into transaction challenges and market challenges. The Table below gives a broad categorization of these challenges with a discussion of a selected few given in the adjoining text.

Transaction Barriers	**High Transaction Costs**	**Other Barriers**	**Uncertainty of Market**
	Digitization and Fragmentation Difficulties		Regulatory Restrictions
	Lack of Transparency in Transaction Process		Incompetent Sponsors
	Data Privacy		Financial Analysis Risk
	Cyber Security		Anonymity of Sponsor Organi-zations
	Lengthy Transaction Initialization Cycle		Cultural Definition of Property Ownership

Tab 6: Some Challenges of The Traditional Fractional Property Ownership Process

1. **High Transaction Cost:** The costs associated with the fractional property financing process varies from platform to platform depending on the extent of regulation and sponsor operating principles. To start with, investors are expected to pay credit card charges for payment processing, which could be as high as 1.5% of investment total. Then, there is value added tax deductions for both payments at the point of investment and withdrawals at the point of liquidation. In addition, many sponsors

charge a processing fee for every investment (Schweizer and Tingyu, 2016). This fee could range from 1% to 2% of invested amount. In cases where sponsors have no equity contribution to the property development and rely solely on this fee, the fee charged could be as high as 3% of the invested sum.

2. **Duration of Transaction Initialization Cycle:** Many investors find the number of days it takes to initiate an investment cycle, i.e., the period before full amount is realized from several investors and funds released to the Developer, much too long. Typical transaction cycle for fractional property financing is similar to those of other crowdfunding project and may run for as many as 90 days (Ethan Mollick, 2014). Although this time is several times shorter than the typical investment cycle of real estate funded from personal savings, the uncertainty about the actual timing is a lot unbearable for many investors.
3. **Digitization and Fragmentation Difficulties:** On the investor side, platforms are much too restrictive about fragmentation sizes. In many cases, the technology behind the platforms simply split the property into equal share of “bricks” due to technical difficulties and enormous computational effort required to have multiple fragments of different sizes. The challenge is to mobilize various investor types to cover the different investment logics exists on the one hand with the sponsor, and the challenge to invest in bits smaller than the technology allows exists on the other hand with the investor. Mobilizing all types of investors, with adapted approaches, makes the main objective of fractional real estate better achieved, and being unable to do defeats the purpose. The more sophisticated the technology upon which a sponsor’s platforms rely, the better the fragmentation options available to investors, whether they are small individuals or large corporates.
4. **Regulatory Restrictions:** In many countries of the world, the laws governing crowdfunding are highly undeveloped. Even some developed countries rely on the general existing public offering requirement of securities to regulate fractional property businesses. Therefore, under the existing laws, fundraisers who raise funds through equity, strictly speaking, are undertaking an act of unauthorized public offering of securities, which may not only suffer severe punishment of the administrative department, but it is also likely to touch the red tapes of “Criminal Law”. To avoid legal risks, a lot of sponsors work hard to offer their products smartly along the lines of these regulations. Unfortunately, this limits the extent to which this method of financing can be fully utilized. Compared to the harsh conditions and the

strict regulation of establishment of securities companies, however, the fractional property financing is still relatively less burdened by such detailed legislation (Xiuping Li, 2016).

5. **Lack of Transparency in Transaction Process:** (Olufemi, 2020) ranks fraudulent practices perpetuated by some sponsors in the Nigerian fractional property financing market as the most important risk factor limiting its performance. Poor regulation and ineffective law enforcement, contribute enormously to the risk of transparency that many such investors encounter in fractional funding ventures (Montgomery Nicolle, 2018). It was not uncommon for dubious managers of some of these platforms to take advantage of the weak regulatory systems in Nigeria and promise unusually high returns, just to lure unsuspecting investors, and defraud them.
6. **Incompetent Sponsors:** Some of the early cases of failure among Nigeria's Fractional property financing firms was brought about by the incompetence of the Sponsor' management team. The managers of some fractional property financing organizations lacked basic real estate managerial experience required to run the business successfully. They imagined that their IT skill was sufficient to run a real estate business. Real estate is a broad field with several interdisciplinary collaborations. Lawyers, economics, developers, architects, engineers, facility managers, etc. all make up key team members in typical property development firms, carrying out functions in development, financing, investing, acquisition, appraisal to operation. For a few IT geeks in a startup to claim overall expertise of these disciplines was certainly asking for too much. In reality, these founders have only basic knowledge of the real estate industry and the skills needed to properly examine the physical attributes of properties, value listings and obtain competitive prices were lacking. This of course led to terrible bad business decisions, for which, unfortunately, the unsuspecting investor suffers.
7. **Financial Analysis Risk:** Again, this is related to skill, competence, knowledge of market conditions and sponsor intents. Many ridiculous sponsors were in the practice of advertising return on investment, exceeding 25%. Yields of this nature are difficult if not impossible to achieve in the Lagos real estate market, which is as best as it can be in Nigeria. Of course, such eye-catching offers are meant to lure investors, whose hopes are dashed when rates get adjusted in time or when the companies simply close down from failing to meet their obligations. The disappointment

and pessimism that follow such incidences often lead to a de-marketing of the system. A rule of thumb to judge the credibility of an offer from a real estate crowdfunding company is to make a comparison of the advertised rates to the interest rate offered by commercial banks on fixed deposits and government treasury bills of the same principal worth and tenure. Once the variance seems too wide and illogical and too good to be true, such offer is likely to be scam. Real estate is usually a stable business and should only promise higher than normal returns when the risk is also higher than normal. It is puzzling though that many investors who have knowledge of this rule will still greedily put their monies on such ventures.

8. **Anonymity of the Organizers:** From the objectives of fractional property ownership, it is evident that; trust, integrity, and accountability of the sponsors, are important qualities to sustain their operations. Unfortunately, the online aspect of fractional property ownership creates a sense of anonymity, makes trust difficult and raises the risk of fraud. Again, many of such businesses lack a proper structure, do not own offices or a functional customer support system, thus, increasing the significance of the risk. Indeed, the operations of some Nigerian fractional ownership real estate firm in the latter years was not very different from typical Ponzi schemes. Investor funds are often diverted to other riskier ventures for quick gains, and funds of new participants were merely used to settle previous members until a drop in the rate of new entrants bursts the bubble.
9. **Cultural Definition of Property Ownership:** Another often-neglected reason why interest in fractional property ownership declined in Nigeria in the latter years, is that the decision to invest in a house in Nigeria is often beyond the reason of providing accommodation and shelter. Nigerians view house ownership as a feat and a status symbol. (Olufemi Oyedele, 2016) identified the “bandwagon-effect” and status symbol of property ownership as the two most important reasons for property investment decision-making in Nigeria. This factor becomes more important as one moves from the bigger urban centers to smaller towns and villages. Unfortunately, since no single participant in a fractional property ownership can claim full ownership of the building or units of the property, this desire is left unsatisfied with this system. In many cases, the exact location of the asset is not even known to investors, and they have to be content with receiving monthly or annual yields for their investment. For low-income earners who struggle to catch up with their peers and for whom actual ownership of a property is a big deal, the idea of investing a

significant sum of money and yet not being able to own a tangible portion of the property makes the venture unappealing. Thus, fractional property ownership is a more popular financing option among higher income earners and elites who are more concerned about investment yield than property ownership and who unfortunately constitute a smaller number of Nigeria's population. Cultural factors of this nature are often neglected when research of this kind is conducted. Historical evidence however suggests that these factors often carry as much weight as other empirical factors required for strategic decision-making. Thus, in the development of a better fractional property financing model for use in Nigerian real estate, particular focus has been placed on the social aspect of property ownership in Nigeria's rural and urban communities.

10. **Others:** The risk of cyberattack, desire of some investors to protect their digital identities especially as it relates to banking and financial data, changing national fiscal policies that mandated such crowdfunding businesses to pay exorbitant government taxes, the lack of disclosure requirements or due diligence on the part of investors have been highlighted by (Adekoya, 2019) as other limitations of the fractional property financing concept in Nigeria.

Given these challenges in fractional property transaction process and in fractional property ownership, the need therefore arises for further research into solutions in recent technologies that can sufficiently address the disadvantages inherit in the model while maintaining its ability to continuously influence investment volumes and to impact property supply in Nigeria. One of such technologies is the Blockchain technology which this researcher has identified as having the potential to address many of the challenges listed above. In the next chapter, a discussion of the characteristics of blockchain and its ability to tokenize a real estate more efficiently shall be discussed.

4 Blockchain and the Real Estate Industry

Blockchain technology gained worldwide prominence in the last decade because of the popularity of cryptocurrencies like bitcoin, ethereum and litecoin. Bitcoin, a digital currency that rely on the blockchain technology is the brainchild of a pseudonymous author: Satoshi Nakamoto, who released the bitcoin white paper in 2008. The white paper outlined the original reference implementation behind a new way of doing digital payments, that was remarkably different from the way typical card and chip payments or other financial technologies like PayPal that dominated the internet until 2008 was done. “Blockchain is a protocol that allows a secured transfer of unique instances of value (e.g., money, property, contracts, and identity credentials) via the internet without requiring the third-party intermediation of companies, banks, or governments” (Pethuru, 2021). It is a “decentralized, immutable and distributed public/shared ledger used for storing digital transactions and consisting of blocks interlinked via a cryptographic signature that is almost impossible to fake or disrupt”. What sets blockchain apart from previous digital storage and retrieval technologies is the fundamental trustlessness, decentralized processes, open-source capabilities and enhanced security that governs transactions on a blockchain. Blockchain thus, typically combines three main technologies: 1. cryptographic keys, 2. peer-to-peer networking, and 3. a digital ledger.

To understand idea behind blockchain in a simple and non-technical way, we will need to think of the ultimate goal of the technology: which is better storage, security and retrieval of information. In that respect, a blockchain is a database, a record-keeping system, or a structured data collection that is arranged and electronically stored in a computer system for quick processing and retrieval. In other words, it is database that stores data in a ledger format (timestamp, description of commodity (e.g., Bitcoin, medical record, or college transcript etc.), value (e.g., dollar amount) and unique user addresses), held like blocks of information. Data is continuously added in a chronological manner and secured through cryptographic encryption – a technique to turn plain text into “secret” so that only the sender and intended recipient can view the content (Casino, Dasaklis and Patsakis, 2019). The system relies on a distributed peer-to-peer network of computers (referred to as nodes) and does not need a centralized authority to confirm the validity of new data or blocks to be added; rather, parties involved in the transaction adhere to specified consensus rules for approving transactions and adding

new blocks to the chain. The blockchain technology takes the database concept a bit further by removing the need for intermediation or for a central authority to be in-charge of the database management.

4.1 The Evolution of Blockchain

As displayed in figure 5 below, blockchain has since transition from the early late 1980s when Chaum David introduced his Digicash to world. DigiCash was an early form of electronic payment that required a user to use software to withdraw cash from a bank as payment for online transactions. This was done by using specific encryption keys to prevent the recipients from seeing the sender's personal information while the transaction was being processed. In Chaum's proposal, a true two-key digital signature systems were coupled in a unique way with commutative-style public key systems. (D. Chaum et al. 1985). Although Digicash never gained commercial success, it was clear that the principles behind the system could be extended to other transactions beyond online payments. Transactions in this sense is a sequence of information exchange, including but not limited to, records of interchanges in economic, legal, and political systems. When transactions are done within a computer network, they are called digital transactions. Transactions define organizational boundaries and safeguard assets. They establish identities, confirm them, and record events. They control how communities, organizations, countries, and people interact with one another. (Iansiti and R. Lakhani, 2017).

In 1991, Stuart Haber and W. Scott Stornetta expanded on this principle and proposed the idea of digital timestamping of electronic documents so that it is not possible for a user to back-date or to forward-date a document, even with the use of advance computer timestamping services. The two were concerned about the question of trust in a digital transaction process, since there always needed to be some independent person or body to verify the authenticity of transactions and it creates real concern if that third party becomes part of a collusion”. Their method involved working on a cryptographically secured chain of blocks where no one could tamper with the timestamps of documents (Kalpa Kalhara Sampath, 2016).

In 1998, Nick Szabo introduced Bitgold, a decentralised currency served as a precursor to the modern bitcoin architecture. Bitgold combines different elements of cryptography and mining such as time-stamped blocks and proof-of-work (PoW) strings, to

accomplish decentralization. Bitgold combines different elements of cryptography and mining such as time-stamped blocks and proof-of-work (PoW) strings, to accomplish decentralizationIn order for transaction data to be securely kept and exchanged with the least amount of trust needed between all parties, a third participant in the transaction process would devote computer power to solving cryptographic riddles. Without a majority of the parties agreeing to accept new solutions, they couldn't begin working on the next problem, therefore the system provided a means for the network to validate and time-stamp new coins. This consensus mechanism provides an immutable record of all system transactions (Szabo Nick, 1998). The phrase "smart contract," which was first used by Nick Szabo twenty years ago, later served as the cornerstone of the Ethereum ecosystem. Without the need for an intermediary like a lawyer, notary, or governmental body, smart contracts allow for the establishing and enforcement of an agreement's conditions. Rather than someone's interpretation of legal language, the provisions are established in and activated by code. The assumption is that a computer code, unlike an authority, is neutral and can eradicate, or at the very least significantly minimize, subjectivity or malpractice. Simple digital currency exchanges, home sales, insurance payouts, and even bets might all be covered by smart contracts (Nick Paumgarten, 2018).

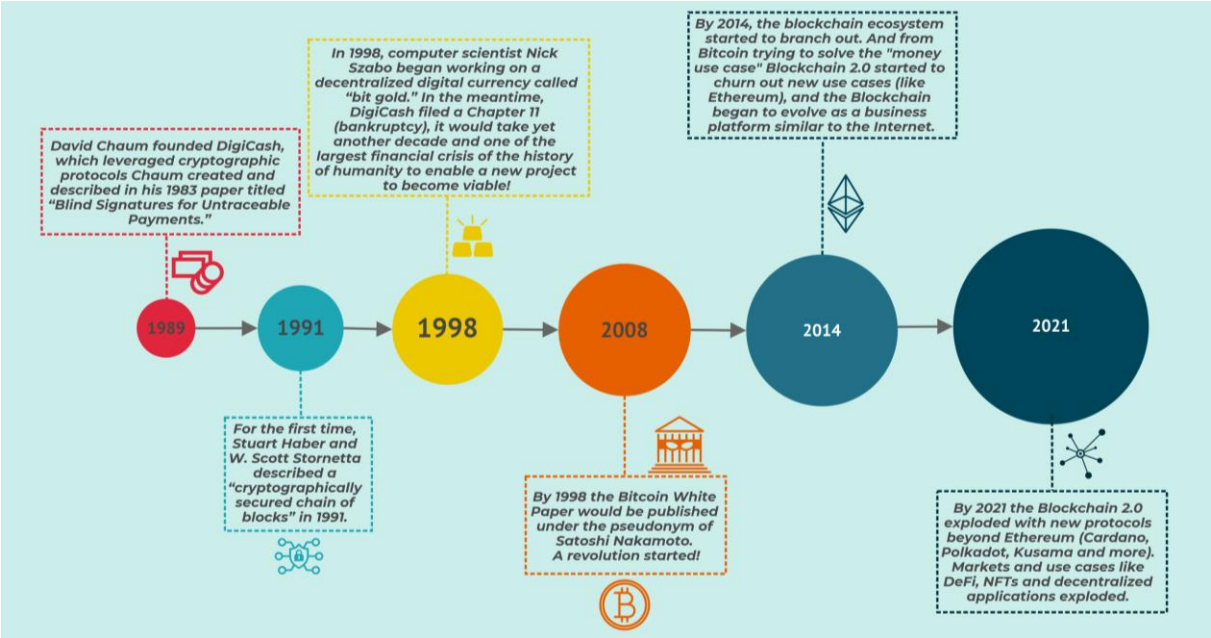

Fig 5 The Blockchain Evolution (Cuofano, 2021)

A major challenge inherent in the blockchain technology before 2008, was the problem of "double-spending" - the challenge of making sure digital currency or transaction data

is difficult to replicate since, once a block of data has been established, duplicating it is as easy as copying and pasting. Since the information with the copied blocks is as accurate as the original, the system continuously accepts duplicates. Under traditional systems, the verification provided by a third party, or an authority eliminates the possibility of double spending. Many digital currencies or transactions on a blockchain attempted to solve the problem by simply going traditional and relinquishing some control to a central authority, which keeps track of each account's balance. Enters Satoshi Nakamoto in 2008: *"I have been working on a new electronic cash system that's fully peer-to-peer, with no trusted third party…double-spending is prevented with a peer-to-peer network, no mint or other trusted parties, participants can be anonymous, new coins are made from hash cash style proof-of-work, the proof-of-work for new coin generation also powers the network to prevent double-spending"* (Satoshi Nakamoto, 2008). With the words quoted above, sent in an email sent on 31st October 2008 an anonymous academic or group of academics introduced the world to a nine-page paper containing findings of a disruptive computer technology for carrying out digital transaction. In addition to solving the issue of double spending, Satoshi's innovation resulted in the development of a massive worldwide network and a number of distributed ledger technologies (DLT). Thus, Satoshi's creation of bitcoin is the source of Blockchain 1.0. The ledger has no master in Nakamoto's blockchain, making it a decentralized, non-permissioned blockchain. In Satoshi's approach, double-spending might be prevented by generating computational verification of the chronological order of transactions using a peer-to-peer distributed timestamp server. That is to say, parties must agree on a single history of the sequence in which transactions were received and transactions must be made known to the public. When a transaction takes place, the payee needs proof that all nodes agreed it was the initial transaction. Figure 6 shows a diagrammatic representation of the processes Satoshi uses to summarize the blockchain's operation.

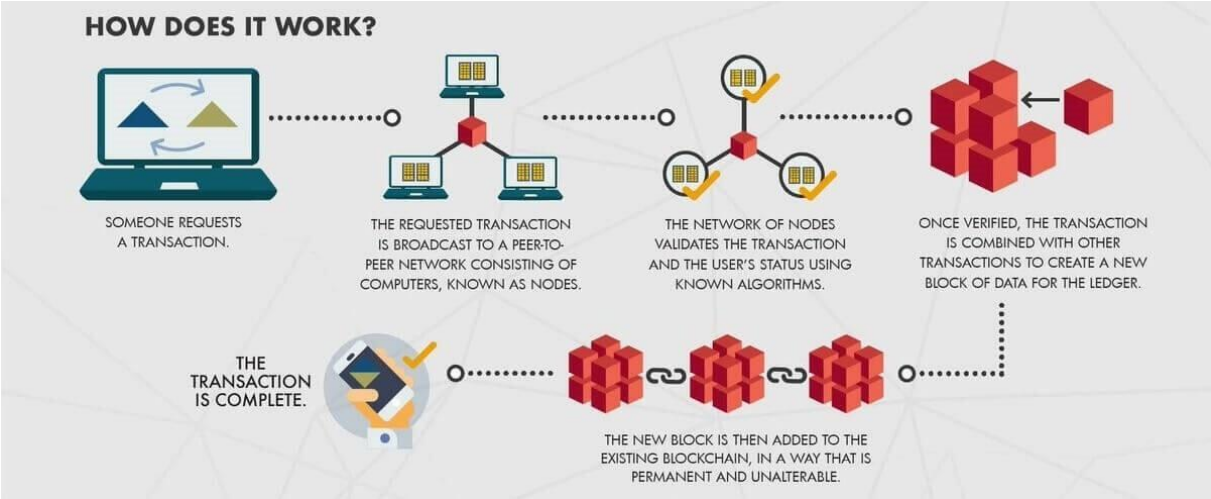

Fig 6: The Blockchain Transaction Process. *(Source: The Burnie Group)*

1. A user asks for a transaction
2. The transaction is broadcast to every computer (sometimes referred to as a node) on the peer-to-peer network.
3. The network validates the transaction using preset consensus procedures.
4. To build a new block of data for the ledger, the transaction is combined with existing transactions.
5. The new Block is included into the current Blockchain and becomes unchangeable and permanent.
6. The deal is concluded.

In summary, the modern blockchain is a distributed and digital ledger of data that continuously adds information in chronological order. The data is immutable once it's added to the chain, thanks to hash (digital fingerprint) being assigned to the block. If transactions in the block are altered, the block's hash is changed. The modified hash renders the subsequent block's invalid, causing it to no longer match the initial hash value of the preceding block. Because of the irreversible nature, it's harder for hackers to tamper and falsify the transactions because any changes must be verified by at least 51% of computers on the network.

Soon after the release of the bitcoin whitepaper, the world's first bitcoin software was downloaded in January 2009 by Hal Finnay who received 10 bitcoins as the first bitcoin transaction. By 2018, there were more than 1,500 cryptocurrencies, popularly called 'alt-coins' and in 2021, bitcoin got to its peak value so far, exchanging for almost $68,000 per coin. Today, there are a lots of billion dollar businesses, including Dell,

Reddit, Expedia, PayPal, Meta, Microsoft that accept bitcoin and other cryptocurrencies as a form of payment. Around 2014, developers and private companies began investigating other use cases of the blockchain technology. Key features of the technology like its immutability, enhanced security, speed, and scalability made many businesses consider ways to adapt the technology to enhance their business processes. Thus, Blockchain 2.0 was born as an adaption of blockchain in other transactional and inter-organizational processes apart from currency. Around this time, the Ethereum ecosystem was conceived by Vitalik Buterin, a Russian-Canadian computer programmer. Buterin argued that Bitcoin and blockchain technology could benefit from other applications besides money and that it needed a more robust language for any development that would lead to an inclusion of real-world assets, such as stocks, real estate, or e-governance, to the blockchain. A new platform with a more powerful scripting language was proposed by Buterin in 2013; this platform would eventually become Ethereum. Anyone may create decentralized applications that are permanent, irreversible, and interact with users on Ethereum. Without the need of conventional financial intermediaries like banks, brokerages, or exchanges, decentralized finance (DeFi) applications offer a wide range of financial services. Blockchain 2.0, for instance, enables cryptocurrency users to borrow money against their holdings or to rent their coins out for interest. Using Ethereum, users can also create and trade non-fungible tokens (NFTs), which are special tokens that reflect ownership of an associated asset or privilege and are accepted by a variety of institutions. Additionally, the Ethereum blockchain network created Smart Contracts, incorporating computer programs that stand in for financial assets like bonds in the blockchain technology. Ethereum Smart contracts are pieces of software that execute when certain criteria are met and are kept on a blockchain. They are used to automate the implementation of an agreement so that all parties can be confident in the result right away, without the need for intermediaries and without wasting time.

4.2 The Blockchain Transition from the Trust Economy

Nick Szabo developed bit gold in the early 1990s to address some of the shortcomings of the conventional financial system. Szabo contends that for transactions to occur in the conventional financial system, parties must establish a high degree of trust in each other. For instance, “a consumer needs to find a broker before they can apply for a loan. Once they've consented to accept the loan from a financial institution, the

institution must have faith that the borrower will make the loan repayments on time. In the same way, clients of a bank must have faith that their funds are safe and not being stolen by the institution" (Zeranski and Sancak, 2020). Consumers and financial institutions are unfortunately prone to fraud and theft while conducting transactions using trust-based systems. The Wirecard payment processor fraud and forgery of 2020 in Germany, is a recent and typical example of how the middleman in a trust-based system can abuse their authority. In fact, Szabo introduced bit gold, a more trustless model for transacting, as a result of the financial system's history of consistent losses and the enormous expense of this fraudulent activity and walled design. Almost all businesses as we know them operate on such trust-based, centralized, and permissioned systems. ERP systems are commonly used in banking, insurance, logistics, and transportation, health care, government, education, and the real estate industry.

The data on a blockchain is arranged very differently than a typical database, in contrast to conventional trust-based systems. A blockchain organizes its data into blocks, as opposed to traditional databases, which store information in tables. Each transaction that occurs on the network can be added to these blocks, which have a set amount of storage. Once a block is full, another block is added to it to accommodate new transactions, creating a chain of blocks known as the blockchain. Blockchains are not kept in a single location since they are decentralized. As an alternative, they are kept on network nodes or PCs. Every node possesses a copy of the network's transactions, or the blockchain, in other words. Therefore, each node connected to the network provides backup for the system. The traditional transaction systems with a centralized architecture and the new systems based on blockchain are contrasted in Figure 7 below. This diagram makes it quite evident that in traditional systems, the intermediary entity was completely in charge of overseeing all interactions between different businesses and people. But with the advent of blockchain, the middleman's function is eliminated, and most network nodes now have to confirm the transaction's legitimacy.

The integration of public blockchain and distributed ledgers to business processes provides enormous advantages to most organizations. To better understand the use cases of bitcoin 2.0, we shall define certain key terminologies associated with the technology and list out use cases that rely on each specific features represented by the terminology as shown in Table 7 below.

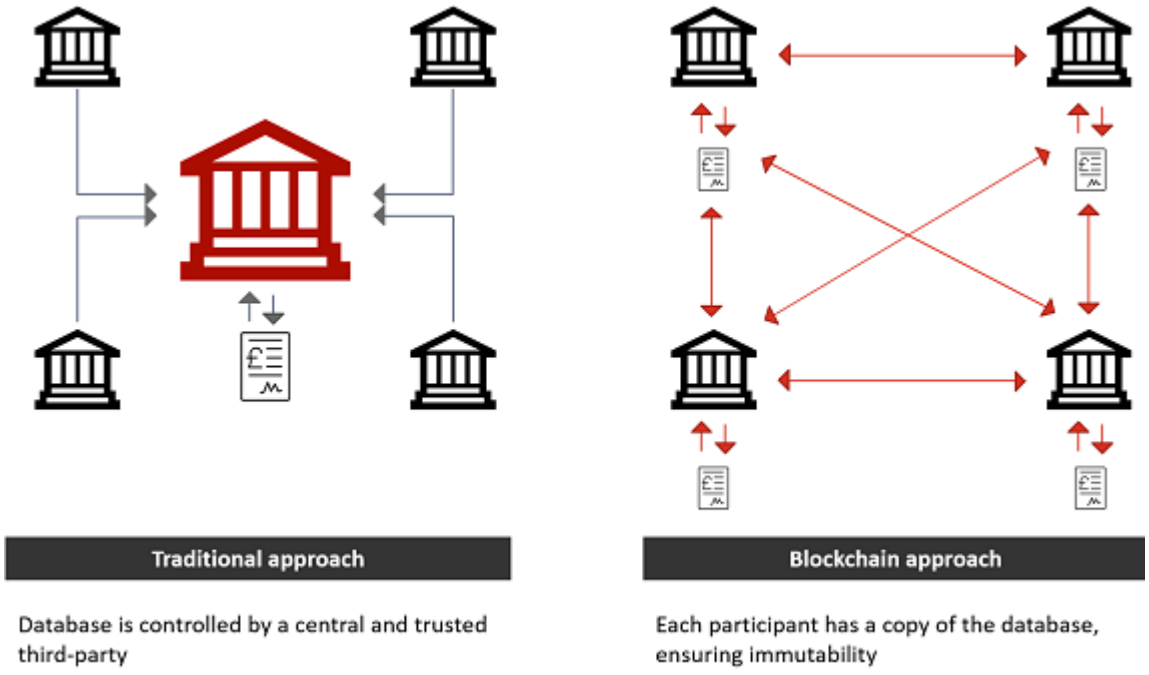

Fig 7: Traditional Transaction systems versus Blockchain-based systems (Arif Furkan Mendi et al, 2018)

The integration of public blockchain and distributed ledgers to business processes provides enormous advantages to most organizations. To better understand the use cases of bitcoin 2.0, we shall define certain key terminologies associated with the technology and list out use cases that rely on each specific features represented by the terminology as shown in Table 7 below.

Blockchain technology is currently being applied increasingly to the main economic sectors of developed countries, especially in the financial sector. The financial industry already gained from the benefits of settlement and clearing, to the point that multiple exchange sites are attempting to introduce their own trading platforms for virtual assets. Therefore, managers must also broaden their selection of products and services. In recent years, the adoption of blockchain technology has gained significant traction not just in the financial sector but also in the real estate market. The convergence of real estate and blockchain tokenization has considerable implications for property developers, owners, and investors. The possibility of expanding the less than 1% of real estate market tradable on an exchange shall become possible with the expansion of the tokenization concept Currently, only 3% of the global financial exchanges is already covered by blockchain tokenized assets.

Feature	Details	Use Case
Tracking/registry	No one party has asymmetric influence over the data and information, which is recorded in an unchanging and transparent manner.	Land title management and transfer
Identity/authentication	Blockchain technology makes it possible to handle identities and rights for authentication or verification, as well as to confirm identity attributes without disclosing sensitive information.	User access and identity authentication in computer applications and IoT devices. Luggage identification in travel and tourism
Settlements	Settling income by keeping track of the movement of commodities and revenues as well as the utilization of services and assets.	Money transfer, exchanges, capital market trading
Transactions	Blockchain enables the real-time payments for transactions at super-fast speed using lightening network. El-Salvador and Chad are two countries currently experimenting with this at national scale	Digital Payment for purchases through lightening networks
Token exchange	Virtual currencies and tokens with inherent value are traded between several parties. Virtual currencies and fiat currencies may also be connected, with equal sums held in escrow accounts.	Non fungible tokens in arts, media and entertainment. Real estate tokenization
Security	DDoS attacks and the alteration of records are virtually unachievable thanks to the widespread use of blockchain technology and the consensus algorithm that verifies all transactions.	Banking
Cost efficiency	Middlemen who take a share of transactions may disappear	Supply chain Management

	because of the ability of blockchain consensus algorithms to build confidence through openness.	
Traceability	An unchangeable ledger can be used to record transactions, which may assist prevent fraud and shield you from accountability.	Supply chain Management
Transaction Speed	By eliminating the need for human oversight, automated smart contracts may speed up the completion of transactions.	Supply chain Management
Confidentiality	As in the case of personal medical records, information might be transmitted across organizations without their cooperation.	e-Governance, elections and voting, medical record keeping

Tab 7 Blockchain 2.0 Use Cases (Eray Eliaçik ,2022).

4.3 A Technical Review of Key Solutions in Blockchain Concept

There are certain key features of the blockchain that makes it uniquely able to address the limitations of the traditional fractionalization process. We shall discuss a few of these principles and how they directly affect aspects of the property tokenization concept.

1. **Cryptography and Security:** The objective of cryptography is to offer private and secure communication routes (Franco, 2015). Without cryptography, hackers and intruders may listen in and even take over the cyber channel upon which transactions occur. The mere thought of this scares away investors. Using blockchain cryptography, a single user transfer data to a different user without involving an unknown third party. Three of the many cryptographic tools that bitcoin uses include
   - Public key cryptography.
   - Hash functions.
   - and private keys in a user's wallet, secured using symmetric key cryptography.

The advanced level of cryptography used in blockchain transactions, assures investors in a blockchain transaction process of two things: 1.) Their personal digital data is secure and 2.) their investment cannot be manipulated by unknown and unwanted third parties. Because there is no single point of failure, blockchain technology is regarded as being more secure than its counterparts. Data is always circulated via several nodes since blockchain operates on a well-distributed network of nodes. This ensures that even if one node is compromised or malfunctions in any way, the integrity of the original data will not be affected (Franco, 2015).

2. **Consensus Protocol:** The very efficient nature of blockchain technologies is due to the consensus algorithm. It is a distinctive trait and an essential component of any blockchain. Simply explained, consensus is the group of active nodes on the network's decision-making process. For a system to function properly when millions of nodes are validating a transaction, a consensus is unavoidably required. It may be compared to a voting process where the majority wins and the minority is required to support it. In actuality, unanimity is what renders the system untrustworthy. The algorithms that run at its heart can be trusted even if the nodes do not trust one another. All members in the peer-to-peer network come to a consensus protocol (Kraft, 2016). A consensus protocol is used to ensure that network members abide by its rules and that the transactions are validated in the correct sequence. This feature of blockchain is how the problems of transparency in fractional property ownership transactions is avoided. The system thoroughly removes the need of a middleman because of his potential of abusing his absolute power. In economic science, transparency is viewed as the sharing of information to participants in the market, information is the polar opposite of transparency asymmetry. According to (Yun and Chau, 2013), to avoid obscurity in transaction workflows, information should be presented in a clear and accurate manner. Blockchain systems satisfies this requirement.

   Additionally, unlike public ledgers which notify the public about transactions and participants, and lack security or authority, private or federated ledgers, linked into a blockchain system, do not have this problem. This is so because every other user on the system keeps track of the network's ledger. To achieve a better result, processing power is spread among the machines. The distributed ledger makes the process transparent and dependable by enabling anyone with the necessary

access to observe the ledger. Distributed private ledgers are immutable and tamper resistance because of the consensus protocol required for modification.

3. **Smart Contracts:** The Ethereum smart contract system, which enables and executes complicated contracts automatically, is one reason the technology is so popular (Omohundro, 2014). For example, a smart contract system makes it possible to precisely define and carry out many types of transactions autonomously, like financial exchanges, derivatives, and insurance contracts. The extension of smart contracts is intended to include applications for information and interactions of records of property ownership in both real estate and automobiles, as well as insurance for earthquakes or weather and automatic property rental. If the contracts are automated, "Distributed Autonomous Organizations," or DAOs, which enable selling procedures, decision-making, and employment administration without human management, becomes possible.
4. **Decentralized Storage:** The ability to hold your assets in a network without being under the supervision and control of a single person, organization, or other body is provided by decentralized technology. By using a key that is attached to the account, the owner can take direct control of their account and transfer their assets to whoever they like in secondary markets. Decentralizing the web with the use of blockchain technology has proven to be a pretty effective method, and it has the potential to completely revolutionize the internet. There is a lower chance of failure or error because a majority of blockchain operations are automated and do not require much human control. With decentralization, users are now in charge of their assets. They are not dependent on a third party to keep their assets in good condition. They could all complete it simultaneously if they worked alone. There is no single point of failure because the decentralized system distributes each database over numerous nodes around the world, so even if one computer is compromised, the blockchain will be secure. There is no potential for individuals to con you out of anything because the system is algorithm-based. No one is allowed to use blockchain for their own financial advantage. Also, traditional trust-based systems are incredibly slow when transactions involve different stakeholders of various investments. Blockchain can help us overcome this issue of speed because it can quickly resolve money transfers. In the end, this saves these institutions a ton of time and money and offers ease to the customer.

5. **Optimal Pricing:** With the aid of a smart contract, a blockchain system can apply the Hungarian method to derive the optimal cost or minimum units of fragmentation that gives the optimal benefit to the investors and developers. The Hungarian method is s a combinatorial optimization algorithm that solves the assignment problem in polynomials (Munapo, 2002). A use case of the Hungarian model is in the systematic review of bids prices when awarding contracts. This can be extended to split-second assignment of an optimal costs and units based on investors offer. For instance, if there are three participants in a transaction process: Paul, Mark, and Chris. They each have varied requirements for investments and compensations. Finding the lowest possible investment required to complete the property from all contributions and a reasonable yield to each investor is the issue here. A matrix representing the problem, is shown in the table below.

	Investment proposal	**Yield Expectation**	**Current Allocation**
Paul	2 euros	3 euros	3 euros
Mark	3 euros	2 euros	3 euros
Chris	3 euros	3 euros	2 euros

Tab 8 Sample Hungarian Matrix

The Hungarian technique, when applied to the above table, could yield the lowest cost, as maybe 4 euros, and apply the above to demand the fragmentation limits.

6. **Scalability**: The ability of Blockchain technology to expand the network's capacity is by far its most impressive feature. This feature arises from the fact that many computers are interconnected, which gives them a greater overall power than a small number of centralized machines.
7. **Blockchain and Regulation**: Stronger regulatory regimes will view a token that makes trading units in a building or a fund as a security token and will subject it to the highest investment regulations. Because it is simpler to develop a tokenized security (a real estate company, trust or partnership, or fund) than to create a security token out of a physical asset like real estate, less restrictive regulatory regimes will try to attract digital business. Strong SECs, such as the United States, take a firm stance and treat tokens as securities, regulating them accordingly. Switzerland is more lenient, whereas the EU is more practical. Tokens are classified in the EU as either security tokens, which are regulated, or utility tokens, which are unregulated. Within blockchain, certain features make the need for regulation

unnecessary (Baum, 2022). For instance, in the aspect of financial due- diligence, money laundering is avoided because the system verifies identities and keep track of token owners in any manner that makes such records immutable or indestructible. All that is needed is for the regulators to be able to call-up such records when necessary.

4.4 Blockchain Tokenization and Fractional Property Ownership

The blockchain technology also offers several opportunities for application in the real estate industry. The immutability and transparency features that the technology affords has made its utilization as a proof of concept in tracking land titles and for the granting of land use right through decentralization and peer-to-peer transfers a major subject for research among many scholars (Chinwe Speranza et al, 2020). Tokenization in the context of blockchain refers to any application of the technology to represent a stake in a different asset. The interest could be direct or indirect, and it could entail having a beneficial stake in real estate (because only four owners are permitted to have registered title legally), with the token serving as proof of ownership. Some rights and income would naturally go to the holder of the token (Baum, 2020). Therefore, a blockchain token is a digital share of an asset (Benedetti et al., 2019), and real estate, works of art, media, intellectual property, and money are all examples of digital non-fungible tokens. The effective division and representation of various assets as digital tokens is made possible by blockchain. Individual "tokens" in real estate serve as asset-level representations of the underlying property with all its rights and duties.

In real estate tokenization, the property is held in trust by a holding company, similar to a sponsor organization in the traditional fractional property ownership system, through which property managers, valuers, auditors collaborate. The company, through this structure manages the development and operation of the whole asset. A blockchain, such as the widely used ethereum blockchain, can be used to establish a smart contract, and to compliment a blockchain tokenization transaction (Antonopoulos & Wood, 2018). Ether, the cryptocurrency of the Ethereum ecosystem is often used as the medium of exchange in such transactions (Johannes Wåhlin, 2021). Real estate tokenization is a broad concept that can refer to various things. It may mean transforming a single property into 1, 000,000 tokens, using a token to represent debt secured against a single property, or reflecting shares in a real estate investment trust with

tokens. The term "digitalization of assets" could be used to refer to all these strategies for tokenizing real estate. Real estate tokenization refers, for the purposes of this research, to the digital fractionalization of real estate assets, debt, and finances.

By combining the concept of tokenization and smart contracts, an efficient transaction process for funds syndication in real estate financing can be developed from conceptualization to the operation phase. In this procedure, so-called "smart contracts" are used to define the contractual terms with the investors. The algorithm included in the digital contract causes the stated events to occur whenever a pre-defined contract condition is satisfied in the transaction workflow. A transaction or the transfer of real estate as digital tokens to an investor's accounts, for instance, can happen without any human involvement. Real estate tokens are normally traded on the digital platforms of holding or sponsor company. They can also be traded through divestments in secondary markets, as in the case of equity ownership, when the investment undergo liquidation or at the end of a transaction cycle. By using smart contracts and the blockchain, the yields and ownership of the tokens are dispersed, transferred, and recorded in a read-only memory (ROM) (Pang et al., 2020).

Utility tokens and security tokens are two distinct types of tokens. Security tokens are digital representations of financial products like, real estate, and commodities that are built on the blockchain. Another distinction that needs to be made in the area of security tokens is between equity tokens, which are akin to traditional shares, and debt tokens, which are the blockchain equivalent of bonds or debt-type fractional property ownership. A utility token, on the other hand, grants the holder access to a particular service, such as cloud storage, conference room use, building entry, and so forth instead of financial returns. Although we can envision how building-related utility tokens could become more helpful and a standard way of accessing space and being charged for that use, this report primarily focuses on security tokens. (Sean Stein Smith,2019). Aspencoins are one the first attempt of tokenization globally. Asper tokens represent a portion of the U.S. state of Colorado's St. Regis Aspen Resort's equity. These digital assets were distributed to buyers via a security token offering (STO), which was first marketed by Indiegogo and produced by Templum. The issuance is a regulated securities subject to SEC regulations and was reported to have an estimated value of $18 million. This first tokenization of a real estate security is frequently attributed to this single asset transaction. Tokenization quickly gained popularity after the Aspencoin

capital round in October 2018. Parking spot in Tech Park Ljubljana is one of the first tokenized properties in Europe (Slovenia, EU). The project report (Blocksquare, 2019) states that "the modest property had been waiting on the market for approximately 6 months, but tokenization allowed the issuer to sell it in 16 days and even create a premium on the valuation. The over twenty token holders of this property have been receiving monthly dividend payouts derived from the rents generated since the tokens of this property began trading on a dedicated decentralized exchange in November 2018. All of this was done without the use of traditional banking thanks to blockchain and smart contract technology. (Wouda, H.P., 2019) recommended the need to introduced tokenization as further enhancement to a blockchain driven transaction process of office building in the Netherland. Figure 8 shows the transaction lifecycle of a typical property tokenization transaction process, and the transaction sequence is discussed in the next section.

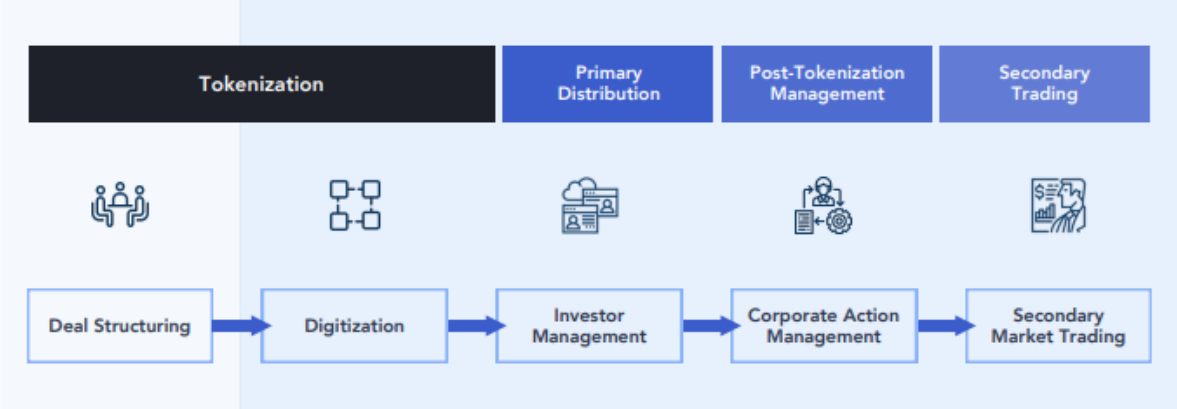

Fig 8 Life cycle of a Blockchain Property Tokenization (Colliers International et al., 2020)

The blockchain tokenization process normally comprises of five stages:

Stage 1: Deal Structuring: this step involves taking decisions about terms and conditions of the token and a selection of the blockchain technology to be employed. Compliance wth legal and regulatory requirements also takes place in the stage. Security token ownership and transfer are typically governed similarly to how traditional securities are governed. Accordingly, compliance is taken into account from the onset. The applicable financial securities commission rules are followed with regard to legal ownership, investor Know Your Customer (KYC) procedures, and other financial compliance measures.

Stage 2: Digitization: this is the implementation of the result of the structuring stage, and it involves deploying the documentation into a blockchain infrastructure with smart contract codes. Tokens can then be issued.

Stage 3: Investor Management: at this stage, the investors are given access to the tokens in return for their capital during the subscription period. l which is often in form of cryptocurrency that was exchanged for fiat currency. The distribution is done via the sponsors platform or in public exchanges.

Stage 4: Corporate Action Management: this involves profit distribution, investor decision making and voting (where the investment is in equity form). Smart contracts embedded in the coin automate these processes. Until the token matures or is redeemed, post-tokenization management will be ongoing (Johannes Wåhlin, 2021).

Stage 5: The final stage, involves liquefying the tokens or secondary market operations: A fundamental difference between traditional fractional property ownership and blockchain tokenization in real estate, is that there is still hardly any interaction between the sponsor and the investors in any of the stages, especially in this final stage. At liquidation, the tokens are traded in secondary market and the earning converted back to fiat currency traded at prevailing exchanges rates. Figure 9 shows various elements in a typical smart contract of a property tokenization process. As indicated in the diagram, the tokenization process is mainly a combination of the fragmentation of the asset (in this case fractional real estate) and a programmable smart contract executed as corporate action, with or without automated regulatory compliance. The diagram is the typical outcome of the digitization phase. A diagrammatic explosion of the detailed transaction process is also shown in figure 10 below.

An inherent characteristic of blockchain property tokenization is the possibility of splitting the assets into equal proportions of the smallest possible unit. This possibility enables several small investors get access to the same property or portfolio of properties in units they can afford. The technology provides the ease of customizability which was missing in traditional investor developer syndication or digitally enabled fractional property ownership. Blockchain tokenization has the potential to dramatically boost the liquidity in the real estate market due to its fractionalization and customizability features. From the standpoint of the issuer, blockchain tokenization enables sponsors to access a broader pool of investors and a wider investor base. The lifecycle of the tokenized

security's operational costs is also decreased by the automated and optimized processes.

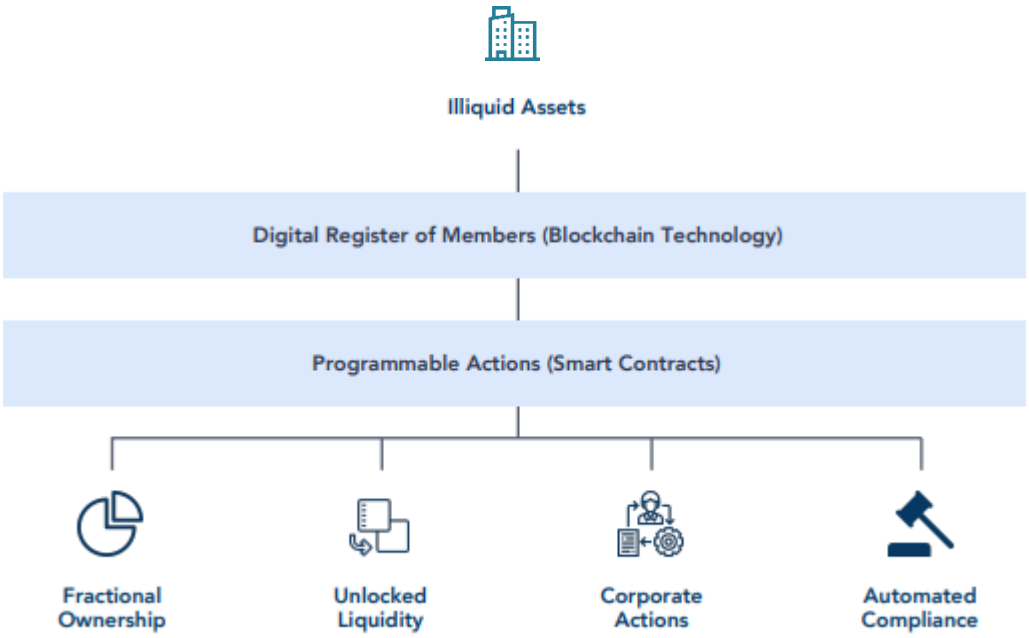

Fig 9: The Blockchain / Smart Contract Digitization Process

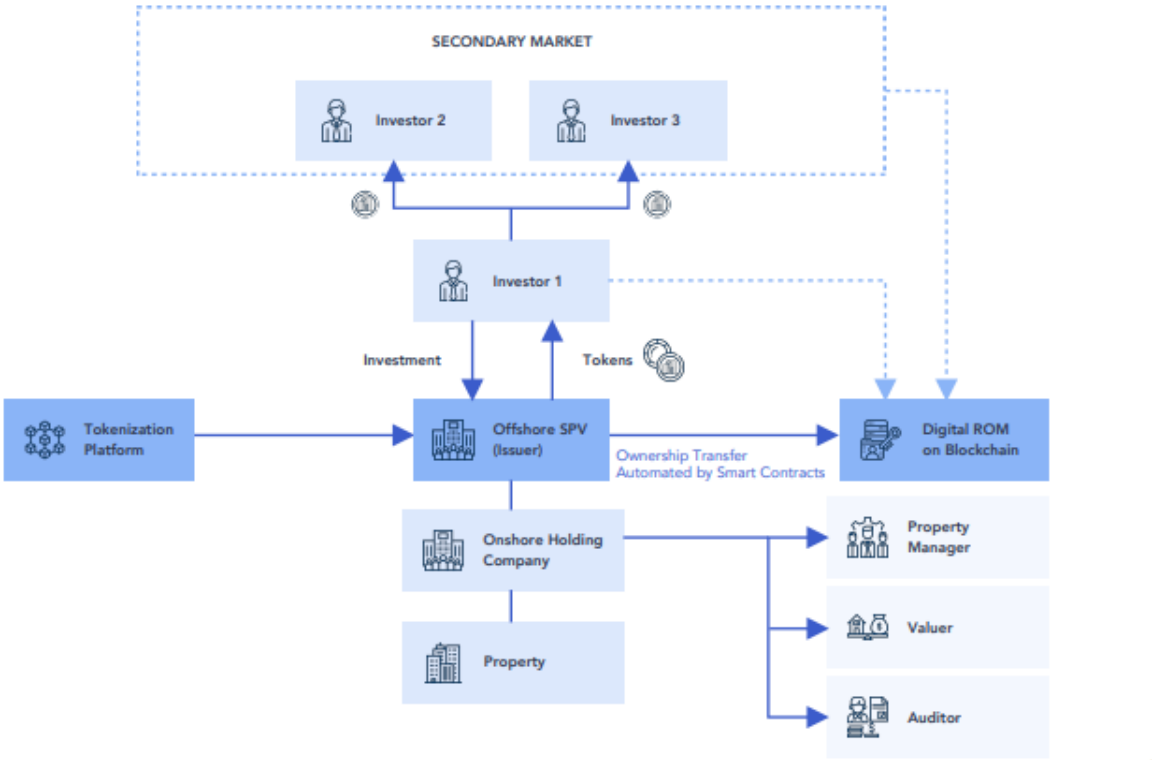

Fig 10: Detailed Illustration of a Tokenization Transaction process

With an immutable record of ownership always kept on blockchain, settlement enabled by blockchain technology enables the transfers of ownership rights in the asset faster and safer. The small real estate tokens that blockchain tokenization offers enable accessible investment opportunities in this asset class in ways that are significantly better than traditional crowdfunding for investors who previously were unable to afford the high upfront capital requirements of property investment. Blockchain tokenization enables customized portfolio rebalancing with nearly instantaneous settlement for larger investors seeking portfolio diversification. This allows investors to sell or buy tokens to change their exposure to a specific asset from the secondary market and flexibly manage a wider range of assets in their portfolio. (Lanzarotti, 2022). This is beside the additional benefits of the applying the technology to property financing such as: the absence of a frequent interaction between investors and sponsors, notary visit, the time spent considering purchase taxes and transaction costs and other factors that could slow down a transaction process. The result is an increase in transaction efficiency and time savings. (Benedetti et al., 2019). (Johannes Wåhlin, 2021) also mentioned automatization, data transparency, secure record keeping and anti-money laundry compliance, as crucial benefits of blockchain property tokenization. On the aspect of debt-type fractional property financing, the process of loan syndication is made seamless with the use of smart contracts in blockchain driven tokenization. Smart contracts constitute a more effective binding contract capable of executing debt default penalties without human intervention. In the equity type investments, the direct automatic transfers implemented by smart contracts make the investors easily enjoy positive fluctuations in the dividends of their investments. What is more, even the leasing of properties at the operating phase can be carried out on blockchain driven transaction system. This is made evident by Hugo Peter et al in their investigation of blockchain application for office transactions in the Netherlands. As concluded by (Hugo Pieter Wouda et al, 2019), the introduction of blockchain to the transaction flow resulted in a less cumbersome, transparent, and efficient process. These benefits of blockchain tokenization prompted the Oxford in its 2020 publication “Tokenization: the future of real estate investments?” to conclude that with blockchain, the high capital requirements for entry into the real estate industry can be avoided because tokenization and smart contracts implemented on the blockchain can democratize the access to real estate investments, can automatized trading, increased cash flows, and enhance compliance and document verification (Baum, 2020).

A relationship exists between the price and the liquidity of property token almost the same way money supply, the velocity of money, the price level and the transaction volume are interrelated in macroeconomics (Buterin, 2017). The equation:

MC=TH

summarizes this relationship. Where:

M = Token supply
C = Price of the token (= 1/p)
P = Price level
T = Transaction volume
H = Holding period of the token (= 1/v)
V = velocity of money

The formula demonstrates that the relationship between token price and token velocity is inverse. Or, to put it another way, the value of a token increases the longer an investor holds it. One distinctive aspect of blockchain tokenization is the enhanced secondary market activity this generates. Recent financial analysis demonstrates that, even in a weak market, the real estate token indexes' total return falls between the S&P 500 and the Detroit housing index (Johannes Whlin, 2021). Additionally, blockchain technology can ensure a secure record-keeping system of the owner right to properties in several developing nations with untrustworthy governments (Benedetti et al., 2019). Anti-money laundry and fraud is thus better supported with increased monitoring and transparent processes.

The technology is however not without its drawbacks. Environmental sustainability is perhaps the most important challenge of blockchain. Blockchain mining consumes an enormous amount of energy and is currently considered one of the biggest contributors to carbon emissions globally. There have been some push backs in the growth of the technology from governments and climate activists from the point of view of environmental sustainability. In reality, though, the real concern should be that an overwhelming 84% of the world’s total energy is still generated from fossil fuel sources. Practical efforts like the attempt by the government of El Salvador to build a community of blockchain enthusiast supported with energy generated from geysers and other renewable sources is needed to overcome this challenge. Additionally, the land use act of many

countries makes it impossible to tokenize some assets like land, as the law does not allow deeds to be held simultaneously by multiple investors. This is particularly important in a clime like Nigeria where direct ownership is a motivation for property investment. (Johannes Wåhlin, 2021) argues that this can be managed by having agreements between the holding company and investors who can hold the, manage and control the property on their behalf. Another issue limiting the implementation of a blockchain fractional property ownership is the legality of the technology in certain political jurisdictions. The Canadian government as well as governments of Turkey, India, Nigeria, China, South Korea have in recent times placed some controls and restrictions about the use of the technology in certain transaction processes. The reason often given for such partial to complete ban is the anonymity of blockchain transactions, which makes it difficult to trace the origin and destinations of transaction. These governments argue that crime, and money laundry will be promoted if the blockchain technology is allowed to thrive unabated. In some other countries, it has been shown that enacting suitable laws and mandating KYC and customer due diligence in cryptocurrency exchanges can limit the activities of criminals who want to take advantage of the system. Switzerland is considered as a pioneer in the regulation of cutting-edge blockchain financial industry technologies. The Uncertificated Securities Act change and the Swiss Law of Obligations amendment, which took effect on February 1, 2021, were significant milestones toward building a reliable environment for blockchain technologies. Distributed ledger technology (DLT)-based trade platforms are now fully supported legally in Switzerland because of this law amendment and the accompanying regulation, serving as a model for other governments throughout the world (Lanzarotti, 2022).

Tokenization has a huge potential for growth, but it is still difficult to achieve because of its inherent complexity, legality, and public involvement. Legislative support will establish a legal framework and oversee the regulation of blockchain technology. One of the major economic sectors, real estate, is now able to fully realize its market potential thanks to the tokenization of real estate assets. In the following section, we shall discuss how a developing country like Nigeria, that struggle with capital mobilization for property mobilization and that already experimented with fractional property financing of some sort, can take advantage of this technology.

4.5 Blockchain in Nigeria

In many developing nations, the trust in government is lacking because people can hardly hold their governments accountable. It is not surprising then, that a trustless and decentralized system like the blockchain economy saw early adoption and grew in leaps and bounds in many emerging economies. Blockchain popularity in Nigeria was driven initially by the volatility of cryptocurrency, the huge gains bitcoin made in 2017 against a depreciating naira and of course the activities of fraudsters who saw the currency as the easiest way to launder 'dirty-money'. The popularity of Bitcoin soared further, following the ENDSARS protests of Nigerian youths against police brutality in 2020 after organizers began accepting donations in bitcoin, to avoid the crackdown of government agencies on their bank accounts and finances. Before the protests, the government had taken a neutral position on cryptocurrencies. A committee set up by the Central Bank of Nigeria (CBN) in October 2017 to investigate the possibility of accepting and regulating the virtual currencies, merely came up with a warning to investors of the risks in investing or trading in cryptocurrencies because of their volatility and the absence of regulation. After the ENDSARS protest, in a seemingly reactionary move, the Central Bank of Nigeria, via a letter sent to financial institutions and published on the Bank's website, barred regulated institutions from facilitating payments for cryptocurrency exchanges and required deposit-taking banks and other financial institutions to immediately close accounts involved in or operating cryptocurrency exchanges (Adedipe, 2022).

The general expectation after the imposition of this restriction was that interest in both cryptocurrency and the blockchain technology will wane in Nigeria over some time and the technology will die a natural death in a few months. Strangely, however, the opposite of this expectation occurred. The bad blood between the government and the Nigerian youth only increased their interest in the blockchain ecosystem, as young people simply went underground and took advantage of the peer-to-peer exchanges that technology offers. The extreme bullish movements of cryptocurrencies in 2021 was also a factor responsible for the increasing interest in blockchain within Nigeria, after the year 2020. So massive was the growth in adoption and use that for several months in 2021 Nigeria ranked third in transaction volumes of cryptocurrency (BBC, 2021). In a seemingly reversal of strategy, the Nigerian central bank in 2021, embraced the

digital legal tender technology and issued a digital currency – the e-naira- to “support governmental intervention schemes for those in underserved areas and enable efficiency in cross-border remittances”, a rejoinder by the CBN in the same year, claimed that their initial policy was only meant to save the Nigerian naira from further depreciation. The position of the Nigerian government in blockchain adoption can thus be summarized as love-hate relationship.

The massive embrace of blockchain by Nigerians since 2017, have resulted in the application of the technology in other areas of the economy beside currency. The use of Oracle’s blockchain technology platform by the Nigeria Customs Service in July 2018 and migration of the Excise Trade Automation Services unto the platform is a typical example. In addition, Sure Remit, a Nigerian non-cash remittance company, was able to raise USD 7 million in its initial coin offering (ICO) in cooperation with South Korea's Hashed cryptocurrency fund company in January 2018. Similar to that, a Nigerian store recently introduced a Point-Of-Sale terminal that accepts virtual currencies as payment in collaboration with an Indonesian cryptocurrency and payments startup called Pundix (Mbadiwe, et al, 2020). According to a report by the Enhancing Financial Innovation & Access (EFInA) in 2021, the blockchain technology might boost Nigeria's GDP by $29 billion by 2030. (EFInA, 2021). Identity management, payments processing through lightening networks, access to finance, and land titling & registration – were identified by the research group as possible areas of implementing blockchain in Nigeria outside of cryptocurrency. The main targets for applying the technology in Nigeria are in areas where it is necessary to instill trust in business, and in government administrative processes. The growing national population and current focus on economic diversification due to declining oil revenue, makes it critical to leverage on the benefits of blockchain technology in the active sectors of the economy.

Within the Nigerian real estate industry, a daring attempt to introduce blockchain in land administration and management occurred last year, when Domineum, a London based, blockchain as a service provider that supports real estate, logistics and supply chain introduced a blockchain land registry solution to be implemented in Abia State, Nigeria. It was the first blockchain-based, public land-ownership record in history approved and backed by an official government, to help digitize property records. With respect to tokenized real estates, they have been there is no mass adoption of the concept in Nigeria so far. Thus, no design concepts have been found as an existing

reference work in the preparation of this thesis. As a result, the research concentrates on defining the topic by identifying the key pain points in the present transaction process of fractional property finance and developing a prototype based on the results. The potentials blockchain has shown in other sectors and the dynamics of the Nigerian population and economy gives indication that any such system formulated with input from people will not only enjoy widespread adoption but also radically improve the deficiencies identified in current property tokenization process.

4.6 Benefits of Blockchain Tokenization to Property Financing in Nigeria

Real estate tokens are digital securities, or financial instruments represented by blockchain tokens, that give access to an underlying real estate asset or real estate development project. These tokens are inexpensive to produce, can be sold to investors directly, and have all the advantages of digital assets. They also contribute to the much-needed liquidity needed for real estate development. The topic of tokenization in Nigeria is being driven by the rise of crowdfunding or fractional property financing in real estate, a growing desire for democratization, stricter solvency regulations for banks, and a growing demand from investors looking for alternatives to low yielding savings accounts. Aside from removing geographic restrictions on capital raising, tokenization may be able to alleviate the capital requirement issue for buyers who are less financially capable. The financing option of fractional property ownership in Nigeria can be impacted specifically in the following areas by blockchain tokenization:

1. **Better Fractionalization:** Tokenization lowers entry barriers for investments by making it easier to distribute ownership interests in an asset across a larger pool of investors, democratizing access to the asset for assets that often have high upfront capital needs for property development. The distribution of new financial products to a larger investor base could be done at a cheaper cost per unit, with different or smaller fractions, and with a fee structure that includes an access premium for the previously inaccessible investment opportunity. Investment flexibility is made possible by the aforementioned factors. Tokenization makes portfolio purchasing more customizable, allows for flexible portfolio construction and diversification, and enhances access to properties.
2. **Operational Efficiency:** The automation of procedures like compliance checks, investor whitelisting, and post-issuance issues like dividend distribution is made

possible by smart contracts, which are programmable activities on the blockchain. Smart contracts also make it possible to program tokens with special properties, allowing for the relatively low operating cost creation of tokenized assets with customizable fee structures and share class-specific attributes. In a blockchain-driven property fractionalization, the ease of fraud and malpractice by unethical sponsors is therefore eliminated. This is due to the absence of the requirement for a central authority to have unrestricted access to the information database.

3. **Reduced Settlement Time:** Unlike traditional financial transactions, which may take days or weeks to resolve, transactions involving tokenized items can be settled relatively quickly. The processes involved in purchasing and selling real estate could be considerably streamlined in the age of blockchain. For instance, a lot of real estate deals today need title insurance and transparency regarding the chain of title. Even the smallest home purchases, comes with significant delay. Environmental evaluations and financial records searches are just two examples of additional data that must be linked to the real estate transaction. The complexity and slow speed of the typical real estate transaction could be significantly reduced by a properly designed blockchain-based solution. Blockchain technology has the potential to fully automate the transaction process even in the commercial real estate (CRE) industry. Finding properties is a time-consuming and data-inefficient procedure that involves numerous, occasionally contradicting data sets. Depending on what is being tokenized, blockchain-based technologies can significantly lower transaction speed in real estate transactions. Although blockchain have historically been too slow in processing transactions, batch processing and the lightening network can fix these problems.
4. **Transparency and Data Protection:** Due to data being dispersed across a network of participating nodes rather than a single centralized database, distributed ledger technology like blockchain is renowned for its immutability and shield against manipulations. Blockchain allows for the tracking and visibility of transaction information, while cryptographic hashes ensure that data privacy is maintained. Transparency in data also provides up-to-date data for investment analysis. The capacity to explicitly link a security to its underlying value drivers, especially for complex derivative products, can provide transparency to the underlying data through secure and accessible recording on blockchain.

5. **Liquidity:** By making it possible for investors to securely transfer shares amongst one another on secondary markets, tokenization increases the liquidity of assets available to them. A strong atmosphere for acquisitions and divestitures is produced by this transactional possibility. Secondary markets also provide more liquidity, and liquid assets can command a premium, increasing asset value. Tokenization expands the pool of possible investors and potentially open up a worldwide investor base.
6. **Reduced Cost:** Costs is reduced by the elimination of intermediaries and improving the effectiveness of procedures. In climes where real estate transactions are subject to high taxes, tokenization will have little impact on transaction costs. For instance, in the UK, purchase expenses could be as high as 6.75 percent; tokenization could lower these costs, but most transaction costs will still be made up of a 5 percent transfer tax that cannot be avoided.

5 Research Methodology

This research is designed to gather information on the transaction problems property developers in Nigeria encounter while mobilizing funds, through the traditional fractional property ownership financing systems. The purpose is to develop a more efficient and robust blockchain transaction model using the most significant pain-points highlighted by multi-parties during interviews and surveys. A mixed research methodology comprising a modified form of action-based research and quantitative research approach was adopted in this research to arrive at the results needed to develop a blockchain driven fractional property ownership transaction model. The proposed model hopefully will provide a pathway for additional research or real-life implementation in the future.

5.1 Research Strategy

Action research can be defined as a research methodology that simultaneously pursues action (or change) and research (or understanding). It is an iterative procedure that advances comprehension of the research concept. Action research is a problem-solving-focused investigation. The goal of this kind of research is to enhance particular procedures or practices. It combines both research and action. In order to address a problem, one problem at a time is dealt with while integrating study, action, and analysis (Cohen et al., 2007). The procedure entails creating and putting into action a plan or strategy to address the research's primary topic by:

- • a spiraling, cyclical process that alternates between critical reflection and action, and
- in the latter cycles, iteratively improving procedures, data, and interpretation in light of the knowledge gained in the previous cycles.

5.1.1 The Action Research Phases

The action research process typically follows the widely used four-phase process of (Lewin, 1948), namely **Plan, Act, Observe and Reflect**. These steps are a cyclical process as shown in the diagram below and elaborated as follows:

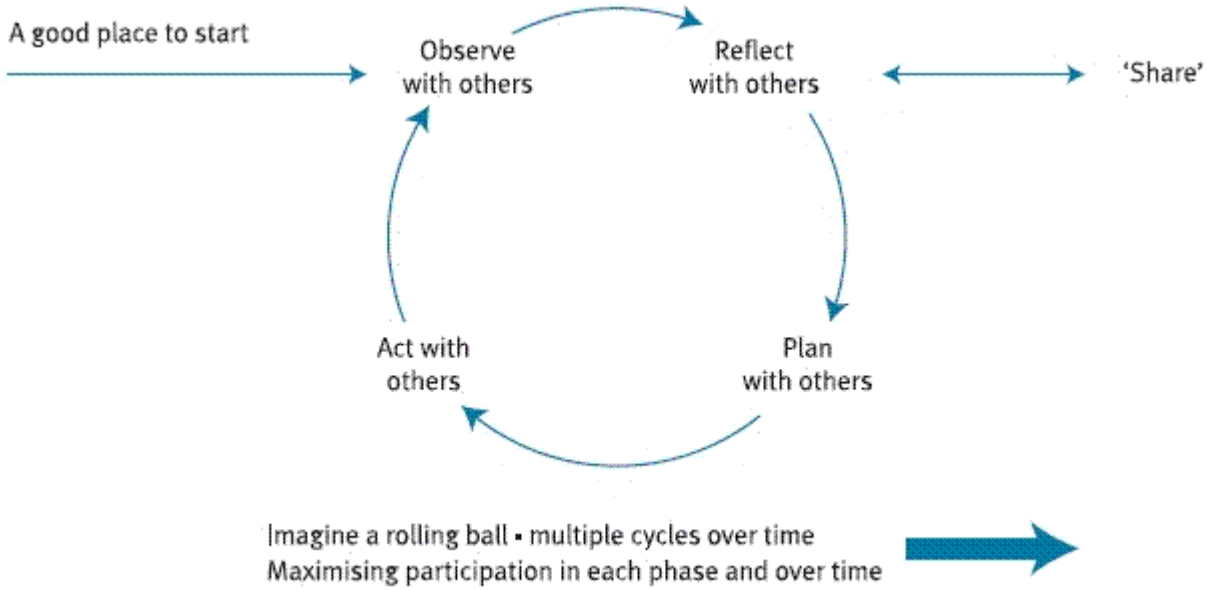

Fig 11 The Action Research Cycle (Phil Crane, 2012)

1. **Plan:** Plans are formed to change the current practice after developing an understanding of the issue. In this research, the problem is the transactional limitations of traditional fractional property funding, and the plan is to introduce blockchain to correct the problem. This entire thesis is concerned with testing the viability of this proposed solution through stakeholder involvement and hypothetical testing. In other words, the next three steps are not within the borders of this study.
2. **Act**: The changes which are planned are implemented or carried out in this phase. For example, the proposed new model will be implemented by one or more of the participating crowdfunding companies to confirm its adequacy.
3. **Observe:** The impact of the change implemented earlier is observed by the researcher. The researcher collects, records, and obtains evidence about the success of actions.
4. **Reflect:** The data and results from the previous phase are reflected upon. The researcher reflects on the results and considers strategies for improvement and future planning begins. If the impact was positive then it becomes part of the strategic process, or else the cycle is repeated.

One main characteristic of action research that makes it adequate for this study is the collaboration between researcher and members of an organization or the sector with the problem, to solve organizational problems. As a result, start-up firms involved in the fractional property ownership business in Nigeria and potential investors have been

included from the early stages, in the collaborative effort of this research to improve the fractional ownership transaction process. The action research process includes building a knowledge base to understand the effectiveness of the action or plan being considered. The time limitation of this thesis to an academic degree, however, will prevent the continuous refining of the initial proposed solution contained in the developed transaction model. In this context, the aim of this thesis is to identify the first plan required to commence the action-based research process.

5.1.2 Justification of the Research Strategy

Research on social concerns like racial discrimination, equality, and the environment frequently uses action research. Thus, it is mostly qualitative in nature and more applicable to the social science e.g., research to investigate the effect of a change in teaching method to students' performance. However, (Martí, 2015) showed that a quantitative scientific research method can be combined with action research in a mixed research format, to improve the knowledge and realities required in various stages of participatory research methodologies like the action research. According to him, the simplest way to include quantitative data into an action research project is to start by analyzing the available statistics sources to contextualize the research issue and to support the necessity for intervention. A classic example of a sequential design is research done by Dabaieh (2013), in which quantitative methods based on primary data come before the participatory/action phase with the intention of aiding its design. This research has adopted a similar strategy. The following features of action research makes it adequate and justifiable to adopt for this study:

- The approach is used to enhance certain procedures. Action research is centered on taking action, evaluating it, and conducting a critical analysis of practices using the data that has been gathered in order to bring modifications in pertinent practices.
- This form of study is made easier by the participation and cooperation of numerous people with various qualities working toward a shared goal.
- Research focuses on particular circumstances and their context. (Bryman, A. et al, 2011)

5.2 Research Blueprint

This research begins from a positivistic philosophical standpoint and assumes that the principles shaping the syndicated property financing model are often determined by societal factors. As a result, the scientific methodological choice of quantitative surveys has been adopted. However, to purify the findings and outcome, a collaboration between the subjects and the researcher will be necessary at subsequent stages of the research development, hence the introduction of the rather interpretative action base strategy. Details of the complete research blueprint is given in figure below 12. As shown in the diagram, this study is exploratory in nature. Exploratory research is done to determine "what is happening, to seek new insights, to ask questions, and to assess phenomena in a new light, with the objective "to portray an accurate profile of persons, events, or situations," and may be an extension of or a precursor to an explanatory study to establish causal relationships between variables (Bell, 1999). The deductive research approach is applied in this thesis The traditional hypothesis-deductive approaches, which start with a hypothesis and then attempt to prove or refute it was utilized for this study. Deductive reasoning is defined as moving from the specific to the universal. If a theory or case study seems to imply a causal relationship or correlation, it may be true in many instances. If this relationship or link did hold true under more general conditions, it can be tested using a deductive approach. Hypotheses that can be derived from the theory's propositions can be used to explain the deductive process. Deduction of conclusions from premises or propositions is, in other words, the focus of the deductive approach. This approach is justified given the availability of an existing theory or framework for the study and the possibility to collect and analyze relevant statistical data (Aqil and Hussain, 2008). Additionally, the stratified sampling technique was relied upon in choosing who to ask to participate in the surveys. In this approach, the population is initially separated into subgroups (or strata) that all have a common trait. It is employed when we want to ensure that all the subgroups are represented, and we may fairly expect the measurement of interest to vary between the various subgroups (Easton and McColl, 1997).

5.2.1 Research Questions

The first step undertaken in the planning of this research is the selection of a focus around the problem. It requires the identification and definition of the investigation.

Research questions about the area of focus and a plan to effectively answer the questions was thereafter developed. An examination of the current fractional property financing model has been discussed in the preceding chapters and aspects that requires improvement have been identified. The blockchain tokenization concept have also been examined and found to have a potential to address the concerns of traditional property tokenization. Thus, this study seeks to find solutions to the problems of transparency, turn-around-time, cost efficiency and other issues currently bedeviling fractional property ownership transactions. The findings from the literature review discussed in the "background" section served as the basis for the following study questions.

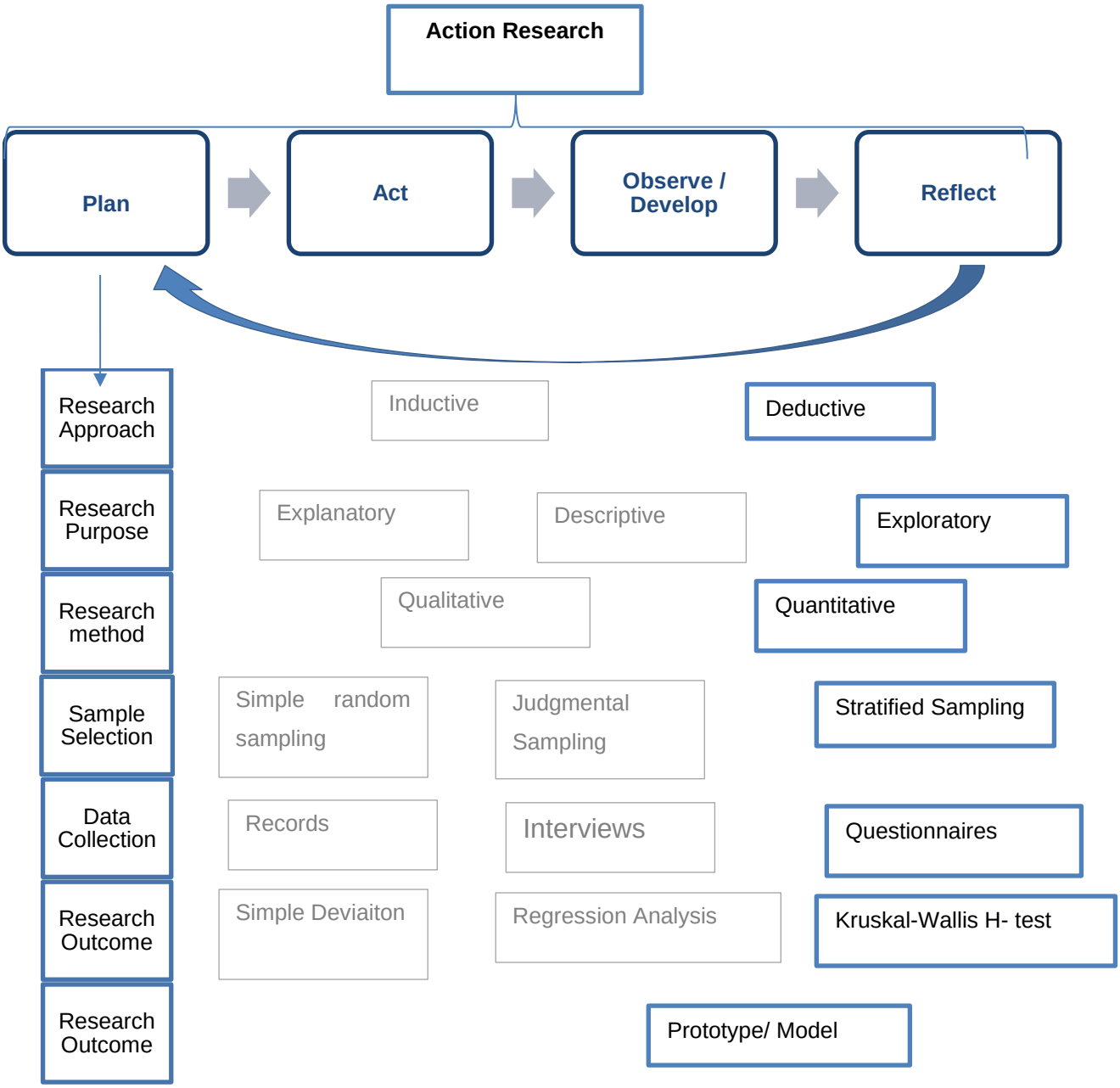

Fig 12 Research Blueprint

I. What are the most important challenges currently facing the existing fractional funding system, which has made it unable to address Nigeria's housing financing and housing deficit problems?
II. What aspects of blockchain technology make it a special remedy for the transactional problems in fractional property ownership of Nigeria?
III. Which implementation model is appropriate for using blockchain technology in the fractional property transaction process??
IV. What are the limitations of this model?

The planning stage of this action study explicitly addresses how the methodology, assessment protocol, and research questions will be incorporated into the action research.

5.3 Research Hypothesis

It is hypothesized that:

1. The inefficient transaction process of fractional property ownership is responsible for the slow adoption of the financing system in Nigeria.
2. Combining Blockchain tokenization with traditional fractional property ownership will improve the efficiency of the transaction process.

Independent samples from the northern and southern regions of Nigeria and from companies in the business of fractional property financing will be collected to prove these relationships. The null hypothesis H_0 in both case is thus: that the independent samples all have the same central tendency and therefore come from the same population. While the alternative hypothesis is that at least one of the independent samples does not have the same central tendency as the others and is therefore from a different population.

5.4 Research Instrument

The quantitative method involved in the research strategy included the collecting of data required to provide answers to the research questions. This technique adopted as shown in figure 12 above is the survey technique. Specific questions required to be answered by the key stakeholders in the existing fractional property financing process, were developed in the form of a questionnaire. Additionally, questions were also

formulated to verify the potential of blockchain to correct the identified challenges. Stratified sampling was used to choose respondents for the survey. To enable efficient triangulation of findings and sample purity, the data was stratified and gathered from a variety of sources (Deng et al, 2016).

Since fractional real estate is the research object, contributions from the few firms still in the business of fractional property financing are needed in the survey to make the action-based process feasible. Therefore, 16 companies have been randomly selected to provide responses to the survey questions. Overall, 14 out of the 16 questionnaires sent were returned. In addition, Nigerians of various age groups, educational background in different the geographic divides of the country: North and south regions, were provided with the electronic surveys. This distinction is intended to reflect the regional divisions and identities that resulted from the structures built and solidified by the colonialists during the process of Nigerian state establishment. The most fundamental division is between the north and south of the Niger and Benue rivers, or the north and south of the entire country. These were the original institutions of the colonial state and continued to be run independently even after the two units were combined in 1914. Both parts of the country have dissimilar cultures and traditions including preference for house design and home ownership. A comparison of the survey responses from both parts of the country will thus give a proper reflection of the average Nigerian consider as a challenge to the fractional property financing process (Eghosa and Suberu, 2005). In general, two separate questionnaires were distributed as follows:

1. Survey to determine the pain-point in the traditional fractional property process, consisting of ten questions and distributed to multi-parties in the north and south of the country.
2. Survey to determine the potential of blockchain to correct the identified challenges, containing twelve questions and distributed to specific professionals in the real estate industry and computer scientists and engineers familiar with the blockchain concept. Sixteen real estate firms involved in the fractional property ownership business also provided got copies of the survey.

The poll included both structured closed questions with yes-or-no or multiple-choice answers and open-ended questions with short answers, as well as responses measured on an ordinal 5-point Likert scale. The questionnaire in this thesis is created and administrated through the google form platform, available as an internet survey tool

and is sent out electronically to different participants. It is difficult to know both the exact number of total questionnaires sent and the response rate. The intention however is to have the questionnaire distributed in a fairly equal way, so as to get representative data from different age groups or educational levels. The Table 15 in appendix A gives an overview of the survey questions.

5.4.1 Questionnaire: Level of Measurement

The survey questions retrieve responses from participants in the ordinal measurement scale. Ordinal scales are a variable measurement scale used to simply depict the descriptional qualities of variables along with their order. These scales are generally used to depict non-mathematical ideas such as frequency, tolerance, expectation, challenges, limitation, satisfaction, happiness, a degree of pain, etc. As recommended by (Parasuraman, 1991), a 5-point Likert-scale (5=strongly disagree, 1=strongly agree) was utilized to retrieve the answers to the question. The proposed statistical ranking method: Kruskal-Wallis H- test which requires the use of ordinal scale measurement as a precondition makes this method valid for the intent (Joshi et al., 2015).

5.4.2 Reliability and Validation of Data

The results of the initial diagnostic report were analyzed, and interpretations made from the responses. A rank of the challenges encountered in traditional fractional property ownership transactions were determined from the data to justify the developed blockchain transaction model. The first action was to describe or summarize the data clearly, then consistent patterns or themes were searched for across the data. Finally, the consistency of the responses in providing answers the research questions and/or prove the hypotheses was evaluated. A consistency in the ranking of participant's response justifies the main element incorporated in the design of a new blockchain transaction model. As mentioned earlier, the reliability of the survey responses was made certain by the involvement of multi-parties, including fractional property sponsor firms and representative investors from all over Nigeria, in the process. The basic criteria for distributing the sources were the existing geopolitical distribution of the Nigeria population. This is effective because real estate decisions are mostly made around cultural and sociological lines, and these lines form the basis of distribution of the national geopolitics (Saunders et al., 2009). This is a way of reducing the possibility of drawing wrong conclusions. Validity and reliability measures whether the concept, conclusion or

measurement is corresponding to the real-world situation; while reliability measures how consistent the measurement is (Mohajan, 2017).

The following actions were taken to increase the validity of this theory.

- Participants answered the questionnaire honestly and simply, and the questions are being delivered using straightforward language.
- The respondents to the survey are diverse in terms of age, degree of education, and location.
- Each participant must be at least 18 years old, have a home of their own, or lived independently in the past.
- The interviews with professionals were conducted with well-known people who have a wealth of knowledge and expertise in the real estate and associated markets.
- The semi-structured nature of the interview questions allows the participant to respond with whatever comes to mind.

5.5 Data Analysis

The scientific method of hypothesis testing is used to determine if a notion is accepted or rejected. The two common methods of hypothetic testing are: 1) Parametric approach and 2) Nonparametric approach. The use of nonparametric or distribution-free tests is often required because the distributional assumption made under a parametric test rarely holds true, especially when it comes to the normal distribution of data (Krzywinski M, 2014). Although, ANOVA test are mostly recommended for surveys of this nature, the researcher's suspicion from experience that the data turned out may not follow the gaussian curve prompted the selection of a nonparametric test. Recent research has proposed nonparametric tests using interval-valued data and the measure of falseness or indeterminacy (Smarandache F., 2010). The tests of homogeneity of variance for uncertainty environment, the goodness of fit test with uncertain parameters, and the Kolmogorov-Smirnov tests under uncertainty were all recommended by (Aslam M, 2021) as common techniques for verifying the neutrosophic hypothesis (Neutrosophy means the study of ideas and notions which are not true, nor false, but its study is between true and false, that is, neutral, indeterminate).

In this research work, the Kruskal-Wallis H non-parametric test has been used to rank the data to confirm the reliability and validity of the suspected similarities and

patterns observed in the multi-party survey conducted. The Kruskal-Wallis H test is a rank-based non-parametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is also sometimes referred to as the "one-way ANOVA on ranks" (Ghoodjani, 2016). In 1952, Kruskal and Wallis developed the test as a reliable rank-based test for the k sample problem as an alternative to parametric methods like the one-way analysis of variance (ANOVA). It is used to test the null hypothesis, which claims that 'k' samples were taken from the same population or an identical population and that the mean or median was the same or an identical value for each sample. The Kruskal- Walli's null test's hypothesis can be expressed mathematically as $S_j = S_2 = ... = S_k$ if S_j is the population median for the jth group or sample. The alternative theory, of course, would be that Si and Sj are not equal. As a result, at least one pair of groups or samples has unique pairings. For instance, you may use a Kruskal-Wallis H test to determine how national wealth affects attitudes against gender-based pay disparity, where attitudes are measured on an ordinal scale (i.e., your dependent variable would be "attitudes towards pay inequity ", measured on a 5-point scale from "strongly agree" to "strongly disagree", and your independent variable would be "national economy type", with three independent groups: "developed country", "middle income country" and " developing country ").

For a Kruskal-Wallis H test to produce a reliable result, the collected data must satisfy four different presumptions. We'll talk about these presumptions next. When the data is in interval form and has some uncertainty, the test is rendered useless. The alternative hypothesis that at least one population varies is tested against the null hypothesis that all k independent samples come from populations with equal averages using the Kruskal-Wallis H test (Sherwani et al., 2021).

Assumption One: The dependent variable needs to be evaluated on an ordinal or continuous scale (i.e., interval or ratio). Likert scales are an example of an ordinal variable (e.g., a 5-point Likert scale from "strongly agree" through to "strongly disagree"). Continuous variables include things like revision time (measured in hours), intellect (measured using an IQ score), exam performance (measured from 0 to 100), and so on.

Assumption Two: The independent variable should consist of two or more categorical, independent groups. Typically, a Kruskal-Wallis H test is used when you have three or more categorical, independent groups, but it can also be used for just two groups (i.e., a Mann-Whitney U test is more commonly used for two groups). Example independent variables that meet this criterion include ethnicity (e.g., three groups: Caucasian, African American and Hispanic), or in the case of this survey geopolitical regions: North and South (Ghoodjani, 2016, James M. Murray, 2017, Laerd statistics, 2020).

Assumption Three: It is necessary for the observations to be independent, which means that there must be no connection between the observations made by the various groups or between the groups themselves. For instance, each group must contain unique members, and no individual may be a part of more than one group. When these assumptions have been broken and the use of a one-way ANOVA is incorrect, the Kruskal-Wallis H test can be employed because it does not presume normality in the data and is considerably less susceptible to outliers. Additionally, a one-way ANOVA is incorrect if your data is ordinal, but the Kruskal-Wallis H test is acceptable.

Assumption Four: The distributions in each group (i.e., the distribution of outcomes for each group of the independent variable) must have the same shape in order to understand how to interpret the results from a Kruskal-Wallis H test (the same variability). In other words, the null hypothesis requires that the independent groups be normally distributed or share a common central tendency. You can use SPSS Statistics to do a Kruskal-Wallis H test to compare the medians of your dependent variable (such as "engagement score") for the various groups of the independent variable you are interested in if your distributions have the same shape (e.g., the groups, Caucasian, African American and Hispanic, for the independent variable, "ethnicity").

However, you can only apply the Kruskal-Wallis H test to compare mean ranks if your distributions have a different shape. Similar distributions of groups only make it possible to employ medians to depict a change in location between the groups. In order to avoid misinterpretations of your results, it is crucial to verify this assumption (Laerd Statistics, 2020).

Since ranking is conditional upon the observed values, so is Kruskal-Walli's test. The null hypothesis is that the H groups of data were randomly assigned from the same group of ranks - in which case each group is equally likely to obtain values above and below that common mean rank. The alternative hypothesis is that, in addition to this random assignment, two or more groups also differ in their mean rank - in which case, like ANOVA, this test assumes the only difference between samples is their mean rank, and any other differences are due to simple chance. In the latter case, in addition to the distributional assumptions mentioned above, observations are also assumed to be distributed symmetrically. The H statistics is calculated form the formula:

$$H = \left[\frac{12}{n(n+1)} \sum_{j=1}^{c} \frac{T_j^2}{n_j} \right] - 3(n+1)$$

- n = sum of sample sizes for all samples,
- c = number of samples,
- T_j = sum of ranks in the j^{th} sample,
- n_j = size of the j^{th} sample.

Procedure

- Combine the observations from the H samples into a single pooled "null" sample while preserving the details of each observation's source.
- Give the sample that was pooled rankings. Use mean ranks rather than sequential rankings for tied observations if two values are equal; otherwise, they both receive the average of the two ranks for which they tie.
- Calculate the sum of ranks (T_j^2) for each group
- Compute the Kruskal-Walli's test statistic (H).

If each n_j is at least 5, the statistic approximates a chi square distribution with H-1 degrees of freedom. In this analysis the IBM SPSS software tool has been used for ease of data processing.

6 Result and Discussion

In this chapter, the results of the survey will be presented, and an analysis will be done to identify the most important challenges limiting the transaction process of traditional fractional property ownership. The order of the challenges is ranked based on the feedback from the responders. As stated earlier, the purpose of doing this is to identify which factor would have more impact and be given priority in the proposed blockchain transaction model. For the scope of this action research, data from diverse sources were collected to enhance the validity and reliability of the findings.

6.1 Survey Distribution

Altogether, the analysis is based on the empirical data that has been collected through surveys conducted among 130 responders in the Northern and Southern regions in the country. 58 of the responders were from the northern part of the country, while 72 people responded from the south. The ranking of the factors listed by the responders as critical to their decision not to participate in a fractional ownership process is obtained by a comparison of the mean ranks from the two group of participants. Additionally, a total of 55 participants with experiences in computer engineering and real estate management were selected from among the 130 responders, and representatives of 14 fractional property financing companies. Of the 55, 19 each were from northern and southern Nigeria, while the rest 14 were representatives of the real estate firms. The questionnaires distributed to these professionals were structured to make them reflect their perspectives and views on the potential of blockchain to correct the factors highlighted by the first groups, in fractional property transactions. Table 8 gives an overview of the responders' demographic distribution from the feedback gotten. While the intention of during survey was to get an accurate a statistic as possible, it is arguable that 130 or 55 responses from a country with a population of 206 million people or 105 million adult is not a fair representation of the Nigerian people. However, the results from the questionnaire can be taken as a proxy for the whole population despite its low number of responders, if it passes the adopted statistical test of variation.

To get a better understanding of the attitude towards the traditional fractional property ownership transaction process as well as the attitude towards the proposed blockchain technology driven transaction model, other demographic features of the responders were also collected. In general, a younger age and a higher level of education tend to

increase the disposition of people towards the new technologies. Younger people between 24 years and 45 years were more disposed to partake in a fractional property transaction and are also more likely to accept a transaction model backed by blockchain. Also, the higher the educational qualification of the responders, the more likely they were inclined to experiment with a blockchain property tokenization. Older people above 50 years, however, were noticeably indifferent towards both fractional property ownership and blockchain driven property fractional property ownership; irrespective of their level of education. This is most likely due to strongly held beliefs about home ownership and the low to absent information and technology literacy level among people of that demography. Furthermore, the responses showed that while the city, town of residence or geopolitical region had an impact on awareness, it did little to influence the choices selected. This is obvious from the higher number of responses from the larger Nigerian cities and towns in the southern part of the country than in the northern part, though there was an almost uniform ranking of the factors in all the responses.

Total responders	**130**
People between the age 18-35 years	50
People between the age 36-55 years	41
People between the age 56-65 years	32
People above 65 years	7
People with maximum high school education	12
People with up to 2 years of higher education	18
People with 4-6 years of higher education	53
People with 1-2 years of graduate degree	36
People with qualification after master's degree	11
Number of representatives of fractional property ownership companies	14
People with experiences in computer engineering or Real Estate	55

Tab 9 Questionnaire Response Overview

Since both fractional property ownership and blockchain technology are relatively new concepts, it was important that the responders have a reasonable knowledge level in both subjects. Therefore, the surveys were sent to only people who are not dependent, but currently live in houses of their own or have lived in their own homes in the past. Figure 13 and 14, shows respective industries of the responders both for the survey 1: to determine the challenging factors in current fractional property ownership

transactions and for survey 2: to determine a list of the factors where blockchain shows a potential to correct the identified challenges.

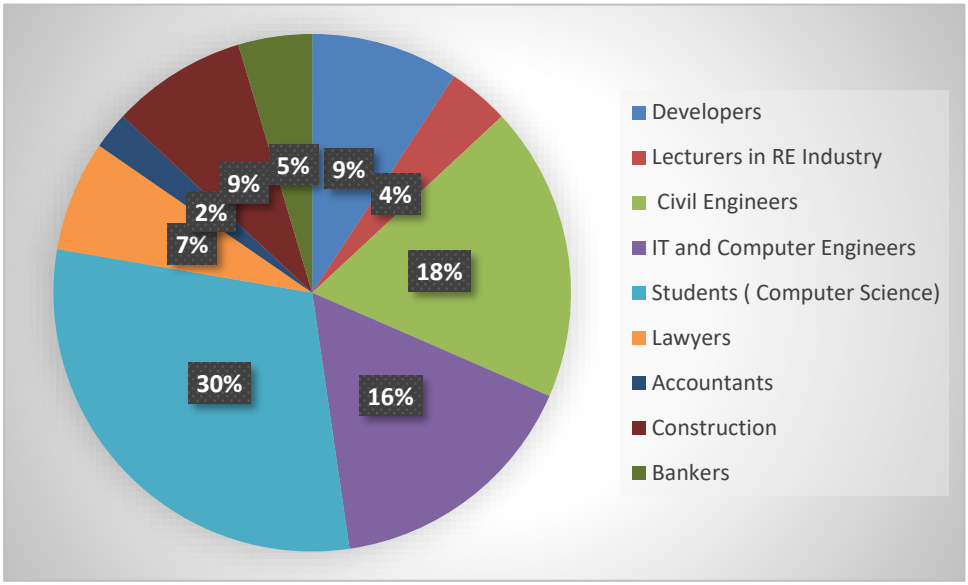

Fig 13 Distribution of respondents' industries. Survey 1 (challenges of fractional property ownership) (n = 130).

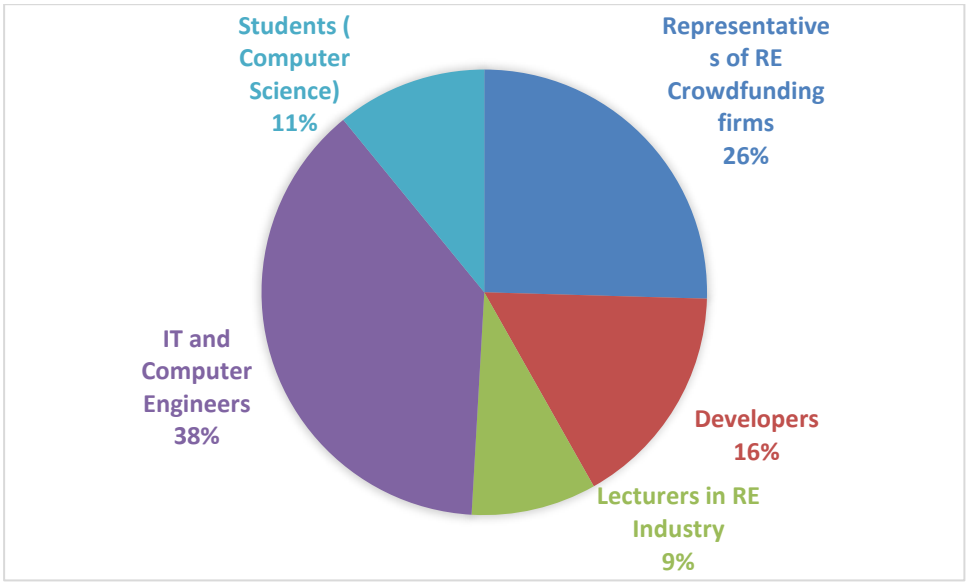

Fig 14 Distribution of respondents' industries. Survey 2 (Blockchain Potential) (n = 55).

6.2 Data Analysis: First Survey Data

An overview of the responses given by the participants in both north and south Nigeria is shown in Fig. 15 to Fig. 19 below. In both groups, high cost of transaction, ease of fragmentation, timeliness of transaction process, ownership rights tend to get the

highest priority in a list of factors responders from both groups identified as challenging in the current fractional financing process.

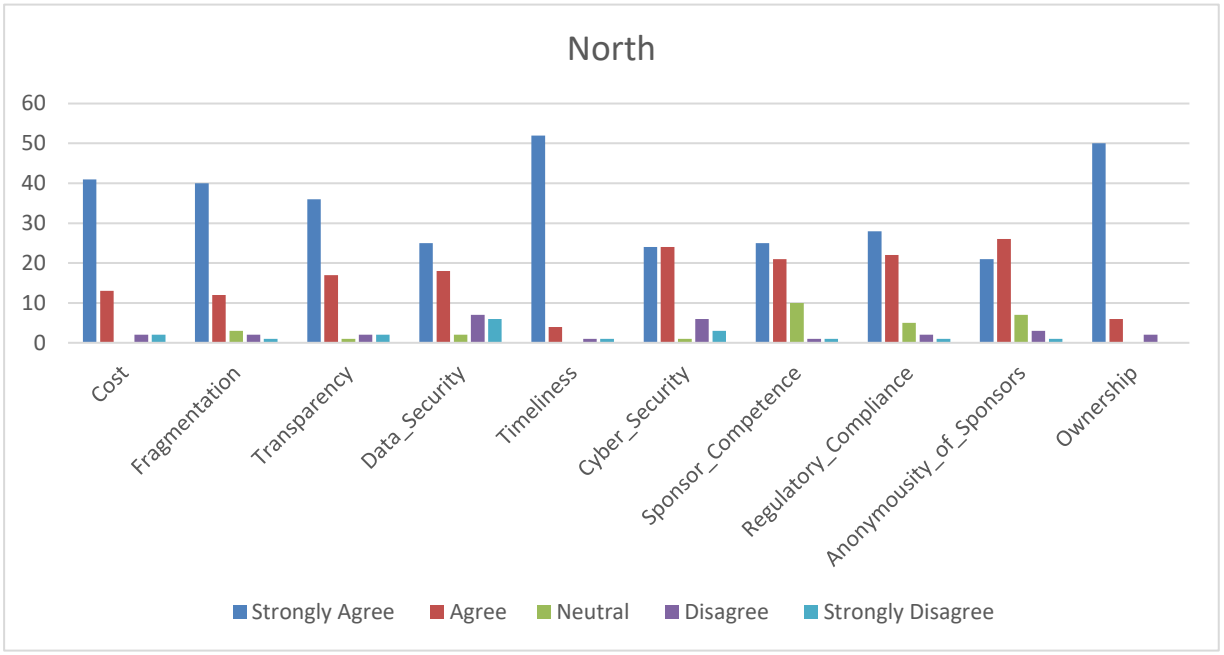

Fig 15 Distribution of Responses to Questions on Factors Limiting Fractional Property Ownership Transaction in Nigeria. (Northern Nigeria. N=58)

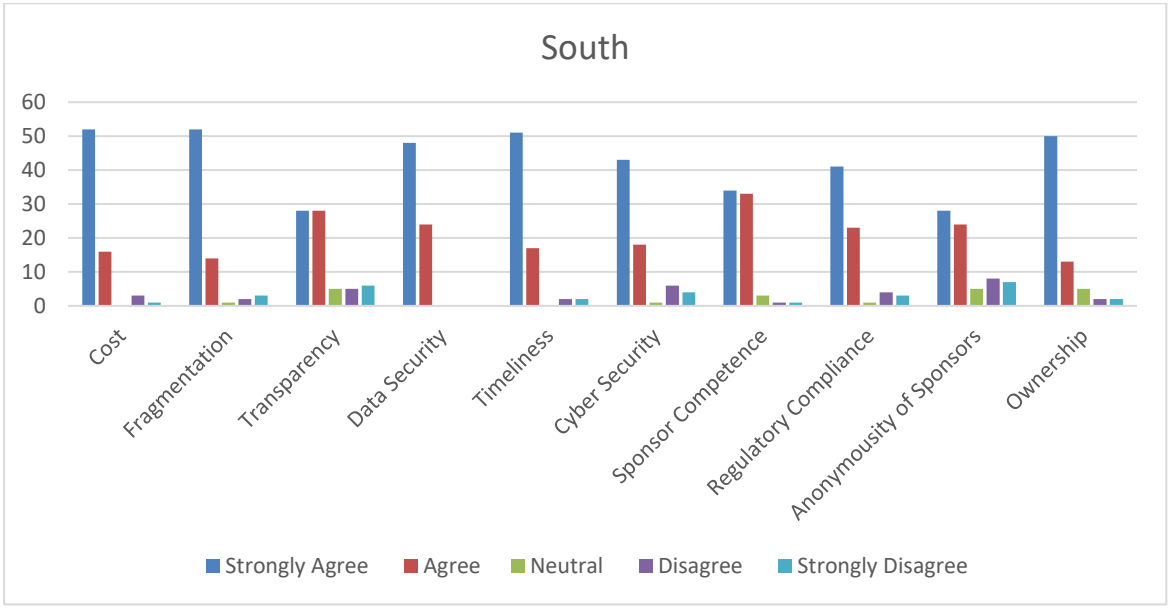

Fig 16 Distribution of Responses to Questions on Factors Limiting Fractional Property Ownership Transaction in Nigeria. (Southern Nigeria. N=72)

Most responders do not really consider cyber security, anonymity of the sponsors and regulatory compliance as having comparative importance as the other factors. The ranking of the factors was done to verify the earlier stated observations, by determining the arithmetic mean (AM) of the responses and ranking the mean afterward, using the SPSS software. The arithmetic mean was calculated using the formula:

$$\tilde{x} = \frac{1}{n} \times \left(\sum_{i=1}^{n} x_i \right)$$

With x = weight given to response, n = number of items in the sample. The arithmetic mean and the ranked mean are given in Table 9 below. The ranks were similar to the earlier assumption stated above. A statistical test is however necessary to ascertain if there are statistical differences between groups of independent variables on dependent variables.

	N	Mean	Std. Deviation	Ranking
Timeliness	130	1.3231	.79937	1
Ownership	130	1.3769	.82842	2
Cost	130	1.4308	.87105	3
Fragmentation	130	1.4769	.93357	4
Regulatory_Compliance	130	1.7000	1.06130	5
Data_Security	130	1.7000	.97766	6
Sponsor_Competence	130	1.7231	.82608	7
Cyber_Security	130	1.8462	1.13753	8
Transparency	130	1.8462	1.17111	9
Anonymousity_of_Sponsors	130	2.0692	1.16930	10
Valid N (listwise)	130			

Tab 10 Descriptive Statistics Showing Ranking of Factors Limiting the Fractional Ownership Process in Nigeria.

6.3 Hypothesis Testing of First Survey Data Using the Kruskal Wallis H Test

The goal of this study is to test the hypothesis that there is a statistically significant difference between how respondents in two regions of Nigeria ranked the challenges of traditional fractional property process. The Kruskal-Wallis H test will be applied to

assess the uniformity of the mean ranks and evaluate whether there are statistically significant differences between two or more groups of the independent variable. Since the data did not follow the gaussian distribution curve according to the Shapiro-Wallis normality test, shown in Table 10 below, the Kruskal-Wallis H test is deemed to be the most appropriate. The proposed test will yield a more accurate and pertinent results from the data set. Other parametric tests using conventional statistics would have produced misleading results.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Cost	.405	130	<.001	.540	130	**<.001**
Fragmentation	.403	130	<.001	.567	130	**<.001**
Transparency	.285	130	<.001	.717	130	**<.001**
Data_Security	.307	130	<.001	.663	130	**<.001**
Timeliness	.449	130	<.001	.452	130	**<.001**
Cyber_Security	.286	130	<.001	.709	130	**<.001**
Sponsor_Competence	.263	130	<.001	.760	130	**<.001**
Regulatory_Compliance	.294	130	<.001	.701	130	**<.001**
Anonymousity_of_Sponsors	.285	130	<.001	.797	130	**<.001**
Ownership	.445	130	<.001	.520	130	**<.001**
a. Lilliefors Significance Correction						

Tab 11 Shapiro-Wilk Test for Normality

The null hypothesis that there is no difference in the mean ranks of the chosen factors is tested using the Kruskal-Walli's test. As shown in Table 11, the Kruskal-Wallis H test indicates that there was no statistically significant difference in the perception of the different groups regarding the challenges of the traditional fractional property ownership transactions for the following variables: High cost of transaction, Ease of fragmentation, Sponsor's or RE firm's competence, and Regulatory compliance issues. For instance, the critical chi square value at 5% significance for 'the ease of fragmenting assets' at a degree of freedom of 1 is 3.841, as obtained from the statistical table of critical values of Chi-square distribution provided in Appendix B on page 106. This value is greater than the value of H calculated from the Krustall Wallis formula. Hence the null hypothesis is valid and can be retained. The same argument goes for the other

three variables mentioned earlier. However, for ‘Transparency of the process’, ‘Data security’, ‘Anonymity of sponsors’, ‘Ownership rights’ and ‘Timelinessness of transaction’, the null hypothesis can be rejected.

Test Statistics[a,b]					
	Cost	Fragmentation	Transparency	Data_ Security	Timeliness
Kruskal-Wallis H	.269	.109	11.777	8.413	11.445
df	1	1	1	1	1
Asymp. Sig.	.604	.742	<.001	.004	<.001

a. Kruskal Wallis Test

b. Grouping Variable: Region

	Sponsor Competence	Regulatory Compliance	Anonymity of Sponsors	Ownership
Kruskal-Wallis H	.257	.060	1.357	9.521
df	1	1	1	1
Asymp. Sig.	.612	.806	.244	.002

Tab 12 Kruskal Wallis H Test for Null Hypothesis on the Factors Limiting the Fractional Ownership Process in Nigeria.

A final ranking of the most important challenges affecting fractional property ownership transactions, as identifed by Nigerians from the survey is given in Table 12 below. High cost of transaction, difficulty in fragmenting the assets to investors demand, breach of financial regulatory guidelines and incompetent sponsors follow each other consecutively in that order of priority.

Cost	**1**
Fragmentation	2
Regulatory_Compliance	3
Sponsor_Competence	4

Tab 13 Final Ranking of the Identified Factors Limiting the Fraction Property Ownership Process in Nigeria

6.4 Data Analysis: Second Survey Data

In the second survey conducted, data representing the responses of the professionals familiar with the blockchain tokenization concepts in real estate crowdfunding, from the south, and north of Nigeria; and from the representative of real estate crowdfunding firms are collated. The distribution of these responses across the ten factors highlighted in the survey are presented below in Figures 17 – 19. Although all ten factors are considered, attention has to be given to the four factors previously selected as the most critical challenges of the traditional tokenization process, in Table 12 above. However, it is noticed from the three charts below, all three groups also selected 'Data security' and 'Cyber attacks' as additional possible areas where a blockchain driven system have potential advantages over traditional fraction property financing transactions. An investigation into the occurrence of a statistically significant difference in the responses is necessary to be carried out as before. The Kruskal Wallis test is applied to test the null hypothesis that there is no difference in any of the responses given for the ten listed factors. Section 6.5 below discusses the result of this test.

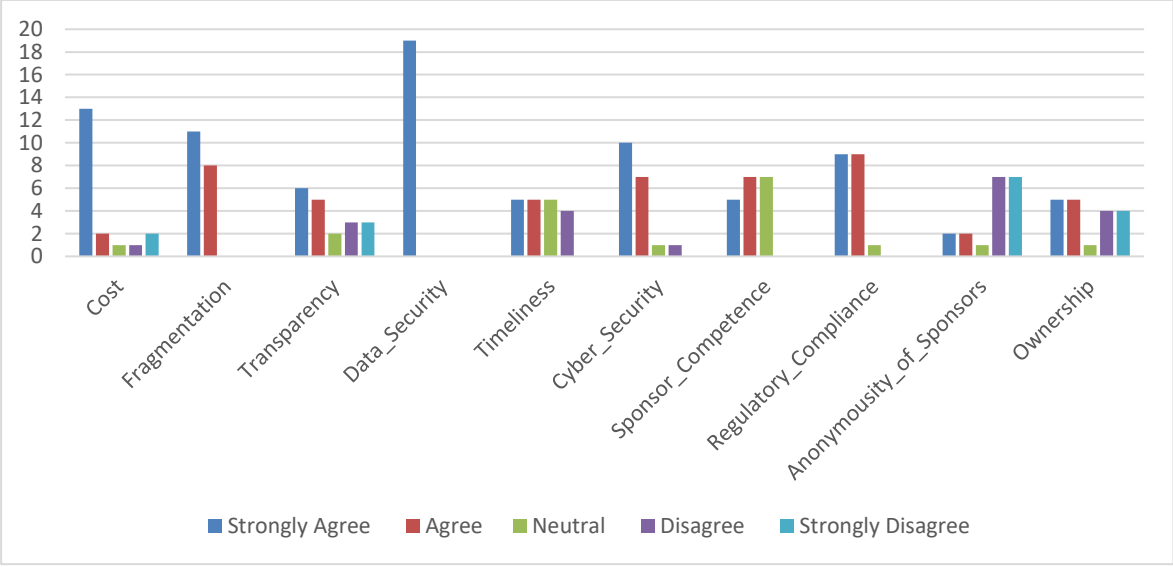

Fig 17 Distribution of Responses to Questions on the Potential of Blockchain to Improve the Fractional Property Ownership Transaction Process in Nigeria. (Professionals in Northern Nigeria. N=19)

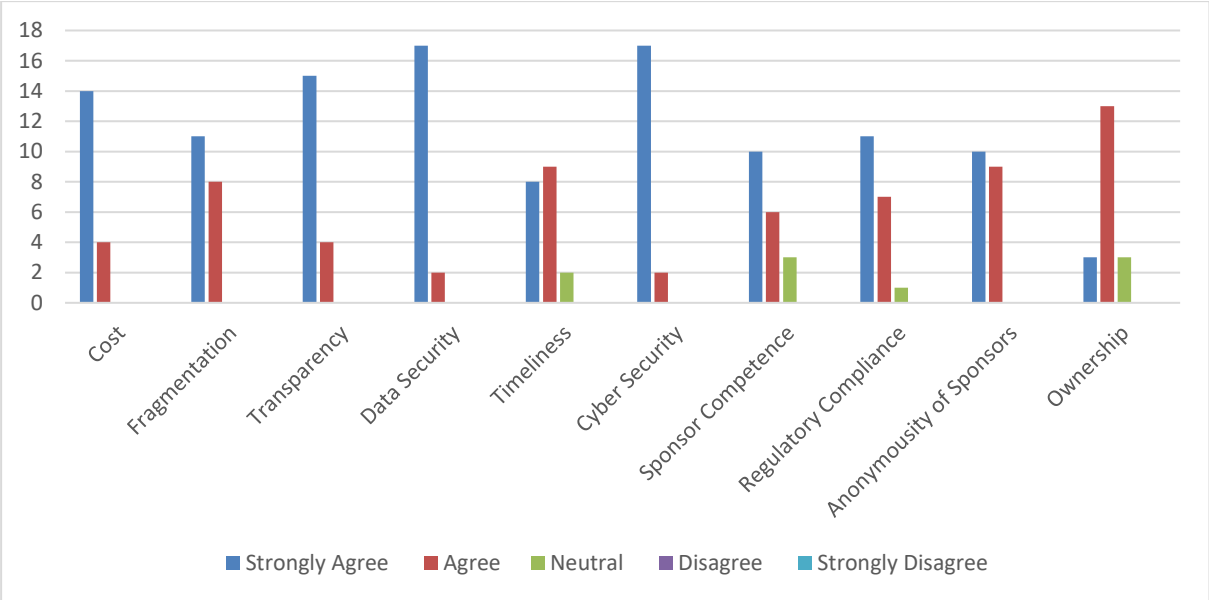

Fig 18 Distribution of Responses to Questions on the Potential of Blockchain to Improve the Fractional Property Ownership Transaction Process in Nigeria. (Professionals in Southern Nigeria. N=19)

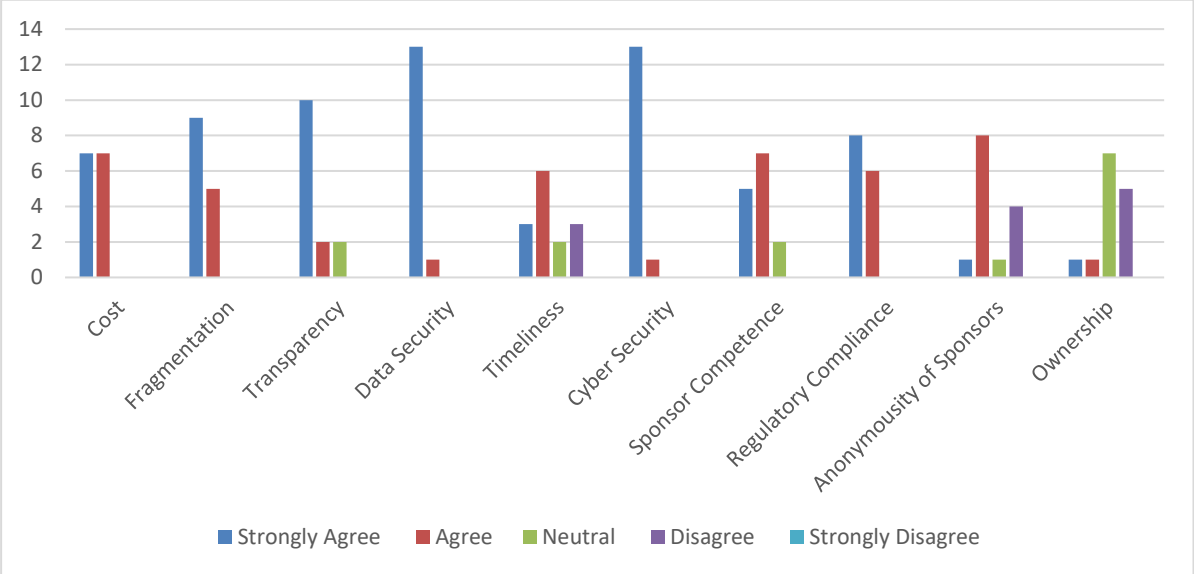

Fig 19 Distribution of Responses to Questions on the Potential of Blockchain to Improve the Fractional Property Ownership Transaction Process in Nigeria. (RE Firms. N=14)

6.5 Hypothesis Testing of Second Survey Data Using the Kruskal Wallis H Test

Table 13 provides the null and alternative hypotheses for the data. The responses of the three group in agreement with the alternative hypothesis that blockchain have the potential to make at least five of the ten selected transaction dynamics more efficient in a fractional property financing process. As expected, the trio of 'High cost of transaction', 'Ease of fragmentation', and 'Regulatory compliance' all have the null

hypothesis retained. Unlike the first test conducted, however, all three groups of participants did not have a consistent belief that blockchain technology can correct the issues having to do with 'sponsors competence' in traditional fractional property financing transactions. Thus, this factor is discarded from the list of critical factors to be given consideration in any attempt to create a more efficient transaction model.

Test Statistics[a,b]					
	Cost	Fragmentation	Transparency	Data_Security	Timeliness
Kruskal-Wallis H	1.360	.170	5.848	.132	6.146
df	2	2	2	2	2
Asymp. Sig.	.507	.918	.054	.936	.046

a. Kruskal Wallis Test

b. Grouping Variable: Region

Test Statistics[a,b]					
	Cyber Security	Sponsor's Competence	Regulatory Compliance	Anonymity of Sponsors	Ownership
Kruskal-Wallis H	10.203	3.595	.552	24.038	15.328
df	2	2	2	2	2
Asymp. Sig.	.006	.166	.759	<.001	<.001

Tab 14 Kruskal Wallis H Test for Null Hypothesis on the Potential of Blockchain to Improve the Fractional Property Ownership Transaction Process.

6.6 Discussion

By combining the result of the two tests and arranging the resulting list of critical factors in ascending order, and assigning ranks to them, we arrive at a final list of critical factors shown in Table 14 below. From the findings of this research, the three factors in the table are the most important to consider when creating a blockchain based transaction model for the fractional property ownership process in Nigeria. Hence, any enhanced model that fails to eliminate the concerns in the listed factors is likely to suffer the same fate as previous attempts to finance real estate in the country. Blockchain technology overcomes the challenges represented by these factors by 1.) improving the fragmentation process using mathematical algorithm in smart contracts, and 2.) by completely removing the need for a middleman to organize the transaction process. By having different fragments or 'bricks' of different sizes and prices, investors of

different categories and net worth are attracted to the property tokenization market, affording the sponsors or property developer more liquidity within a shorter time. Also, by removing the need of a middleman using smart contracts, blockchain based tokenization eliminates a lot of abnormalities associated with the traditional system. The advance cryptography and decentralization that is synonymous with blockchain makes the absence of middlemen not strongly felt. The entire transaction process now appears to be between a group of investors and a competent real estate developer at the initiation, and between third parties in a secondary market or an automatic reimbursement performed by smart contracts at the termination. To illustrate the proposed blockchain solution a visualization of the process has been provided in figure 20. As easily observed, the Sponsor is almost completely missing in the transaction process.

High Cost of Fractional Units	**1**
Ease of Fragmenting Asset into multiple small units	2
Competence of the Sponsors / Organizers	3

Tab 15 Final Summary of Critical Factors to Give Attention in Blockchain Driven Model

Beside the need for an Issuer at the beginning to put the entire infrastructure in place and to kickstart the transaction process, blockchain tokenization almost run completely autonomously.

The suggested transaction model illustrated in Figure 21, has components that are essentially the same as traditional property tokenization, however, the enhanced technology will obviously result in a faster negotiation, more optimized fragmentation, and less costly process. Due diligence from an increased informational dependability and stakeholder trust is better performed, and the possibility of cyber-attacks or personal digital data breeches are almost absent in such blockchain systems. The presented flow diagram is a high-level transaction model of how a blockchain driven tokenization in the Nigerian property market should look like from the research findings and the researcher's perspective. The design is not to be taken as a complete software engineering design model or an advanced prototype architecture. The proposed application must be redesigned in detail and implemented in stages, beginning with the standardization, and then monitoring and control, until the other steps in the action research that seeks to improve the process is complete.

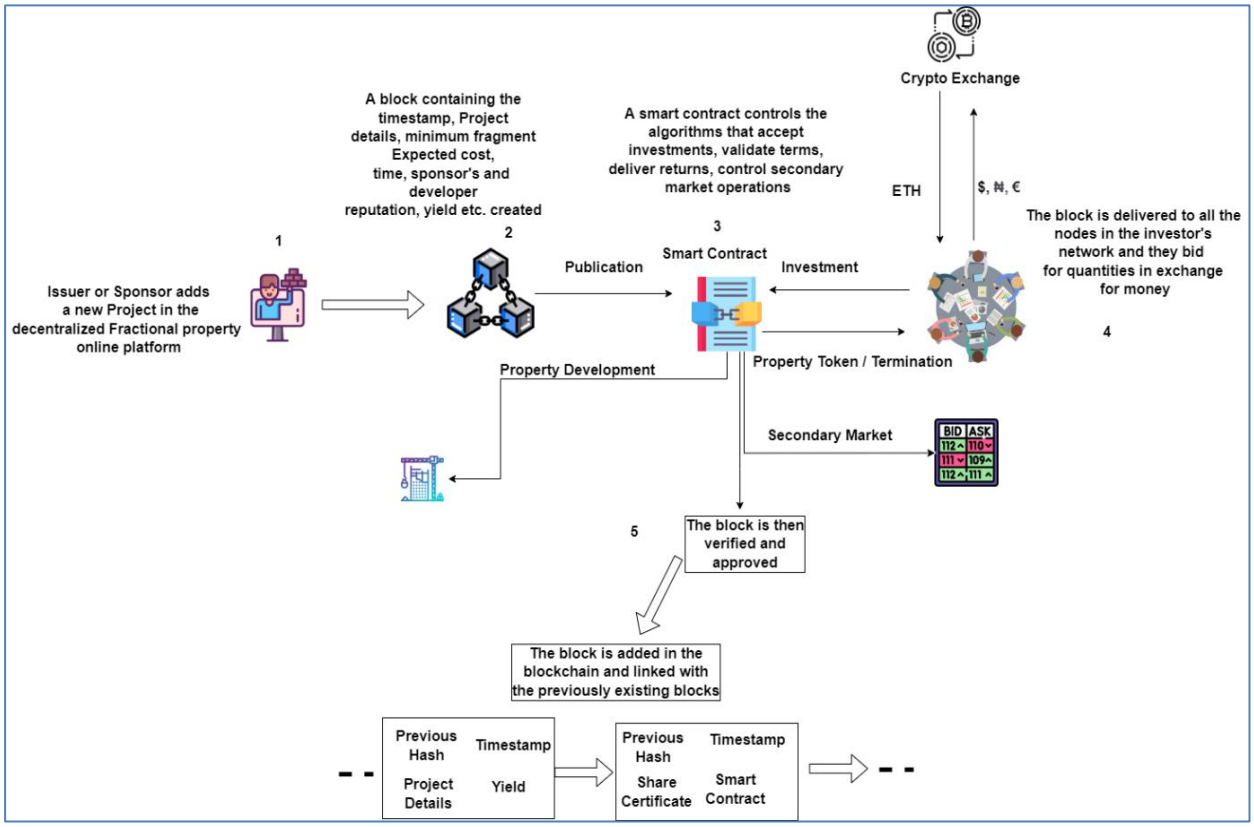

Fig 20 Summarized Steps Involved in The Proposed Blockchain Property Tokenization Model

While the focus in this model is to capture and implement corrections on the identified pain points of the existing system, blockchain by its very nature also tackle aspects of the other seven challenges of traditional fractional property ownership, identified at the beginning of this thesis. For instance, the cultural ideas of property ownership that ascribe all the control to an individual, was strongly highlighted by many responders in the survey as deterrents to their participation in current property crowdfunding. If such a concern is neglected, we stand a chance of making the same mistakes that have hindered the current process; and the final goal of reducing the Nigerian housing deficit will be defeated. (Baum, 2021) have suggested the so-called Hybrid models of property tokenization which involves the combination of some traditional elements with typical blockchain design models. Blockchain technology can be relied upon to produce a hybrid opportunity, where the rewards received combine a utility (the use of space) and a return (revenue and/or capital) without necessarily creating a conflict in the system or becoming altruistic. The fractionalization of private residential property, where rent/buy hybrid structures can be partially financed by hybrid tokens, is an excellent

example with significant growth potential. By using these tokens, a resident can become a shareholder in the building rather than the fully-debt-financed owner of a specific flat or bricks. Utility rights are granted by the smart contract based on percentage of token owned and on seniority of shares.

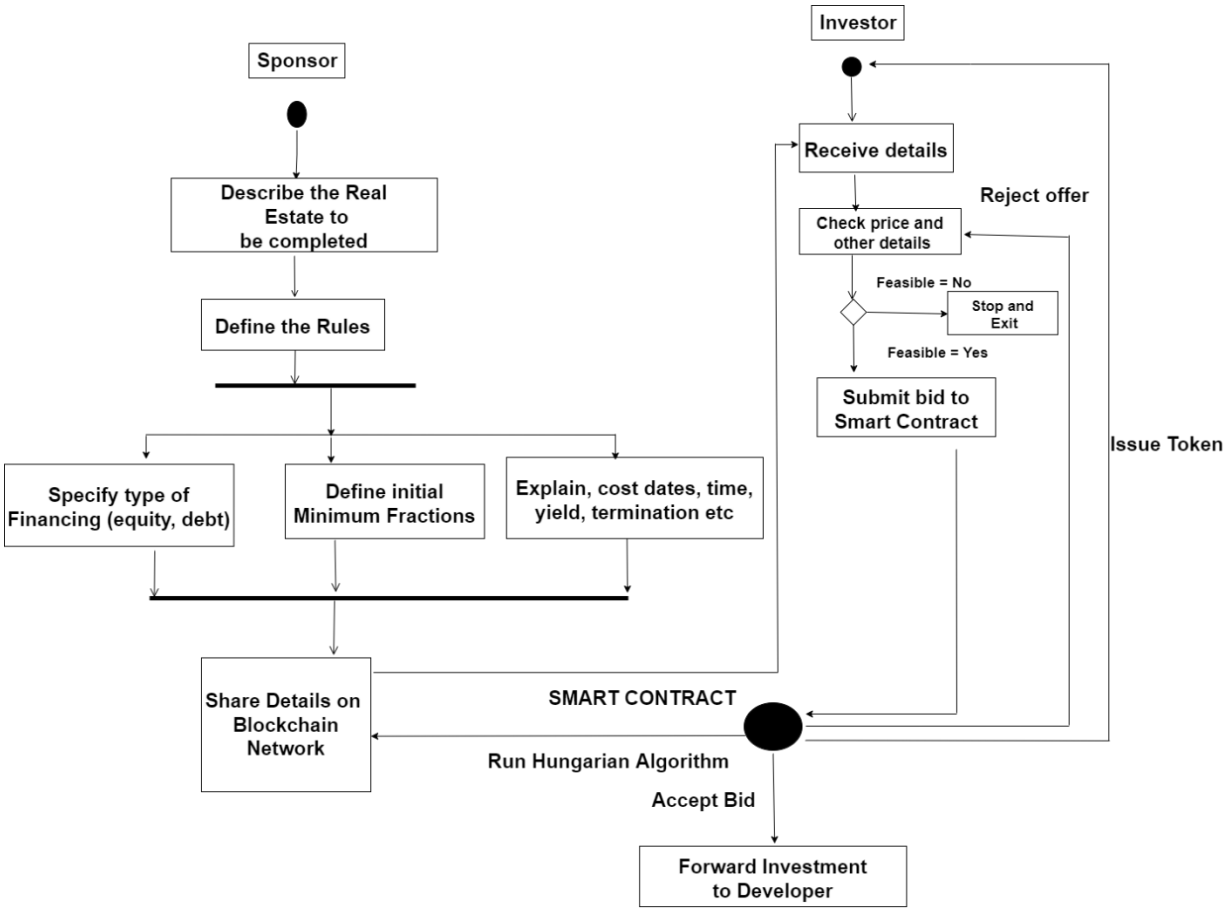

Fig 21 Proposed Blockchain Fractional Property Transaction Initialization Model

In Chapter 4, we hypothesized that in a perfect world, tokenization might possibly avoid rules, taxes (especially stamp duty land tax), fees, achieve disintermediation, speed up transactions, prevent the release of public information, take advantage of blockchain's efficiency, and permit cryptocurrency trades. Our research and model have shown that only most of these benefits—speed, cost, fragmentation and customizability, privacy, and blockchain—have a possibility of being implemented through blockchain tokenization. The summary in Table 15 represents the most important factors we seek to integrate in the model, and we succeeded in doing so. The application being created will have a big impact on the economic advantages of tokenization. The main challenges of real estate tokenization in property financing in Nigeria which is the

general opinion have limited interest and participation and prevented the fractional property model to gain substantial traction will thus be solved. It is recommended that further research be done by implementing and testing the proposed model in the other phases of the action research. It is preferable to invest in blockchain-supported solutions to commercially viable ideas with a strong demand than to run the risk of improperly using the tokenization or crowdfunding and detracting from its attraction.

7 Conclusion

In this research, we suggested a more efficient technology to carry out the traditional web based fractional ownership transactions in Nigeria. The proposition is made necessary by the existence of some challenges in the traditional process of property tokenization, which prevented the traditional model from gaining substantial traction in Nigeria. Other options for financing private building projects in Nigeria, whether from public or private sources, are fraught with paucity of funds, stringent requirements, or extreme bureaucracy. This research itemized ten factors limiting the traditional real estate crowdfunding in Nigeria from relevant literature reviews. Nigerians of different background and demography were subsequently interviewed to get a ranking of the selected challenges. The varying cultural divides in the country which can create disparity in the choices and buying decision people make, led the researcher to perform the surveys across the north and south divide of the country. The Krustall Wallis non-parametric test was then used to verify the occurrence or non-occurrence of significant outliers in the samples. Four factors: high cost of transaction, ease of fragmentation, Sponsor's competence and Regulatory concerns were identified by the responders as the most critical factor discouraging them from participating in fractional property campaigns. A subsequent survey among professionals familiar with the basic concept of blockchain tokenization, revealed that the challenges posed by three of those factors: high cost of transaction, ease of fractionalization, and Sponsor's competence can be sufficiently addressed by introducing blockchain technology to fractional property ownership transactions. These findings were used to develop the prototype of a basic blockchain driven transaction model for real estate crowdfunding in Nigeria.

Blockchain real estate tokenization is an intriguing concept that has the potential to radically transform the whole real estate sector in Nigeria. The customizability of offers, which reduces the amount of monies needed for direct investment in real estate and promotes accessibility; the lower transaction cost, absence of a central authority who can manipulate the system, speed of transactions, and the transaction process efficiency are the most important advantages from the viewpoint of investors. From the standpoint of the Sponsor, owners of the platforms

and property developers, tokenization increases liquidity enormously, because of the multiple players that can now have access to the real estate market. Besides these possibilities and benefits are the inherent security and transparency that the technology affords. Nigerians who are concerned about ownership rights in fractional real estate ownership can also take advantage of hybrid opportunities available in blockchain property tokenization. In addition to periodic financial returns, hybridization in blockchain tokenization provides the possibility of utility tokens or usage rights to the properties based in share ownership and seniority of tokens. The outcome of implementing the proposed model is that more and more residential properties will be constructed in Nigeria and this will help bridge the widening housing supply lag.

Although this research suggests a blockchain driven model that could improve the present process, the proposition has certain limitations and the researcher have identified some areas that require more research. First, the few countries where blockchain tokenization have been implemented in real estate financing are developed economies where the infrastructures needed for successful implementation where not lacking. It is feared that Nigeria being an emerging economy, there may be a few hiccups that may limit the ease of a seamless implementation, especially when it comes to interfacing with banking technology, banking regulations and with electricity supply. The volatility of bitcoin, association of the technology with criminal activity, and the electricity required to power the computer processes of the numerous users, are enough reasons for Nigerians to ascribe a negative connotation to blockchain and NFTs. However, the fact that there are already many functionals blockchain driven systems in the country provides a template to adopt for executing the proposed model. Second, the surveys conducted with professionals were done on the assumption that they have extensive knowledge with the blockchain technology, have participated in several fractional property transactions, or have acted on behalf of the owner. However, there is no guarantee that this is certain, and responders may have simply provided responses based on their whims. Where this occurred, it will result in a low external validity of the results because only a small number of stakeholders were interviewed. More stakeholders could be questioned to guarantee that all roles are covered in order to strengthen the external validity. Additionally, investors—the crucial participants in a transaction process—should be the subject of attention. Third, research on legal and technical

aspects are not included in this study. Data protection regulation, and the financial regulation of cryptocurrency transactions for instance, is a significant reform in Nigeria legislature at the moment. Research is still needed to determine how privacy regulations would affect the application under consideration. The same holds true for the expenditures associated with creating and implementing the suggested tool. Further study on these subjects is required when comparing the current system and one that will rely on blockchain.

In conclusion, blockchain tokenization presents the real estate investing industry in Nigeria with intriguing new opportunities. However, the technology is still at the early stages of development, and it will take time for real estate applications to advance and be accepted. If emphasis is not given to the benefits of digital blockchain fractionalization of property assets, which has a small market, weak economics, and considerable barriers, there is a strong risk that innovation will be delayed by years, if not decades. This researcher recommends further study and a continuation of the action-based research. Further research will include details of the technical aspects, application development and a continuous testing and refinement done in collaboration with investors and the fractional property firms; as dictated in the **Plan, Act, Observe and Reflect** phases of an action research.

Declaration of Authorship

I hereby declare that the attached master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Location, Date	Signature of the student

Appendix

Appendix A

S/N		General Demographic Questions					
1		What is your Name?					
2		How old are you?					
3		What is Your Profession?					
4		Which geopolitical region of Nigeria do you stay (North, South)?					
5		What city or town do you stay?					
6		How many years of education do you have?					
7		Do you own a property entirely on your own at the moment?					
8		Do you currently share ownership of a property with others, or have you engaged in fractional property ownership in the past?					
9		if you answered not above, would you consider fractional property ownership in the future?					
10		In a fractional property investment, would you prefer to jointly own full rights to the property or are you content with just giving out funds as a loan and obtaining interests for the debt over time?					
		Identifying Challenges with Traditional Fractional Property Ownership					
	Pain-points	**In a fractional property ownership process:**	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
			1	**2**	**3**	**4**	**5**
1	Cost	The high transaction cost is a limitation that could make me look for an alternative source of real estate financing					
2	Fragmentation	I find the minimum amount required to invest in a fractional property transaction sometimes too high and this makes me not invest in such deals					
3	Transparency	I find the lack of transparency in the fractional property ownership process challenging enough to influence my decision to partake in it or not					
4	Data Security	My personal data security is important to me, and I am not comfortable with having					

		financial transactions on online platforms with limited regulations					
5	Timeliness	The traditional fractional property ownership process takes too long to initiate. I have a problem waiting for the full expected cost of the property to complete					
6	Cyber Security	I am worried that hackers and Programmers with malicious intent could disrupt the operation of a fractional property financing website and all financial data could be lost or manipulated					
7	Sponsor Competence	I fear the many managers of the platform lack both real estate managerial and financial management competence.					
8	Regulatory Compliance	I am worried that many fractional property ventures do not meet financial regulatory requirements					
9	Anonymity of Sponsors	I am not comfortable with the fractional property transaction process because the managers of the funds are anonymous					
10	Ownership	When I invest in properties, I like to own, control and be able to make final decisions about it. I am concerned that fractional property ownership doesn't allow me to do this					
		Identifying Potentials of Blockchain Tokenization in Fractional Property Ownership					
1		What is Your Profession?					
	Opportunities	Do you think applying Blockchain tokenization in the Nigerian fractional property ownership transaction process?	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
2	Cost	would reduce the total cost of the transaction?	**1**	**2**	**3**	**4**	**5**
3	Fragmentation	would provide better distribution of shares or fractions and reduce the entry requirements?					
4	Transparency	would lead to an altogether transparent process devoid of internal manipulations?					
5	Data Security	would secure my personal data better?					
6	Timeliness	would lead to quicker transaction turnaround time?					
7	Cyber Security	protect my investment from external manipulations?					

9	Sponsor Competence	reduce the concerns I have about sponsor's real estate management competence					
10	Regulatory Compliance	reduce the concerns I have financial regulatory oversight on the sponsors?					
11	Anonymity of Sponsors	reduce the concerns I have about the anonymity of the managers of my funds?					
12	Ownership	improve the way I own and control the property?					

Details of Survey Questions

Ranks

	Region	N	Mean Rank
Cost	North	56	63.95
	South	74	66.68
	Total	130	
Fragmentation	North	56	64.50
	South	74	66.26
	Total	130	
Transparency	North	56	53.56
	South	74	74.53
	Total	130	
Data_Security	North	56	75.29
	South	74	58.09
	Total	130	
Timeliness	North	56	56.43
	South	74	72.36
	Total	130	
Cyber_Security	North	56	69.33
	South	74	62.60
	Total	130	

Sponsor_Competence	North	56	67.26
	South	74	64.17
	Total	130	
Regulatory_Compliance	North	56	66.34
	South	74	64.86
	Total	130	
Anonymousity_of_Sponsors	North	56	61.33
	South	74	68.66
	Total	130	

Rank sum of the Challenges of Fractional Property Ownership Transaction from North and South of Nigeria

Ranks			
	Region	N	Mean Rank
Cost	Professional North	19	26.89
	Professional South	19	24.08
	Firm	14	29.25
	Total	52	
Fragmentation	Professional North	19	26.95
	Professional South	19	26.95
	Firm	14	25.29
	Total	52	
Transparency	Professional North	19	22.50
	Professional South	19	27.76
	Firm	14	30.21
	Total	52	
Data_Security	Professional North	19	26.74
	Professional South	19	26.74
	Firm	14	25.86
	Total	52	
Timeliness	Professional North	19	31.55
	Professional South	19	20.18
	Firm	14	28.21

	Total	52	
Cyber_Security	Professional North	19	32.97
	Professional South	19	23.13
	Firm	14	22.29
	Total	52	
Sponsor_Competence	Professional North	19	31.13
	Professional South	19	22.50
	Firm	14	25.64
	Total	52	
Regulatory_Compliance	Professional North	19	28.29
	Professional South	19	25.66
	Firm	14	25.21
	Total	52	
Anonymousity_of_Sponsors	Professional North	19	37.71
	Professional South	19	14.58
	Firm	14	27.46
	Total	52	
Ownership	Professional North	19	25.21
	Professional South	19	18.79
	Firm	14	38.71
	Total	52	

Rank sum of the Potential of Blockchain to Address the Listed Challenges of Fractional Property Ownership Transaction in Nigeria, from Survey Responders in North and South of Nigeria and Selected Real Estate Firms.

Appendix B

	P										
DF	0.995	0.975	0.2	0.1	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	.0004	.00016	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.55	10.828
2	0.01	0.0506	3.219	4.605	5.991	7.378	7.824	9.21	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.86	16.924	18.467
5	0.412	0.831	7.289	9.236	11.07	12.833	13.388	15.086	16.75	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.69	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.18	11.03	13.362	15.507	17.535	18.168	20.09	21.955	24.352	26.124
9	1.735	2.7	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.92	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.3	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.79
18	6.265	8.231	22.76	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.9	27.204	30.144	32.852	33.687	36.191	38.582	41.61	43.82
20	7.434	9.591	25.038	28.412	31.41	34.17	35.02	37.566	39.997	43.072	45.315

Chi square Critical Values Table

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