

---

---

# APPLICATION OF QUANTITATIVE RISK ASSESSMENT TECHNIQUES IN PROPERTY INVESTMENT APPRAISAL IN ENUGU URBAN, NIGERIA

**Nnamani OC**

Department of Estate Management, University of Nigeria Nsukka  
E-mail: collins.nnamani@unn.edu.ng

## **Abstract**

*Property investment projects are frequently subjected to unpredictable future, encompassing uncertainties and various forms of risks which impact the anticipated level of returns that should compensate for risks taken by investors. The level of sophistication in property investment risk assessment is quite elementary compared to other investment media. This state of affairs has led to project failure and loan default by the investors. The principal aim of this paper is to investigate the extent of application of quantitative risk analysis techniques in property investment appraisal by Estate Surveying and Valuation Firms in Enugu Urban. In addition, the paper examines some quantitative risk analysis techniques. The study surveys top management in the estate Firms. The main sources of data and information for the research comprise literature review and empirical survey. For empirical survey, data was collected via in-depth interview and structured questionnaire. The study briefly examined sensitivity analysis, scenario technique, decision tree procedure, Monte Carlo simulation, risk-adjusted discount factor (RADF) model, sliced income approach, certainty equivalent cash flow, standard deviation and modern portfolio theory. Results from the survey show that most Firms do not apply quantitative risk assessment techniques; risk assessment is largely handled in a subjective manner. However, few Firms apply sensitivity analysis and risk adjusted discount rate methods. Generally risk analysis in property investment appraisal has remained relatively under-researched in Nigeria. Only limited research is available.*

**Keywords:** Risk, Uncertainty, Quantitative Risk Assessment, Investment Appraisal, Property Investment, Enugu Urban.

## **Introduction**

The real world investment environment is constantly changing – it's volatile, unpredictable and seems to become more complex by day. By its very nature, it is fraught with instability, risks and uncertainties; and this is more pronounced in developing countries such as Nigeria. Jovanovic (1999) captured it succinctly; he posits that the real world we are living in is a world of uncertainty, a world which future occurrence and conditions we are, in most cases, not able to predict. He went further to state that the permanent

confrontation of man with this growing complexity together with the need to overcome it, force one to continually forecast future circumstances of nature in order to get adapted. One is compelled to predict because he/she needs to take well informed and rational investment action in this confrontation with the environment. The only clearly defined certainty is the past, while investment problems relates to the future.

Property investment projects in Nigeria are frequently subjected to unpredictable future, encompassing uncertainties and various forms of risks which impact the anticipated level of returns that should compensate for the risks taken by the investors. Risks in real property investment result from several factors which include; political, social, economic, environmental and technological. The erratic exchange rate; high and unstable interest rate; inflation as it affects rental income and capital value and socio-political instability such as militancy, insurgency and kidnappings have all contributed to property investment failures and financial distresses. Some property investment projects are abandoned before completion; some barely break even, providing neither a reasonable income nor a fair return to the investor. Some fund borrowers lost their investment due to inability to repay loan sourced from credit institutions for property investment project; and in such case, the investment is foreclosed by the lender. These issues have been as a result of the Estate Surveying and Valuation firms not employing robust quantitative risk analysis techniques in property investment appraisal.

Stakeholders in residential property investment in Nigeria, most importantly the Estate Surveyors and Valuers could make bold claim to leadership role in investment/development appraisal against the background of their academic and professional training vis-à-vis the knowledge content required in property investment appraisal. Umeh (1977) aptly captures it as follows: estate surveyor and valuer in Nigeria, and particularly the one who took a good course in Estate Management or Land Economy occupies a clearly focal point in decision valuation. He further stated that, 'the training of professionals and graduates in Estate Management and Land Economy in its range and coverage – cutting as it does across many important disciplines while offering its

core subjects...; gives the valuer a position of eminence in decision appraisal. He is well equipped to operate solo in many cases or to synthesise and synchronise the contributions of joint appraisers in cases where the decision valuation calls for consortium of experts'.

Having established the professional role of the estate surveyor and valuer in property investment appraisal, some questions agitate the mind; firstly, how do Estate Surveying and Valuation Firms perceive and measure risk in property investment? Secondly, do Estate Surveying and Valuation Firms in Nigeria like their counterparts in other developed nations; adopt risk assessment techniques in property investment analysis to mitigate the impact of risk and uncertainty in investment decision making? Thirdly, do they adjust for risks using rigorous, quantitative risk analysis techniques that account for risk explicitly? This study will investigate the above posited questions with the purpose to make recommendations that will enhance the quality of appraisal reporting in property investment appraisal in Enugu urban and other parts of Nigeria. Therefore, the main objectives of this paper are; to examine the various quantitative risk analysis techniques employed in property investment analysis, and to determine the extent of their application by Estate Surveying and Valuation Firms in property investment appraisal in Enugu urban.

## Literature Review

### *Property Investment Appraisal*

Investment appraisal is 'the evaluation of prospective costs and revenues generated by an investment in a capital project over its expected life'. (Centre for Financial and Management Studies, 2014). Savvides (1994) opines that it is a methodology for calculating the expected return based on cash-flow forecasts of many often inter-related, project variables. Business Dictionary (online) defines investment appraisal as 'an evaluation of attractiveness of an investment proposal, using methods such as an average rate of return (ARR), internal rate of return (IRR), net present value (NPV), or payback period'.

Baum and Crosby (1995) assert that property investment appraisal has two distinct applications. According to them, the word 'appraise' as defined by the Shorter Oxford Dictionary means:

1. to fix a price for;
2. to estimate the amount, or worth of.

They argued that the term 'appraisal' should not be

used to cover either meaning. They opined that the first meaning implies to what is known in UK as the valuation process or, appraisal process in the US; and the second meaning is the estimation of worth to an individual, given his/her subjective estimates of relevant factors. Summarily, the use of the term valuation will be for the prediction of the most likely selling price; and analysis for the estimation of worth. From the above definitions and from diverse literature, it can be deduced that investment appraisal refers to the second meaning of the word to appraise – the estimation of amount, or worth of. The worth of an investment must be expressed either as a rate of return or as an excess value over price at a given target rate. The main trust or purpose of investment appraisal is to assess the economic prospects of a proposed investment project by examining the costs and benefits emanating from such investment (Ogbuefi, 2002; Savvides, 1994).

Considerable research work and practicable development of worth appraisals so far has centred on appraisals of investment worth. Property investment appraisal assists the investor in diverse ways. An investor who wants to buy a property investment will want to check if it is in tandem with his or her own assessment of worth. Also a property owner will from time to time compare the worth with that of the market. This will aid the investor to decide on whether to hold on to an existing property, refurbish, redevelop or dispose it; or to buy a new property. Property investment appraisal aids in decision making – it helps the investor to choose between alternative investment opportunities. It aids in appraising the viability of refurbishment or redevelopment schemes and also a decision tool for financing arrangement (Wyatt, 2007).

### *Risk and Uncertainty*

A contemporaneous approach of the risk concepts sees risk as constancy in the socio-economic activities. The term risk can be defined in many ways. As stated earlier, a comprehensive definition of risks that incorporates the two aspects (threat and opportunity) considers risk as being an uncertain event or condition that in case of manifestation will have a positive or negative impact over the project's objectivity. The positive impact which can be referred to as the degree to which actual performance may

exceed the expected performance is called the 'upside potential', while the negative impact is the amount by which it falls below expectation is known as the 'downside risk'. In the general sense, risk is used to denote the exposure to adversity or loss; in other words it represents "the probability that a specific adverse effect or event will occur in a given population". In the analytical sense, risk could be regarded as the description of the extent to which the actual outcome of an investment action or decision may diverge from the expected outcome (Hargitay & Yu, 1993; Ajayi, 1998; Enever & Isaac, 2002; Burja & Burja, 2009).

Uncertainty is something that we cannot tell the future outcome. According to Hargitay & Yu (1993), uncertainty is synonymous with the lack of knowledge and information.

The distinction between risk and uncertainty is widely acknowledged. Enever & Isaac (2002) stated that "in statistics, risk relates to a situation where a probability or weight can be assigned to a possible outcome arising from a decision, while uncertainty is the situation when the likelihoods of the outcome are unknown, and hence no measure of probability can be made". Furthermore, uncertainty is taken to be anything that is not known about the outcome of an investment at the time when the decision is made; in contrast, risk is taken to be the measurement of a loss, identified as a possible outcome of a decision (Byrne & Cadman, 1984).

Although the difference between risk and uncertainty is established, the terms in property investment are used interchangeably (Kalu, 2001; Adair & Hutchinson, 2005). According to Baum, Nunnington and Mackmin (2006), when a valuer describes a property investment as being 'risky', he/she is implying some relative measure of uncertainty about the expected returns:

- The rent expected in the future may not be realised, i.e. the rental growth will be less than anticipated.
- Increase in rent will not occur at the time expected, e.g. property may become vacant and take some time to re-let.
- The capital value of the property on re-sale may not be realisable, may not increase with time or may fall with time.
- Costs associated with holding the property,

such as repairs, may be unexpectedly high.

Risk in the above context is synonymous with uncertainty (McIntosh & Sykes, 1995).

#### ***Quantitative Risk Assessment Techniques***

Risk analysis is an integral aspect of investment appraisal which enhances the quality of investment decision making. Savvides (1994) reasons that risk analysis is not a replacement for normal investment appraisal methodology but rather a tool that enhances its results. Risk analysis supports the investment decision by giving the investor a measure of the variance associated with a project appraisal return estimate and being importantly a decision making tool, risk analysis has many applications and functions that extends its usefulness beyond pure investment appraisal decisions. The techniques used for risk analysis depend on the quality and quantity of the information available. The analysis methods can be subdivided into qualitative and quantitative methods. The quantitative approaches are based on mathematical models and only apply if sufficient risk-specific data is available. In an ideal scenario and where sufficient data is available, both significant and likelihood of an event can be derived on a quantitative, and therefore more objective basis. According to COSO (2004), quantitative analysis techniques can be broken down into benchmarking, probabilistic and non-probabilistic methods.

Qualitative analysis is the most basic form of risk analysis which is based on judgement, experience and intuition. Qualitative risk analysis methods can be used when the level of risk is low and does not warrant the time and resources necessary for making a full analysis. These methods are also used when numerical data available are not adequate for a more quantitative analysis that would serve as the basis for a subsequent and more detailed analysis of the investment risk. The qualitative techniques include: brainstorming, questionnaire and structured interviews, evaluation for multidisciplinary groups, judgement and evaluation of specialists and experts (Delphi Technique). Probabilistic models (e.g. Monte Carlo simulation) measure both the likelihood and impact of events, whereas non-probabilistic models are relied upon when available data is limited. With probabilistic approaches to risk assessment, expected value is estimated and also they generate a range of possible outcomes for values across optimistic and pessimistic scenarios. The paper examines the various risk analytical methods that are effective in

the treatment of risk in general and which are now being adapted for the analysis of risk associated with property investment assets (Hargitay & Yu, 1993; Ajayi, 1998).

**Risk-Adjusted Discount Rate (RADR) Technique**

In this approach, the adjustment to all risk yield or the DCF discount rate are based on a perceived required rate of return which compensates for all the investment risks. The required rate is based on the risk-free rate of return, plus a subjectively determined risk premium which is expected to compensate the investor for the extra risks involved (Hargitay & Yu, 1993). The risk-adjusted discount rate or the required rate of return used to adjust discount rate in taking account of risk is derived from Fisher (1930). The rate 'I' can be constructed from the following function:

$$(1 + i)(1 + d)(1 + r) - 1 \dots\dots\dots(i)$$

Where i represents a return for time preference, d represents a return for expected inflation and r represents a return for taking risk. The risk free rate (RFR) which is an average of gross redemption yield on medium or long dated government gilts, is a function of i and d:

$$RFR = (1 + i)(1 + d) - 1 \dots\dots\dots(ii)$$

Therefore

$$RADR = (1 + i)(1 + RFR) - 1 \dots\dots\dots(iii)$$

Equation (iii) is the risk-adjusted discount rate. The greater the amount of perceived risk, the higher is RFR. In practice, this is not the way the risk-adjusted discount rate (RADR) is normally constructed. According to Baum & Crosby, 1988; Hargitay & Yu, 1993, the risk-adjusted discount rate is constructed in a simpler manner: required rate of return = risk-free rate of return + risk premium, i.e. RADR = RFR + RP. The difference is usually small, and can be shown to be of no consequence as the choice of 'RP' is arbitrary. For example, if RFR = 10% and RP = 2%, then  $(1 + RFR)(1 + RP) - 1 = 12.2\%$ ;  $RFR + RP = 12\%$ . The use of risk-adjusted discount rate implies that more return is required to compensate for greater risk.

The major criticism of RADR is that the selection of the risk premium is completely subjective. There is no consensus on the modus operandi for estimating and quantifying the perceived risk and the correct amount of adjustment. Another shortcoming is that an increasing discount rate applied to future cash flows carry the danger of double discounting. In practice, this approach of risk assessment is difficult tends not to be reliable; however, because of its relative simplicity, it remains popular preliminary screening

of investment proposals (Hargitay & Yu, 1993; Babawale, 2007).

**Certainty Equivalent Method**

The certainty equivalent method is derived from the concept of utility theory. Under this approach, the decision maker must first evaluate a cash flow's risk and specify how much money to be received with certainty. This approach quantifies risk through adjusting the projected cash flows of the investment to cash flows which are achievable with a reasonable and calculable degree of certainty. The cash flow streams, converted into a stream of certainty equivalent cash flows, are then discounted to at a risk free rate (Hargitay & Yu, 1993; Ajayi 1998).

According to Hargitay & Yu (1993), the main problem of this approach is the determination of the certainty equivalent cash flows. There is no practical way to estimate certainty equivalents. Each individual would have his or her own estimate, and these could vary significantly. For this reason, the certainty equivalent method is not very often used for risk analysis in investment decision making, although some investment analysts have suggested that the approach is theoretically superior to RADR which is popular in practice because analysts find it far easier to estimate discount rates based on current market data than to derive certainty equivalent cash flows.

Baum & Crosby (1988); Hargitay Yu (1993) stated that objective selection of certainty equivalent cash flows in property investment could be achieved by the use of 'best estimate' or standard deviation analysis of the perceived normal distribution of the expected cash flows. This approach eliminates the difficulties associated with the use of RADR – the problem of double discounting and subjectivity in the selection of a risk premium.

**The Sliced-Income Approach**

The sliced income approach is a more rational method compared to RADR and certainty equivalent cash flow in taking account of risk for an ideal property investment. This approach combines the two elements of the risk adjustment discount factor approach and the concept of certainty equivalent method. In essence, this method is a DCF model using the layer/hardcore approach with the assumption that the core income is guaranteed and therefore should be discounted at risk-free rate. The additional incomes expected after rent reviews or reversion is to be discounted at the risk-adjusted rate to reflect their more risky top-slice nature (Baum & Crosby, 1988; Hargitay & Yu, 1993; Ajayi, 1998 and Baum, Mackmin & Nunnington, 2006).

The rental income of a leased property is divided into two – the current rent and the future rent. The current rent is relatively guaranteed and should be discounted at a risk-free rate because it is certain. For instance if the rent review period of the leased property is in the next five years, then the rental income before the next rent review is certain if there is no default. According to Baum, Mackmin & Nunnington (2006), “the riskiness is likely to be a function of the tenant's ability to pay the rent, which can be judged reasonably accurately given a thorough assessment of the tenant's credit rating”. The additional rental income expected after the rent reviews or reversion are uncertain and therefore should be reflected by discounting at risk-adjusted rate to show their more risk top-slice nature.

Baum (1987) presented sliced income approach as a more accurate means of identifying and allowing for property investment risk than the gauche risk-adjusted discount rate approach and the certainty equivalent technique. To support his position, he outlined the following precise characteristics of the sliced income approach as follows:

- (1) It is an explicit, DCF appraisal model which provides an estimate of both expected and certain cash flows.
- (2) It allows for risk.
- (3) It provides a single point appraisal figure, although a range can be derived.
- (4) It allows direct comparison with a fixed interest gilt of similar maturity.
- (5) It is a progression beyond both RADR and CE techniques as, unlike these traditional methods, it is capable of distinguishing that element of property income which is guaranteed from that which is risky.

### ***Sensitivity Analysis***

Sensitivity analysis has been thoroughly discussed within risk analysis literature, revealing an extensive and diverse approach to sensitivity analysis including numerous reviews. According to Bock and Truck (2011), sensitivity analysis is a common component of investment appraisal that forms part of the early risk analysis and seeks to improve project formulation and appraisal by identifying the main sources of uncertainty. Sensitivity analysis in its simplest form, involves changing the value of a variable in order to test its impact on the final result. It is therefore used to identify the most important, highly sensitive variables (Savvides, 1994). Jovanovic (1999) explained sensitivity analysis as the calculating procedure used for prediction of effect of

changes of input data on output result of one model. This procedure is often used in investment decision making related with the investment project evaluation under conditions of uncertainty. In other words, it is a procedure that analyses how the changes of certain input values (income, costs, value of interests, etc.), produced due to inappropriate prediction or for some other reasons, influence certain criteria values and the total investment project appraisal. Ajayi (1998), stated that sensitivity analysis is used to know the effect of changes in variables such as discount rate, investment horizon, annual cash inflow/cash outflow; would have on the returns of an investment project, or what variable exact the most significant impact on return. Many simple explorations of risk are made possible by sensitivity analysis as a quantitative measure of risk assessment which has gained tremendous application as a result of the opportunities for rapid recalculations offered by personal computer and spreadsheet packages (Baum & Crosby, 1988; Ajayi, 1998).

In property investment appraisal, sensitivity analysis explores the impact of uncertainty on key input parameters such as rent and rental growth, target rate of return, holding period, interest rate (for borrowed capital) and the exit yield by examining the degree of change in the valuation caused by a pre-determined change in one or more of the key input variables. According to Wyatt (2007) “Usually a margin of 10–20% either side of the expected values of the key variables is tested to measure the effect on value. A more sophisticated analysis may apply more realistic variations to the key variables; for example, more upside variation in rent in a rising market. Or different positive and negative percentage changes may be applied depending on the variable; for example, plus or minus 10% for rental value and plus or minus 2% for rental growth”.

Bannerman (1993) argues that there is no standard methodology for performing sensitivity analysis; generally, the most common form of the approach involves the changing of the values of certain variables which are thought to be 'critical' in the cash flow in order to determine the effects of such changes on the final result. He also discussed the methods of sensitivity analysis that are in general use as well as those used by the property appraisal profession. The methods presently in wide application include; switching values method, the global sensitivity analysis and systematic or stepwise sensitivity analysis. All the three methods of sensitivity analysis that are in general use are also extensively used in property investment appraisal, although the stepwise method is more dominant in use because of its

straightforwardness of application.

The systematic or stepwise method of sensitivity analysis can take a number of procedures: break even, single variable and multi-variable analysis. According to Sayce et al. (2006), sensitivity analysis involves several steps:

- The decomposition of the drivers of the performance of an investment into their component parts (the number is dependent upon the availability of information, the analyst's time, the clients requirements and computer programming constraints). Sensitivity analysis is easy to undertake with either property investment appraisal packages or spreadsheets.
- The identification of the critical variables in the investment project through testing by trial and error.
- The calculation of the impact of the changes in the critical variables on the outcome of the project.
- Altering combinations of critical variables to explore their joint impact on the project investment.

#### ***The Single Variable or One Factor at a Time Sensitivity Analysis***

The one factor at a time approach is the most elementary and commonly used variant of sensitivity analysis. Each variable factor is altered by a fixed proportion (for instance  $\pm 10\%$ ) of the expected outcome, while holding every other variable constant, consequently testing the effect of this on returns or profit. This approach is simple to implement, computationally inexpensive, and useful to provide a glimpse at the model behaviour (Saltelli, 1999). Sayce et al. (2006) stated that the shortcoming of this approach is that it can be misleading because it assumes a symmetrical range around the best estimation. Upside and downside risk are seldom symmetrical.

#### ***Multi-Variable Sensitivity Analysis***

The multi-variable approach could be treated as a second-level sensitivity technique to determine the effect of the changes in various combinations of sensitive variables. For instance two risky variables can be combined to generate a matrix of outcomes. This two-tier analysis would make stronger the accuracy and dependability of the risk analysis.

Sensitivity analysis is easy to implement and computationally inexpensive, though, it is without its

shortcomings. One of the limitations of the variants of sensitivity analysis is that they consider the effect of one or two variables, and the changes to those variables, at a time; no understanding is gathered of how they all interact, consequently, the full picture is not provided; also no probabilities are used in sensitivity analysis. Furthermore, correlation is considered the most important limitation. Two or more variables are said to be correlated if they tend to vary together in a systematic manner. Such relationship is common in a set of risk variables. The existence of correlated variables among the designated risk variables can, however distort the result of risk analysis. The two most popular variants of the sensitivity analysis method (stepwise sensitivity analysis and switching values method), which keep changing one variable at a time while keeping the others constant, are often justified only if there is no significant correlation between the variables. To keep this simple, correlation should be best handled during multi-variable or simulation analysis rather than in single variable sensitivity analysis. Thus, sensitivity analysis should for all practical purposes, be limited to the single, uncombined variables. In essence, therefore sensitivity analysis should be regarded as a test of the limits of each of the variables, irrespective of the interrelationships or correlation (Bannerman, 1993; Savvides, 1994; & Sayce et al., 2006).

In summary, Sayce et al. (2006) argued that whilst sensitivity analysis forms a useful start in the risk analysis process, in itself it is not a risk assessment technique. They further posited that the erroneous perception amongst many in the property investment market is that sensitivity analysis and the use of data table is an all-encompassing risk analysis method for property investment.

#### ***Scenario Technique***

The scenario technique is an improvement on sensitivity analysis. The use of scenarios can enhance the arrangement of sensitivity analysis by grouping estimates to suit particular combinations of circumstances or scenarios. According to Sayce et al. (2006), scenario testing extends sensitivity analysis by taking a range of possible values for the key variables and combining them to generate a range of possible outputs (IRRs and NPVs). A major skill of an investment analyst undertaking a scenario testing is the capacity to identify the key variables that impact prospective cash flows and of outputs (that is the performance measures). The dissimilarity between scenario testing and sensitivity analysis is that the former examines the impact on the value of changes to several variables simultaneously and as a result

the key variables might respond to economic changes.

Just like in sensitivity analysis, there are steps in carrying out scenario testing. The steps in scenario analysis include:

- The starting point is to determine the input variables the scenarios will be built around. Sensitivity analysis, in particular the testing for the impact of each variable over a realistic range on the performance measures (IRR and NPV) is carried out. This aids to ascertain those variables that have a substantial bearing on the DCF analysis (Sayce et al., 2006). In general, the investment analyst should concentrate on two or three most critical input variables that will determine the DCF analysis output and build scenarios around these variables.
- The second step is to determine the number of scenarios to analyse for each variable. With two or three critical variables, the investment analyst could construct three future scenarios – the best (optimistic), the most likely (realistic) and the worst (pessimistic) to examine the effect on cash flow analysis outputs (IRR & NPV). Schwartz & Ogilvy (1998) in Ratcliffe (2000) affirms that between two to four is the normal bracket of scenarios sufficient to explore the possible futures within which decisions will have to be taken, but there is the danger of always ending up with three scenarios (though, in practice, this is often the case). Inexperience with scenario building tempts those involved to generate a 'good' and a 'bad' at the extremes, and an 'average' in the middle, with a tendency to drift towards the middle, and treat it as the 'most likely' single-point forecast. All the advantages of a multiple-scenario method are then lost. At the same time, it is important to avoid drafting several scenarios that are simply slight variations on the same theme. An underlying danger, moreover, is that analysts endeavour to construct the 'right' answer in a single scenario. The true value of the scenario building exercise is stressed as being the experience of exploring a set of distinct and plausible futures that could unfold.
- The third step is the estimation of the investment cash flows under each scenario.

According to Sayce et al. (2006), at this point the analysis does not give any idea of the likelihood that any of these discrete outcomes might actually occur.

- Finally, the outcome of each scenario will be assigned some measure of probability or likelihood and a sum of the weighted average cash flow analysis is calculated.

The final step is generally built around discrete probability outcomes. Discrete probability modelling does not properly reflect the uncertainty or risk that might be associated with the expected cash-flows – it calculates an expected value rather than a measure of variation or uncertainty. It is usual to test optimistic, realistic and pessimistic scenarios but special attention is paid by investors and lenders to the pessimistic scenario because, for obvious reasons, they are particularly concerned with the downside risk of the investment (Sayce et al., 2006). In summary, although constructing more scenarios may be realistic than fewer, it becomes more difficult to gather information and differentiate between the scenarios in the term of the investment cash flows. Therefore, estimating cash flows under each scenario will be easier with say five scenarios than if there are ten scenarios. The issue of how many scenarios to consider will depend on the ability of the analyst to forecast cash flows under each scenario.

There are several advantages in the application of scenario technique in risk analysis as highlighted in the definitions above which is its ability not to describe just one future, but several realisable futures placed side by side; and the large number of different scenario technique points to the fact that the ways of building a scenario are very flexible and can be adjusted to specific task/situation. In contrast to some of these strengths, scenarios have several drawbacks: One of the major shortcomings of scenario analysis is the lack of empirical market data evidence on which to base selection of probabilities; even if the scenarios have been very carefully constructed, it still relies on subjective assessments of scenarios and associated probabilities. Data and information from different sources have to be collected and interpreted which makes a deep understanding and knowledge of the investment under investigation absolutely necessary. Furthermore, the practise of scenario building is time consuming (Mietzner & Reger 2005; Sayce et al., 2006).

#### ***Decision Tree Procedure***

The decision tree is another approach for considering

uncertainties in investment decision-making which has remained simple and effective. Just as in scenario analysis, decision trees generally look at risk in terms of discrete outcome. Conventionally, decision tree analysis allows enormous or complicated decision problems to be broken into smaller sub-problems which can be solved separately and then recombined (Byrne & Cadman, 1984; Hargitay & Yu, 1993). Decision tree is a diagrammatic representation of a tree and the branches. The first step to understanding a decision tree is to distinguish between the four basic components. According to Hargitay & Yu (1993), the four basic components include; the action nodes, the event nodes, the pay-offs and the probabilities.

The action node or root node represents the starting point of the decision tree, where the decision maker is faced with the decision to make a choice from a few alternatives. Different courses of action take different paths or branches from each node and move to the right, leading to an event node. The aim of the exercise is to assess what a risky investment is worth at the node. The action node is usually represented as squares on the diagram. The event nodes represent the different possible outcomes emanating from a course of action. Each outcome will have a branch and lead to a result. The event nodes represent uncertain outcomes and have probabilities attached to them. The possible outcomes and the probabilities of the outcome occurring must be figured out based upon the information available. They are normally drawn as circles.

In general, the number of steps required for the development of decision tree can vary from case to case depending on the details and sequencing of the analysis. Byrne & Cadman (1984) posited that decision tree is developed in three or four steps:

- The first step is in developing a decision tree is to outline the phases of risk that could be expected in the future. All possible action – outcome sequences are put on the tree, working from left to right. Putting the decision problem in this form is not necessarily clear-cut. Extraneous elements need to be removed, so that only the bare branches of the problem remain.
- Once the phases of the analysis have been put down and the outcomes of each phase are defined, the numerical value which indicate the intermediate results then need to be evaluated together with the probabilities for the various uncertain outcomes. These are then put on to the diagram at the appropriate

points.

- The final step in a decision tree procedure which is the usual method of analysis is known as 'folding back' the tree working from left to right, working backwards through the tree construction.
- An additional step, sometime employed, is to apply sensitivity analysis to the tree, altering the variable values and probability distributions, and determining the best courses of action which then result at each node.

Generally less complex decision trees are simple to use, simple to understand and offer many advantages in investment decision-making. Petri & Napoca, (2010) and Damodaran (2009) highlighted some key benefits that accrue from using decision trees which include; graphic, efficient, revealing, complementary, dynamic response to risk, risk management, etc. Notwithstanding the numerous benefits that accrue from applying decision trees, it is startling that they still do not find wide acceptance in risk analysis (Nayab, 2011; Damodaran, 2008). According to Damodaran (2008) decision trees are capable of handling risks that are sequential, but risks that affect an investment simultaneously cannot be easily modelled in a decision tree. Decision trees generally look at risk in terms of discrete outcomes. Some disadvantages of decision tree are; instability, complexity, unwieldy, costs, too much information, and analysis limitations (Nayab, 2011). An understanding of the pros and cons of a decision tree analysis reveals that decision tree disadvantages negate much of the advantages, especially in large and complex trees.

Decision trees are used in different disciplines including game theory, engineering, diagnosis, artificial intelligence, and data mining; and have long been used in business management. The use of decision trees in the property appraisal profession are still at their early stage of development and need to be fully researched (Baum, Mackmin & Nunnington, 2006 and Hargitay & Yu, 1993). Hargitay & Yu (1993) posited that decision tree procedure has capacity in its use in areas such as property development and investment, which has to do with future allocation of resources. According to them, the applicability of decision tree could be improved by combining it with sensitivity testing; and additional extension may include the application of simulation by using continuous variables instead of discrete variables.

### ***Standard Deviation***

In statistics, the standard deviation is a measure used to quantify the extent of variation or dispersion of a set of data. One of the analytical definitions of investment risk is 'the variance or volatility of returns'. The most often used measures of variability are the variance and the standard deviation. The variance is the average of the squared deviation from the mean of a distribution, while the standard deviation is the square-root of the variance (Hargitay & Yu, 1993). Standard deviation attempts to quantify the amount of potential variability of the future rate of return of an investment about its mean position. It simply gives a form of average variation of investment returns about the mean, both for downside risk and upside volatility. When return is normally distributed, then the variance and standard deviation will portray the dispersion accurately. According to Hargitay and Yu (1993), the justification to use variance and standard deviation as an appropriate measure of risk is not restricted to normal distributions only; provided the shape of the distribution is symmetrical, with finite variance, the investor's interest can be explained with quadratic utility function, variance and standard deviation can be considered as the appropriate measure of risk.

In finance literature, standard deviation is the commonest statistical indicator used as a measure of risk with return variations of a given asset such as bonds, stocks and property investment. In property investment analysis, standard deviation appears to be the most common risk measure among practitioners in the advanced nations such as the United States and Australia (Mao, 1970). Evans (2004) has also revealed that the standard deviation is the most popular risk measure for investors, which is consistent with the findings of Mao (1970). Young (1977), Greer (1979), Sykes (1983), Baum and Crosby (1988), Hargitay and Yu (1993), Ajayi (1998), and Kalu (2001) applied standard deviation in property investment risk analysis. Standard deviation used as a risk measure may be used as a measure of dispersion in all symmetrical (normal) and even moderately skewed distributions (Baum & Crosby, 1988). Standard deviation is a probabilistic technique of risk analysis since it uses all available data, and therefore provides a more sensitive measure of volatility while adopting probability distribution for its use. The key parameters (rental value, rental growth rate, target rate of return (TRR) and exit yield) in property investment analysis are uncertain, consequently, they are represented by probability distributions (Byrne & Cadman, 1984).

Though the standard deviation model is the most useful approach to incorporating risk into an

investment decision-making, it is without some limitations. Baum and Crosby (1988) raised some issues in the use of standard deviation in property investment analysis regarding the nature of probability distribution of variables used. Measurement of risk becomes more complex to accomplish where the likely values of the variables are drawn from a skewed distribution, and where values from year to year are partially correlated. Skewness is the measure of asymmetry of a probability distribution. It explains the tendency of a distribution of values of a variable to deviate from the normal curve. This is where the mean value is not equal to the median and the mode. If the distribution is highly skewed, then the measure of risk will be misleading. This is not likely to be a major problem since property investment parameters are drawn from normal or moderately skewed distribution. However Baum and Crosby state that problem may arise in an upward-only rent review during a non-inflationary situation. The likely rents at review may substantially skew the distribution. Cash flows in property investment could be mutually independent or perfectly serially correlated. If cash flows are assumed to move from serial independence to perfect serial correlation, the computation of standard deviation changes; this in turn alters the probability distribution of the likely outcomes from the investment. This does not really complicate the calculation. The standard deviation problem becomes complicated when the cash flows are highly correlated overtime, even as others may be more nearly independent. This is what happens in most real world situations. This problem could be addressed by the adaptation of Hillier's model to real estate investment risk analysis.

### ***Monte Carlo Simulation***

Simulation is one of the most powerful analytical tools available for decision-makers in the analysis of business decisions, especially under the conditions of uncertainty and risk (Byrne & Cadman, 1984; Hargitay & Yu, 1993). According to Hargitay & Yu (1993) simulation is a numerical procedure involving mathematical models. The Monte Carlo simulation is a quantitative technique for the analysis of continuous risk. It presents an additional dimension to risk analysis by bringing in objectivity and dynamism to investment appraisal making it a rational extension of sensitivity and scenario analyses (Crudden, 2012). Sensitivity and scenario analyses deal with discrete variables while Monte Carlo simulation deals with probability distribution of continuous variables. Probability distributions describe the outcomes of varying a random variable, and the probability of occurrence of those outcomes. If the random variable

assumes only discrete values, the corresponding probability distributions are called discrete probability distributions. Binomial, poisson and hypergeometric distributions are examples of discrete probability distributions. Conversely, when the random variable takes continuous values, the corresponding probability distributions are called continuous probability distributions. Examples of this kind are normal distribution, exponential distribution and gamma distribution (Raychaudhuri, 2008).

There are different numbers of steps in carrying out Monte Carlo simulation (Hargitay & Yu, 1993; Ajayi, 1998; Damodaran, 2008; Raychaudhuri, 2008 and Crudden, 2012). Crudden (2012) provides typical steps for executing Monte Carlo simulation risk analysis in commercial property investment as follows: developing a feasibility model, sensitivity analysis, describe variable ranges, ascribe probabilities, test for correlations, and run model.

As stated earlier, the Monte Carlo simulation is among the most potent analytical tools available for risk assessment. It allows the decision-maker more comprehensiveness, clarity, thoroughness and understanding (Loizou & French, 2012). The Monte Carlo simulation helps the decision-maker to be more consistent and rational in his decisions (Schoemaker, 1993). Monte Carlo simulation to an extent de-humanise decision making process by making allowance for the rationalization of the various risks, increase consistency, and brings to bear the multiplicity and extent of risks involved. The outcomes of analysis can help optimize design specifications, identify investment projects based on rough data, and help the investor and/or developer understand and compare the risk involved in carrying out a particular project (RICS, 2003). Notwithstanding the immeasurable, rational benefits derived in the use of Monte Carlo simulation in risk assessment, there are some vital issues that must be dealt with in the context of applying simulation in risk measurement (Damodaran, 2008). These issues include: Garbage in, garbage out, historical data may not fit distributions, variation in distributions, varying correlation across input variables.

Risk analysis using simulation approach has been in use at least since 1973 in the cash flow-based appraisal of real estate investment decision-making (Pyhrr, 1973). Byrne and Cadman (1984) initially demonstrated the application of simulation in risk analysis for property development project. Monte Carlo simulation is widely used in the appraisals of financial securities subject to uncertainty (An & Qi,

2012) and also application to private residential investments (Johnson et al., 2006). According to Pfnur and Armonat (2013), “modelling using simulative risk analysis has been applied in particular to decision scenarios involving direct investments in commercial real estate, with which the following is concerned”. The works of Kelliher and Mahoney (2000), MacFarlane (1995) both provide an excellent introduction and pragmatic illustrations. Jackson (2009) with the aid of this approach appraised special sustainable real estate investment projects. Van der Spek and Hoorenman (2011) explored another field of application of Monte Carlo simulations in financial decision-making for direct real estate investments. They investigated the optimal loan-to-value (LTV) ratio in the financing of real estate investment projects using simulations. Brown and Schuck (1996) and Pfnur (2011) applied risk analysis simulations in portfolio management decision making under conditions of uncertainty. Monte Carlo simulation appears very capable of providing insights into risk aspect of property investment projects at first sight (Hargitay & Yu, 1993), Farragher and Savage (2008) found out that real estate investment decision-making practices, in particular, appears to be static at low level.

Monte Carlo simulation techniques in property investment decision-making process is usually applied to DCF appraisal model – the base model configured either for the calculation of the project's NPV and/or IRR, where the timing of future individual cash-flows are likely to be difficult to determine. Enever and Isaac (2002) posit that simulation methods are most likely to be of use in connection with residual valuations of development projects because there is large number of possible outcomes for each variable. These variables might include projected rental levels and yields, construction costs and professional fees, bridging finance, and time taken to construct, let, and/or sell the completed project. Nonetheless, Monte Carlo simulations have been successfully applied in other forms of property investment as enunciated above. What is expedient in the application of Monte Carlo simulation in property investment appraisal is to make sure that the operational model is well constructed, the nature and correlation between the input variables accurately identified and factored into the model; and lastly, the number of simulation runs should generate a statistically significant samples of results.

### ***Modern Portfolio Theory***

So far the discussion on risk analysis techniques has mainly been concerned with the risk associated with

individual property investment. The MPT is concerned with group of real estate assets or portfolio. The applicability of MPT as a tool in managing real estate portfolio risk has been extensively discussed by many researchers. There are quite a number of debates on the applicability of MPT on real estate investment analysis by many researchers. These studies at various times have expressed divergent views on the suitability and applicability of MPT in real estate analysis.

Young and Grieg (1993) proved mathematically that real estate is unsuitable for MPT analysis due to the heterogeneous nature of real estate. Also, the real property market is illiquid and different from the stock market. They added that real estate investment returns depends on varying circumstances of investment properties which make MPT an inaccurate guide for real estate asset allocation. They infer that diversification by location and real estate type may not be adequate to forecast expected returns. Nonetheless, Young and Grieg (1993) suggest that more research and additional sophisticated models of interaction between real estate and other investment portfolios are required before MPT can be employed in real estate analysis. In a 'roundtable' organized by Buildings, the issue of suitability and applicability of MPT in real estate was raised by real estate's leading portfolio management experts in the United States when they had the opportunity to meet face to face with 'father of MPT', Harry Markowitz. Reinbach (1993) quoted Markowitz submission – real estate can be explained and measured with financial theory tools, subject to number of issues about the subject. The most identifiable factor is the lack of reliable real estate data. Stock and bond market data have been sufficient to deal with any investment management tools, especially when daily transactions take place with many cyclical price movements. However, most of the real estate market data were derived from a valuation-based index. Another problem with real estate is the effect of illiquidity on pricing and waiting for a best price.

At the present time, most practitioners and academics have acknowledged MPT as a standard tool for analysis of real estate investment. Periodically, the understanding of MPT has been enhanced alongside a number of assumptions and suggestions that have been made by several studies. The institutional investors' interest on real estate investment has grown over the years and therefore more sophisticated techniques are increasingly developed and used to appraise risk and returns of real estate portfolios. Risk reduction in a real estate investment by portfolio

diversification is a fundamental part of investment success of portfolio management strategy. McIntosh and Sykes (1985) outlined diversification criteria as unit size, location and use, and rent review pattern. Within property portfolios investment, the traditional approach to defining diversification grouping is to use geographical region and real estate use categories (e.g. commercial, residential, industrial, agricultural and recreational property investments). A number of surveys of institutional investors' diversification strategies show that real estate type and geographical spread are the most important diversification yardsticks. Webb (1984) found that 62 per cent of institutional investors diversified real estate by geographical spread while 61 per cent diversify by real estate type. Louagand (1992) established that 89 per cent of investors studied diversified by real estate type and 72 per cent by geographical location. In addition, 41 per cent by economic location and 54 per cent ranked real estate type as the most significant diversified criterion.

De Witt (1996) proved that most real estate fund managers diversify real estate portfolio deliberately and rigorously using real estate type or location as the main criterion for portfolio construction. The study of Mueller and Laposa (1995) revealed that real estate type allocation could enhance investor's returns over real estate market and/or economic cycles. MacGregor (1990) proposed that the real estate portfolio could be constructed by categorising the region in line with economic base; whereby underlying assumption will produce similarity within the unit of analysis. The other factor related to portfolio diversification is the unit size. McIntosh and Sykes (1985) reasoned that the most crucial factor affecting portfolio performance is the size of the individual properties comprising the portfolio. The smaller the number of individual properties in a portfolio, the greater the risk that poor performance in one of the properties will reduce the performance of the combine portfolio. According to them, the risk in such circumstance could be minimised by increasing the number of units within the portfolio and making sure the portfolio is not disproportionately filled with particularly large properties. Kallberg et al. (1996) established that diversification benefits were shown to be the greatest with smaller properties and are most valuable at higher target levels of return. Conversely, Mueller and Laposa (1995) affirmed that real estate size is not a good pointer of a potential diversification determinant since the value of each real estate type varies exceedingly.

Generally, the MPT structure makes many assumptions (see Hishamuddin, 2006 & Iyiola et al.

2012 for outline and discussion on these assumptions) regarding the investment markets. Not any of these assumptions are entirely valid, and each one of them jeopardizes the MPT to an extent. The MPT has been highly censured in spite of its theoretical significance. Censors question its practicability as an investment strategy, since its model of financial markets does not agree with the real world in several ways. In recent times, key underlying assumptions of MPT have been grossly challenged by fields such as the behavioural economics; its crude assumptions being a major prejudice (Iyiola, et al., 2012).

In their review of relevance of MPT as investment portfolio tool in portfolio decision making, Iyiola, et al (2012) affirm that regardless of the theory's shortcomings, it is still generally accepted and further researches are being conducted to improve on its principles. For instance, the post modern portfolio theory is a substantial improvement of the theory. The post-modern portfolio theory achieves far greater diversification than does the MPT in investment portfolio. The PMPT uses the alpha coefficient and the beta coefficient to appraise investment. The alpha coefficient measures an investment performance relative to its risk; the beta coefficient measures an investment's return relative to the market as a whole. Furthermore, the PMPT separates alpha and beta generated revenue, and then considers each individually to maximize their performance. It is also more adaptable to the individual investor and can gauge risk relative to the investor's minimum acceptable return for an asset.

In real estate portfolio investment, the slow adoption of MPT is mainly the result of the nature of the real estate market. The implementation of MPT tend to be generally difficult and complicated as a result of high illiquidity, high transaction cost, lack of uniformity in data of real estate indices and the characteristics of the return distribution (Hishamuddin, 2006, Viezer, 2010). Real estate practitioners' contend that MPT concepts ignore important features of the market and decision-making process. Researchers have acknowledged these reservations and invented various possible solutions. According to Adair, et al. (1994), real estate analyses requires good quality data and need to be buoyed by a strong research base. Now and then, the understanding of MPT in real estate has advanced side by side a number of assumptions and suggestions that have been made by several studies. In a study carried out by Sandberg (2005) on the use of portfolio theory within real estate research, the following key findings were made; within contemporary real estate investment research, there is

an extensive appreciation and application of different portfolio models. The real estate research at the moment is completely capable of using and developing complex portfolio theory, occasionally with appropriate adjustments made in conformity to the peculiar characteristics of real estate.

In conclusion, the use of portfolio theory will most likely increase even more in future as a result of changes in the real property investment market; increasing volatility and complexity of property investments, increasing sophistication of property investors, increased financial focus within real estate investment and globalisation. According to Sandberg (2005) more effective portfolio models which better replicate the underlying real estate characteristics should be developed. This will strengthen the capacity of the MPT to address even more complex portfolio problems and challenges within the future real estate investment market research.

In summary, risk analysis techniques are broadly classified in qualitative and quantitative approaches. In qualitative approach, the most commonly used analysis techniques are cross-functional workshop, interviews, surveys and benchmarking. These techniques are used for initial screening of risk and do not incorporate empirical methodology. The quantitative risk assessment techniques require numerical values for both impact and likelihoods using data from a variety of sources (COSO, 2012). The quantitative risk analysis techniques could be further divided into deterministic and probabilistic methods. The deterministic approach gives a point estimate and includes risk adjustment techniques such as risk-adjusted discount rate, certainty equivalent cash flow and sliced income approach; sensitivity analysis, etc. The probabilistic models include the scenario technique, decision tree procedure, standard deviation, Monte Carlo simulation and modern portfolio theory.

The risk adjustment techniques attempt to provide a form of quantitative opinion, but in a subjective manner. Sensitivity analysis is easy to use and computationally inexpensive. To some it is the first useful step in the process of risk analysis, but its conclusion do suffer from lack of preciseness, conciseness and comprehensiveness. Scenario technique is advancement on sensitivity analysis technique. It extends sensitivity analysis by taking a range of possible values for key variables and combines them to produce a range of possible outputs. There are several advantages in the application of scenario technique in property investment risk analysis; in contrast, it has some

major drawbacks which chief among them is the lack of empirical market data evidence on which to base selection of probabilities.

Decision trees provide a flexible and formidable approach of dealing with risk that occurs in phases, notwithstanding the numerous benefits, they still do not find wide acceptance in risk analysis and most importantly in real estate investment practice. Decision trees are capable of handling risks that are sequential, but risks that affect an investment simultaneously cannot easily be handled in a decision tree. Standard deviation is the most widely used measure of dispersion. In the use of standard deviation in risk analysis, there are some possible problems that could be encountered. These problems can be surmounted by modeling the standard deviation using certain reasonable assumptions. The Monte Carlo simulation is one of the most powerful analytical tools available for decision making under the conditions of uncertainty and risk. It presents an additional dimension to risk analysis by bringing objectivity and dynamism to risk appraisal making it a rational extension of sensitivity and scenario analyses. It deals with probability distributions of continuous variables. Notwithstanding the immeasurable benefits in the use of Monte Carlo simulation in risk assessment, there are some issues that must be put into consideration in the use of this approach; these issues include garbage in, garbage out, historical data may not fit the distributions, variation in distributions and varying correlation across input variables.

In the use of Monte Carlo simulation in property investment risk analysis, the operational model should be well constructed, the nature of correlation between input variables accurately identified and factored into the model; and the number of simulation runs should generate statistically significant samples of results. Risk reduction in real estate investment by portfolio diversification is a fundamental part of investment success of portfolio management strategy. The fundamental objective of MPT is to maximize return and minimize risk through an appropriate strategy of diversification. The MPT structure makes many assumptions which are not entirely valid regarding the property investment market. The MPT concept ignores important features of the property market and investment decision-making process, nevertheless, a strong research base and good quality data will strengthen the capacity of MPT to address complex portfolio problems and challenges in real estate investment.

On a final note, it is important to point out that the

above quantitative risk analysis techniques are hardly ever applied by themselves. In practice, more than one approach is applied. According to Hargitay and Yu (1993), using a number of complementary rational methods on a particular real estate investment project will help the project's riskiness to be better appreciated and also, decision-making more effective. Both, Matysiak and Ormerod (2002) put forward that: "It is wise to use a number of complementary approaches to risk assessment, all grounded in a rigorous and preferably quantitative framework. In other words a 'risk process' should be developed rather than a single technique being applied."

#### *Previous Studies*

The following studies have investigated the application of risk management techniques in the real estate industry.

Gehner, Halman and de Jonge (2006), conducted a survey using 31 of the largest real estate developers in Netherlands comprising independent real estate development companies, financier related, contractor related, investor related and other categories (owner-user, housing corporation). A total of fifteen developers responded, comprising 7 independent developers, 3 financier related, 3 contractor related, 1 investor related and 1 remaining categories. Results show that 100% of the developers use intuition/experience, qualitative description (100%), scenario/sensitivity analysis (80%), risk premium (27%), checklist (20%), assessment of total risk exposure (13%) and probabilistic techniques (0%) for risk analysis. These results indicate that the most used techniques the by developers are intuition/experience and qualitative description; followed by scenario/sensitivity analysis. No single developer use probabilistic techniques. Wiegelmann (2012) investigated the application of risk management techniques in leading European property development organisations. The study surveyed 69 prominent property development companies in UK, Germany, Italy, France, Switzerland, Spain and Austria. The study achieved 43.7 per cent response rate. The results of the survey show that 69.9% of the property development organisations approach risk assessment primarily in subjective and intuitive manner. Other established methods are sensitivity analyses and scenario techniques with each 45%. The inclination to use these approaches is because they are practical comparatively straightforward to apply. Probabilistic techniques are the least use; Monte Carlo simulation (10.1%), value at risk (7.2%) and decision tree procedures (4.3%).

In the Nigerian context, the following studies are established (Ibiyemi and Teller, 2013; Otegbulu et al., 2012; and Ogunba, 2002). The study by Ibiyemi and Teller (2013) hypothesised that Lagos real estate firms do not account for risk explicitly in property investment valuation practice. 110 Valuation firms were sampled and a response rate of 90.90% was achieved. Results show that 70% and 9% of the Firms always use conventional and contemporary RADF techniques respectively; 8% and 50% never used the techniques. 65% seldom use sensitivity analysis and ENPV. 80%, 87%, 90%, and 80% never used the Monte Carlo simulation, standard deviation, certainty equivalent cashflows, and stochastic decision trees respectively. No firm ever used the sliced income approach and portfolio theory. Otegbulu et al. (2012) surveyed the level of application of the various risk assessment techniques in property development projects in Abuja, Nigeria. The study investigated 80 estate surveying and valuation firms. A total of 69 firms responded comprising 23 project managers, 20 developers, 14 feasibility consultants and 12 that engage in the above three functions. Findings show that qualitative description is the most often used method (mean = 4.15). This is followed by scenario testing (mean = 3.54), use of intuition/personal experience (mean = 3.39), use of checklist/risk assessment matrix (mean = 2.99), and the analytic network process (mean = 1.42). Ogunba (2002) investigated the application of risk analysis by development surveyors, corporate developers, and development lenders in pre-development appraisal in Southwestern Nigeria. The study surveyed 193 surveying firms, 111 development lenders and 18 corporate developers; a total of 113, 32 and 10 responses were actualized for surveyors, lenders and corporate developers respectively. Findings show that none of the surveyed group applies probabilistic risk analysis techniques in pre-development appraisal.

The above reviewed studies in Europe and Nigeria show that, generally, risk analysis and management is still generally handled in a subjective manner. Any notion that real estate practitioners are now applying robust and sophisticated risk management techniques is erroneous as this is scarcely manifested in actual practice. The most commonly applied risk techniques are subjective assessment, scenario/sensitivity analysis and risk-adjusted discount rate. Very few practitioners most especially in some parts of Europe and Australia apply Monte Carlo simulation, decision tree procedure and value at risk techniques. Generally, risk analysis in property investment appraisal has remained relatively under-researched. Only limited research is available. These studies most

especially in the Nigerian context focused mainly on property development and property investment valuation with none describing the level of application in property investment analysis/appraisal. Consequently, this study investigates the extent of application of quantitative risk techniques in property investment analysis by Estate Surveying and Valuation Firms in Enugu Urban with the view to fill the identified knowledge gap and also enrich the risk analysis literature in property investment.

### Methods and Data

The aims of the research were to; examine the various risk assessment techniques in property investment analysis; and to determine the frequency of application of the risk assessment techniques by Estate Surveying and Valuation Firms in Enugu urban in residential property investment appraisal. The study adopted a combination of qualitative and quantitative approach comprising literature review and data collection (questionnaire survey and interviews). The main purposes of the literature review was to establish what research has been previously conducted concerning application of risk assessment techniques; and to examine the various risk assessment techniques in property investment appraisal using textbooks, technical reports, journal articles, and conference proceedings. For the empirical survey (data collection), the study population comprises the 49 Estate Surveying and Valuation Firms in Enugu urban. Using the Taro Yamane formula at 95% confidence level, a sample size of 44 firms was estimated and selected by purposive sampling technique. The questionnaire were administered personally to members of top management in the firms. The respondents were instructed to select from listed risk assessment techniques the ones they apply. Multiple selections of techniques by each respondent were allowed. Out of the 44 questionnaire distributed, 37 were returned, 35 were correctly filled and 2 were incompletely completed and so were excluded from the data analysis. The response rate was 79.55%. Data collected were analysed using descriptive statistics comprising frequency and percentage. Results were presented in tables.

### Results

Table 1 shows that under sex, 24 (68.6%) of the respondent are male while 11 (31.4%) are female. On position in the firm, 20 (57.1%) are principal partners, 2 (5.7%) are associate partners, 8 (22.9%) are branch managers, 2 (5.7%) are resident surveyors, 2 (5.7%) are general managers and 1 (2.9%) a managing partner. On educational qualification, 7 (20.0%) have

HND, 14 (40.0%) have B.Sc./B.Tech, 9 (25.7%) have M.Sc./M.Tech, and 5 (14.3%) have Ph.D. For professional qualification, 7 (20.0) are FNIVS, 20 (57.1%) are ANIVS/RSV, 2 (5.7%) are ANIVS and 6 (17.1%) are probationers. On years of professional practice, 6 (17.1%) have between 1 – 5 yrs, 6 (17.1%) have 6 – 10 yrs, 2 (5.7%) have 11 – 15 yrs, 6 (17.1%) have 16 – 20 yrs, 5 (14.3%) have 21 – 25 yrs, 3 (8.6%) have 26 – 30 yrs, 7 (20.0%) have above 30 yrs in professional practice.

**Table 1: Demography of the respondents**

	Frequency	Percent
<b>Sex</b>		
Male	24	68.6
Female	11	31.4
<b>Position in the firm</b>		
Principal Partner	20	57.1
Associate Partner	2	5.7
Branch Manager	8	22.9
resident surveyor	2	5.7
general manager	2	5.7
Managing Partner	1	2.9
<b>Educational qualification</b>		
HND	7	20.0
B.Sc./B.Tech	14	40.0
M.Sc./M.Tech	9	25.7
Ph.D.	5	14.3
<b>Professional qualification</b>		
FNIVS	7	20.0
ANIVS/RSV	20	57.1
ANIVS	2	5.7
Probationer	6	17.1
<b>Years of professional practice</b>		
1-5yrs	6	17.1
6-10yrs	6	17.1
11-15yrs	2	5.7
16-20yrs	6	17.1
21-25yrs	5	14.3
26-30yrs	3	8.6
above 30yrs	7	20.0

**Source: Field Survey 2015**

**Table 2 Application of various risk analysis techniques by firms**

	Frequency	Percent
Individual subjective assessment	22	88.0
Sensitivity analysis	15	60.0
Scenario technique	2	8.0
Decision tree procedure	0	0.0
Simulation methods (e.g. Monte Carlo Simulation)	0	0.0
Risk-adjusted discount rate (RADR) model	9	36.0
Sliced income approach	3	12.0
Certainty equivalent cash flow	2	8.0
Standard deviation	0	0.0
Portfolio theory	0	0.0

**Source: Field Survey 2015**

Table 2 shows the frequency of usage of various risk analysis techniques by the Firms. Subjective assessment 22 (88%), sensitivity analysis 15 (60%), risk-adjusted discount rate (RADR) 9 (36%), sliced income approach 3 (12%), scenario technique, 2 (8%) and certainty equivalent cash flow 2 (8%).

### Discussion

Findings from various literature showed that risk in property investment analysis could be assessed quantitatively or qualitatively. The qualitative approach to risk analysis is grossly inadequate to handle property investment risks considering the ever changing investment environment and most importantly the many and varied risks associated with property investment. The qualitative analysis does not require numerical values. The other broad classification of risk is the quantitative approach. The quantitative techniques require numerical values to test impact and likelihood. The quantitative techniques are further divided into point estimate or deterministic approaches and stochastic or probabilistic approaches. The deterministic approaches include risk-adjusted discount rate (RADR), sliced income approach, certainty equivalent cash flow and sensitivity analysis. The probabilistic approaches are scenario technique, decision tree procedure, Monte Carlo simulation, standard deviation and modern portfolio theory. The above listed approaches are by no means exhaustive. The deterministic or single point estimate approaches have some elements of subjectivity in them and are not considered appropriate. The probabilistic models are most suitable in handling property investment risks as they do so explicitly and objectively using probability distribution. Both deterministic and probabilistic approaches to risk analysis have their strengths and weaknesses. In some cases, the weaknesses could be reasonably surmounted.

Findings from survey indicate that only forty per cent of Estate Surveying and Valuation Firms apply quantitative risk analysis technique in property investment analysis. This clearly show that real estate practitioners in the study area do not factor in quantitative risk analysis in viability appraisal of property investment notwithstanding the highly volatile business environment and the painfully varied risks associated with real estate investment. This is not the case in some developed climes. According to Ogunba (2004), there is a wide disparity in the balance of teaching and practice of risk analysis between developed and developing countries.

Result shows that among Firms that apply risk analysis techniques, over eighty per cent adopt

individual subjective assessment, sixty per cent and thirty-six per cent apply sensitivity analysis and RADR respectively. Studies by Ogunba (2004); Otegbulu, Mohammed and Babawale (2011); Ibiyemi and Tella (2013); confirms that most real estate practitioners adopt subjective judgement in risk analysis for property investment/development purpose. Also survey conducted in Europe by Akintoye and MacLeod (1997) and GeiBner and Wiegelmann (2012) show that stakeholders in property investment industries depend mainly on intuition, judgement and experience. According to Akintoye and MacLeod (1997), this approach cannot be regarded as a formal technique. This finding supports Daniel Kahreman postulation. In 2002 he won the Nobel Prize in Economics for integrating insights from psychological research into economic science, especially as it concerns human judgement and decision-making under uncertainty. According to this theory, fundamental limitations in human mental processes cause people to employ various simplifying strategies or heuristics to ease the burden of mentally processing the information required to make judgements and decisions. Other formal techniques adopted by the Firms are sensitivity analysis and RADR. This finding also support the works of Akintoye and MacLeod (1997), Ibiyemi and Tella (2013) and GeiBner and Wiegelmann (2012). Sensitivity analysis and RADR are deterministic and subjective, though practical and less cumbersome to apply; they are not suitable for robust quantitative risk analysis. Greer and Kolbe (2003) refers to them as traditional techniques that fail to generate a risk measure different from the appraiser's personal viewpoint regarding risk and therefore are not amenable to exact communication of risk perception. This indicates that Firms do not analyse risks explicitly and objectively leading to investment failures. Other deterministic techniques sparingly used by the Firms are sliced income approach and certainty equivalent cashflow.

The survey shows that scenario analysis, decision tree procedure, Monte Carlo simulation, standard deviation and modern portfolio theory are not used by the Firms. These are probabilistic techniques and are sometimes referred to as contemporary risk measures. Probabilistic approaches to risk analysis do not only estimate expected (mean/average) value but also gives a sense of the range of possible outcomes for values across good and bad scenarios using probability distribution. Ogunba (2002) established that estate surveyors adjust for pre-development risk using rudimentary adjustments of volatile variables rather than probabilistic procedure. Otegbulu, Mohammed and Babawale (2011) posit that real

estate professionals are not applying advanced and quantitative techniques in their assessment and the implication of this on real estate investment is that decision could be disastrous and may result in property market collapse and investment loss.

### **Conclusion and Recommendation**

Property investment is one of the most challenging amongst other businesses. Unfortunately, the industry has a very poor reputation for managing risk, with many investment projects failing and some performing below expectation or not performing at all. The changing conditions in the real estate investment market such as change in the security of income flow, increasing complexity and volatility, and increasing sophistication of investors, etc. have made the market more volatile and risky. These vagaries in the business environment provide the incentive and the impetus for valuers to take cognizance of the importance of risk analysis in property investment appraisal.

The quantitative description of risk in practical sense entails the use of frequency or probability. The importance of probabilistic approach to risk analysis cannot be overstressed. With the adoption of probabilistic methods in risk assessment, not only that an expected value (mean/average) is estimated, but also a picture of the range of possible outcomes for values across different scenarios is achieved. The firms do not adopt probabilistic methods of risk assessment. The study has revealed that most Estate Surveying and Valuation Firms in Enugu urban are not aware of risk analysis techniques in property investment decision-making; the few that does, adopt mostly sensitivity analysis and RADR techniques. These techniques are subjective in nature. Subjective risk assessment in decision-making is grossly inadequate considering the ever changing and highly volatile business environment and more importantly the peculiar nature of property investment.

The study hereby recommends that further study should be conducted in order to assess the factors that limit the application of quantitative risk assessment in property investment appraisal.

### **Acknowledgement**

The author acknowledges and deeply appreciates the Nigerian Tertiary Education Trust Fund (TETFund), for funding this study through the institution-based research (IBR) fund intervention.

## References

- Adair, A. and Hutchison, N. (2005). The reporting of risk in real estate appraisal property risk scoring. *Journal of Property Investment & Finance*, 23(3), 254-268. Retrieved August 13, 2015, from <http://dx.doi.org/10.1108/14635780510599467>
- Ajayi, C.A. (1998). *Property investment valuation and analysis*. Ibadan: De Ayo Publications.
- An, M. Y. and Qi, Z. (2012). Competing risks models using mortgage duration data under the proportional hazards assumption. *Journal of Real Estate Research*, 34(1), 1-26.
- Babawale, G. K. (2007). Risk analysis in property investment using Monte Carlo simulation technique. *Journal of Land Use and Development Studies*, 3(1), pp. 35-49.
- Bannerman, S. (1993). Sensitivity analysis for property appraisal. *Journal of Property Valuation and Investment*, 11(3), 248-256. Retrieved July 2015, from <http://dx.doi.org/10.1108/EUM0000000003306>
- Baum, A. (1987). Risk-explicit appraisal: a sliced income approach. *Journal of Valuation*, 5(3), pp.250-267. Retrieved November 8, 2015, from <http://dx.doi.org/10.1108/eb008011>.
- Baum, A. and Crosby, N. (1988). *Property investment appraisal*. London: Routledge.
- Baum, A., Nunnington, N. and Mackmin, D. (2006). *The income approach to property valuation* (6<sup>th</sup> ed.). London: Estate Gazette.
- Brown, G. R. and Schuck, E. J. (1996). Optimal portfolio allocations to real estate. *Journal of Real Estate Portfolio Management*, 2(2), pp. 63-73.
- Buck, K and Truck, S. (2011). Assessing uncertainty and risk in public sector investment projects. *Technology and Investment*, 2, 105-123. Retrieved January 15, 2015, from <http://www.scirp.org/journal/PaperDownload.aspx?paperID=5167>
- Burja, C. and Burja, V. (2009). The risks analysis for investments projects decision. *Annals Universitatis Apulensis Series Oeconomica*, 11(1), 98-105. Retrieved February 23, 2015, from <http://www.oeconomica.uabi.ro/upload/lucrari/1120091/09.pdf>
- Byrne, P. and Cadman, D. (1984). *Risk, uncertainty and decision-making in property development*. London: E. & F. N. Spon Ltd.
- COSO (2004) *Enterprise risk management – integrated framework: executive summary*. Durham: Committee of Sponsoring Organisations of the Treadway Commission (COSO).
- COSO (2012). *Risk assessment in practice*. Durham: Committee of Sponsoring Organisations of the Treadway Commission (COSO).
- Crudden, M. (2012). A discussion of the Monte Carlo technique applied to commercial property: examining risk in perspective. *Public Infrastructure Bulletin*, 1(8), 1-10. Retrieved October 7, 2015, from <http://www.epublications.bond.edu.au/cgi/viewcontent.cgi?article=1048&content>
- Damodaran, A. (2008). *Strategic risk taking: a framework for risk management*. New Jersey: Wharton School Publishing.
- Enever, N. and Isaac, D. (2002). *The valuations of property investments* (6<sup>th</sup> ed.). London: Estate Gazette.
- Evans, J. L. (2004) Wealthy investor attitudes, expectations, and behaviors toward risk and return. *The Journal of Wealth Management*, 7 (1), 12-18.
- Farragher, E. J. and Savage, A. (2008). An investigation of real estate investment decision-making practices. *Journal of Real Estate Practice Education*, 11(1), pp. 29-40.
- Fisher, I. (1930). *The theory of interest - as determined by impatience to spend income and opportunity to invest it*. New York: The Macmillan Co.
- Gehner, E., Halman, J. I. M., and de Jonge, H. (2006) 'Risk management in Dutch real estate development sector: a survey', The 6<sup>th</sup> International Postgraduate Research Conference in the Built and Human Environment. University of Salford.
- Greer, G.E. (1979). *The real estate investment decision*. Baltimore: Lexington Books.
- GeiBner, W. and Wiegelman, T. (2012). Quantitative methods for risk management in real estate development industry. *Journal of Property Investment & Finance*, 30(6), 612-630. Retrieved August 12, 2015, from [http://www.researchgate.net/.../280169655\\_Quantitative\\_methods\\_for\\_risk\\_management\\_real\\_estate\\_development\\_industry/](http://www.researchgate.net/.../280169655_Quantitative_methods_for_risk_management_real_estate_development_industry/)
- Hargitay, S. E. and Yu, S. (1993). *Property investment decisions*. London: E & FN Spon Ltd.
- Hishamuddin, A. H. (2006). Modern portfolio theory: is there any opportunity for real estate portfolio? *Malaysian Journal of Real Estate*, 1(1), 14-26. Retrieved March 2, 2016 from [https://www.researchgate.net/.../48267844\\_Modern\\_Portfolio\\_Theory\\_Is...](https://www.researchgate.net/.../48267844_Modern_Portfolio_Theory_Is...)
- Ibiyemi, A and Tella, E. (2013). Critical issues in economic risk consideration by commercial property investors and valuers in Nigeria: The case of Lagos. *International Journal of*

- Emerging Science and Engineering, 1(12), 35-43.
- Iyiola, O., Munirat, Y. and Nwufo, C. (2012). The modern portfolio theory as an investment decision tool. *Journal of Accounting and Taxation*, 4(2), 19-28. Retrieved March 29, 2016 from <http://www.academicjournals.org/JAT>
- Jackson, J. (2009). How risky are sustainable real estate projects? An evaluation of leed and energy star development options. *Journal of Sustainable Real Estate*, 1(1), pp. 91-106.
- Johnson, R., Lizieri, C. M., Soenen, L. and Worzala, E. M. (2006). Simulating currency risk on private investments in real estate. *Journal of Real Estate Portfolio Management*, 12(9), pp. 91-102
- Jovanovic, P. (1999). Application of sensitivity analysis in investment project evaluation under uncertainty and risk. *International Journal of Project Management*, 17(4), 217-222. Retrieved December 4, 2014, from <http://www.sciencedirect.com/science/article/pii/S0263786398000350>
- Kalu, I. U. (2001). *Property valuation and appraisal*. Owerri: Bon Publications.
- Kelliher, C. F. and Mahoney, L. S. (2000). Using Monte Carlo simulation to improve long-term investment decisions. *The Appraisal Journal*, 68(1), pp. 44-56.
- Loizou, P. and French, N. (2012). Risk and uncertainty in development: a critical evaluation of using the Monte Carlo simulation method as a decision tool in real estate development projects. *Journal of Property Investment & Finance*, 30(1), 198-210. Retrieved August 13, 2015 from <http://dx.doi.org/10.1108/14635781211206922>
- MacFarlane, J. (1995). The use of simulation in property investment analysis. *Journal of Property Valuation and Investment*, 13(4), 25-38. Retrieved July 6, 2015, from <http://dx.doi.org/10.1108/14635789510099427>
- MacGregor, B. D. (1990). Risk and return: constructing a property portfolio. *Journal of Valuation*, 8(3), pp. 233-242.
- Mao, J. C. T. (1970). Survey of capital budgeting: theory and practice. *Journal of Finance*, 25(2), 349-360.
- McIntosh, A. P. J. and Sykes, S. G. (1985). *A guide to institutional property investment*. London: MacMillan Publishers Ltd.
- Mietzner, D. and Reger, G. (2005). Advantages and disadvantages of scenario approaches for strategic foresight. *Int. J. Technology Intelligence and Planning*, 1(2), 220-239.
- Mueller, G. R. and Laposo, S. P. (1995). Property type diversification in real estate portfolios: a size and return perspective. *Journal of Real Estate Portfolio Management*, 1(1), 39-50.
- Ogbuefi, J. U. (2002). *Aspects of feasibility and viability studies*. Enugu: Institute of Development Studies, University of Nigeria.
- Ogunba, O. A. (2002). Pre-development appraisal and risk adjustment techniques in Southwestern Nigeria. Unpublished PhD thesis, Obafemi Awolowo University, Ile-Ife, Nigeria.
- Otegbulu, A. C., Mohammed, M. I. and Babawale, G. K. (2011). Survey on risk assessment techniques applied in real estate development project in Nigeria (*A case study of Federal Capital Territory, Abuja*). *Journal of Contemporary Issues in Real Estate*, 1(1), 189-202.
- Pfnur, A. and Armonat, S. (2013). Modelling uncertain operational cash flows of real estate investments using simulations of stochastic processes. *Journal of Property Investment & Finance*, 31(5), pp. 481-501. Retrieved August 20, 2015 from <http://dx.doi.org/10.1108/JPIF-12-2012-0061>
- Pyhrr, S. A. (1973). A computer simulation model to measure risk in real estate investment. *Journal of American Real Estate and Urban Economics Association*, 1(1), pp. 48-78.
- Ratcliffe, J. (2000). Scenario building: a suitable method for strategic property planning? *Property Management*, 18(2), 127-144.
- Raychaudhuri, S. (2008). Introduction to Monte Carlo simulation. Proceedings of the 2008 Winter Simulation Conference Miami, Florida. Retrieved October 7, 2015 from <http://www.informs-sim.org/wsc08papers/012pdf>
- RICS (2010). Discounted cash flow for commercial property investment. RICS Guidance Note. London: Royal Institution of Chartered Surveyors (RICS).
- Saltelli, A. (1999). Sensitivity analysis: Could better methods be used? *Journal of Geophysical Research*, 104(D3), 3789-3793.
- Savvides, S. C. (1994). Risk analysis in investment appraisal. *Project Appraisal*, 9(1), 3-18.
- Sayce, S., Smith, J., Cooper, R. and Venmore-Rowland, P. (2006). *Real Estate Appraisal: from Value to Worth*. Oxford: Blackwell Publishers.

- Schoemaker, P. (1993). Determinants of risk-taking: behavioral and economic views. *Journal of Management Studies*, 30(1), pp. 107-129. Retrieved October 19, 2015 from [https://www.researchgate.net/publication/5152565\\_Determinants\\_of\\_Risk\\_Taking\\_Behavioral\\_and\\_Economic\\_Views](https://www.researchgate.net/publication/5152565_Determinants_of_Risk_Taking_Behavioral_and_Economic_Views)
- Sykes, G. (1983). The assessment of property investment risk. *Journal of Valuation*, 1(3), 253-267. Retrieved November 8, 2015, from <http://dx.doi.org/10.1108/eb007935>
- Umeh, J. A. (1977). *Feasibility and viability appraisal*. Ibadan: Onibonoje Publishers.
- Van der Spek, M. R. and Hoorenman, C. (2011). Leverage: please use responsibly. *Journal of Real Estate Portfolio Management*, 17(2), 75-88.
- Viezer, T. W. (2010). The application of modern portfolio theory in real estate in Guerard, J. B. J. (Ed.). *Handbook of Portfolio Construction*. US: Springer
- Webb, J. R. (1984). Real estate investment acquisition rules for life insurance companies and pension funds: a survey. *AREUEA Journal*, 12(4), 495-520.
- Wiegelmann, T. W. (2012) *Risk management in the real estate development industry: investigations into the application of risk management concepts in leading European real estate development organisations*. PhD thesis. Bond University, Australia.
- Young, M. S. and Grieg, D. W. (1993). Drums along the efficient frontier. *Real Estate Review*, 22(4), 18-29.
- Young, M.S. (1977). Evaluating the risk of investment real estate. *The Real Estate Appraiser*, September/October, 39-45.