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https://doi.org/10.3390/buildings13061560

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Abstract: The ground can become saturated during prolonged downpours. If sewers and drains are unable to cope, overflows will be inevitable. This situation could affect properties that are not designed to cope with flood hazards. It is pertinent that property investors should consider flooding and the likelihood of its occurrence when making investment decisions. The question is, "do they?" This study investigates the factors that influence residential property investment decisions in flood-risk areas of the Lagos metropolis. This is achieved by evaluating a range of locational, neighbourhood, structural, market/economic, behavioural, and risk characteristics in the determination of residential property investment choices in areas that are susceptible to flood risk. The data were sourced from private investors and registered real estate agents in the risk areas of Lagos State, Nigeria. Structured questionnaires were used for data collection purposes, and only valid responses were used for the data analysis. The results show that the availability of infrastructural supply, the crime rate in the neighbourhood, and the property location could significantly motivate investors' decisions with respect to property investment in flood-risk areas. The perception plot shows that behavioural factors have the highest bearing on the investment decisions for private investors, at 4.4, followed by economic factors at 4.0 and locational factors at 3.6. The plot also shows that neighbourhood factors have the highest bearing on the investment decisions for estate agents, at 4.6, followed by economic factors at 4.0 and locational factors at 3.6. This implies that there are various degrees of correlation between the factors examined in this study. It is important to highlight the relevance of the findings for the field and pave the way for future scientific development in flood-risk management.

Keywords: decision-making; flooding; investment; private investors; properties; property agents; property values; real estate developer

Citation: Oyetunji, A.K.; Amaechi, C.V.; Dike, E.C.; Ayoola, A.B.; Olukolajo, M.A. Factors Influencing Stakeholders' Decision to Invest in Residential Properties: A Perceptual Analysis of Flood-Risk Areas. *Buildings* **2023**, *13*, 1560. https://doi.org/10.3390/buildings13061560

Academic Editor: Pierfrancesco De Paola

Received: 23 May 2023
Revised: 10 June 2023
Accepted: 13 June 2023
Published: 19 June 2023

1. Introduction

The real estate industry is vital to the modern economy. The real estate market is the market that encompasses all transactions that involve dealing in rights or access to land and buildings [1]. It forms the backbone of the urban economy, being a fixed factor

market; hence, an efficient real estate market is most important for a well-functioning urban environment. This implies that countries cannot create wealth without real estate or be wealthy without possessing it [2]. Real estate has also been found to have relative impact in various economies, including developing nations such as Nigeria and developed nations such as the UK [3,4]. According to Minguzzi [5], real estate helps boost the modern economy in the following four ways: Firstly, it enables economic activity through the production and supply of space for industry and business. Secondly, real estate secures employment provisions for professionals, artisans, and other workers. Thirdly, it complements and supports the government's infrastructure policy through real estate development. Lastly, real estate provides an investment outlet for institutional investors to maximise returns on investible funds. Real estate investment has become "the largest asset class globally" in terms of value [6]. Savills World Research [7] considers that global real estate is a more valuable asset class than all stocks, shares, and bonds combined and reveals that the driving force behind the growth that has made property most importantly sought after is the investment funds.

Due to the increasing demand for land and its unavailability in desirable places, citizens gravitate to different areas, including those prone to flood risk. This suggests that people do not see flooding as a barrier to urban growth and expansion. Adebimpe et al. [8] termed flooding an overflow or retention of water in a normally dry area. In this study, the flood-risk areas are described as hotspots. Therefore, a place that regularly experiences flooding can be termed a "*flood risk hotspot*". The occurrence of flooding in such an area could be attributable to the overflowing of rivers, natural waterways, and surface runoff [9]. The increasing frequency and severity of rainfall due to climate change has contributed to the persistent rise in flooding events [10]. The impact of flood events in recent times has arguably been unprecedented worldwide. These incidents have caused deaths, injuries, and property losses [11–13]. Flooding has also been found to be seasonal, as Etuonovbe [13] added that the rainy season is not the best time for the inhabitants of Lagos. This period is characterised by persistent flooding, which submerges several houses, resulting in damage and, in some cases, death. The various forms of flooding that occur in the state include tidal, river, flash, drainage, sewage, urban, and pluvial [13]. According to Aderogba [14], the primary factors contributing to flooding in all local government areas of Lagos include canal blockages, insufficient drainage infrastructure, heavy rainfall, and encroachment.

The global problem of flood events is becoming more severe due to climate change and population drift. Incidents of flooding that wreak havoc on the urban infrastructure are now commonplace. According to research, various types of floods are triggered and aggravated by natural and manmade activities within a given environment. Examples include tidal, pluvial, sewers and drains, groundwater, fluvial, and those from manmade activities [14–17]. Flood incidents can, therefore, be classified according to type, causes, and the extent of the damage. According to Brockhoff et al. [10], most areas experience flooding after downpours due to their impervious surfaces and rapid urban expansion in many flood-prone areas. The impacts are common to both developed and developing countries. This is true for the present study area, as flooding is a common phenomenon after downpours in most locations in Lagos, Nigeria. The criteria for defining flood-risk areas could vary by country. However, it is noteworthy that factors such as the frequency and magnitude of flooding, land elevation, proximity to water bodies, the presence of floodplains, and the level of development in an area could contribute to the flood risk of the area. As put forward in this study, the flood-risk areas are those that (i) regularly flood whenever it rains, (ii) are within the proximity of water bodies, and (iii) are defined as at high risk of flooding by the Nigerian Hydrological Agency due to the historical background of those areas.

Flooding affects more properties than any other environmental hazard and hinders sustainable development [18,19]. Over the last two decades, Nigeria's urban population has grown exponentially [20,21]. The upsurge in population has increased the demand for housing [22]. Additionally, it has increased the demand for property and generated much

pressure on land, infrastructure, and social services. Flooding has been more common in some areas of Nigeria in recent years due to the rising urbanisation pattern and the increasing number of metropolises without adequate planning and drainage facilities [23–25]. A study on the review of Environmental Impact Assessment (EIA) noted that hazards such as flooding could impact sustainable development [25], which could include key aspects of valuation, such as depreciation and appreciation of property values. The effect on property prices in the affected natural disaster area could further be explained by the categories of property strata, housing, and landed property [26]. However, Basu et al. [27,28] concluded that with the growing rate of urbanisation, the presence of trees can influence the quality of the environment and, in turn, aid in flood control.

Ayoola et al. [29] also modelled the externalities necessary for assessing residential property values. The value assigned to a property is contingent upon the existence of several distinct bundles of characteristics [30,31]. In coastal environments, for instance, a recent literature review considered the effects of flooding on residential properties, reflecting different models for determining its values [32]. In all, the peculiarity of the stakeholders engaged in the real estate market and the heterogeneity of real estate assets might be attributable to the varied values assigned to real estate property interests [33]. This means that people make choices, and the decision-making method is often particular to the issue at hand. While some options are simple and seemingly straightforward, others are difficult and involve a multistep decision-making process. How people perceive and decide about risk is a complex phenomenon [34]. No widely agreed framework embraces all real estate investment decision-making features, although, over time, many of its facets have been established and investigated [35–38]. Continued residential property investment in areas prone to flood risk calls for examining the factors that are responsible for continued property market activity, and whether the combination of these factors supersedes the risks associated with investing in residential properties in these environments. External and internal sources could influence individuals' decision-making behaviours. The factors could include prior experience, awareness of flood duration, and socioeconomic, situational, and geographic variables [39–42].

The analysis of the influencing factors and other issues that arise from the findings of the present study form the basis for a decision-making guide for residential property investors. Therefore, to examine the investors' decision-making behaviour in this present study, it was important to establish the drivers that could motivate property investment, with a view to understanding their perceptions of risk considering the impact of flood risk on the environment. This study therefore aims to understand and explain the factors that influence investors' decisions in investing in property in areas with the likelihood of pluvial flooding, using Ibeju-Lekki and Ikorodu—two notable local government areas susceptible to pluvial flooding in Lagos State, Nigeria—as a case study.

2. Determinants of Investment in Flood-Risk Areas

The research about risk perception will help in understanding how choices are made. The perception of risks is multidimensional (rational and emotional) in nature [43,44], combined with the perceived likelihood and anxiety associated with it [45]. Researchers have shown that risk characteristics can be grouped into two dimensions: cognitive and emotional [46,47]. Humans often deviate from rational behavioural norms [48,49]. Slovic [50] states that when people choose natural hazards, they rely on intuitive risk perceptions. Individuals' perceptions influence their decision-making behaviour. Theories have been developed to understand how people make choices and the reasons for those choices. Juliusson et al. [51] suggested that previous choices may influence subsequent ones. When something positive results from a decision, people are more likely to decide similarly when facing a similar situation. On the other hand, people tend to avoid repeating past mistakes [52]. This is because future choices made based on past experiences are not necessarily the right choices. This approach conflicts with what one may expect (see Ref. [51]).

People's beliefs about natural hazards can influence risky investment decisions [53]. More precisely, a person's perception and assessment of the possibility of floods would likely determine their attitude toward investing in an area delineated as at risk of flooding. Solomon and Qin [53] asserted that increased public perception of floods could be attributed to the environmental effects of climate change. However, human expectations and reactions to threats are complex [54]. Investment motivations and subsequent decisions are affected by various determinants, which make the process dynamic, complex, and difficult.

Numerous variables may also contribute to influence the decision to invest in real estate. These variables could be classified into environmental, neighbourhood, accessibility (location), and property (structural) variables [55]. Sean and Hong [56] delineated the variables that could influence property investment decisions in Malaysia, into neighbourhood, financial (economic), structural, and locational factors. According to Wong et al. [57], the value attributes assigned to investment decision-making would be influenced by the property's physical characteristics (e.g., structure, size, and design of the property) and neighbourhood characteristics (e.g., distance to schools, malls, parks, markets, and the rate of crime risks). Maleki and Zain [58] discovered a strong association between housing prices, environmental facilities, and property design (structural). The present study identified variables that have been shown to impact property investment decisions in general and assessed whether they could also motivate investment decision-making and contribute to investment in areas susceptible to flooding.

Due to the susceptibility of flood-risk areas, it can be said that a thin line demarcates areas at risk of flooding and those that are not. This is because an area might be flooded overnight despite not being designated as a floodplain. Studies have investigated factors that could influence property investment decisions. These studies are mainly focused on non-flood-risk areas. There is a dearth of research and information on those factors that could inspire investment in flood-risk areas—especially in Lagos, Nigeria. This research gap needs attention considering the growing threat of floods, climate change, the constant demand for land and landed property, and the need for sustainability. In order to address this problem, this study examines how knowledge and experience of flood risk can influence private investors' (i.e., homeowners and renters) decisions on property investment selection in areas that are at risk of flooding. Additionally, the study explores how well estate agents understand the needs of private investors whenever they are approached for property investment transactions. This is necessary to ascertain their expertise in terms of comprehending their clients' decision-making behaviour.

3. Materials and Methods

This aspect of the paper elaborates on the research tools and the approach taken to achieve the goal of the study. It also gives detailed descriptions of the study area.

3.1. Research Questions

The definitions of the research questions and the research objectives are very important aspects of the research. To start with, it is important to note that housing investment decisions are the result of multiple factors, but for property investors the most important considerations are still return on investment (ROR), long-term property ownership, and arbitrage space. Investors classify their property investments based on different stages of property management and their ROR to be defined as investors. Both investors and agents are more inclined towards speculative transactions, so the residential attributes of real estate may be ignored. Thus, the definition of the study object/respondents was critical, and the respondents were all informed about this study's goal. To achieve the objectives of the study, the following research questions are asked and addressed in this paper:

(i) What factors do property investors consider in making residential housing decisions in flood-risk areas?
(ii) How well do the estate agents understand the requirements of property investors when making residential housing decisions?

(iii) Compare and rank the perceptual analysis of the responses obtained in (i) and (ii).
(iv) What inferences can be drawn from their perceptual analysis?

3.2. Research Process

Due to the nature of the research, the research process for this study is presented in this section. The steps taken in undertaking this research are represented in the flowchart described in Figure 1.

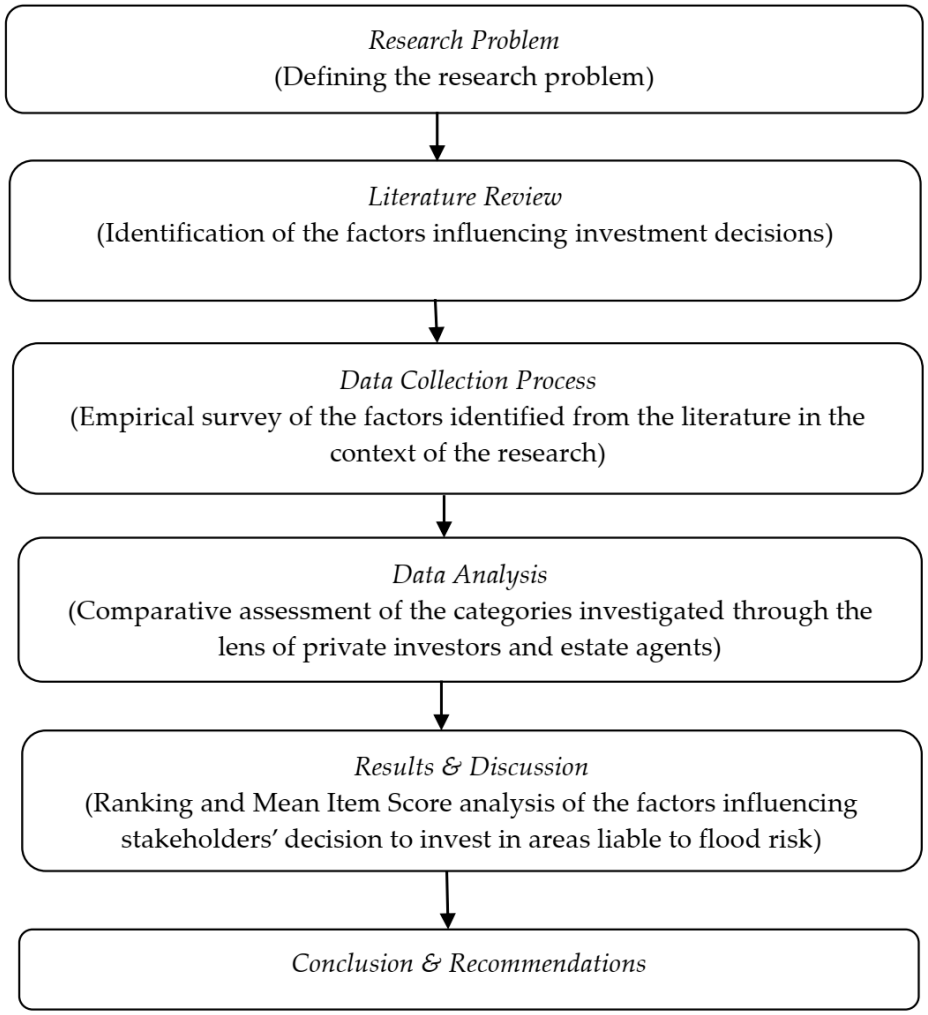


Figure 1. Flowchart used in this research methodology.

3.3. Study Area

This research took place in Lagos—Nigeria's former federal capital. Lagos is often referred to as the nation's economic capital. The state is situated in the geographical region of South-Western Nigeria. It is Nigeria's primary commercial centre and potentially the country's most economically viable state. The state remains Nigeria's economic hub and one of Africa's fastest-growing urban cities [59], serving as the country's commercial and socio-political nerve centre [60,61]. Ambode [62] attributes Lagos's advantages to its hosting of over 50% of Nigeria's commercial activities, comprising businesses, manufacturers, and financial institutions, as well as small and medium enterprises; based on GDP, this would rank Lagos amongst the five most productive economies in Africa were it to be regarded as a sovereign state. Lagos is the largest urban area in West Africa, according to the United Nations [63], due to its density and population growth rate. The state is located in South-Western Nigeria between latitudes 6°2′ N and 6°4′ N and longitudes 2°45′ E and 4°20′ E. It

is made up of 20 local government areas (LGAs). Lagos State is bounded by Ogun State to the north and east. It is also bordered on the west by the Republic of Benin and on the south by the Atlantic Ocean. It has been determined that water, wetlands, lagoons, creeks, barrier islands, beaches, and estuaries occupy 40% of the overall land area of Lagos State [64]. In addition, there is the need to have information on the soil, vegetation, and land cover of the area in producing flooding maps [65–67]. Figure 2 shows the map of the study location.

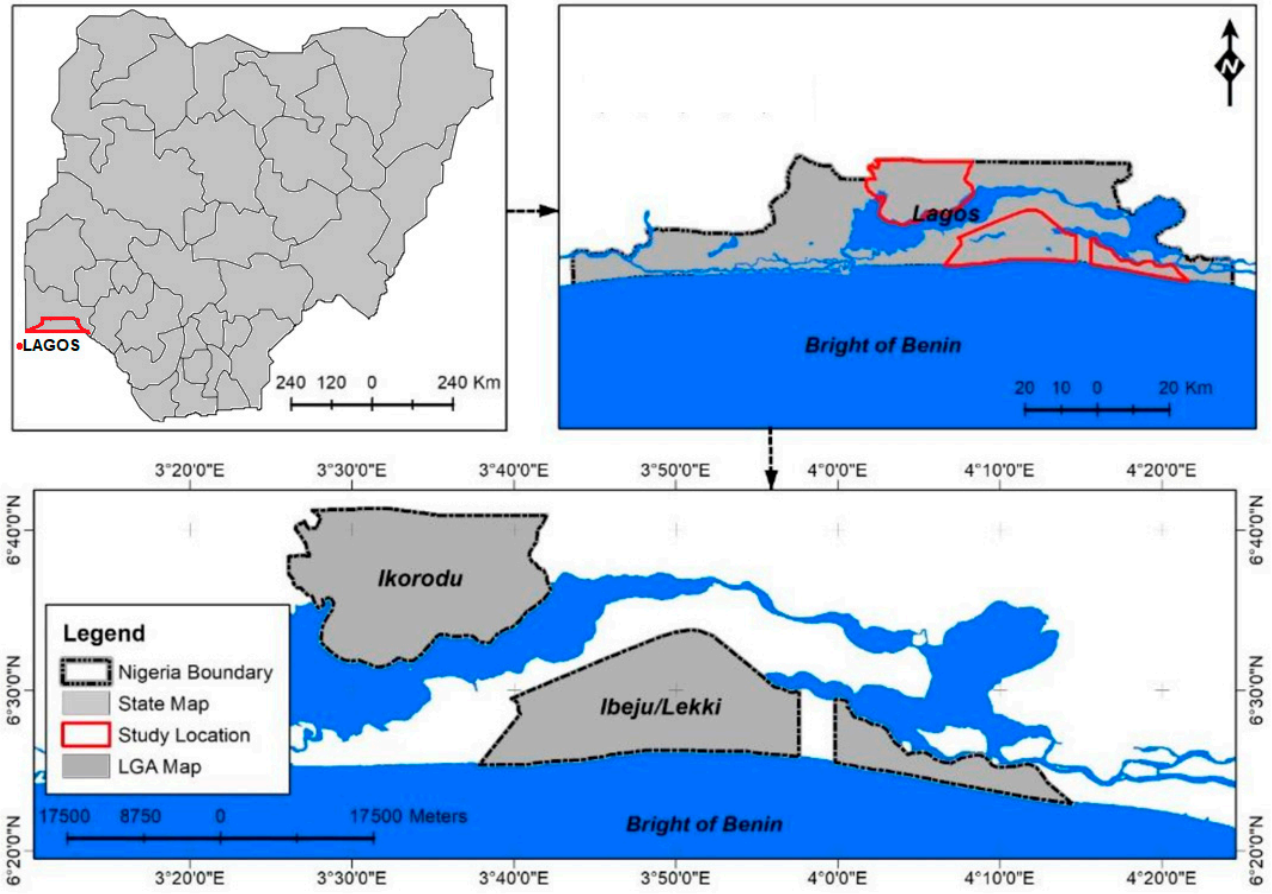


Figure 2. Map showing the study locations (Ibeju Lekki and Ikorodu).

Lagos State has a long history of flooding dating back to the pre-colonial era. The state is located on a low-lying coastal plain with an average elevation of about 1.5 m above sea level, making it particularly susceptible to flooding [68–70]. The earliest recorded incidence of flooding in Lagos State dates back to when the Ogun River overflowed its banks and caused significant damage to properties and livelihoods in the area. In the post-colonial era, Lagos has experienced several devastating floods, particularly in the 1960s and 1970s. The most severe of these occurred in 1963, when heavy rains caused the Ogun River to overflow its banks, resulting in the loss of lives and significant damage to properties and infrastructure. The state, which has experienced remarkable urban growth, has recently been faced with persistent urban flooding. The most severe flooding incidents occurred in 2012 and 2017, which resulted in the loss of lives and significant damage to properties and infrastructure. The occurrence of flooding could be attributable to poor urban drainage systems, unsustainable growth, the impacts of climate change, and inadequate data for proper planning [71].

The low slope angle delays water's drainage from the land; this, combined with the increase in runoff generation associated with urban expansion, increases its flood risk level. This study is based on Lagos, Nigeria, as there are high flood risks due to incessant flooding being very challenging in this region. The understanding of additional data

on Lagos and the flood patterns there, supplemented by official statistical records from census reports or government data records, helps to portray the context for readers. In the annual flood outlook report by the Nigeria Hydrological Services Agency (NHSA) [72], the primary factors responsible for flooding in Nigeria were identified as soil moisture, extreme weather patterns attributed to climate change, the operational efficiency of dams (particularly those in proximity to the nation's borders), and topographical features. The study conducted by Adegboyega et al. [73] highlighted that land-use alterations, such as urbanisation, can act as a catalyst for the occurrence of urban flooding. In an earlier study, several anthropogenic factors were identified as contributing to flooding [74]. These factors include insufficient drainage, improper disposal of waste into water bodies, construction activities along waterways, and the overflow of rivers and dams. In major parts of the state, flooding is mainly caused by runoff water during the rainy season. This present study is on the surface-water runoff flooding, which occurs as a result of excessive rainfall. The climate in Lagos is equatorial, with rain throughout the year. Most precipitation falls during the rainy season—usually between March and September or April and October [75].

3.4. Data Collection

In this subsection, the details on the research tools used are presented. It also presents context for the research questions of the study, the residential description of the study area, the characteristics of the respondents, and the questionnaire descriptions. In this study, the questionnaires were designed using online versions that were distributed via electronic copies and hard copies. A comprehensive literature review on this subject area was conducted for developing the questions used in the questionnaire design. The timeline for the collection of the questionnaire was within a 6-month period (January to July 2022). The questionnaires were administered for the collection of data in this study. Ethical considerations were also made for the study, and consent was received from the respondents. The respondents were also informed of what the study would cover and the justification for the study. Moreover, this study covers a gap in knowledge in this area. The target location for the study is an area that is densely populated. The houses in the area are densely occupied, and the residents leave home early to get to mainland parts of Lagos to avoid traffic congestion or use public service buses.

The target population for the study consisted of private investors in areas with the likelihood of flooding and estate agents involved in advising, management, letting, and sales of property within the domain of the surveyed location. The private investors are classified in this study as landowners (landlords) and renters (tenants) with interest in the landed investment. While the former has an investment in ownership, the latter have an investment in occupation and pay rent for the right to occupy the property for a given time. This right to occupy is known as a leasehold investment, and this right can be valued and sold in the marketplace. Retrieval of property information from real estate professionals is essential in housing studies [76]. Therefore, the opinion of the property agents was also sought. The directory of members of the profession was obtained from the national secretariat of the Nigerian Institution of Estate Surveyors and Valuers (NIESV). Based on the sample size, there were 186 estate surveyors and valuers that fell within the local government areas (LGAs) under investigation, and this formed the sample survey for estate agents.

The respondents' demographics cut across the upper class, the middle class, and the lower class. The housing properties traded by the investors and agents who participated in the questionnaire were privately owned properties. The distribution of the residential properties in this area includes bungalows, multi-storey buildings, detached houses, and fenced buildings. There are some corner shops, parks, and a few industrial buildings in the area as well. Using satellite images retrieved from publicly available map data, the street maps with the distribution of various buildings in the study area was visualised. Different studies were identified that utilised such mapping techniques in the description of the study areas [77,78]. The typical distribution of the residential location shows bungalows,

multi-storey buildings, semi-detached buildings, and detached buildings. Figure 3 shows the distribution of residential properties in Ibeju Lekki, Lagos. Figure 4 shows the satellite map showing the places in this study area for Ikorodu and Lekki, Lagos.

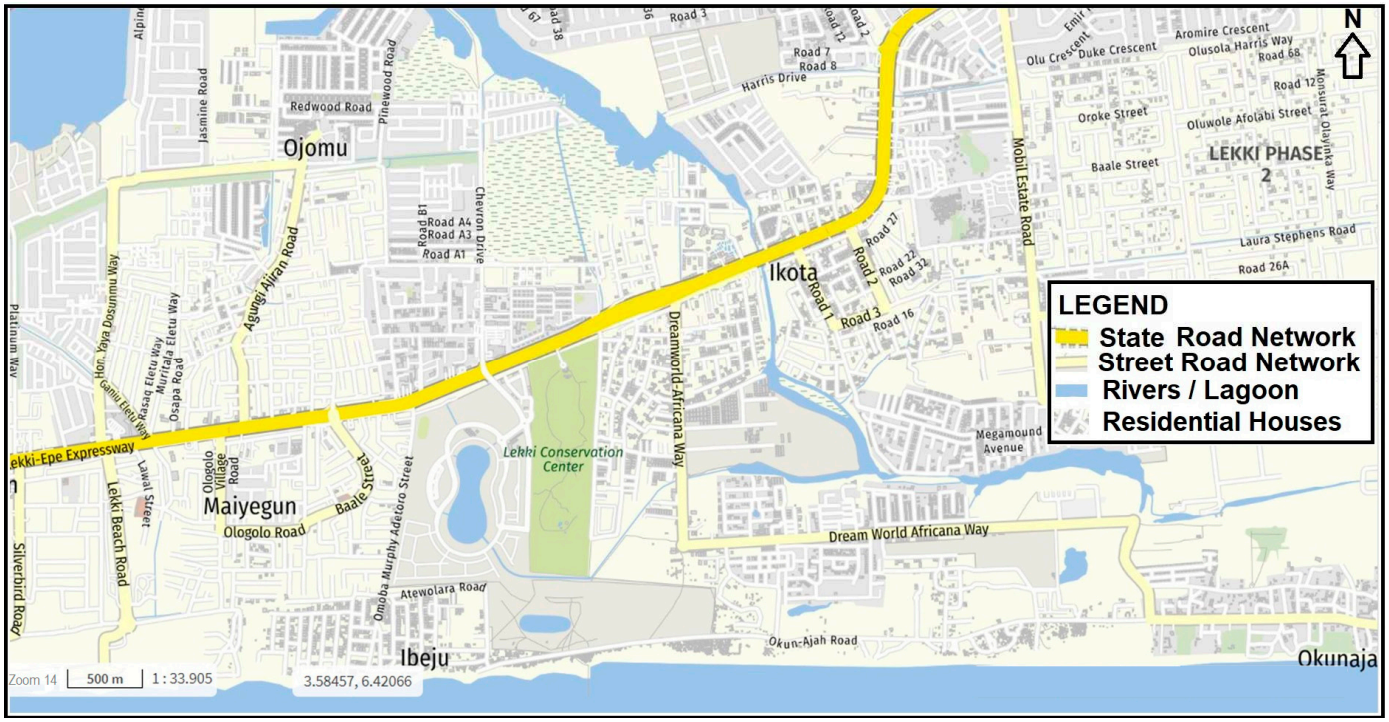


Figure 3. The distribution of residential properties in Ibeju Lekki, Lagos, showing proximity to water bodies (the map data were retrieved from OpenStreetMap data via Mapz.com (Supplementary Materials)).

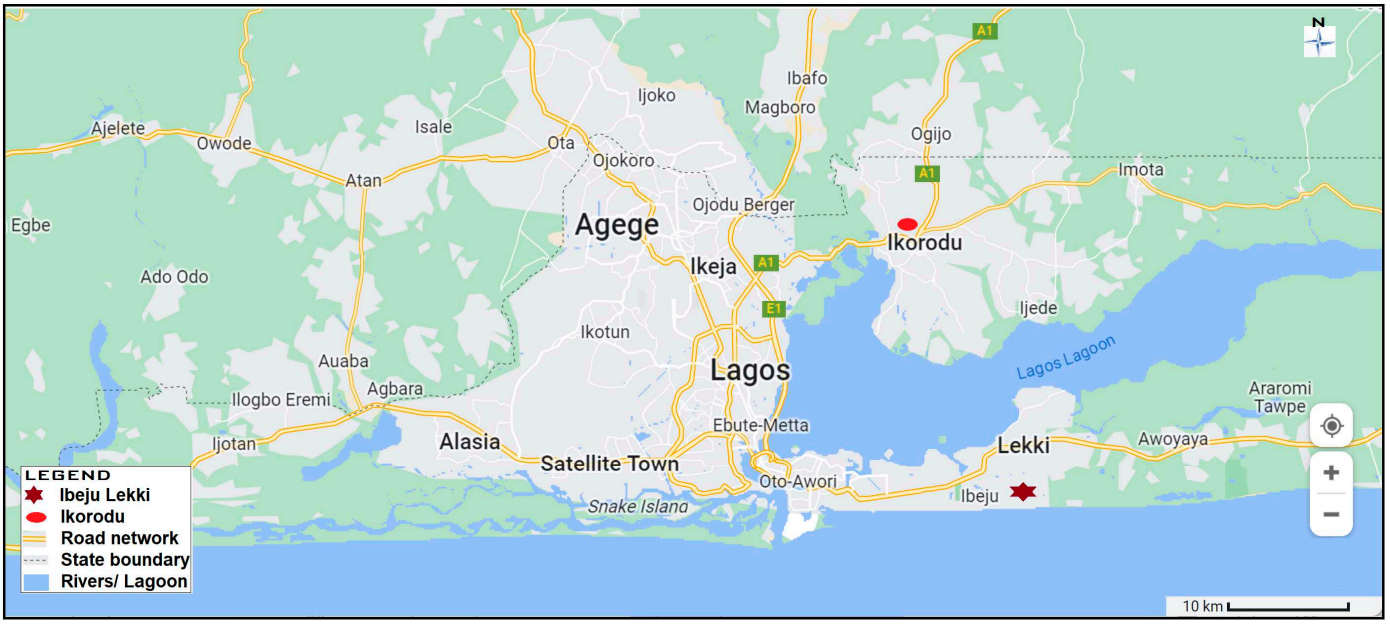


Figure 4. The satellite map on the places in this study area, showing Ikorodu and Lekki, Lagos (the map data were retrieved from Google Maps).

3.5. Survey Procedure

First, the data were collected using questionnaires, and then they were tested for reliability. The factors selected were carefully identified from the literature search. The approach used in the survey was also considered based on the sample size and the expected results. This study employed a non-probability sampling technique for the private investor group by adopting a snowballing approach that depended on a referral system of data collection from those available and accessible to partake in the study. Snowball sampling has a high sampling error and is particularly susceptible to selection bias [79,80]. However, in a developing country such as Nigeria, identifying survey participants through their residence as an alternative sampling approach is very difficult. This is because land specifics are incorrectly recorded or not registered.

Another important aspect of this study was the criteria for considering flood-risk areas, which include those residences that are within 500 m of water bodies. In this study, we considered Ikorodu and Ibeju Lekki, as these locations are also close to water bodies in Lagos State. Furthermore, these areas have been recorded as having high precipitation and flooding records. It was also observed that some of the houses in these areas are uncompleted buildings. As such, some workers may be found in such uncompleted buildings within the study area, as well as squatters. There may also be squatters on the property and others who have recently bought a property or moved into the neighbourhood. As a result, a snowball sampling strategy was sufficient, because the estate agents operate within the investigation area and have built their client base. This method has been successfully applied in housing market studies in developing countries (see Ref. [81]). The same approach was applied to the present study, using an email drop-off survey to administer the questionnaire. The estate agents were requested to refer the researcher to three out of their numerous clients, with at least one from each study location—one from the island (Ibeju Lekki) and another from the mainland (Ikorodu). This process does not constitute a violation of data security, because it is permissible within the ambit of the law in Nigeria.

This study investigated the factors that influence residential property investment decisions using a survey of flood-risk areas in the Lagos metropolis. The estate agents were asked questions regarding their knowledge of flood risk and the factors that they believed influenced the private investors' decisions whenever they decided to own or rent properties, while the private investors were asked questions on what factors they considered as influencing their decisions to invest. This study performed the Cronbach's alpha test to ensure that the questionnaire items (data) were internally consistent, metrically reliable, and valid. The Cronbach's alpha values obtained for private investors' and estate agents' (Table 1) responses in this study demonstrate that the questionnaire items are consistent, reliable, and valid.

Table 1. Cronbach's alpha test.

Variable	*No. of Items*	*Private Investors'*		*Estate Agents'*	
		Actual	*Standardised Items*	*Actual*	*Standardised Items*
Motivating Factors	37	0.858	0.873	0.862	0.873

The Cronbach's alpha coefficient is an evaluation instrument that is utilised for assessing internal consistency. It provides an indication of the degree to which the individual items that make up a scale or test are assessing the same underlying construct. The value of Cronbach's alpha can be determined by conducting an analysis of the intercorrelations amongst the items that make up a scale. It can take on values between 0 and 1, with higher values signifying a greater degree of internal consistency. For the purposes of research, an acceptable value is considered to be one that is at or above 0.7, while a number that is at or above 0.8 is considered to be good. Statistical software programs such as R, SAS, and SPSS can be utilised in order to compute Cronbach's alpha, but the latter (SPSS v27) was utilised

in this study. These software solutions offer the necessary capabilities for calculating Cronbach's alpha from the item responses, which are scored from the sampled participants in the study. Other measures of internal consistency include the Spearman–Brown coefficient, which estimates the hypothetical reliability of a scale if its length were to be increased or decreased, and the split-half reliability coefficient, which involves splitting the items in a scale into two halves and assessing the correlation between them. Although the questionnaire was subjected to other forms of internal consistency testing, the Cronbach's alpha test was utilised in this study. This is because the Cronbach's alpha test is widely used and recognised as a reliable and valid measure of internal consistency [82–86]. As a result, it is the go-to test instrument for examining the reliability of scales or tests in numerous disciplines of study and measurement.

Numerous areas in Lagos State are affected by floods on an annual basis. In 2010, floods were recorded in Ajegunle, Agiliti, Ikorodu, Ikoyi, Ipaja-Ayobo, Mile 12, and Victoria Island [87]. Following the annual flood forecast announcement of the hydrological services agency on 28 May 2020, the Lagos State government advised residents to be alert to flooding. Two LGAs (Ibeju Lekki and Ikorodu) were selected for investigation. They were chosen because of their historical disposition to flooding, their present flood-risk status based on the hydrological service agency alert, and the high impact on the most recent flooded properties [88,89].

An initial content analysis of previous research and the authors' knowledge of the residential investment sector were used to identify factors potentially influencing decision-making for residential property investment (see Refs. [56,58,77,78] and a pilot study [90]). These resulted in 37 factors that were grouped into 6 categorical factors—namely, location, neighbourhood, structural, market/economic, behavioural, and risk, with each category having its own sub-factors. The individual categories had subunits of factors that were subsequently investigated. The categorical factors and their associated subunit factors are presented in Tables 2–4. The investigated subunits of factors were assigned codes F1–F37. This was to facilitate easy identification, referencing, and manageability. It was also used for both ranking and decision-making based on significance levels. To ease the identification of each factor selected, the six categorical factors were delineated into these 3 tables.

Table 2 comprises the location and neighbourhood categories.

Table 2. Nomenclature for the location and neighbourhood categories.

Category	Factors	Code
Locational	The property's actual location	*F1*
	The possibility that the actual place the property is located will be flooded	*F2*
	The distance to the workplace	*F3*
	The proximity of shopping malls/market to the property's precise location	*F4*
	The proximity of worship centres to the property's precise location	*F5*
	The accessibility of transportation services	*F6*
	The proximity of healthcare facilities to the property's precise location	*F7*
	The population density where the property is situated	*F8*
Neighbourhood	The property's neighbourhood road network	*F9*
	The neighbourhood's serenity	*F10*
	The neighbourhood's topography/terrain	*F11*
	Availability of electricity and other infrastructural supplies	*F12*
	The susceptibility of the neighbourhood to flooding	*F13*
	The neighbourhood's drainage system	*F14*
	The neighbourhood's crime rate	*F15*
	The neighbourhood's level of pollution	*F16*

Table 3 comprises the structural and market categorical factors.

Table 3. Nomenclature for the structural and market/economic categories.

Category	Factors	Code
Structural	The size of the building and/or land	*F17*
	The size of the living and/or dining area	*F18*
	The number of bathrooms in the property	*F19*
	The interior and exterior façades of the property	*F20*
	The design and aesthetics of the property	*F21*
	The condition and age of the property	*F22*
	The availability of parking space	*F23*
	The number of rooms within a property	*F24*
Market/Economic	The investment cost compared with its associated benefits	*F25*
	The analysis of the market conditions	*F26*
	The future economic conditions	*F27*

Table 4 comprises the behavioural and risk categorical factors.

Table 4. Nomenclature for the behavioural and risk categories.

Category	Factors	Code
Behavioural	Sentiment (bias) regarding investment	*F28*
	Experience in real estate investment	*F29*
	Reliance on other people's investment decisions	*F30*
	Psychological preparedness to cope with flooding	*F31*
	Financial preparedness to cope with flooding	*F32*
	Emotional attachment and willingness to take risks	*F33*
	Attitude towards risk that is independent of financial circumstances	*F34*
	Behavioural influence	*F35*
Risk	The risk level associated with the property's location	*F36*
	The level of risk awareness	*F37*

The variables deployed in Table 4 were carefully selected from the literature search. Those selected were common factors used regarding investments in general, and specifically for property investments. Some of the references that have adopted these factors were identified and placed in the 3rd column of Tables 2–4. The factors that were selected were all particular to the study area; as a result, they were selected and utilised. Although the data for this study were gathered using a structured questionnaire survey, only questionnaires containing relevant answers were essential to the study. They were validly reported as valuable responses to the research. As a result, responses from 75 property agents and 75 property investors were used for the data analysis. Table 5 summarises the valid and correctly completed responses that were found to be suitable for the analysis used for this present study, based on the questionnaire distribution strategy used.

Table 5. Questionnaire response rates.

Respondents	Distributed	Returned	Valid
Private Investors	111 (100.00%)	89 (80.18%)	75 (84.27%)
Estate Agents	186 (100.00%)	93 (50.00%)	75 (80.64%)

3.6. Methods of Analysis

The research tools used in the analysis are presented in this subsection. This study places a primary emphasis on residential building in flood-risk locations, because of the significance such structures pose to the built environment. All the respondents deployed in this study are active stakeholders in the built environment of Nigeria, where the study was conducted. Some definitions of key terms used in the study were formulated in order to guarantee that the respondents were provided with comprehensive information on the subject matter at hand. For example, the questionnaire included provisions to define the terms residential building, floods, and flood risks. This helped the respondents to understand the topic at hand and removed any bias that may have been caused by a lack of information or ignorance. The questionnaire survey administered to investors was meant to identify their perceptions of flood-risk areas, as well the factors influencing their decision to invest in the areas despite them being notable for flooding. Likewise, the estate agents' perceptions were investigated to determine how well they comprehend the requirements of their clients (investors) when rendering services. The questionnaire was designed by eliciting information from the literature regarding property investment in general and flood risk in particular. From this information, the most common variables in the literature were selected for investigation, and a 5-point Likert scale was drawn and administered to the surveyed participants. The results of the field survey form the basis on which this study is hinged.

It was necessary for this study to use a well-validated research tool known as the Likert scale in order to facilitate the responses and unify the answers; this, in turn, made it possible for us to conduct the analysis. The answers to the various variables that measured property investment motivations were coded from 1 to 5 on a five-point Likert scale [90]; the respective meanings were strongly disagree, disagree, neutral, agree, and strongly agree. The factors that were taken into consideration in this inquiry were asked about using a five-point Likert scale. The responses to the categorised alternatives on the Likert scale were computed to determine their mean scores for each component in accordance with their level of relevance, and then the factors were sorted according to their weighted level of significance. The many categories were represented by numeric values of 1, 2, 3, 4, and 5, thanks to the use of the Likert scale.

The mean score is defined as the average number of samples (or respondents), as defined in Equation (1). The mean score (MS) for these respondents is given as follows:

$$\text{MeanScore, MS} = \frac{(n(5) + n(4) + n(3) + n(2) + n(1))}{N} \quad (1)$$

where: $n(5)$ is the number of strongly agree responses, $n(4)$ is the number for agree, $n(3)$ is the number for neutral, $n(2)$ is the number for disagree, $n(1)$ is the number for strongly disagree. while N is the total number of respondents.

However, to obtain the mean score using the Likert scale, one must take the average of the options that have been categorised, taking into account the factors that were used to categorise the options. In this study, the mean agreement of the answers to the various statements was calculated, and then the means were ranked. This amplified the mean score results by condensing the quantitative results into an easy-to-understand language type suitable for deductive reasoning. In this study, the results were analysed using the mean and standard deviation. The mean is denoted by "M", while the standard deviation is represented by "SD". Although the authors did run a median analysis as a way of checking the quality of the results from the information gathered during the field survey, it was decided to use the mean and standard deviation, since there was an intention to rank the identified variables in order to reach a logical conclusion as to the position of each variable on the log, so as to place each variable on a position in the log table. Since the mean and standard deviation are helpful in arriving at these conclusions, the same methods have been adopted by various studies in built environments, as discussed in the next section. Thus, the authors saw fit to make use of the same method in actualising the goal of the

study, which was to identify and investigate the factors and then rank them based on their Likert scale scores. As adopted in this research, the criteria for the decision rule are set out in Table 6. This was used to obtain the ranking and decisions of the variables presented in Tables 2–4.

Table 6. Criteria measurement for mean analysis.

Range of Mean Score	Interpretation
$5.00 \geq x \leq 4.50$	Most significant
$4.49 \geq x \leq 3.50$	Significant
$3.49 \geq x \leq 2.40$	Moderately significant
$2.39 \geq x \leq 1.50$	Slightly significant
$1.00 \geq x \leq 1.49$	Less significant
$0.00 > x < 0.99$	Not significant

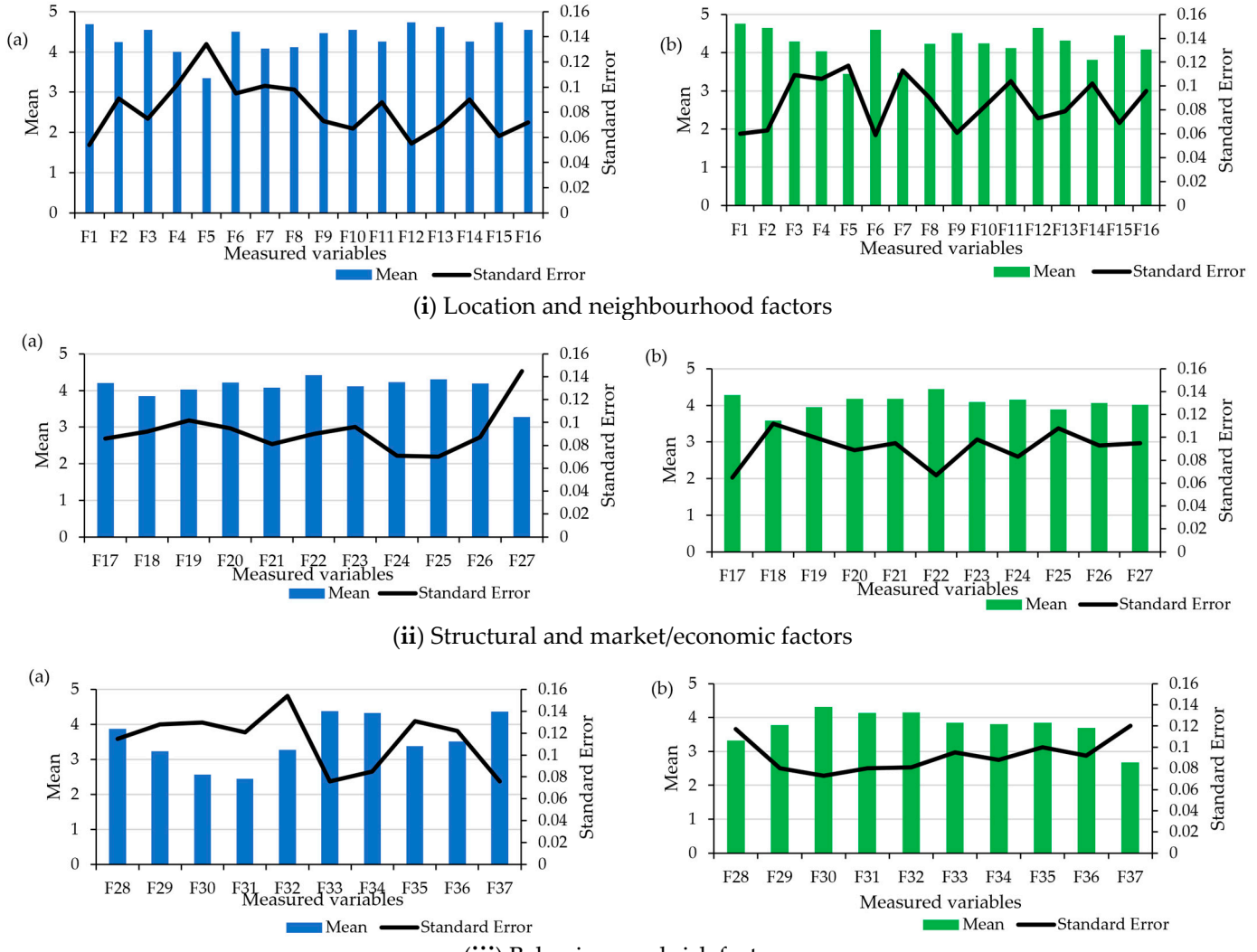
4. Results and Discussion

The results from the field survey were computed using the mean and standard error to show the respondents' perceptions on the topic of interest. The computed mean and standard error depicting the respondents' (private investors and estate agents) perceptions are given in Figures 5 and 6. These results summarise their responses to comments on motivating factors that could influence investment decisions, particularly when the areas have the potential risk of flooding. The mean values for the variables investigated from the purview of the private investors ranged between M = 4.74 (SD = 0.470; 0.525) and M = 2.44 (SD = 0.998), with a variance of 2.30. Based on the evaluation indices set out in the Section 3.6, the combination of the total variables investigated reveals that from the purview of the private investors, 8 of the factors were recorded as most significant, 22 were significant, and 7 were moderately significant, while none was deemed insignificant in influencing property investment decisions within the surveyed flood-risk areas (see Figure 5(ia–iiia) and Figure 6(ia–iiia)). In the same light, the estate agents' perceptions about what could inspire private investors to invest in flood-risk property were also examined. The mean values for the factors ranged between M = 4.76 (SD = 0.516) and M = 2.68 (SD = 1.035), with a variance of 2.08. Based on the evaluation indices, 5 of the factors were considered "*most significant*", 28 were recorded as significant, and 4 were moderately significant, while none was deemed insignificant.

The findings in Figure 5(ib–iiib) and Figure 6(ib–iiib) highlight five variables that the estate agents believed that the private investors would consider when deciding to invest in areas with the potential risk of flooding. These variables had mean scores greater than 4.50 on a 5.00 scale. They included the property's actual location (*F1*), the probability that the actual location could be flooded (*F2*), and the provision of electricity and other infrastructural supplies (*F12*). Other factors within this group included the proximity/accessibility of transportation services (*F6*) and the property's neighbourhood road network (*F9*). The group of factors that were considered in line with the private investors' opinions were the property's actual location (*F1*), the accessibility of transportation services (*F6*), and the availability of electricity and other infrastructural supplies (*F12*). This may imply that these factors are very important and non-negligible in influencing residential property investment decisions. The investors agreed that these factors play a prominent role in driving their decisions, and the estate agents shared the same opinion on this.

From the mean results computed using the private investors' opinions, the eight "most significant" factors included the availability of electricity and other infrastructure supplies (*F12*), the crime rate in the neighbourhood (*F15*), and the actual location of the property (*F1*). Others included the neighbourhood's susceptibility to flooding (*F13*), the distance to one's workplace (*F3*), the serenity of the neighbourhood (*F10*), the neighbourhood's level of pollution (*F16*), and the proximity/accessibility of transportation services (*F6*). Private

investors generally accepted that these considerations must be prioritised in order to make sound residential real estate investment decisions, particularly in a flood-risk zone. When the decision criteria were applied, the seven lowest-ranked variables were deemed to be "moderately significant": behavioural influence (*F35*), the proximity of worship centres to the property (*F5*), future economic conditions (*F27*), financial preparedness to cope with flooding (*F32*), reliance on other people's investment decisions (*F29*), psychological preparedness to cope with flooding (*F30*), and financial preparedness to cope with flooding (*F31*).



(**i**) Location and neighbourhood factors

(**ii**) Structural and market/economic factors

(**iii**) Behaviour and risk factors

Figure 5. Perceptual analysis of (**a**) private investors and (**b**) estate agents on motivations of property investment decisions, using mean item score.

Moreover, the availability of electricity and other infrastructural supplies (*F12*) ranked first (M = 4.74) as the most significant factor that could influence their property investment decisions. This demonstrates the critical role of infrastructure provision in determining the value attributable to property investments. According to Ihuah and Benebo [91], the effective functioning of economic activities and the attainment of an environment's development level rely on available infrastructural provisions. Since the private investors agreed and preferred to invest in flood-risk neighbourhoods with adequate infrastructural supply, one might argue that infrastructure is a necessary component of residential growth. This study corroborates Elliot's [92] assessment of infrastructure services' impact on real

estate for better or worse. Figure 7 shows the plots from the perceptual analysis showing the ranking and mean for each variable considered.

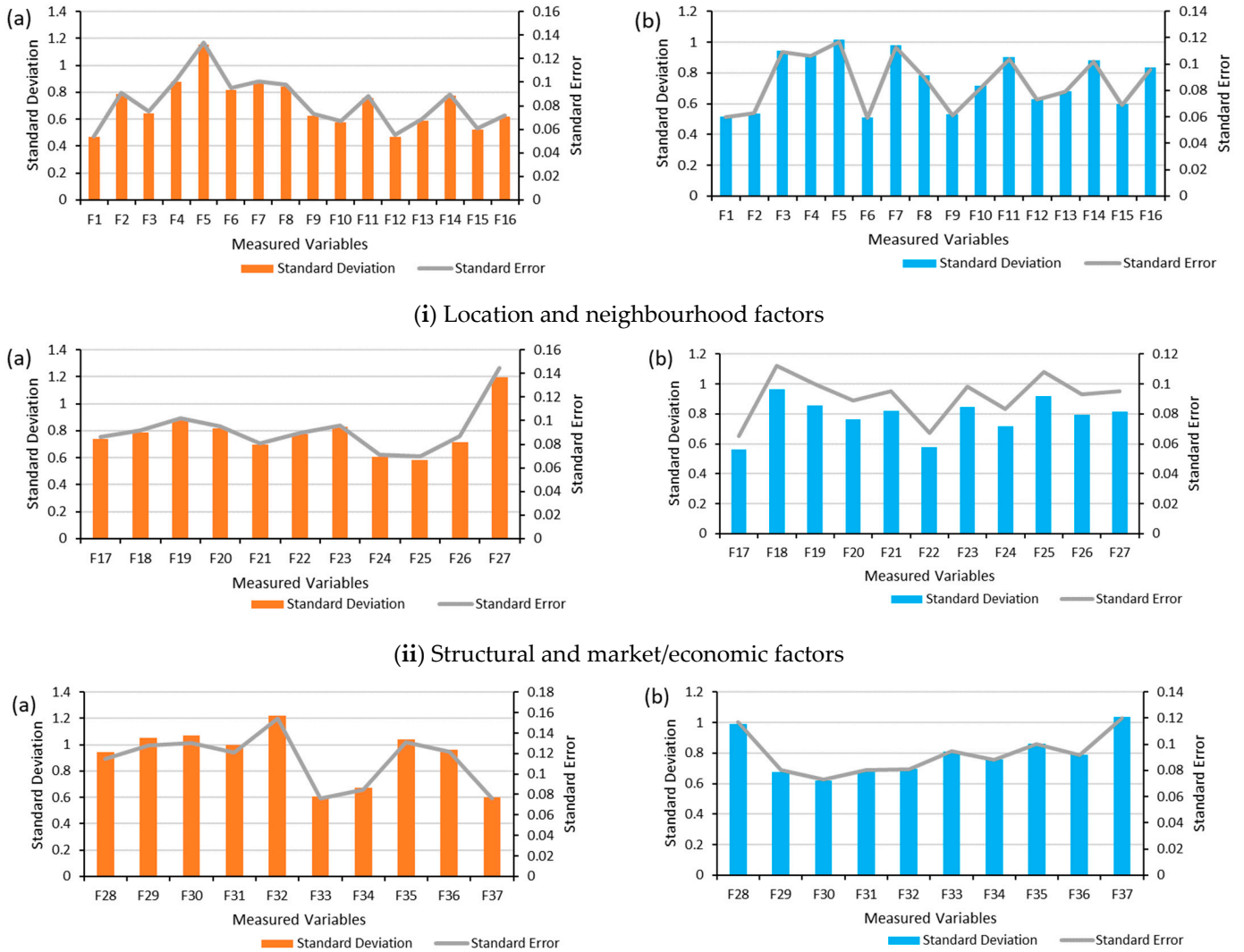
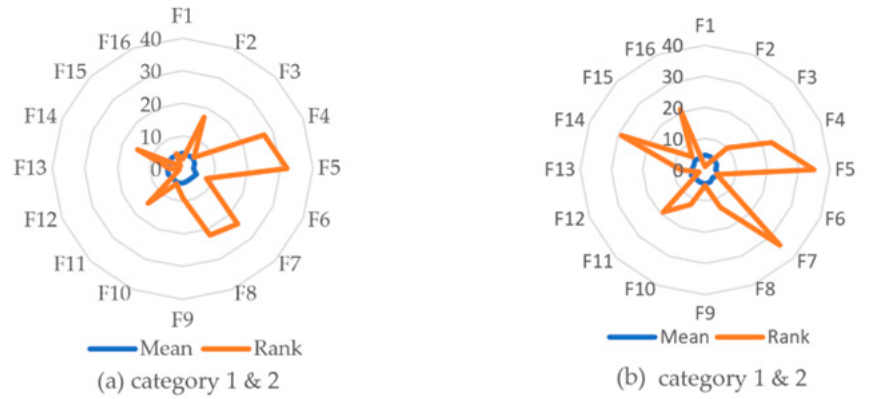


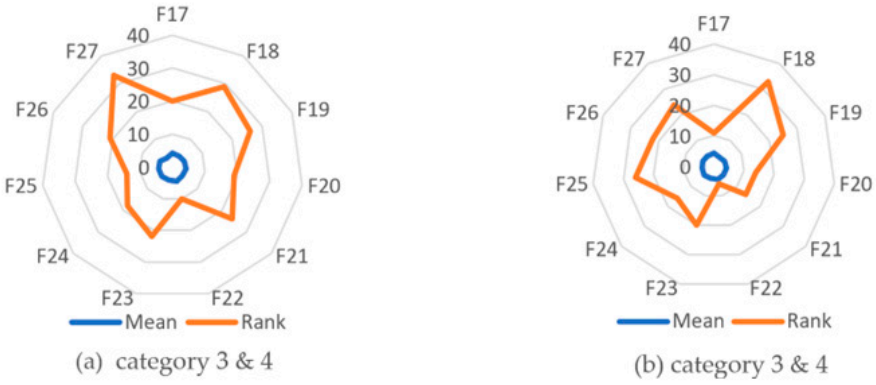
Figure 6. Perceptual analysis of (**a**) private investors and (**b**) estate agents on motivations of property investment decisions, using standard deviation.

The findings of this study, as shown in Figures 5–7, indicate that the private investors have slightly different preferences, ranking the neighbourhood's crime rate (*F15*) as the "*most significant*" factor that could influence their investment decisions in a flood-risk area. This means that home-seekers and -owners who are investors would be willing to pay for or settle in a neighbourhood devoid of crime [93,94]. Moreover, Clark and Herrin [95] reported that a high murder rate in a neighbourhood will negatively affect the return on property investment. This indicates that people put a high premium on security when making informed decisions about property investment. Based on the ranking of the most significant factors that could motivate investment decisions in flood-risk areas, this study's findings placed the availability of electricity and other infrastructure supplies (*F12*), along with the crime rate in the neighbourhood (*F15*), ahead of the property's actual location (*F1*) (M = 4.69). This contradicts the widely held belief among real estate professionals that location is the primary determinant that encourages property investment decisions.



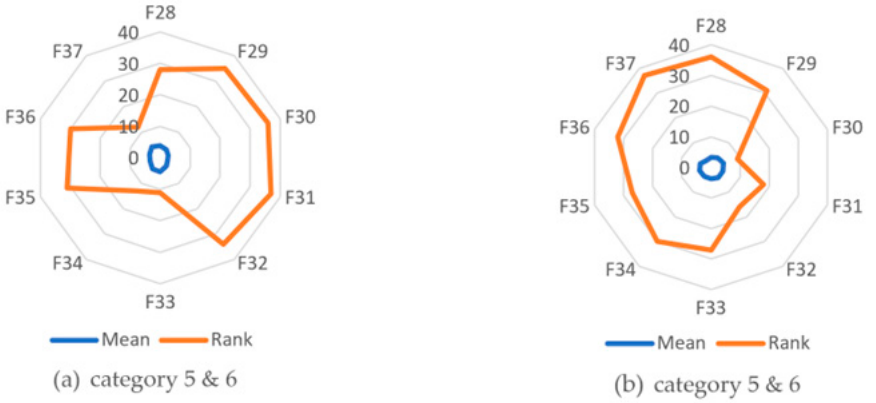
(a) category 1 & 2 (b) category 1 & 2

(**i**) Location and neighbourhood factors



(a) category 3 & 4 (b) category 3 & 4

(**ii**) Structural and market/economic factors



(a) category 5 & 6 (b) category 5 & 6

(**iii**) Behaviour and risk factors

Figure 7. Perceptions of (**a**) private investors and (**b**) estate agents regarding motivations of property investment decisions in flood-risk areas, using rank analysis.

The private investors agreed that the distance to their workplace (*F3*), with a mean value of 4.55, is one of the "*most important*" factors that could motivate their investment decisions. Thus, this study's findings corroborate the assertion of Topcu and Kubat [96] that accessibility is a critical determinant of residential property values, based upon which decisions are made. Additionally, it supports Abidoye [97] in that a homebuyer or tenant will consider the gap between their workplace and their residential home when determining where to live. This may explain why the majority of respondents preferred to remain in their current location despite the possibility of flooding. An additional reason could be that traffic congestion may result in lateness to work; hence, this contributes to choosing an area near their workplace.

The property market conditions (*F26*), with a mean score of 4.19, were identified as another "*significant*" factor that influences property investment decisions. This result is consistent with Thompson and Strickland's [98] and Zhang et al.'s [99] findings that external factors such as changes in market conditions and the economic environment impact property's market value. This suggests that the majority of the investors consider the state of the property market. Therefore, this study also supports the findings of Gallimore et al. [93], as individuals' convictions about property markets can influence their investment decisions. Lastly, the findings in the present study show sentiment (bias) regarding investment (*F28*) and the level of risk awareness in investing (*F37*) as moderately significant factors, as well as the reliance on other people's investment decisions (*F30*), psychological preparedness to cope with flooding (*F31*), and financial preparedness to cope with flooding (*F32*) being significant factors. The highest-ranked factor in that category was *F30* (M = 4.31), followed by *F31* (M = 4.15) and *F32* (M = 4.14). This shows that there is positive behaviour of the respondents towards decision-making to invest in these areas, as well as the need to understand the reasons for deciding to invest.

The radar charts in Figure 7 show the ranking relationships and hierarchy of the various variables against the perspectives of the private investors and the estate agents in this study. This was carried out to use the relationships established from the radar charts to determine the elements that influence property investment in places that are prone to flooding. In spite of this, the plot has some relevance to the scope of the study, which seeks to understand the elements that influence the perceptions of stakeholders. However, this study is more in line with studies that explore the perspectives of non-experts.

Another important aspect of this study is the presentation of the perception mapping based on this investigation, showing the key considerations made. Sixteen of the twenty-two variables identified as "*significant*" by the private investors were rated equally by the estate agents: the proximity of shopping malls and/or markets to the property's precise location (*F4*), the population density where the property is situated (*F8*), the neighbourhood's topography or terrain (*F11*), the size of the building and/or land (*F17*), the size of the living and/or dining area (*F18*), the number of bathrooms within the property (*F19*), the property's interior and exterior façades (*F20*), the property's design and aesthetics (*F21*), the property's age and condition (*F22*), parking space availability (*F23*), the number of rooms within the property (*F24*), comparison of the investment cost with its associated benefits (*F25*), the analysis of the market conditions (*F26*), emotional attachment and willingness to take risks (*F33*), attitude towards risk that is independent of financial circumstances (*F34*), and the risk level associated with the property's location (*F36*). The responses of estate agents to the "moderately significant" variables indicated that of the seven variables defined as "moderately significant", only the proximity of worship centres to the property's precise location (*F5*) was in line with the private investors' view.

5. Perceptions and Considerations

The input of stakeholders in the built environment, and the real estate sector in particular, is very important in decision-making, policymaking, setting industry practices, and the development of relevant standards [90,100]. Perception analysis is very important, as considered in various studies on investment decisions for residential areas [26,29,39]. Thus, we also applied perception analysis in the present study and presented the considerations for decision-making. However, this plot gives bearing on the scope of the study, which aims to elucidate the factors that influence stakeholders' perceptions, but more in line with studies that explore the perceptions of non-experts. Flood risk/susceptibility maps have been created using data-driven techniques or multi-criteria decision-support systems to investigate the link between flood risk and consumer/investor behaviour. Although the topic of identifying the most significant factors affecting investments in flood-prone areas is intriguing, it can be seen that the survey included many factors that were related not to floods, but to housing decisions. These factors include electricity and crime rates, which affect the house prices and residential location choices, and they are related to the study

area. However, this study also shows the limitations of the perceptual analysis in considering that the respondents may have answered the questions as if they were participating in a survey for investments in normal conditions, rather than in a flood-prone area. As a result, it is important to add that future studies should recognise that flood-risk studies that are based on quantitative research that examines climatic, topographic, land-use, and anthropogenic factors should be carried out.

Another area of future research on flood-risk areas should be investigated to include other characteristics, including the physical characteristics of properties in natural disaster risk zones, such as materials, number of floors, slope, and drainage quality. However, it is noteworthy that the findings of this study are based on perceptual analysis, and the considerations include the locational, neighbourhood, structural, economic, behavioural, and risk factors. Since these points made were on the technical, professional, and safety recommendations, it is the stern advice of the authors to conclude that these flood-risk areas need to be categorised in future studies to identify the areas of high, medium, and low risk. In addition, the authors also discourage the decisions made by some people to reside along these flood-risk regions and coastal areas, due to some level of uncertainty and unpredictability of flooding. In other words, it is not advisable for people to willingly live in flood-risk areas, as the limit of flood risks can be high and can pose great risk in terms of loss of lives, loss of investments, and loss of properties. However, due to the increased technological advancements, there has been an increase in development in coastal regions, flood-risk regions, and on water, through the use of land reclamation, the use of floating building technologies, and the use of flood defence systems as protective structures. It is the authors' view that property investors and stakeholders should conduct necessary checks before investing in these areas. The reason for the inclusion of non-flood-related factors was to assist the non-technical respondents (i.e., estate agents) in answering the survey questions and improve the relevance of the study for property investors who are not flood experts, as well as for those property investors who are experienced in challenging areas such as flood-risk areas, brownfield areas, high-crime areas, etc. In light of this, we applied perception analysis to the present study and suggested the factors that should be taken into consideration when making a decision. This study investigated how private investors feel about having to deal with floods in their everyday lives, as well as the factors that influence their investment choices. Figure 8 shows the plot that was obtained from the perception analysis in the study, based on the relationship between private investors' and estate agents' perceptions on factors influencing investment decisions.

The findings of our perception analysis on the relationship between the two independent variables in Figure 8 show that the six factors investigated have high interconnections. According to the perception plot, the highest determinants are the locational factors, followed by the neighbourhood factors. The plot also shows that behavioural factors have the highest bearing on the investment decisions for private investors, at 4.4, followed by the economic factors at 4.0 and the locational factors at 3.6. The plot also shows that neighbourhood factors have the highest bearing on the investment decisions for estate agents, at 4.6, followed by the economic factors at 4.0 and the locational factors at 3.6. It is interesting to note that risk factors are the least considered by the estate agents, as they will try to find tenants for various properties, as long as they will earn sales commissions. In that light, this study notes decision-making factors for investing in this area, but it does not direct investors to invest in flood-risk areas. The study also identified that there are reasons to make these decisions to invest in flood-risk areas, based on the survey conducted. Nonetheless, this study presents recommendations and professional advice to such decision-making approaches. This study was intended to determine the elements that affect property investment in flood-prone regions. In a nutshell, it is advised that the investors must ensure necessary due diligence by conducting feasibility studies, studying environmental data, assessing structural building plans, looking into flooding maps in the area, seeking expert opinions, and consulting flood consultants for EIA reports on flood-risk areas. It is pertinent that the right professionals are also contacted in making such

investment decisions in these flood-risk areas. While it is understandable that real estate developers and real estate agents are not responsible for monitoring or estimating hazard risks, they make huge contributions in the built environment. However, it is noteworthy to add that flood mitigation decision-making and investment decisions in flood-risk areas are important for both the business analysis and the flood experts, but flood monitoring is mainly the job of scientific experts.

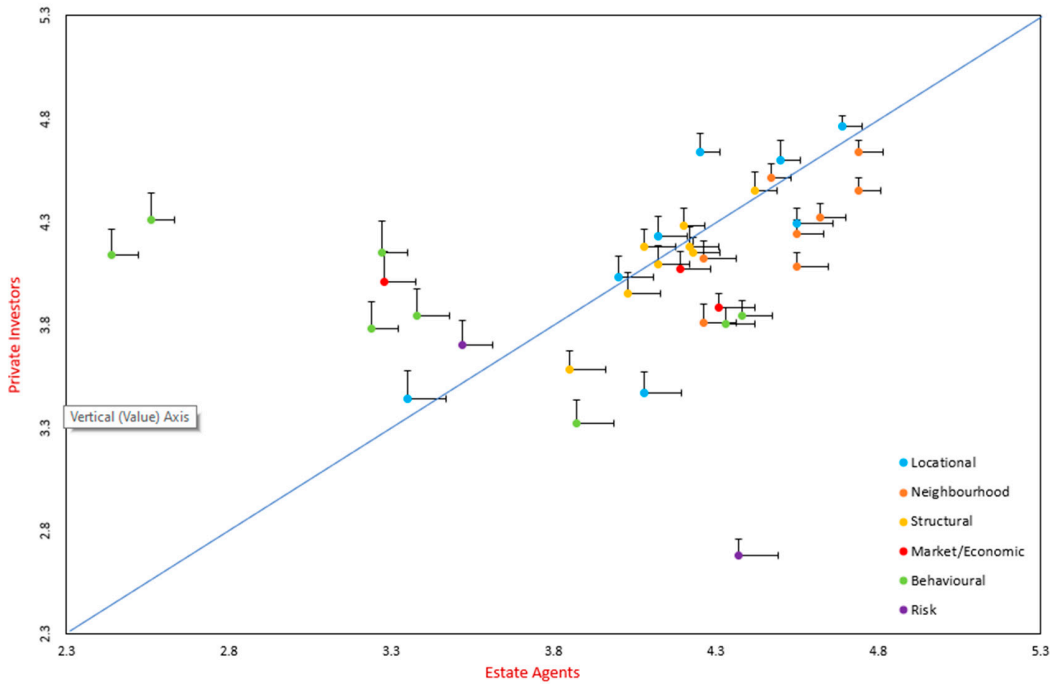


Figure 8. Relationships between private investors' and estate agents' perceptions on factors influencing investment decisions.

While it is impossible to avoid hazards, limiting development in hazard-prone areas can reduce harm. From the authors' perspective, it is harmful to focus on the settlement process of flood-prone areas when the whole world is fighting to reduce the risk of flooding in cities as part of adaptation to climate change. Risk reduction must be ensured by informing residents about the threat, discouraging them from living in such areas, increasing urban retention through the development of green and blue infrastructure, and striving to move people away from the threat and not settling these places. Conversely, there are still people who prefer to reside in riversides, coastal areas, and other such flood-risk areas. Consequently, future research using similar surveys should also emphasize flood risks to provide more related factors, as well as the statistical analysis to validate the accuracy of the results, and respondents should be presented with a more detailed understanding of these risks in such surveys. Furthermore, future studies could be conducted by considering the stakeholders in the built environment as the study respondents, which would help with the recommendation to conduct a review of stakeholders' propositions, e.g., regulation requirements, elaboration of standards, local/national coding requirements, implementation programs, maintenance, cost, and infrastructure requirements, etc.

The factors considered in this study are also based on the study area; as a result, the research results do not portray a generalised study but, rather, a case study approach; as such, they cannot be used in other places. This work briefly addressed the problem of the genesis of the flooding in the study area, with some discussion of the legal aspects of living in areas at risk of flooding in these parts of Lagos State, Nigeria. As such, residences in these flood-risk areas may also require some level of security and insurance for both lives and properties. There should be safety markers, the use of flood warnings, phone notifications for hazard warnings, and the use of loudspeakers at strategic locations in case of flooding

or similar hazards. It is also recommended that there should be plans made in flood-risk areas for the evacuation of people and properties in the event of any imminent danger or suspected flood warnings in those flood-risk areas. As regards the justification for the present study, we identified some studies on the risks of flooding in different communities investigated by various researchers, which also conducted perceptual analysis of flood-risk areas. The use of cognitive mapping and flood modelling could also be conducted in making decisions on the assessment of flood-risk areas in future studies. Also, more mapping documents on other residential location choices (RLCs) can be digitised for flood-risk areas using map data like Mapz (Supplementary Materials). Lastly, there should also be real-time access to hydrological and weather data for those residents in these flood-risk areas. Other recommendations are given in the following section.

6. Conclusions and Recommendations

This study investigated the factors that influence investment decision-making in flood-risk areas by examining two selected local government areas that are at risk of flooding during the rainy season in Lagos State, Nigeria. This was achieved through a questionnaire survey of private investors' and estate agents' opinions to fulfil the research objectives. The data were analysed using the mean item score for ranking and comparative assessment of the agreement analysis. The research findings provide insight into the perceptions of flood risk, shedding light on decision-making and the factors considered when making investment decisions. Thirty-seven factors that could influence investors to invest in flood-risk areas were identified from the literature and evaluated in this study.

The highlights of this study's findings are as follows: First, people's perceptions of risk can have a significant impact on their willingness to invest in flood-risk reduction measures. Second, people's perceptions of risk can be influenced by a number of factors. This means that their perceptions of risk can vary widely, even within the same community. Third, people's perceptions of risk can be inaccurate, because people often rely on heuristics, or mental shortcuts, to make decisions about risk. Hence, there could be a likelihood of underestimating or overestimating flood risk. Therefore, this research can help to identify the factors that may influence people's willingness to invest in flood-risk reduction measures. By understanding how people perceive risk, investors can develop more effective strategies for promoting investment in flood-risk reduction measures. This can help to make the built environment more resilient to the impacts of flooding.

The results were categorised based on a new metric criterion. The 4.5 threshold on a 1–5 Likert scale was introduced as a metric to give a novel contribution to the decision-making criteria. Adopting the stated metric, the following was found:

(a) From the private investors' purview, eight factors were recorded as the most important factors influencing property investment decisions in areas prone to flooding: *F1* (the actual location of the property), *F3* (the distance to the workplace), *F6* (the accessibility of transportation services), *F10* (the neighbourhood's serenity), *F12* (the availability of electricity and other infrastructural supplies), *F13* (the susceptibility of the neighbourhood to flooding), *F15* (the neighbourhood's crime rate), and *F16* (the neighbourhood's level of pollution).

(b) From the estate agents' purview, only five factors were recorded: *F1* (the actual location of the property), *F2* (the possibility that the actual location of the property will be flooded), *F6* (the accessibility of transportation services), *F9* (the property's neighbourhood road network), and *F12* (the availability of electricity and other infrastructural supplies).

(c) In comparison, only three factors—*F1* (the actual location of the property), *F6* (the accessibility of transportation services), and *F12* (the availability of electricity and other infrastructural supplies)—were common to both groups of respondents.

(d) In calculating the results of the decision criteria rule table, the opinion of each respondent was calculated on a five-point Likert scale. For evaluating the perceptual analysis on which this paper was developed, a decision criterion was applied to

ensure uniformity. As a result, since the research focused on a developing nation, the researchers opted for the use of a unified measurement system for the proper classification of the results. Despite the range of different studies defining their own methods of classification, this study used the computation of finite-degree classification of the results—which is a unified measurement method in higher educational institutions—as a clustering technique for making informed decisions.

(e) According to the perception plot, the highest determinants were the locational factors, followed by the neighbourhood factors. The plot also shows that behavioural factors have the highest bearing on the investment decisions for private investors, at 4.4, followed by the economic factors at 4.0 and the locational factors at 3.6. The plot also shows that neighbourhood factors have the highest bearing on the investment decisions for estate agents, at 4.6, followed by the economic factors at 4.0 and the locational factors at 3.6. This implies that there are various degrees of correlation between the factors examined in this study.

This information will be useful to existing and prospective real estate investors, as it suggests what to look out for when making decisions. The findings of this study can guide prospective investors and other stakeholders when deciding on developmental projects, particularly in areas that may be at risk of flooding. This is because the flood-risk areas cannot be left untouched, because of land scarcity, increasing population growth, and the need to meet the demand for housing provision to accommodate population growth. This study presents innovations by filling the knowledge gap in the research looking at these attributes in Nigeria, while also considering megacity investment and flood-risk investments in areas of property development to guide prospective investors on whether or not investing in flood-risk areas is worth it.

This survey focused on property investment and decision-making in areas at risk of flooding in Lagos State, Nigeria. However, a nationwide survey would provide a broader view of the motivations behind real estate property investment decisions in other areas prone to flood risks in Nigeria. The shortcomings of this research are reflected in the study's interpretation and generalisation of its findings. First, the inference drawn was focused on a relatively small sample size, thereby affecting the generalisability of the findings. Future studies could adopt a larger sample size for the rank agreement analysis. This could help provide more robust insights. Second, other parametric analyses could be performed in addition to increasing the sample size. This may reveal significant gaps among stakeholders' perceptions of decision-making motivators in property investment. Future works could also consider the use of flood modelling and the development of cognitive maps from perception analysis in investigating decision-making in flood-risk areas. Since flood risk is a major threat to the built environment globally, perceptual assessments of investment decisions in flood-risk areas could play a valuable role in improving flood-risk management. It is vital to highlight the relevance of the findings of this research for the field and pave the way for future scientific development in flood-risk management such as machine learning.

Supplementary Materials: Some of the map data were sourced from OpenStreetMap via Mapz. Mapz (2023). Map of Lagos area using Map Data: OpenStreetMap (ODbL). Available at: https://www.mapz.com/export/checkout/preview/664901, accessed on 4 June 2023.

Author Contributions: Conceptualisation, A.K.O.; methodology, A.K.O.; software, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; validation, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; formal analysis, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; investigation, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; resources, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; data curation, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; writing—original draft preparation, A.K.O.; writing—review and editing, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; visualisation, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; supervision, A.K.O.; project administration, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D.; funding acquisition, A.K.O., C.V.A., A.B.A., M.A.O. and E.C.D. All authors have read and agreed to the published version of the manuscript.

Funding: Lancaster Environmental Centre (LEC) and the School of Engineering—both of Lancaster University, UK—as well as the EPSRC's Doctoral Training Centre (DTC) are highly appreciated for their help in conducting this study. Furthermore, the funding of Overseas Postgraduate Scholarships by the Niger Delta Development Commission (NDDC) and the Tertiary Education Trust Fund (TETFUND)—both in Nigeria—is also appreciated. The support of Universiti Tenaga Nasional (UNITEN) under the BOLD25 Initiative is also acknowledged.

Institutional Review Board Statement: Ethical considerations were made, and ethical approval was obtained for the study. Ethical approval was obtained from Lancaster University Research Ethics Committee (Ref: FST19074) on 27 February 2020, and amended Ethics approval FSTREC (Ref: FST20016) was obtained on 30 October 2020.

Informed Consent Statement: Informed consent was obtained from the participants.

Data Availability Statement: The data supporting the reported results cannot be shared at this time, as they have been used in producing more publications based on this research.

Acknowledgments: The authors acknowledge the support of Lancaster University and the University of Benin in conducting this study. We also appreciate the expert feedback of the members of the built environment in Nigeria during the development of this manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

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