Is there Value in Waiting? An Empirical Study of Real Options Application to Australian Property Developments

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and ethics procedures and guidelines have been followed.

I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

Kwabena Mintah

29th January 2019.
Dedication

I dedicate this dissertation to my mother, Grace Mensah and my two Aunts, Akosua Tiwaa, Abena Konadu of blessed memory and my dear wife, Betty Norah Agyemang. How I wish…
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## Abbreviations

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<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<td>API</td>
<td>Australian Property Institute</td>
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<tr>
<td>ARCH</td>
<td>Autoregressive Conditional Heteroscedasticity</td>
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<td>AUD</td>
<td>Australian Dollars</td>
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<tr>
<td>BOPM</td>
<td>Binomial Option Pricing Method</td>
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<tr>
<td>B-S</td>
<td>Black-Scholes Formula</td>
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<tr>
<td>CBD</td>
<td>Central Business District</td>
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<tr>
<td>CE-BOPM</td>
<td>Certainty Equivalence of the Binomial Option Pricing Method</td>
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<tr>
<td>CPI&lt;sub&gt;a&lt;/sub&gt;</td>
<td>Construction Price Index</td>
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<td>CPI</td>
<td>Consumer Price Index</td>
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<td>DAVI</td>
<td>Development Asset Value Index</td>
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<td>DCF</td>
<td>Discounted Cash Flow technique</td>
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<td>FPOM</td>
<td>Fuzzy Pay-Off Method</td>
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<tr>
<td>GARCH</td>
<td>Generalised Autoregressive Conditional Heteroscedasticity</td>
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<tr>
<td>GBM</td>
<td>Geometric Brownian Motion</td>
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<tr>
<td>GFC</td>
<td>Global Financial Crisis</td>
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<td>GLA</td>
<td>Gross Lettable Area</td>
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<tr>
<td>IPD/PCA</td>
<td>Investment Property Databank/Property Council of Australia</td>
</tr>
<tr>
<td>IRR</td>
<td>Internal Rate of Return</td>
</tr>
<tr>
<td>IVSC</td>
<td>International Valuation Standards Council</td>
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<tr>
<td>JLL</td>
<td>Jones Lang Lasalle</td>
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<tr>
<td>MAD</td>
<td>Market Asset Disclaimer</td>
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<tr>
<td>NLA</td>
<td>Net Lettable Area</td>
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<tr>
<td>NOI</td>
<td>Net Operating Income</td>
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<tr>
<td>NPV</td>
<td>Net Present Value</td>
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<tr>
<td>NatHERS</td>
<td>Nationwide House Energy Rating Scheme</td>
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<td>OPT</td>
<td>Options Pricing Theory</td>
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<td>PAPI</td>
<td>Property Asset Price Index</td>
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<tr>
<td>PDE</td>
<td>Partial Differential Equation</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>PGI</td>
<td>Potential Gross Income</td>
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<td>PIR</td>
<td>Property Investment Research</td>
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<td>PV</td>
<td>Present Value</td>
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<td>QUAN/quan</td>
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<td>QUAL/qual</td>
<td>Qualitative</td>
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<tr>
<td>REIT</td>
<td>Real Estate Investment Trust</td>
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<td>RBA</td>
<td>Reserve Bank of Australia</td>
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<td>RLB</td>
<td>Rider Levett Bucknall</td>
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<td>RICS</td>
<td>Royal Institution of Chartered Surveyors</td>
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<td>RO</td>
<td>Real Option</td>
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<td>ROA</td>
<td>Real Options Analysis</td>
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<td>ROV</td>
<td>Real Options Valuation</td>
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<td>SSA</td>
<td>Student Studio Accommodation</td>
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Abstract

“Real options are toehold investments designed to better prepare the investor to meet uncertain events in the future” (McGrath, 1997).

Property development is inherently uncertain. As a result, prognosis of the performance of any property development market is fraught with uncertainties which can cause serious financial consequences for property developers. Australian property developers consistently struggle with uncertainties attached to decision making regarding property development projects because of the inevitable boom and bust periods. As a result, property development projects are initiated based on uncertain outcomes. The situation is compounded using the discounted cash flow technique (DCF) which adopts adjustment to discount rates to reflect uncertainties in financial feasibility evaluation. Similarly, its inability to incorporate a broad range of values for dealing with uncertainties in development feasibility evaluation affects property decision making under uncertainty conditions and has been criticized severely. Thus, DCF relies on uncertain inputs to derive outcomes. Despite its numerous shortcomings, DCF is still a popular method for evaluating financial feasibility of property development projects in Australia.

Real options; a theory developed to incorporate flexibility in decision making for dealing with uncertainties in evaluating capital intensive projects has been used in industries such as mining, oil and gas, pharmaceuticals, research and development and now, Australian residential property development. Real options can provide solution to investments under uncertainty, particularly, relating to capital intensive projects. Despite the potential of real options, the theory has not been widely adopted for decision-making by practitioners in determining financial feasibility of Australian residential property development projects. Literature shows that the slow adoption is due to factors including lack of empirical support for real options through practical applications. Furthermore, practitioners, especially those operating in Australian property developments (long term investors, valuers, developers etc.) are yet to fully understand how to value embedded flexibility. Beyond empirical support, countries where selected case studies have used real options for evaluating financial feasibility of projects also lack wide practical adoption. This suggests the possibility of other reasons behind the slow adoption. It must be stated that real options and flexibility, for the purposes of this dissertation are used interchangeably.
The focus of this dissertation is to examine the empirical support for real options through valuation of flexibility using selected real options valuation models, identify risk management strategies from flexibility and investigate requirements for potential integration of real options theory and valuation in practical property development decision making. The overall aim of this dissertation is to deliver evidence that supports the adoption of real options theory in practice, which can then drive adoption in property development decision making in Australia.

The dissertation adopted a mixed method (quantitative and qualitative) approach with embedded case studies. Firstly, case studies were selected based on gaps in literature using theoretical sampling. Similarly, the risk management characteristics of real options theory through flexibility was explored using the case studies, visualized in a conceptual model and validated by practitioners during the second phase of the research. The second phase adopted semi-structured interviews for data collection, which was analyzed using thematic analysis.

In conceptualizing flexibility in property development, results indicated that there are several flexibilities embedded at different stages of the property development process. These options are either naturally embedded or require a property developer to invest in creating such flexibilities. It is argued that real options in property development can be classified into four categories depending on where they are embedded in the property development process. For example, initiation of a project, design, construction and after completion. Selected real options models that could be used for evaluating the value attached to flexibilities were explored to deepen practitioners’ understanding for potential adoption in practice. Based on the conceptual model, a risk management tool for mitigating risks throughout an entire property development project was developed and validated by practitioners.

Findings from the application of real option models for evaluating financial feasibility of selected residential property development projects embedded with specific types of flexibilities delivered evidence in support of real options as opposed to discounted cash flow techniques. Three case studies embedded with different types of flexibilities; a large-scale residential project including medium rise buildings and two high rise residential projects embedded with:

- Staging-executing a capital project in stages;
- Delaying-postponing the start of a project to a later date;
- Switching options-changing the use of a project respectively.
Results from the staging option application (base and worst cases) revealed that real options valuation was able to capture approximately 11.4% and 2.7% respectively, of profitability through flexibility missed by the DCF technique. Similarly, results from the delay option indicated to the developer that deferring the start of an unviable project until a later date when uncertainties are resolved can have a positive impact on profitability. The final case study involved a switching option application. The original idea of a mixed-use project was profitable under both DCF and real option valuations albeit better results from the options valuation. For example, whereas the IRR was 12.95% for the switching flexibility, the original design had 11.5%. The potential payoff from the switching output flexibility as opposed to the original idea was found to represent 7.2% of the undiscounted cost of the project including extra investment required to embed the flexibility.

The second phase of the dissertation examined how property developers deal with known and unknown risks, factors required for integrating real options valuation into practical property development decision-making, how long-term investors perceive real options/flexibility and potential barriers to adoption. Findings revealed that contrary to suggestions in property literature that practitioners set discount rate based on potential risks, contingency is rather used to deal with risks in property development. Requirements for integrating real options in practical property decision-making include education and training of practitioners, highlighting the benefits of real options theory over existing property valuation models and involvement of stakeholders. On the contrary, certain factors that could pose as hindrances to the adoption of real option in practice were identified as a vicious cycle of blame, planning related issues, financing and design obsolescence of embedded flexibility.
Chapter 1 Introduction

1.1 Background to the Dissertation

“The DCF model is not only incomplete, but its use may lead to costly errors. Investors must decide when to invest, how to modify operating plans during the life of the project, and when to sell the investment. Existing research shows that the conventional DCF techniques can be poorly suited for investment valuation in the presence of "real options" (Sirmans, 1997).

In the 21st century, flexibility has become an important consideration across all economic sectors due to the pace at which changes occur and the direct impact on businesses. In the property and construction sector, these changes can have serious financial consequences due to long investment horizons, the difficulty and cost associated with retrofitting existing buildings to suit the changing needs of occupiers if such changes are an afterthought and not incorporated in building designs from inception of the property development project. As a result, future flexibility in buildings has become an important issue in property development and investment. This is heightened for major developers (for example, property fund managers, pension funds-investing through property funds specifically for property development, real estate investment trusts, real estate development and operating companies etc.) who instigate developments with the aim of either selling the properties, holding them as part of an existing portfolio to increase possible returns and provide access to quality property assets or offer a development revenue stream.

In Australia, some developers including ISPT, Frasers Property and Oliver Hume Developers have all set up real estate investment funds for clients to access exposure to residential property developments. Some of these companies set up the funds for developing residential units for sale and might not necessarily hold the assets after completion. Even though investments in residential properties offer diversification benefits in a mixed asset portfolio (see Cocco (2004), Goetzmann (1993), Goodman (2003), Lin Lee (2008)), the risks inherent in property development/investment cannot be overlooked. Risks including those that emanate from planning, through to construction and operational risks during the leasing phase after completion. The situation is similar for property developers who are into trading and do not primarily hold onto completed residential developments as a portfolio (though market forces may sometimes necessitate holding), as changes in the economic environment during the process of property development can lead to poor financial performance.
Due to complexity and the long term nature of property developments, property developers face considerable uncertainty in their property development activities. Loizou and French (2012) indicated that uncertainties and risks in property development include land cost, cost of financing, construction, timing of development, income revenue and other socioeconomic factors. It can be argued that uncertainty associated with the revenue generated through either sale, leasing and capital growth is the most critical as it has a direct impact on the profitability of investments, especially for residential property developers who have a defined investment horizon (normally between 3-5 years and then sell off completed developments). In view of uncertainties and risks in property developments, profit maximisation often requires a long-term strategy in the form of design flexibility in both the delivery and structure. Structural flexibility is where buildings can adapt to different uses to suit changing needs of occupiers in changing market conditions. Flexibility in building design and construction focusses on aiding property developers to have the possibility to alter their property development delivery strategy in response to changing market conditions. The cyclicality of the property market is inevitable. As a result, Peiser and David (2012) argued that it is important for property developers to retain flexibility to both increase and decrease the production of units and installation of infrastructure and change the mix of units depending on market conditions.

Despite the potential of building flexibility to enhance uncertainty and risk assessment, high rise residential property developers operating in the Australian property development market are still grappling with risks and uncertainties because of the use of traditional valuation methods for feasibility analysis. Financial feasibility evaluation is vital in any residential property development activity, because without an appropriate numerical measure of the potential future payoff from a proposed development, rational developers and investors are assumed not to commit to property development projects. Practitioners in the Australian residential property development market employ several techniques in determining the financial viability of proposed property developments.

Shapiro et al. (2013) indicated that in practice, the most widely accepted method of financial feasibility evaluation is the discounted cash flow technique (DCF). DCF uses two main measures of profitability; net present value (NPV) and internal rate of return (IRR). Classical economic theory states that if the NPV of an investment (development) is positive, a risk-neutral firm will choose to develop (Cunningham, 2006). Since NPV is derived from future cash flows based on forecasts, it is susceptible to changes due to the potential impact of uncertainties and risks from the economic and business environment (Leung & Hui, 2002).
Furthermore, Hayes and Abernathy (1980) and Hodder and Riggs (1985) have questioned the inability of the DCF technique to analyse and incorporate values attached to strategic flexibilities (real options (RO)) in financial evaluation of property development projects. Myers (1984) argued that the most problematic issue with DCF is its failure to account for time-series linked investments (e.g. strategic investments) which are often growth opportunities (options/flexibilities). That is DCF technique cannot properly evaluate flexibility because it is a right, not an obligation. Therefore, the valuation of flexibility is contingent upon a specific situation occurring in the business environment rather than having a deterministic value as suggested by DCF.

Due to these uncertainties and the inability of DCF to incorporate the value of flexibilities into financial feasibility evaluation of property development projects, Luehrman (1998) proposed that a better valuation approach is one that would incorporate both uncertainty and decision-making required for a property project to succeed. Flexibility in buildings (both in design process delivery and structure) that serves as strategic rights for risk mitigation and for capitalising on emerging opportunities can be termed as real options. The term “real options” was coined by Stewart Myers in 1977 because of the application of options pricing techniques (OPT) to real assets (real estate, infrastructure etc). Therefore, real options theory has its roots in financial options and gained popularity after the seminal work of Black-Scholes (Black & Scholes, 1973), extended by Merton (1976). Myers (1977) referred RO to the adaption and application of OPT in finance to the valuation of investments in non-financial or “real” physical assets where much of the value of an asset is attributable to flexibility (managerial flexibility in decision making). Copeland and Antikarov (2001) suggested that when a property developer has the right but not the obligation to exercise such a right to defer, expand, switch, abandon, or temporarily shut down until its expiration date, there is an embedded option/flexibility. As a result, an entire property development project can be considered as a series of flexibilities at different stages of the property development process.

The logic behind such an application to the property sector is that investments in real assets (property) gives a firm or developer the right but not the obligation to a stream of future cash flows which are discounted to present value to determine the viability of proposed investments (Baldi, 2013). A similar logic is applicable in residential property development projects where a developer has the right but not the obligation to commence development or defer until such a time imposed by either planning permission or contractual obligations. Furthermore, in financial options, the future value of an asset is calculated from a range of
figures to capture all possible future payoffs due to uncertainties. A similar range of values can be generated for the determination of future property values and a single numerical figure calculated to represent the possible future payoff for a residential development for decision-making. As the decision to execute a project in residential property development is based on the single numerical figure (Vimpari & Junnila, 2014a) that represents the possible future payoff from developments, the use of a range of values (distribution) can capture all future possibilities, hence accounting for uncertainties much better than single point estimates of DCF. French (2011) and Byrne and Cadman (1984) have suggested that dealing with uncertainties in the property sector requires the use of a range of property values to calculate the single numerical information required for decision-making.

Hoesli et al. (2006) adopted Monte Carlo simulation which uses a range of values (distribution) to capture uncertainties in valuation. Atherton et al. (2008) also used Monte Carlo simulation but in the evaluation of a specific property development case study and discussed that significant improvements can be made to normative models when a range of values (distribution) is used in evaluating the profitability potential of property developments. Their conclusion was that in dealing with uncertainties, analysts must conduct a deeper analysis of uncertain variables in a valuation model to develop a better understanding of the implications of uncertainties in decision-making in property developments.

Myers (1984) argued that real options theory could be used to complement DCF valuation as an attempt to link together financial and strategic managerial decision analysis. Thus, real options has been developed and devoted to complement DCF analysis, particularly in the valuation of projects that are irreversible under conditions of uncertainty. Kester (1984) after examining the growth opportunities using real options framework, summarised that options “integrates capital budgeting with long-range planning”. McDonald and Siegel (1986), McDonald and Siegel (1985) suggest that if the future is uncertain and an investment is durable and illiquid such as property, the ability to pursue a different investment or not to invest at all in the future has an economic value. Sattarnusart (2012) concludes that the use of only DCF biases the results of financial feasibility but a combination with real options enhance decision making. Furthermore, real options analysis (ROA) enhances uncertainty assessment and real options valuation (ROV) evaluates managerial flexibility and models potential future opportunities to enhance strategic decision making in property and construction projects. Managerial flexibility arising from real options embedded in property developments enable firms to alter (e.g. expand, contract, defer) future actions in response to
the arrival of new information. In summary, real options theory has been developed to enhance evaluation of financial feasibility of property developments that are inherently uncertain.

1.2 Problem Statement

Uncertainties that exist in residential property developments pose considerable risks to developers in the form of unfavourable changes in economic conditions. One strategy adopted by residential property developers engaged in land banking in Australia against future unfavourable outcomes due to uncertainties, is the use of presales before commencement of construction. Some residential developers (particularly developer-traders) primarily, use presales as a risk management tool to mitigate potential downside risks from uncertainties because they have not accepted the idea that uncertainties can have positive impact on profitability, consequently, flexible strategies are not built into developments. Though presales are important in risk mitigation for developers in the event of default in settlement through deposit retention, it can cause loss of future revenue to developers if residential property prices rise in future albeit locked in contracts, because upside opportunity is lost through contractual obligations. It is therefore argued that there are other opportunities that are embedded in flexibility (real option) which developers could capitalise on during development. In view of this, residential property developers require flexible strategies that can deal with uncertainties better.

In practice, property development process is infinitely flexible and cannot be static or prescribed; circumstances alter cases depending on context (Fisher & Collins, 1999). Managing uncertainties in residential property developments require active decision making in the form of inherent strategic alternative decisions that can serve as both a hedge against future unfavourable outcomes and at the same time enable property developers to capitalise on emerging opportunities when market conditions are favourable. The value of these strategic flexible future decision rights is generally tied to uncertainty and the ability of developers to flexibly respond to changes in economic conditions during the execution of projects.

a distinction between real options “in” projects and real options “on” projects. However, Wang and de Neufville (2005) indicated that both options “in” projects and options “on” projects define the basic unit of flexibility and offers important insights into flexibility in physical systems such as those that may be deployed in residential property development. It must be stated that real options and flexibility, for the purposes of this dissertation are used interchangeably.

The valuation of flexibility or real options existing in residential property developments is not as straightforward as determining the cost. The reason is current valuation methods including the widely accepted DCF is incapable of incorporating the stochastic process through which asset values change. Besides, the value of flexibility is intrinsically embedded in tomorrow’s opportunities based on uncertainties (Myers, 1984). Trigeorgis (1993a) indicated that any attempt to ignore changes in input variables because of uncertainties or use DCF to evaluate tomorrow’s opportunities from flexibility leads to serious errors.

Unexpectedly, residential property developers, practitioners and stakeholders in the Australian residential property development market are still applying DCF technique to evaluate the financial viability of development projects despite its inability to capture flexibilities and deal with uncertainties. For example, in Australia, according to KPMG (2017), DCF continues to be the most widely used method for valuation. In addition, other alternative measures such as return on investment and development yield are also used in practice (Roumboutsos et al., 2013). This means that the valuation of, and justification for investment in flexibility is hampered in practice using DCF because it is incapable of evaluating the values attached to flexibility or real options. Gehner (2008) postulates that flexibility requires extra investment, but property developers do not know how these extra investments in flexibility will be valued. Therefore, there is the need for justification of investments in flexibility because flexibility requires initial extra investment to retain the right to capitalise on emerging opportunities.

Despite the potential of ROA and ROV in evaluating values attached to flexibilities in capital intensive projects under conditions of uncertainty, the theory lacks practical adoption. Practitioners have been slow in adopting the method. Kogut and Kulatilaka (2001) suggested that firms have not embraced the idea that organisations can proactively exploit risk and uncertainty rather than absorbing it through the risk adjusted discount rate. Teach (2003) found only 9% of respondents from 30 industries were using real option theory in decision
making. Recently, Bennouna et al. (2010) also found that only 8% of respondents from a list of 88 large firms in the US are using real options theory in practical decision making.

Principally among the reasons given was the inadequacy of evidence supporting its practical application and effectiveness in different contexts, sophistication and difficulty of ROV models for determining values of flexibility embedded in capital intensive projects (de Neufville & Scholtes, 2011, Lander & Pinches, 1998, Oppenheimer, 2002). Leading authors including Geltner and de Neufville (2012) and Vimpari (2014) have suggested the need for further evidence of the ROV applications in practice using empirical data. de Neufville and Scholtes (2011) indicated that ROV models demonstrate promise in the evaluation of flexibility but they have not been extensively tested in real applications using empirical data. Therefore, further evidence is needed by testing the practical application of ROV to different case studies using empirical data to expand the breadth of enquiry of real options theory. Literature suggests that ROA is capable of enhancing risk assessment in property developments better than risk adjusted discount rates of DCF (Vimpari, 2014). However, studies on how the method actually enhances risk assessment is limited. Furthermore, some case studies have been conducted in other parts of the world including USA, UK and Finland. However, ROA is yet to be embraced by the property industry in these countries. This is an indication that case studies alone as demonstration may not be enough to achieve practical adoption. Could there be other factors required before practical adoption may be achieved beyond practical application?

1.3 Scope of the Dissertation

The scope of this dissertation covers the research questions and objectives, selected case studies and the study area under consideration. Therefore, any information not regarded as contributing to the dissertation is excluded. In view of this, the study area chosen is the Australian residential property development market. As a result, the case studies were chosen from the Australian residential property market with associated data. Predominantly, proposed property developments are initiated, executed and managed by major property firms. Therefore, quantitative data on the selected cases are sourced from residential property developers operating in the Australian residential property development market. Their identity is not disclosed due to confidentiality, but they are recognised leading Australian property developers.
The data was in the form of projected cash flows, required rates of return, project duration and the estimated costs of selected development projects necessary for financial feasibility evaluation of property developments. Other forms of data including volatility of residential property returns were estimated from historical data of property returns sourced from organisations including Core Logic RP Data, IPD Australia, Property Council of Australia, Reserve Bank of Australia (RBA) and Australian Bureau of Statistics. Information from reports published by leading property operating companies such as JLL, Savills, Urbis and a host of others were also used in the dissertation. Moreover, the selected case studies focused on high rise residential developments, large scale infill high rise residential property development and purpose-built student accommodation developments. This covers one of the major sub-sectors in the larger property development context in Australia. Even though the focus is limited to high rise residential property developments, the adopted unit of analysis encapsulates different types of property developers thereby covering a broad spectrum of development stakeholders. Since the data is sourced from third party organisations that are deemed credible, no attempt was made on the part of the researcher to verify the data. The researcher relies on the credibility of these institutions and believe the data supplied is accurate and well suited for the dissertation.

Residential development is one of the major sectors in the property development market in Australia. As a result, the outcome of the dissertation can have far reaching impacts in the property industry. There are three cases selected for the dissertation; the first two focus on examining the financial feasibility of residential development projects using ROV models from the perspective of developer-traders. The last case study uses investor-developers as the unit of analysis. It was important to demonstrate the application of ROV models to projects initiated by an investor-developer because the value of flexibility can only be realised after completion of a development. Examining the case studies from these two main perspectives ensured that the larger spectrum of stakeholders in the Australian residential property development market benefit from the findings of the dissertation. In addition, since ROA enhances risks and uncertainty assessments, the findings of the dissertation will benefit high rise residential property developers, property advisors, valuers and other stakeholders in the property industry in risk management.
1.4 Research Questions

Flexibility in process design delivery of projects is important because of uncertainties. The models developed for the appraisal of values attached to flexibility are yet to be accepted by the property industry due to inadequacy of evidence supporting its practical application and effectiveness in different contexts. Besides, the researcher is of the view that the property sector would also greatly benefit if property developers invest in embedded flexibilities for improving risk and uncertainty assessments and the lifecycle performance of assets (e.g. adaptability into other uses or building flexibility to change the internal layouts more efficiently). Embedded flexibility requires initial investment plus developers and other property stakeholders need justification for building flexibility investments before consideration may be given to those investments. That is, stakeholders need to know the values associated with building flexibility investments for decision making. The research questions are;

i. What is the main approach to uncertainty and risk management adopted by Australian residential property developers?

ii. How does RO theory improve uncertainty and risk management in residential property development?

iii. Using residential case studies, is RO theory supported in residential development projects, compared to conventional property development evaluation techniques?

iv. How would different property stakeholders justify investment in building flexibility for uncertainty and risk management in residential property development?

v. What factor(s) are required to integrate ROA and ROV models into property development feasibility evaluation?

vi. What are the potential barriers to adoption of RO theory in practical decision making in Australian residential property development?

1.5 Objectives of the Dissertation

The major purpose of this dissertation is to test the practical applicability of RO theory through valuation of flexibility using selected case studies from the Australian residential property development market to either support or oppose the adoption of RO theory for property development decision making in practice. The objectives of this dissertation follow the general approach to real options research which focuses on determining the value of real options in capital projects with the aim of improving investment decision making under
uncertainty by property practitioners and to demonstrate the ability of ROV to value flexible managerial decisions. As a result, these objectives are enumerated for the dissertation:

i. To review and establish the nexus between real option theory, valuation and property development;

ii. To develop real option conceptual model for categorising flexibilities embedded in the property development process to enhance risk management;

iii. To examine how Australian residential property developers currently deal with uncertainty and risks in feasibility analysis;

iv. To apply real option models to feasibility evaluation of selected practical case studies using empirical data and to compare the results with conventional property development evaluation technique;

v. To suggest ways of justifying investment in building flexibility in Australian residential property development;

vi. To evaluate the requirements for integrating real option techniques into Australian residential property development decision-making;

vii. To determine any potential barrier(s) to adoption of real option theory in practical decision making in Australian residential property development.

This is accomplished through firstly, a literature review to establish the connection between real option theory, valuation and property development. Secondly, the development of a conceptual framework for identifying flexibilities at different stages of the property development process. The conceptual framework aids the identification of both naturally embedded and other managerial flexibilities within the property development process; from inception to completion. A single conceptual framework developed (Baldi, 2013) lacks connection to the property development process. It was a matrix classification of flexibilities existing during the commencement of construction of a property development project. In view of this, there is the need to conceptually examine real options theory and develop a model for systemisation of flexibilities embedded in the property development process to demonstrate how real options also enhance uncertainty and risk assessment in practice. This dissertation develops a framework connected to the different stages of the property development process in a flow network that illustrates the different types of flexibilities at different stages. The aim is to provide a visualisation tool that property developers/investors can use to identify flexibilities at different stages of the property development process to enhance potential practical adoption and deepen the understanding of practitioners on flexibility. Such a
practical conceptualisation of ROA which can serve as a manual on flexibility is missing in
the literature, particularly, linking flexibility to different stages of the property development
process using a flow network. Furthermore, this dissertation examines how Australian
residential property developers currently deal with uncertainty and risks in feasibility analysis.

Another objective of this dissertation is to apply selected ROA/ROV models to evaluate
financial feasibility of high rise residential property developments in the Australian residential
property market with the aim of either providing evidence to support its practical application
or oppose its adoption for practical decision making. Besides, existing literature (de Neufville
& Scholtes, 2011, Vimpari, 2014) suggests that there is the need for further case studies to
deliver evidence to support practical adoption of real option models in practice. Furthermore,
it is aimed at improving the analytical procedures that are used in evaluating flexibility in
property developments and aid practitioners develop a better understanding of ROA and ROV
in practical settings to assist in any practical adoption. The applications also expand the
breadth of enquiry of ROA/ROV because they are initial applications from the Australian
property development market.

Building flexibility requires property developers to invest in flexibility at the initial stage of
a project to retain the right to capitalise on future opportunities. Justification of such
investments in building flexibility is not straightforward, limited and new within the
Australian high rise residential property development context. Furthermore, before these
flexibilities (such as efficient layouts and mobile walls) are embedded in projects, stakeholders
need to know the values attached to flexibility in order to decide whether to
invest or otherwise. Therefore, there is the need to investigate the means of justifying
investments in flexibility from the perspective of stakeholders and the potential acceptance of
embedded flexibility as a risk management strategy among practitioners. Thus, the
dissertation explores ways of justifying investment in building flexibility.

Lastly, in conformity to the direction of current research on ROA/ROV which is seeking
answers to ways of integrating ROA framework in mainstream financial feasibility evaluation
of property developments in practice, this dissertation aims to determine factors required for
adoption in practice. This is the initial attempt to elicit information from practitioners in the
Australian high rise residential property development market on requirements for accepting
and adopting ROA/ROV methods in property practice and potential barriers to adoption.
1.6 Research Framework

This dissertation represents exploratory research which investigates the potential practical adoption of ROA in the residential property sector in Australia by utilising both quantitative methods with embedded case studies and qualitative methods, generally known as mixed methods research (Johnson et al., 2007). Specifically, the use of embedded case studies in a mixed research method is labelled as an advanced form of mixed method. Figure 1-1 shows the research framework and the process of fulfilling the objectives of this dissertation. It also details the specific methodology chosen for this dissertation, the two phases and specific stages within the whole research process.

The research is conducted in two main phases where quantitative evaluation of embedded case studies is followed by the qualitative phase. The quantitative and qualitative methods are adopted for different enquiry components in this dissertation. The research questions belong to the two major strands of quantitative and qualitative research strategy enquiry, as a result, there is the need to adopt different methods for different research questions. The objective is to deliver evidence from multiple sources both quantitative and qualitative to inform and encourage practitioners to pay attention to using ROA in high rise residential property development decision making. The dissertation is conducted in five stages based on the research questions stated in Section 1.4.

Stage one is dedicated to examining and reviewing literature on valuation methods for evaluating high rise residential property developments, property development processes, uncertainties and risks in property development, real option theory, flexibilities existing in property development and areas in the property sector where flexibility has been implemented and evaluated through a real options framework. This provides insight into ROA applications in the property sector and particularly residential development and enables the researcher to determine gaps in the literature. The gaps formed the basis upon which this dissertation developed research questions, research methods and contribution to existing knowledge on ROA in high rise residential property developments in Australia.

Stage two covers research methodology based on the research questions. The research methodology is a mixed method approach with embedded case studies. This is primarily due to the nature of research questions which falls into the two research strategy methods of enquiry; quantitative and qualitative. As a result, the quantitative method with embedded case studies is adopted to test the practical application of ROA to high rise residential property
development and the qualitative stage is used to answer the ‘what’ and ‘how’ questions of the dissertation.

**Figure 1-1 Research Framework**

Stage three deals with evaluating financial feasibility of flexibility investments in high rise residential property developments in the Australian property market using empirical data. There are three selected residential case studies, therefore the dissertation adopts three different ROV models to evaluate the values associated with flexibility. The aim is to determine whether ROV models work in such situations as the models are still being tested in practical conditions. The ROV models chosen are fuzzy pay off method (FPOM), binomial
option pricing method (BOPM) and Samuel McKean Equation. After evaluation, the results were analysed within the context of high rise residential property development within Australia and compared to existing literature on ROA from elsewhere around the world. This opened the opportunity to ask some pertinent questions using the case studies as evidence of real practical application of ROV using empirical data.

Based on stage three, question for the face to face semi-structured interviews for stage four were designed and conducted to elicit information from experts in the Australian residential property development market on the potential of adopting ROA in decision making, particularly in evaluating financial feasibility of developments with embedded flexibility. It focuses on examining whether developers account for uncertainties and risks in required rates of return in property development, factors required before ROA could be integrated with mainstream valuation methods and how stakeholders can justify investment in building flexibility. At this stage, the conceptual model is validated by practitioners and changes suggested by those practitioners are applied to refine the model.

Finally, stage five is used to combine the findings from the quantitative and qualitative phases into a single discussion geared towards practical application of ROA in the residential property sector in Australia. This provides insight into the requirements from experts in the Australian property industry before adoption of ROA for decision making in practice could be achieved. This provided pointers on the issues to focus on to achieve adoption of ROA in practice because it is argued that evidence from case studies alone may not suffice to ensure adoption in practice. Finally, the conclusions from the dissertation are discussed. This incorporates recommendations and further research to deepen the theoretical propositions of ROA and practical understanding of practitioners.

1.7 Limitations of the Dissertation

This dissertation is subject to certain limitations particularly the case study constraints. The residential cases are selected from among several property asset classes which have unique characteristics. As a result, the findings of the dissertation are used to form analytic generalizations. All assumptions in this work have been carefully considered and in appropriate cases, real life data have been used to derive the results of the valuation.

Data were retrieved from credible sources to support its quality and hence the reliability of findings. Interviewees were guaranteed anonymity to ensure that the participants gave the
data with confidence. All participants were chosen because of their expertise and knowledge in the Australian high rise residential property market. This ensured that the views obtained from the face to face semi-structured interviews would be relevant to the dissertation. As a result, the dissertation is limited to the study of residential development in the Australian property market.

Finally, the difficulty of participants finding time to participate in the interviews caused delays to the delivery of major milestones but did not affect the overall output of the dissertation. During the interviews, only verbal and written notes given as part of the interview were transcribed and analysed to derive the results for the dissertation. Gestures, body language and other forms of communication were not factored into the analysis of this dissertation as some qualitative studies do.

1.8 Dissertation Outline

This sub heading outlines the structure and arrangement of the dissertation. Chapter One is dedicated to giving an introduction and background to enhance understanding. A detailed introduction, outline of research questions, objectives and contribution to knowledge which form the pivot of this dissertation is discussed and serve as the reference point for the entire dissertation. Moreover, timeline, scope, and limitations are all discussed in Chapter One.

Chapter Two discusses the literature on residential property developments and flexibilities (real option). This Chapter provides an outline of property development and the entire process through which residential property developments are completed. The uncertainties and risks inherent in property development and how uncertainties impact on final property values upon completion of development were introduced. This Chapter culminates in discussing the means through which uncertainties are addressed by conventional evaluation methods in property development and concluded with the various criticisms levelled against the DCF. Since economic cycles are known to impact on property developments, a discussion was presented on the sources of risks in property development. The Chapter also discusses the background to real options theory, the development of the theory, methodologies for options (flexibility) valuation, typologies of real options and the application of real options theory to the property sector. The different sub sectors under property where ROA has been applied is also discussed. This resulted in the determination of gaps in the literature and current direction of research on ROA theory in property development.
In Chapter Three, the focus is on a presentation of the research methods capable of aiding the researcher in achieving valid, reliable and justifiable results. This entailed a justification for the choice of methodology that is used to answer the research questions of this dissertation. The research process and design is also discussed in this Chapter in order to give an account of how the dissertation was completed. The sources of data and limitations are discussed to ensure that the credibility and accuracy of the results was placed in proper context within the Australian high rise residential property development market.

In Chapter Four, a conceptual model that categorises flexibilities in residential property development projects for ease of identification and evaluation by property practitioners has been developed. The conceptual model was developed using investor-developers as a unit of analysis because most flexibilities are long term strategies for dealing with uncertainties. This was a suggestion given by practitioners during the validation process to improve the model’s practical applicability. A table of different types of flexibilities and possible ROV models for evaluation is also presented in this Chapter. The main aim of developing the model is to have a practical tool to aid practitioners to identify and evaluate flexibilities as part of financial feasibility.

Chapter Five presents the findings and results of the first case study application. The case study evaluated the value attached to a horizontal phasing of a high rise residential property development project. Chapter Six discusses the second case study which focuses on evaluating the option to delay in a high rise residential property development project. The third case study is discussed in Chapter Seven. A residential tower was embedded with flexibility to switch output to a student studio accommodation. This case study was used to justify investments in flexibility for retaining upside future opportunities.

The qualitative stage of the dissertation is discussed in Chapter Eight. The Chapter examines the use of required rate of return as the main measure of risks in residential property development, measuring the acceptance level of ROV models among property practitioners, determining ways of integrating ROV models in practical decision making in residential property developments and how stakeholders can provide justification for investment in building flexibility.

Chapter Nine provides the results and findings from the quantitative phase, combined with the qualitative phase. The Chapter delves into the practical and theoretical significance of the findings of the dissertation. Finally, conclusions are discussed in Chapter Ten in addition to
contribution to knowledge, thesis evaluation, recommendations and areas for further research. The implications of the findings of this dissertation for the broader Australian property industry and for policy direction are also enumerated in Chapter Ten. Apart from the practical implications of the findings, a summary, answers to research objectives, recommendations and further research have been discussed in the Chapter.
Chapter 2 Literature Review

2.1 Introduction

“Robust design is a passive way to deal with uncertainty. Flexible design is the active way to deal with uncertainty” (Anonymous as cited in de Neufville and Scholtes (2011 p.39)).

This Chapter discusses the relevant literature from various sources including but not limited to books, journals, scholarly articles, working papers and other electronic documents related to the topic of this dissertation. The focus is to discuss the scholarly works of leading authors on the topic to demonstrate the contribution of this dissertation to the existing literature. The gaps in the literature are also enumerated based on the discussion of the existing scholarly works. The Chapter also discusses property development, process of property development as postulated by different authors, and delves deeper into the different stages in property development, uncertainties and risks in property development, their sources, and effects on residential property development decisions. The effects of economic cycles on property markets and how changes in the economic environment affects property decisions is also explored.

The Chapter also examines the different theoretical framework propositions for explaining price determination in property markets and their in-built assumptions. These theories include the four quadrant model by DiPasquale and Wheaton (1992) and the classic real estate system model (Geltner et al., 2007). Even though these models can predict to a certain extent the operations of property markets leading to property value determination, the models usually rely on market expectations without capturing risks and uncertainties measured by the use of standard deviation in property investments.

Furthermore, different property valuation techniques including DCF and their attributes are explored, and how weaknesses result in uncertain valuations that are used in residential property development decision making. The weaknesses of the DCF technique is discussed to pave the way for exposition on real options theory, typologies of real options and selected ROV applications in the property sector. Conceptual underpinnings of real options theory are contrasted with DCF to determine the strength and weaknesses of both methods. In reviewing the various applications, a greater focus is given to the property and construction sector in order to examine the results derived from previous studies and how real options theory enhances
uncertainty and risk analysis. The applications in the property sector are divided into different sub-sectors including real estate markets, leases, technology investments, building flexibility, and land valuation. Gaps in the existing literature are determined during a review of the various applications to clearly indicate the contribution of the dissertation to knowledge. Lastly, a summary of the Chapter is provided to conclude the discussion and the gaps identified.

2.2 Property Development

Different groups of people engage in property development activity at different times to create shelter. Society has also evolved over time to realise the importance of providing shelter. As a result, property development has also become a field of specialisation. This includes companies and individuals doing property development for profit, charity and non-governmental organisations who are developing properties to serve social interest and corporate organisations engaged in property development to support the operations of their business. Apart from property development becoming an area of specialisation as a profession, it has also become a discipline of study which has witnessed contributions from several authors. Scholars including Graaskamp (1981), Havard and Platts (2008), Healey (1991), Isaac et al. (2010), Reed and Sims (2015) have all contributed and provided information on property development to advance studies and understanding of practitioners and stakeholders in the field. In the next sub-section, several definitions of property development are discussed, and emphasis is given to the definition adopted for this dissertation.

2.2.1 Definition of Property Development

In the extant literature, there are several definitions of property development. In some cases, the terms real estate development and property development are used interchangeably. Even though there is a distinction between the two terminologies, they are both generally accepted when used interchangeably. In this dissertation, property development is adopted as opposed to real estate development. According to Healey (1991, p. 36)

“Real estate development is taken to be the transformation of the physical form, bundle of rights, and material and symbolic value of land and buildings from one state to another, through the effort of agents with interests and purposes in acquiring and using resources, operating rules and applying and developing ideas and values”.
This definition emphasises both the physical form of land and bundle of rights which generally is attached to the ownership. Rights including possession, enjoyment, exclusion, alienation, control and disposal. Rights given to owners of land and property are usually grouped into different forms of interests including freehold, leasehold and licenses. In Australia for example, there are free hold interests, leaseholds and licenses held by different owners to different parcels of land. There are also crown lands that offers absolute ownership in perpetuity to owners. The transformation of the physical form includes changing the land from one state to another. For example, converting agricultural land into a residential development is a transformation of the physical form of the land. Different agents are involved in property the development process including developers, investors, engineers, contractors and other stakeholders with various objectives. These agents use resources to create value in property development.

Miles et al. (2007) offers a definition of real estate development as the continual reconfiguration of the built environment in response to various needs of society. This involves both new construction and reconfiguration of existing structures to adapt to current needs. In practice, some Australian property developers have a business model of responding to opportunities to execute infill inner city developments as a way of reconfiguring the built environment. This reconfiguration is usually in response to changes in consumer tastes and preferences (Miles et al., 2007). For example, changes in tastes and preferences of consumers in Australia has resulted in the growth in high-rise apartment developments, particularly, in inner cities and urban fringes which is a recent phenomenon in the Australian residential property market.

Havard and Platts (2008) generalised the definition and suggested that property development is the transformation of land/property from one state to the other. This definition considers the changes that may arise because of man-made activities on the land aimed at creating space for specific purposes. It also encompasses land only, but includes existing properties because in some cases, refurbishments, updating, demolishing and other activities can constitute property development. Havard (2014) suggests that,

“real estate development, or property development, is a multifaceted business, encompassing activities that range from the renovation and re-lease of existing buildings to the purchase of raw land and the sale of improved land or parcels to others”.
This definition captures residential property development approach in Australia which generally uses the sub-division of large parcels of land, and improves them for sale to clients. Improved lands include those with title, but construction must be executed by the purchaser or a contract is signed for the construction to be executed by the vendor as a complete service. As succinctly put, development can be relatively simple such as obtaining approval to subdivide land for onward sale or complex as developing an office building (Coiacetto, 2009). For example, master plan community developments initiated by Australian residential property developers may either include land and property as a complete package or just the lots.

Reed and Sims (2015) indicated that property development is the combination of land, labour, materials and finance as factors of production to result in the change of land use and/or a new or altered building. Isaac et al. (2010) identifies the need for an entrepreneur (property developer) to initiate, combine the factors of production and manage the process of property development until completion. While some of the definitions include land, others omit it and focus only on the structure to be developed on the land. The commonality among the definitions is the transformation from one state to the other. Isaac et al. (2010) suggested two major points; a developer and the process of development. Property development takes considerable time and effort to complete and therefore, the need for a developer can’t be over emphasised within the process of property development to serve as the entrepreneur to drive development. Development is naturally a staged activity and therefore goes through stages before completion.

2.2.2 Property Development Process

Property development by nature, is a staged activity because certain activities are required to be completed before others are initiated. Therefore, property development has different stages which may possibly be sequential or might not follow the prescribed stages consecutively depending on the operations of the entity engaged in development.

Tiesdell and Adams (2011, p. 3) postulated that

“Real estate development process is a production process that creates the built environment. ...to operate effectively, it involves a conscious attempt to have a calculus of the risks and reward that drives it, the interests of, and constraints upon key development actors including developers, landowners, designers, contractors and investors.”
This definition raises three key themes; risks in property development and the compensation a developer gains from assuming those risks in the form of profits in most cases, the different actors involved in property development and their interests in engaging in property development. The property development process involves long term commitment spanning a considerable period with complexities emanating from the varying interests of actors and agents. For instance, typically property developers develop for profitability, but architects seek aesthetics. Local authority/council on the other hand enforces building regulations and oversee planning, whereas investors want to maximise return on investment. As a result, there is a complex web of interrelationships between stakeholders with different objectives in property development activity.

Several concepts from different disciplines have been applied in establishing the property development process. However, these models provide a general framework of ideas but with relatively little empirical support (Fisher & Collins, 1999). As a result, models developed with the aim of capturing and describing the property development process have not had any major breakthrough in practice due to the lack of evidence. Healey (1991) suggested four main models of property development process:

i. Equilibrium model;
ii. Agency model;
iii. Structure model;
iv. Event sequence model.

2.2.2.1 Equilibrium Model

The equilibrium model follows the neo-classic traditions of economic assumption, where property development activity is predicated on economic signals about effective demand which is demonstrated through rent levels and yields (Healey, 1991). The equilibrium model assumes that property development is a function of demand, therefore developers basically produce to satisfy an existing demand. This is true in the case of developer-traders who are basically, producers of space. The model also emphasises supply of property products reaching the market at the right time, at the right place and at the right price. In view of this, demand for properties without an adequate supply results in increasing rents and decreasing yields which translates into higher land and property values. One way of measuring a specific property market’s performance is through the vacancy rate.
Several criticisms have been levelled against the equilibrium model of property development and Healey (1991) indicated that, the assumption of a perfectly operating market is false, because it does not capture speculative risk. Furthermore, the model ignores uncertainty in respect of future gains/losses due to timescale, therefore making it lack the impetus to give accurate results (Howells & Rydin, 1990). Lastly, this model and its assumptions form theoretical underpinnings of several valuation and appraisal methods leading to distortions in property values and different yields (Adams et al., 1985, Howells & Rydin, 1990). Surprisingly, the equilibrium model underpins most of the literature on price formation in property markets (DiPasquale & Wheaton, 1992, Geltner et al., 2007). In summary, the equilibrium model works well in very stable property market conditions where participants have perfect knowledge of the market. This is contrary to the operations of most property markets because even in the most transparent property markets, there are still private placements for sale of properties leading to imperfect information among market participants.

### 2.2.2.2 Agency Model

The agency model focuses on actors in the development process and their relationships (Fisher, 2005). The agency model combines the different actors in property development, their roles and interests to explain the development process. Property development is executed by different actors with different aims and roles. This ranges from developers, designers, architects, planners, landowners, real estate agents, engineers, project managers and others. Usually, the developer is the initiator of the development and assembles the necessary inputs such as land, labour and financing to execute developments.

In Figure 2-1, the roles, status and aims of the different actors and agents in property development are delineated to explain the agency model. A landowner for example releases land for development after receiving payment from the developer, architects and designers transform the ideas and concepts of a developer into a workable scheme, the project managers represent the interests of the developer on site and the real estate agents market the development in most cases, either as off-the-plan sales or a completed project as developers normally execute projects speculatively, financial feasibility based on prevailing yields and rental levels are the guiding variables. Lastly, the roles adopted by actors in the development process may vary with time and development because in some cases, investors may also be developers and vice versa. A local council when developing an office for their own use becomes a developer,
therefore different actors may assume different roles at different times during the process of property development.

2.2.2.3 Structure Model

According to Healey (1991), the structure model focuses on the forces which organise the relationships between actors in the property development process and the resultant dynamics in the property market. It is underpinned by the theory of urban economics and the forces that drive property developments. The main factors that drive and shape property developments are political, economic, social, legal, and technological. In general, economic forces determine business activities in a particular country. This is the main driver of occupational demand and the performance of the financial markets determine the cost and availability of capital for property developments (Fisher & Collins, 1999).

The political and legal systems play key roles in the process of development. The acquisition of title to land and navigating planning laws are example of activities that can impact on development. Therefore, developers are generally concerned with the political and legal issues
in countries of operation. In Australia for example, the planning regime has very strict requirements before development and construction permits are issued. Other factors such as technology and its advancement impact on property development considerably. In recent times, the use of offsite manufacturing and other efficient technologies are driving faster property developments. Lastly, environmental issues relating to sustainable construction have also gained popularity in recent years. In view of this, some developers have significantly altered operations to create spaces that can mitigate the impact of construction activities on climate change. Investors and occupiers have also realised the benefits of sustainability, hence, demand for sustainable buildings has increased significantly. For example, in the year 2015, there was 116% increase in green building certifications by the green building council of Australia (Green Building Council of Australia, 2015).

2.2.2.4 Event Sequence Model

The event sequence model focuses on the stages in property development based on timescale and activities to be performed at specific phases during development. Events involve actions, decisions, agreements and contracts; and this happens during interaction among the various actors involved in property development (Fisher & Collins, 1999). The event-sequence model describes the various stages that occur when property development takes place (Tiesdell & Adams, 2011).

In this dissertation, the event sequence model is adopted because it offers the opportunity for the determination of different types of flexibilities at different stages of property development. Furthermore, real options theory combines the actions available to developers and identifies the exact stage within the development process where the flexibility exists, thereby enhancing options analysis. Therefore, the event sequence model offers the opportunity to examine the different stages of property development and flexibilities embedded at those stages. In summary, all the models play key roles in shaping the dynamics of the property market. Even though the focus of each model varies from one to another, there is a combination of the models at some point within the process before property development is initiated. For example, the equilibrium model guides developers in accepting the execution or rejection of specific developments based on profitability, and once development starts, the event sequence model is adopted.
2.2.3 Stages of Property Development

The event-sequence model suggests that the property development process involves stages where specific activities occur. Property development includes evaluation, preparation, implementation and disposal (Cadman & Topping, 1995). The four-stage event-sequence model was expanded by Reed and Sims (2015) to include initiation, evaluation, acquisition, design and costing, permissions, commitment, implementation, and let/manage/dispose. This is shown in Figure 2-2 and though it is sequentially presented, it may not follow perfect sequencing in practice.

**Figure 2-2 Property Development Process**

In Figure 2-2, the property development process is diagrammatically presented to enable visualisation. It has been adapted from the stages proposed by Reed and Sims (2015) starting from initiation until completion. Even though let/dispose is the last activity in this model, depending on the motive of a developer and the source of capital for a development project,
let/dispose may occur earlier than other stages because developers are typically required to achieve presales of proposed developments before debt capital is provided by financial institutions for a project. Equity investors may have a similar philosophy.

Isaac et al. (2010) suggested the process of property development includes choosing a location, site identification and detailed survey, outline of scheme and appraisal, negotiating for site acquisition, design, planning consent, finance, site acquisition, detailed plans, tender documents for construction, construction, and let/manage/dispose. This process can either be sequential or unordered depending on circumstances and developers’ approach to executing projects. Miles et al. (2007) proposed a similar eight stage model of the property development process based on the event-sequence model. The process begins with the inception of an idea, refinement of the idea, feasibility, contract negotiation, formal commitment, construction, completion and formal opening, and finally property/asset/portfolio management. Comparatively, the various propositions of the event sequence models reveal some overlaps and differences.

A deeper analysis of some stages demonstrate that differences emanate from terminologies and not specific activities undertaken in specific stages. Furthermore, the process is not static as defined, but a specific development and its dynamics determine the flow of events. In practice, a developer can shorten the process to achieve this same objective of maximising profitability (Havard & Platts, 2008). It is posited that the most important stage is the appraisal, where a decision is taken to execute or reject a project depending on the outcome of financial feasibility study. In subsequent sub-sections, the focus is on discussing the individual stages in the property development process.

2.2.3.1 Initiation

Most property projects start as a speculative development based on factors that determine the potential for property prices to enable a profitable outcome including demand, changing demographics, economic, and social metrics within a specific geographical area. Often, a speculative property developer with extensive knowledge of a specific development market would normally initiate the idea. Peca (2009) argues that idea inception begins with an unsatisfied need in a market or on an underutilized existing site. Similarly, other actors (for example investors, local authorities/councils, corporate organisations) within the property market can also initiate a development project (Miles et al., 2007, Reed & Sims, 2015).
Rigorous market research is conducted by the potential developer to determine if a specific product is in demand by occupiers.

Property developments are initiated against the backdrop of favourable market conditions by property developers to make profit. This is true for profit driven private property developers rather than the public sector or a non-profit organisation which typically have different motivations. Tiesdell and Adams (2011) suggest that in the private property development sector, the overriding objective is primarily one of profit maximization. Profit maximization of potential return from development fulfils the classic economic theory of the risk-return relationship (Ratcliffe et al., 2009). In seeking stable and profitable investments for their shareholders, institutional investors including superannuation funds and other property companies normally invest in the property sector as initiators of property developments. At this stage, a decision is taken as to the use, size, and the form of the development. In terms of ideas generation to meet established objectives, Tiesdell and Adams (2011) argued that property development is about imagination, opportunity and venture, therefore, successful developers are usually those who are able to utilise information in a useful manner.

2.2.3.2 Providing an Outline Scheme and Appraisal

Developers initiate the process of development and serve as entrepreneurs to combine other factors of production to achieve their objectives. Isaac et al. (2010) suggest that a developer would consider a scheme to be viable based on two main conditions; existence of planning consent or realistic chance of securing the consent and a market demand for the proposed development that can produce returns greater than cost of development. This view is supported by Reed and Sims (2015) that market research and appraisal stages are the most critical in the development process because developers are guided by outcomes of appraisals based on market research to choose projects to execute. Thus, market research serves as a process of conducting due diligence (Peca, 2009).

Any potential property development is subject to feasibility and viability analysis. Viability/appraisal includes market research, both in general and specific terms, and the financial evaluation of the proposed development (Reed, 2007). Financial viability assessment is underpinned by market research to determine demand for a proposed development because developers execute projects to satisfy demand from occupiers. In view of this, Havard and Platts (2008) argue that property developments need to respond to and meet the needs of the
market-place. Ratcliffe et al. (2009) state that market research is fundamentally concerned with demand and supply: demand, whether proven, based on perception or latent is a difficult variable to investigate from which to derive accurate results with certainty. Havard and Platts (2008, p. 73) define market research as

“The process of establishing whether there is a market for the product being developed, at what price it will let or sell, how long it will take to lease or sell, on what terms and to whom”.

Market research basically is an examination of the attributes of a development that attracts demand to generate the needed cash flow to make the development financially viable. Therefore, developers must decide to what extent further enquiries, searches, surveys and tests will have to be conducted, by whom and at what cost, so that there is sufficient information available in order to analyse financial feasibility of a development proposal (Ratcliffe et al., 2009). Peiser and Frej (2003) suggested that financial feasibility analysis is executed in two stages; quick and dirty or a detailed multi period DCF analysis.

In summary, the significance of financial evaluation in property development cannot be overemphasised as preliminary feasibility and viability analysis results in the preparation of initial outline necessary to begin discussions with local authority regarding planning permission (Isaac et al., 2010). Therefore, a proposed scheme may or may not be implemented depending on the outcome of financial appraisal. In view of this, market research is an essential part of any analysis involving property development (Havard & Platts, 2008). The results of market research are used to initiate the process of financial appraisal. Whereas private sector developments focus on establishing potential profit in relation to risks, public sector/not-for-profit organizations ensure that costs are recovered after a development (Reed & Sims, 2015). In analysing the profit potential of a development, a prudent developer does a critical assessment of variables including rental levels, property values and yields, costs and time for completion because these variables determine financial viability of proposed projects. As a result, developers always include into financial appraisals an allowance for profit, or return, for the time, capital and effort involved in creating an asset because property development has a long duration (Guy & Hanneberry, 2008). This feasibility stage of property development should be undertaken before any commitment is made because at this stage, a developer has flexibility to abandon a project. Guy and Hanneberry (2008) further concludes that various development proposals are normally evaluated before the most appropriate scheme is finalised.
2.2.3.3 Site Acquisition

Site acquisition is subsequent to project acceptance after financial viability analysis of a project. At this stage, the developer and the professional team are satisfied with the outcome of the financial and physical evaluation. Preparation of grounds/land for work to begin on a proposed development is initiated. Reed and Sims (2015) suggest two issues to deal with during the site acquisition including; legal and ground works.

(a) Legal Investigation

If the developer is the owner of the site, a development can proceed without the need for such an investigation into the title and ownership. However, in cases where a developer has to acquire land from a third party, there is the need to undertake a careful search to determine the rightful owners of the land and the interest inherent in the ownership including easements, caveats, covenants and encumbrances on the title (Reed & Sims, 2015). Any mistake in determining the rightful owner of the land can result in legal tussle that has the potential to undermine the success of a project. For as long as a legal suit persists in court, the financial viability of the project erodes with time due to potential changes in market conditions and legal costs.

(b) Ground Investigation

Investigation into soil characteristics and testing is one of the requirements that must be fulfilled before land acquisition because the capacity of a soil to bear the load of a development is crucial. Apart from the load bearing capacity, a developer must also investigate access and drainage, all existing services (electricity, water, gas, sewerage, and telecommunications etc), contamination, geological and environmental issues and to ascertain their capacity to serve the proposed development (Reed & Sims, 2015). At this stage, developers need to be aware of any potential land contamination, because if it is present, a potentially profitable development can turn into financial losses (Ratcliffe et al., 2009). Recently, this has resulted in the use of environmental experts in property development to avoid developing in contaminated areas. These experts also provide advice on possible ways of cleaning contamination before commencing development.
2.2.3.4 Design

At the design stage, developers attempt to graphically translate their ideas into a workable document to guide execution. In most cases, design is the responsibility of a developer because project ideas emanate from developers. Since design is inextricably linked to market demand, it is deemed as an iterative process that keeps changing in tandem with the market. This is affirmed by Ratcliffe et al. (2009) that the development project and its design are continuously developed and refined as more information becomes available. The final product may differ significantly from the initially conceived ideas as the developer attempts to refine it to suit market demands and other regulatory requirements.

Economically, demand and rents are influenced by the needs of the marketplace. Squires and Heurkens (2015) argued that good projects are those with designs that best fit the needs of the marketplace. In view of this, developers work with architects to design projects that are market driven. Prudent developers rely extensively on market analysis to make decisions regarding the continuity of proposed designs. Even though developers engage in development for different reasons such as speculative or responding to market needs, a design that does not satisfy the needs of the market is in most cases bound to fail. In cases where tenants’ needs are known, design is quite straightforward. Conversely, designs for speculative developments are different because of uncertainty associated with tenant or buyer occupancy needs and desires. As a result, market research becomes the main tool for determining the needs of target market. This makes it imperative for developers to consider the views of relevant stakeholders such as estate agents, investors, architects, engineers, town planning consultants and other professionals in accepting the final design (Syms, 2010).

Recently, an approach to development has been the consideration of different flexibilities embedded in irreversible investments including property projects. At this stage, a developer has the choice to flexibly design a project to take advantage of future market fluctuations. For instance, flexible investments such as designing to capitalise on upside potential can be incorporated into property developments at this stage. This is achieved by designing to retain the flexibility needed to easily and cost efficiently change the use of a project should the need arise. These changes can be achieved by designing internal layouts efficiently to meet changing needs of a market for property development projects. Flexibility in construction delivery can be examined at this stage to embed strategic options into a project.
2.2.3.5 Planning Permissions

Without obtaining the required planning permission, a developer cannot legally commence excavation or construction. Planning authorities exert a considerable influence in property development decisions. As a result, all designs must be developed on the backdrop of obtaining planning permission. In the process of development, initial design for a proposed scheme is submitted to planning authorities for advice and feedback at a per-planning meeting. Subsequently, an appointed architect bases a comprehensive design of the development on the initial brief because major variations would warrant the submission of new planning application. Havard and Platts (2008) argued that building up a relationship with the right people in various authorities and agencies including planning officers is important to give a developer and his team a good understanding of the local planning system and the requirements for the issue of a planning permit. Such a relationship enables developers to informally seek the opinion of planning officers to shape proposed designs to meet planning requirements in order to minimise cost, uncertainty and time loss.

The acquisition of planning permit can be very complex, requiring detailed knowledge of the appropriate legislation, regulations, overlays and policies. Local knowledge of how a specific planning authority operates is considered beneficial although not critical. This necessitates the employment of ‘in-house’ experts or the use of consultants where planning problems are envisaged (Reed & Sims, 2015). It is therefore important for a developer to consider the planning permit as an important part of any development process. In some cases, a planning permit may take a considerable period which affects the timing of a development and completion date. Planning delays may impact on a development to affect the financial viability.

2.2.3.6 Commitment/Finance

Funding is one of the key factors a developer considers as part of conceiving the idea for a property development because without finance, the project cannot be executed. MacLaran (2014) argues that the ability of developers to execute development projects is dependent on their capacity to either borrow or use their own financial resources. This is broadly dependent on the type of developer; for example, public organisations usually provide their own capital to fund property development projects but profit driven organisations such as superannuation funds may provide capital in the form of investing in a fund specifically set up for property
development. Private property operating companies on the other hand depend on commercial banks/lenders for financing.

A developer chooses the most appropriate source of finance for a proposed project. There are two main sources of capital; equity and debt (Havard & Platts, 2008, Reed & Sims, 2015), and a third source referred to as grants (Havard & Platts, 2008). Equity generally refers to finance from the purchase of completed forward sales or sales from completed projects, issuance of shares to the public and other corporate organisations. Debt is given in exchange for collateral acting as security, is typically time-bound and incorporates a return for the lender in the form of interest (amortised or capitalised) paid by the borrower to the lender (Peiser & Frej, 2003). In property development, two main forms of debt financing are available to a developer. Firstly, there is short-term finance to cover costs during the development process itself. Secondly, long-term finance (sometimes called ‘funding’) is used to cover the cost of holding the completed development as an investment or, alternatively, to secure a buyer (investor) for a completed scheme (Reed & Sims, 2015).

Debt finance is one problematic area for property developers as there are several conditions required by commercial banks before advancing financing for a project. For example, most financial institutions require a level of presales or preleasing before providing finance for property development projects (Peca, 2009). As a result, several ways have been developed through which developers can attract debt financing. These include development finance from a bank, commercial mortgage where a loan facility is arranged and advanced to the company but not tied to a specific project, sale and lease back transactions, forward sale of a project, syndicated loans, term loans, overdraft, joint ventures, mezzanine loans and public private partnership agreements (Isaac et al., 2010, Ratcliffe et al., 2004). This list is not exhaustive because there can be a combination of different forms of debt capital sources to achieve the same objective.

A prudent developer will review the financial viability of a project to be confident of project outcomes. Financial viability analysis is monitored constantly until project completion due to uncertainties with respect to time and changing market conditions. As these factors are critical, developers normally pause at certain stages of the process to re-examine the financial viability and ascertain that the estimate is based on the best possible information (Reed & Sims, 2015). Once commitment is made, a developer must then negotiate with and
appoint a construction contractor. Ratcliffe et al. (2009) posited that there is wider acceptance of the benefits to be derived from selecting and involving a contractor at the earliest possible point in the design process. To ensure value for money, developers may adopt performance bonds (as a percentage of contract value) negotiated with the selected contractor and any nominated subcontractor, specialists or suppliers providing a design service.

2.2.3.7 Construction/Implementation

Construction work begins at this stage and the precursor is the procurement of all raw materials for a development including land, labour, finance, management and all other professionals needed to execute a project. At this stage, commitment has been given, therefore, a developer loses most flexibility of altering designs to match new market demand if not incorporated already. Besides, the cost computations and final project evaluations are all completed based on the agreed designs and hence, any change can result in cost changes (increase or decrease).

Some important factors that must be taken into consideration during this stage are time, cost, performance/quality, risk, ability to make changes, project characteristics, client resources and factors outside the control of the development team (Reed & Sims, 2015). One of the most important aspects of this stage is the selection of an appropriate contractor and the choice of contract to execute a development. The contractor may or may not contribute to the design but may be called in to construct the building(s) as designed. Apart from the selection of a contractor which is pivotal to fulfilling the project objectives, the developer is also confronted with the challenge of deciding which contract type best serves the interest of a project. Construction contracts may include design-bid-build, design and build and management contracting (Reed & Sims, 2015). The choice of a specific type of contract is dependent on the advantages that it offers as compared to other types of contracts. The developer must take as much interest in the running of a project as in its promotion and monitor the market constantly to ensure that the product is right, which, may involve changing the specification at some point in time to fit the demand from the market if there is still flexibility to do so.

2.2.3.8 Marketing for Sale/Letting with Potential Asset Management

Depending on whether a project is developed for a tenant(s), corporate occupier or individual, this stage may occur at different periods in the process of development. If a project is developed for a corporate occupier/client, it is normally executed without marketing. However, speculative developments are different because developers must market the project before,
during and after completion of a project or until either there is a financial or tactical reason to stop marketing. As a result, a speculative developer must spend considerable time examining the needs of the market before committing to a design.

According to Miles et al. (2007) “A good real estate marketing is the comprehensive process of planning, creating, and communicating activities that results in selling or leasing the most space or product for the greatest return in the shortest amount of time”. The marketing phase is an important part of the property development process because developers use the opportunity to attract clients for the project. In some cases, clients who are part of a previous project executed by the developer are informed about the prospects of a new project by the same developer. Depending on their experience from a past property transaction, these existing clients may either partake in the current project or discard it. As part of the marketing process, a developer should analyse and determine the appropriate time to market for a real estate product as ill-timed projects are generally bound to fail. The reason is that, the success of most real estate projects is based on right time to market, right price and right product for a specific target market. Therefore, it is important for developers to ensure the timing is right because marketing is not a cure for ill-timed projects (Miles et al., 2007).

Marketing is at the forefront of the developer’s thoughts from inception, hence, a marketing team is involved as well (Syms, 2010). Peca (2009) suggests that in speculative development, there is constant marketing and sales effort to ensure that a developer can dispose of a project. It can be argued that the success of a development is interwoven with the ability of a developer to dispose of a project after completion. At present, due to requirements of pre-sale as a condition for debt funding by financial institutions in most countries including Australia, high rise residential developers now appear to have marketability at the top of the agenda (Ratcliffe et al., 2004). Development companies adopt several marketing strategies including site boards and hoardings, brochures, advertisements, internet presence, mail shots, email, launching ceremonies, show suites, on-site offices and public relations.

This usually involves promotional (communicating through various means to create awareness among the target market) events, commission schedules etc to attract the target market to the real estate product. Coiacetto (2009) argues that several large Australian property development firms can engage in persuasive advertising rather than informational due to their sizes. Usually, depending on the size and scale of a development project, a marketing or an information centre with brochures and facilities to enhance customer experience is included in the promotions.
For example, in Australia, a master plan community of over 4000 homes usually involves a
large office with several marketing staff, amenities and videos to induce response from clients,
whereas small infill inner city developments usually have small on site offices. Miles et al.
(2007) suggest that regardless of size of a development project, the facility set up for marketing
and promotion should be aimed at coherently and logically presenting the development story
to attract and convince clients or to induce response from clients.

It is equally important to determine the right mix of media to use for the promotion. This is
highly dependent on the target audience. There are several channels to use for the promotion;
newspapers, magazines, trade publications, internet advertisements, television, radio,
newsletters and websites (Havard & Platts, 2008). The mix of electronic and paper is dictated
by the target market and their inclination to a specific media. Whereas in Australia, Mum and
Dad investors and owner occupiers are inclined to traditional forms of advertisements such as
newspapers, radio and television, young professionals and millennials entering the property
market as first home buyers would favour internet and website advertisements. Therefore, it is
important for a developer to determine the target audience and choose the appropriate media
for promotion. Lastly, developers usually use signages as a tool for promotion of development
projects. In practice, these signages are usually attached to the hoarding around the site before
and during construction to create the needed awareness. As the necessary awareness is created
to increase demand and induce sales, developers can benefit from increase in values of
properties, due to lag in supply. To this end, developers usually reserve the most sought-after
units or lots in a development to capitalise on increased values in future.

Letting may take several years to complete depending on the size of a project, the state of the
market and other driving forces. Timing can be before completion or the developer may wait
until after a development is completed. Even after completion, the developer has a choice to
sell the building completely to an investor or lease directly to prospective tenants gradually.
The riskiness of a development, especially relating to market dynamics manifest at this stage
of a development because the developer must have the flexibility to accommodate any changes
in the investment market prior to completion of a development whether positive or negative
(Reed & Sims, 2015). Where the project is speculative, the keynote must be flexibility – in
both physical and tenure terms (Ratcliffe et al., 2009). Flexibility offers a developer the
opportunity to make contingent decisions upon the availability of better information to
capitalise on upside potential and mitigate potential losses due to changes in market conditions.
In summary, property development is a staged activity with activities occurring at different stages over a considerable timeframe. Once started, developers have very little incentive to discard it because of sunk costs and prospects of financial loss. The staged nature of the process also suggests there are potential threats of changes in market conditions which require developers to be proactive in strategically planning the execution of development projects. In Figure 2-2, the property development process is visually displayed. Even though the activities are arranged sequentially, in practice, the process is not static. The process begins with initiation and ends when the completed project is let or sold off to an investor. The next section discusses the organisation and operations of the property market in which developers decide to execute or abandon a property project. It also details the drivers behind speculative developments.

2.3 Property Market

Developers, investors and other stakeholders operating in property markets evaluate property development decisions based on price determination mechanism and react to changes that occur in the operations of the market. Different models of price determination in property markets have been developed. This dissertation discusses two of the models proposed because they are related closely to the argument of the dissertation. This expounds the discussion in the context of formation of property values and how uncertainties and risks impact on property values.

The property market can be considered as a combination of two interlinked markets; asset (or investment) market and rental (or space/occupier) market. Therefore, supply of and demand for properties can either be in the form of investment or occupation. The development market is comprised of mainly suppliers of building stock who react in direct response to rising property demand. In practice, the investment and development markets are sometimes the same, especially when an investor instigates a development project. In this sense, practitioners normally distinguish between only two markets; investment and space market. It is also usual to find several players in both the space and asset markets.

2.3.1 Space Market

The space market consists of players who are bidding for properties for their own specific use (Geltner et al., 2007). Demand in the space market emanates from individuals and families seeking a place for occupation, or small and large corporations seeking to use the space for
business purposes. Suppliers of property in the space market are property owners or investors who let property to tenants in return for rental cash flow. Investors include individual property owners, high net worth individuals owning property and other property investment companies (or superannuation funds).

### 2.3.2 Asset Market

Asset market players are primarily owners of property assets which are ready for sale or to be let to potential tenants/occupiers (Geltner et al., 2007). Property owners are mainly the suppliers of properties in this market, but demand emanates from large investors seeking to either increase their portfolio sizes or reposition or diversify their investment portfolio. Some of these investors are listed property companies, superannuation funds and high net worth individuals. There are also developers/construction companies, independent developer investors, conversion-seekers, owner-occupants, banks, insurance companies, other entities owning property through securitised products.

Ownership of property confers the right to a stream of future cash flows from the asset in the form of rental payments from tenants. Miles et al. (2007) suggest that cash flows are normally in two forms; rental payments receivable weekly or monthly and capital return resulting from sale of an asset after the investment horizon. The price at which a property could be sold is outside the purview of an owner because property values are affected by exogenous factors. Two main theoretical propositions explaining the formation of prices in the property market are the real estate system by Geltner et al. (2007) and the conceptual framework posited by DiPasquale and Wheaton (1992). The interaction between the space, asset and development markets are espoused by these theories resulting in price formation in the property market.

### 2.3.3 DiPasquale and Wheaton’s Model

DiPasquale and Wheaton (1992) studied the United States property market and suggested that though in the short run supply of space in the property market is fixed, in the long run, equilibrium of the property market is achieved. A four-quadrant model as shown in Figure 2-3 was proposed as a set of closely interdependent markets to explain the price mechanism and the operation of a property market. In their submission, it was assumed that when space is owner-occupied, the notion of two separate markets no longer holds (DiPasquale & Wheaton, 1992).
DiPasquale and Wheaton (1992) proposed that demand for premises for occupation by firms and households is created in the space market. This is governed by rental price, referred to as rent determination quadrant as shown in Figure 2-3. In the asset market however, ownership and management of property stock is financed by landlords, investors and debt facility providers. The operation in this market is governed by potential asset valuations and investment returns arising from demand for property. Addition to existing stock through construction occurs in the development market when property values are higher than construction costs leading to potential profitability.

**Figure 2-3 DiPasquale and Wheaton's Model**

The interplay of the forces of demand and supply for space determines rent in the space market, and demand for investment properties depends on the profit-making potential of property as an asset class compared with other investment assets such as stocks and bonds. All things being equal, demand for rental properties due to business expansion or population growth leads to higher property prices through the increase in rents resulting from excess demand over supply. This triggers the need for the asset market to respond to the rising property prices by demanding new construction from the development market.
Supply of new construction is provided by the development market based on potential profits. This is determined by analysing potential market prices of new construction as compared to costs of construction. This results in a cycle of demand and supply until the long run equilibrium of the market is achieved. This is supported by Geltner et al. (2007) who argued that the four quadrants depict four binary relationships that together complete the linkages between the space and asset markets. It is also useful in examining the effect on the long-run equilibrium in the property market simultaneously, both within and between the space and asset markets.

A conspicuous limitation is the inability of the model to account for uncertainties in demand and supply analysis. Due to uncertainties, property development decisions based on potential demand are prone to substantial deviation from reality. Due to time lags of construction projects, there is also supply uncertainty which impacts on the outcome of price determination in the asset market. In summary, even though this model explains price formation in the property market, uncertainties impacting on the operations of the market affects decision making of the stakeholders and can result in serious financial consequences.

### 2.3.4 Real Estate System

The real estate system captures the operations of property markets and seeks to present how decision making in the property development industry is shaped by occurrences in other sub-markets (asset and space markets). Geltner et al. (2007) suggested that the property market has three components including the asset market, the space market and the development industry as shown in Figure 2-4. Geltner et al. (2007) analysed these three markets and broadly determined the activities in the property market. In subsequent discussions, the activities in these three sub-markets as determined by Geltner et al. (2007) is explained along with how uncertainty builds up in the financial evaluation model and its impact on property development activities.

The three sub-markets are interdependent and interact to create a balance in the real estate system. In the space market, supply and demand emanates from landlords and tenants respectively. As a result, demand for the existing supply of properties drives property prices in the form of rents and occupancy levels. Demand for property is influenced by potential dynamics of the market. Growth in demand and rise in occupancy rates are dependent on the performance of local and national economies. Generally, demand is measured and forecasted
by the players in the market. As a result, it is susceptible to changes which have serious financial consequences for development and the entire property market.

As demand for property rises, with supply remaining constant, rents increase. This results in a rise in cash flow for investors operating in the asset market. Property investors who are holding various property asset classes either as individual investments or in a portfolio recognise this phenomenon as an incentive for further investment. Property practitioners tend to ascertain whether increases in cash flows are translating into increase in property values. A quick informal in-house appraisal of specific investment assets is executed to ascertain whether property values are increasing or otherwise. For commercial properties, the income capitalisation method is usually adopted for appraisal of commercial properties.

**Figure 2-4 Real Estate System**

![Real Estate System Diagram](image)

The income capitalisation method has a cap rate component which is affected by changes in supply and demand for properties because they are fundamental to forecasting of property market performance in terms of rents, sales and property values. The determination of cap rate
is based on several factors including the opportunity cost of capital because investors mostly compare expected rates of return with other asset classes to determine the expected capitalisation rate (cap rate) for property investment. Similarly, cap rates may be determined based on the cost of borrowing from the capital market. Furthermore, cap rates are affected by changes in supply and demand for properties because they are fundamental to forecast of property market performance in terms of rents, sales and property values. As property values are computed, they are compared to current construction costs to determine profitability of potential property developments.

In the broader development industry, trader-developers who are engaged in speculative development compare current construction costs with property values to determine profitability of property developments. If the difference between construction cost and property value is positive, property developments are likely to be profitable; hence developers proceed with development. However, there is an inherent uncertainty regarding cash flow, cap rates and demand for property. These variables used in determining profitability of developments are affected by, inter alia, supply of properties, local economy, and performance of capital market, inflation, and interest rates. Consequently, property values are affected by changes in these variables which can only be forecasted at the time of evaluating financial viability of property developments. Demand, supply and occupancy rates that drive rents upwards and downwards are all based on forecasts in the property development industry. The consequences of any variation in projected estimates adopted by a developer can be significant. As a result, it is important to deal with (and minimise) uncertainties and risks in property development.

### 2.4 Risks and Uncertainty in Property Development

This sub-section considers the definition of risks, uncertainties, sources of these risks and uncertainties as well their effects on property development. This is to place the discussion of uncertainty and risk in the context of this dissertation and their role in property development decision making. Further, the concept of uncertainty that underpins the theory of real options is discussed.

#### 2.4.1 Definition of Risk and Uncertainty

It is widely accepted that risk and uncertainty are an integral part of the property development process (Graaskamp, 1981, Reed & Sims, 2015). Uncertainty is defined as when an outcome may or may not occur and its probability of occurring is not known but risk is when an outcome
may or may not occur and its probability of occurring is known (Sloman, 1995). This is supported by Epstein (1999) who referred to risk as situations where the perceived likelihood of events of interest can be represented by probabilities, whereas uncertainty denotes circumstances where information available to a decision-maker is too imperfect to be measured through probability. Thus, when a probability of occurrence is determined for an uncertain event, it becomes a measure of risk Byrne (1995). Byrne and Cadman (1984) stated that the measurement of a loss identified as a possible outcome of a decision by an entity is risk whereas uncertainty refers to the unknown about the outcome of a venture at a point in time of the decision making. In property development specifically, Adair and Hutchison (2005) define risk as the probability of not realising a particular set target rate of return. Uncertainty on the contrary is a situation where outcomes and their probabilities are not known. These definitions shed light on the outcome of an investment or venture based on imperfect information during decision making such as property development decisions which are based on forecasts. In this sense, property developers can be optimistic about forecasts of property values during development, but uncertainty around major variables including demand, cash flow, interest rates and costs can affect the outcome.

It can be inferred from Adair and Hutchison (2005)’s definition that financial outcomes of property development evaluations are not known and the probability of achieving a targeted development yield/profit is also unknown. Undoubtedly, uncertainty is an inherent part of the property development process and emanates from imperfect information about the different input variables and current and future market conditions. Unfortunately, circumstances that can have major impacts on financial viability cannot be determined before executing developments. Therefore, eliminating uncertainty from property development will not be entirely possible (Lorenz et al., 2006). Unless the market price of a property is known, any estimate of value is uncertain and the role of property development analysts is to assess prevailing market conditions and produce a single judgement of an estimated value of a development when completed in the midst of uncertainty (Joslin, 2005,RICS, 1994). Arguably, uncertainty is more prevalent than risk, yet, relatively little attention is given to it in formal models which is similar to property development financial evaluation in practice (Epstein, 1999). Since these inputs for the determination of property values are uncertain, the outcome of property development valuation is also uncertain (French, 2007,Loizou & French, 2012).

In summary, property development processes are characterised by complex long duration and cyclical movements in values (Louw, cited in Gehner, 2008). It is therefore difficult to
accurately estimate construction costs, rent levels, demand or sales revenues before completion. Even though property development involves an initial investment at the beginning of a development process, market conditions in the construction industry and the property market on completion of a project can change. Consequently, demand may dissipate before completion of a proposed development. The dynamics of the property market combined with the complex duration of development projects make projections/forecasts very difficult.

2.4.2 Sources of Risk and Uncertainty in Property Development

Uncertainties emanate from different sources and impacts on profitability analysis of property development projects. For example, Dullisear (2001) indicates that property development risk can be classified into four broad categories including commercial, construction, land and social. Loizou and French (2012) suggested that key sources of uncertainty include land cost, costs of financing, construction, timing of development, sale and rents and other socioeconomic factors (Loizou & French, 2012). These sources must then be examined individually during financial feasibility analysis of property development to determine their relative impact on profitability. Developers need to examine these sources of uncertainty to determine their likelihood of occurrence and their impact on specific projects to develop mitigation.

2.4.2.1 Land Cost

Land cost is one of the most important components of determining the profitability of a proposed property development. Together with other costs associated with construction, a developer is able to determine the total cost of a project in order to compare with the potential value to determine financial viability. Newell and Steglick (2006) conducted a survey of the importance of property development risk factors and indicated that land cost is the third most important risk factor considered during property development. Land for development is also affected by planning restrictions and other regulations. As such, developers must make the effort to ascertain the land use permitted on the specific land. Uncertainties emanating from duration of planning permits can be lengthy and time consuming thereby delaying securing planning consent which can affect the financial viability of property projects (Loizou & French, 2012). Similarly, when land prices are disproportionately high in relation to current property prices, developers face the risk of over payment which can reduce profit.
2.4.2.2 Costs of Financing

The source of capital for most property development projects is both equity and debt. Generally, developers are exposed to changes in the cost of capital, which is usually the weighted average cost of capital (WACC) when developers use both equity and debt capital. These changes may be due to movements in the broader economy and other related factors such as performance of the economy and demand for capital by other investors. As a result, any delay in the estimated time for completion of a project has effect on profitability. Loizou and French (2012) suggest that increases in time and interest rate decreases the profit margins of developers and affects viability of developments. In some situations arranging financing can be difficult for developers (Gehner, 2008).

2.4.2.3 Timing for Construction

Property developments are characterised by complexities and take considerable time to complete. The timing is also tied to cash outflows in terms of construction costs and cash inflows denoted as revenues in the form of deposits and settlement upon completion of and hand over of projects. As a result, any delays in the estimated construction time have enormous implications on financing costs and profitability (Loizou & French, 2012). For example, Newell and Steglick (2006) argued that time delay risk is an important risk for developers. Moreover, there can be legal and contractual implications for delays especially when a project is timed to meet specific market demand. As a result, developers are wary of time.

2.4.2.4 Construction

The construction stage of property development is risky because it typically attracts the largest cash outflows. In view of this, developers must examine the characteristics of the land for development (Loizou & French, 2012). Due to uncertainties with land characteristics and its ability to support development, it is important to analyse and perform soil testing to ascertain whether there is no contamination to avoid extra costs in land preparation which can affect profitability. Gehner (2008) suggested that construction costs can exceed budget during tendering. Similarly, delays in construction timing may also affect profitability.
2.4.2.5 Sale and Rents

Developers normally sell or lease a proportion of a project before commencement and this is typically a requirement of the lending entity(s) before funding is provided. The main reason for such a requirement for debt funding is for lender’s risk mitigation and to achieve lower costs of financing. It must be noted that the main driver of most development projects is profitability. Because the determination of profitability is evaluated at the inception of projects, any variation in the projected revenues can have significant impact on profitability. This may not be ascertained until completion of development due to uncertainties. For example, a wrong estimation of development yield can also affect profitability due to over optimism in analysis. In summary, uncertainty in property development emanates from several sources and impacts on profitability. Some of them can be controlled internally to curb risks, others are exogenous and are out of developers’ control. As a result, their impact cannot be eliminated entirely should adverse events occur, they may be mitigated through strategic initiatives such as flexibility (which has been proposed over the last decade). In the following sub-section, how uncertainties and risks can be dealt with in property development is reviewed.

2.4.3 Dealing with Risks in Property Development

Uncertainty parameters are difficult to predict. In forecasting around uncertainties, academia and property development practitioners have resorted to the use of statistical analysis to predict trends for some of the uncertain variables. Graaskamp (1981) supports statistical analysis and argued that the business risk situation can be improved by applying improved forecast techniques through statistical research of critical variables that impact on the success of property developments. In dealing with uncertainties, Enever and Isaac as cited in Joslin (2005) indicated that the individual analyst has three possible options of handling uncertainty; ignore it, express it verbally, and express it numerically. Numerical expression of uncertainties metamorphoses into risk management. This is evidenced by Byrne (1995) who states that if practitioners are able to assign probability to input variables that are uncertain, it will enhance the determination of a range of possible outcomes and the resulting output is a measure of risk.

On the numerical approach to dealing with uncertainties, Chen and Khumpaisal (2009) developed a risk management approach to a commercial property development by selecting 29 risk assessment criteria using the analytical network process. They then applied it to a large urban regeneration project in Liverpool. The result was a model for analysing risks in property
development to assist developers in decision making. Practitioners also use a system of ratings and matrices based on their subjective judgements of certain risk factors. Lastly, the use of quantitative analysis methods based on market risks research such as the capital asset pricing model can serve as an important measure of risks (Sagalyn, 1990).

Provision for unforeseen events in the form of contingency is another way of accounting for uncertainties and risks in property developments. Since property development is typically a long-term proposition, it is inherently risky and requires strategies to mitigate the effects of risks and uncertainties. Quantification of the actual economic cost of uncertainty and risk can be through provision of a contingency budget in a project cost that is commensurate with the project’s unique technical and market risks (Espinoza, 2011). That is, the level of perceived risks and uncertainties determine the contingency budget (De Sousa, 2000). Contingency is normally added to the base budget (which is a deterministic estimate) (Loizou & French, 2012) as a way of providing developers with the flexibility to deal with uncertainty and risks that pose negative financial consequences for projects (Ford, 2002).

**Figure 2-5 Risks in Property Development Fused with Development Process**

Source: Adapted from Sattarnusart (2012)
In Figure 2-5, the uncertainties impacting on property developments are economic, political, social, technological, project risks and natural events. These risks and uncertainties impact on the entire development process leading to cost and value uncertainties. Cost uncertainty affects the process of development from inception to construction. Value uncertainty occurs either before or after completion of a project. Before the completion, pre-sales/pre-lettings target could be missed, leading to value uncertainty. In cases where pre-sale/pre-letting target is achieved, developers lose upside opportunity. However, the risk of losing upside opportunity is better than the downside risk occurring. These uncertainties relating to cost and value are the major input parameters for financial feasibility analysis of property developments. As a result, the numeric outcome of financial modelling based on uncertain inputs leads to inaccurate outputs, hence poor decision making. Therefore, valuation techniques that use forecasts may not accurately predict future property values for decision making.

A better way to model uncertainties is to reduce the impact of uncertainties with a focus on the most important variable analysed by property developers; project values (Geltner & de Neufville, 2012). In Figure 2-6, it can be observed that there are several exogenous factors that affect profitability of property development projects. Analysing all variables is nearly impossible due to the complexity associated with modelling several factors simultaneously. In view of this, Geltner and de Neufville (2012) suggested the combination of all sources of uncertainty into a single project value uncertainty for modelling as shown in Figure 2-6.

**Figure 2-6 Modelling Uncertainty in Property Development Projects**

Source: Geltner and de Neufville (2012)
In recent times, dealing with uncertainties in capital projects has become important to both academia and industry. Flexibility in building and building design capable of capturing upside opportunities and mitigating downside losses have been proposed as probably the most plausible means of dealing with uncertainties and risks. Kogut and Kulatilaka (2001) argued that firms can proactively exploit uncertainty and risk because potential upside gains can inure to the benefit of property development firms/developers and embedded flexibility can also ensure capped losses during the process of development. Literature on flexibility in buildings is still growing and this dissertation contributes in this area by analysing how flexibility enhances risk assessment and evaluates the value embedded in flexibility in some selected high rise residential property developments in Australia. An exposition of flexibility in buildings and its valuation is given under Section 2-6.

In summary, the property development process is affected by several uncertainties which can metamorphose into risks. This is achieved when probability distributions are assigned to the likelihood of an uncertainty occurring. Uncertainty abounds in property development and it affects costs, prices and interest rates. Therefore, changes in construction costs, property prices and required rate of return sought by developers can impact on property developments financially. These changes emanate from exogenous factors including economic, social, technological, political, internal project-based risks, natural catastrophic events and others. A critical examination of the uncertainties can be grouped into cost and value uncertainties. Since these risks arise out of uncertainty, property developments may/may not yield the desired results in future (Leung & Hui, 2002). In such case, contingency is resorted to as an option to mitigate effects of risks and uncertainties. However, flexibility can turn risks into opportunities and mitigating effects of uncertain events.

2.5 Property Valuation

It is posited that property development valuation or financial feasibility analysis is the most important activity developers undertake before accepting or rejecting a development opportunity. In property parlance, valuation is the process of estimating the current market value of a property asset. One method is to determine the present value of future cash flows of a development, that is the discounted value of all estimated future liabilities and benefits (French & Gabrielli, 2005), rendering property developments unprofitable in the event of changes in forecasts. As a result, there is the need to incorporate and account for uncertainty in property development financial feasibility analysis.
Several property valuation methods are available for estimating the potential value of property developments. They include income approach (DCF/direct capitalisation), residual /turner approach, cost approach, profits method and sales comparison (API, 2015). This dissertation introduces real options valuation methodology which has been developed recently for the valuation of flexibility in property developments and other assets. In the next sub section, two main methods; residual approach and DCF are discussed. They are widely used valuation methods in practice, particularly for property development evaluation.

### 2.5.1 Residual Valuation Method

The Residual approach involves determining the capital value/gross development value (GDV) of a proposed development and deducting all costs to be incurred to develop a building of the required standard to generate the required cash flow. The costs of a development may include construction costs, infrastructure fees, professional development fees, costs of financing and compensation for undertaking the risks of development. These costs or liabilities are deducted from the potential gross development value to derive the residue. This residue represents the maximum bidding price for the land on which a proposed development may be constructed. The residual valuation method can be demonstrated using two scenarios below; scenario A and B.

#### Scenario A:

**Residue to land**

\[
\text{GDV} - \text{Total Cost} = \text{Residual Value}
\]

- **GDV**
  - Gross development value: estimated value of a completed development

- **Total Cost**
  - Total Cost:
    - All construction costs,
    - interest on construction,
    - professional fees & developer’s profit

- **Residual Value**
  - Maximum bid for site and includes acquisition costs, professional fees and finance of land cost

Whereas in scenario A the computation is focused on determining the maximum amount to bid for land before acquisition, scenario B adds land cost to the total development cost for computation of potential profit achievable by a developer.
### Scenario B

#### Residue to profit

\[
\text{GDV} - \text{Total Cost} = \text{Developer’s Profit}
\]

<table>
<thead>
<tr>
<th>Gross development value: estimated value of a completed development</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>All construction costs, interest on construction, professional fees and land cost</td>
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</table>

This method of valuation assumes a developed property in its highest and best use form to determine the potential profit from the development. As a result, the potential profit is highly correlated with the demand for the proposed development because in theory the higher the demand for the proposed development, the higher the price of the development and the profit thereof. Furthermore, the residual approach determines the value of developable land as a function of a proposed asset to be built on the land. A similar assumption underpins the use of ROV models for the valuation of land and property assets. Therefore, as the value of a proposed asset to be built on developable land increases, the underlying land value should also increase. However, in practical settings, this is not incorporated in the valuation of developable land using this model. As a result, the effects of uncertainties in terms of potential upside gains and downside losses are unaccounted for in the valuation of development projects.

#### 2.5.2 Discounted Cash Flow Technique

DCF technique suggests that the value of an asset (proposed property development) is the present value of the expected future net cash flows (Damodaran, 2012). French and Gabrielli (2004) suggested that the value of a development project is the discounted value of all estimated future liabilities and benefits. DCF technique uses measures including net present value (NPV) and internal rate of return (IRR) to determine the viability of a projects. Whereas NPV denotes the difference between present value of potential future cash flows and costs of a project, IRR represents the potential rate at which a project breaks even. Thus, a benchmark rate for a property developer to decide whether to accept and execute a project or reject it.

If NPV of an investment is positive, a risk-neutral firm will choose to develop (Cunningham, 2006). This is supported by Ross (1995) and Doraszelski (2001) position that investments (developments) should be made when NPV equals or exceeds zero. Internal rate of return must
be higher than the hurdle rate or required rate of return for a developer to initiate a development proposition. In principle, the required rate of return incorporates potential risks associated with a development project. As a result, in practice, the required rate of return for most development projects tends to be between 15%-20% on the undiscounted cost / the potential value of a project. Mathematically expressed, IRR is the interest rate that ensures that a project break even. Thus, when the IRR is used to discount a series of future cash flows, the resulting present value is zero. It is still a popular method for property development project evaluation among practitioners. It is a method that measures efficiency, hence its popularity among practitioners despite the numerous problems (Hartman & Schafrick, 2004). The decision rule is that to accept a project, IRR must be greater than the appropriate discount rate. If the IRR is lower than the selected discount rate for a development project, then the project must be rejected. There are several documented issues associated with the use of IRR including the problem of multiple real-valued IRRs, complex-valued IRRs, the IRR is, in general, incompatible with the net present value (NPV) in decision to accept/reject a project proposal, and the IRR criterion is not applicable with variable costs of capital (Magni, 2010). Since the IRR and NPV were chosen by the developers of the selected case studies in evaluating development projects, the thesis adopts same for the valuation to determine the economic viability of the projects. This will aid the discussion on real options valuation as it will concretise the argument for the adoption of real options valuation for financial feasibility evaluation of property development projects.

However, the use of uncertain input variables in the DCF method in determining a future payoff from property development results in uncertain valuation (French & Gabrielli, 2005). DCF technique has also been criticised by leading authors, (see for example Dixit and Pindyck (1995),Hayes and Abernathy (1980),Hodder and Riggs (1985),Myers (1984)). Dixit and Pindyck (1995) argued that the use of DCF assumes property development decisions must be made now or never and that property development projects will be executed continuously over a certain period and at a fixed scale despite future eventualities. The traditional approach thus ignores the possibility that capital investments can be started at some other time. Therefore, DCF technique assumes a passive approach to property development projects without any intervention from developers to alter project outcomes under changing market conditions. In practice, property projects are actively and constantly managed by property developers to ensure that outcomes are controlled to a certain extent. In this regard, DCF ignores the intrinsic value attached to managerial flexibility. The value of flexibility is the ability of management (developer) to capitalise on upside potential while capping downside losses emanating from
changes in market conditions in the property industry. Developers can adapt and revise their strategy in response to unexpected market developments that cause fluctuations in cash flows, costs and rates of return leading to deviation from original expectations.

Sirmans (1997) opposed the use of DCF technique for property development financial feasibility evaluation on the grounds of its insufficiency for evaluating property projects under uncertainty conditions. Sirmans (1997, p. 95) concluded that,

“The DCF model is not only incomplete, but its use may lead to costly errors. Investors must decide when to invest, how to modify operating plans during the life of the project, and when to sell the investment. Existing research shows that the conventional DCF techniques can be poorly suited for investment valuation in the presence of "real options".

DCF uses deterministic cash flows in the financial evaluation of proposed property development projects. Therefore, there is the assumption of an expected scenario whereas, expectations of property values can deviate from actual property prices upon completion. Property developers normally alter yearly cash flow levels in tandem with potential changes in market conditions during financial modelling, but DCF does not account for flexibility values. It assumes that developers of proposed property development projects will passively be inflexible in their approach to managing development projects.

Flexibility in decision making is valuable in property development but DCF does not incorporate asymmetric managerial decisions that can improve potential positive gains while also minimising downside losses (Trigeorgis & Mason, 1987). Yeo and Qiu (2003) argued that the asymmetry in the probability distribution of NPV or payoff expands the true value of a project by enhancing its upside potential while limiting downside losses. Therefore, Trigeorgis (1993a) suggests that a correct valuation methodology requires an expanded NPV rule which captures both the passive NPV of expected cash flows, and a value component for the combined value of the flexibility represented by the project's real options (flexibilities). Therefore, Expanded NPV = passive NPV + combined option (flexibility) value.

A project with negative NPV is likely to be rejected by any prudent developer but flexibility of managerial decisions or a collection of options (flexibilities) that can aid a revision of management’s future actions, contingent on uncertain future developments introduces an asymmetry or skewness in the probability distribution of NPV, which makes such a project attractive (Trigeorgis, 1993a). The reason is that, contingent claims on an asset do not have the
same discount rate as the asset itself. This asymmetry in the NPV can be properly analysed and determined by viewing flexibility of management’s action in a real options (flexibility) framework (Trigeorgis, 1988, 1991). Any attempt to ignore the value embedded in flexibility or use DCF to evaluate values embedded in flexibility leads to undervaluation (Trigeorgis, 1993b). In sharp contrast to DCF, real options framework explicitly accounts for irreversibility, uncertainty and entrepreneurial flexibility in financial modelling which can be used in decision making, thereby generating superior results.

**Figure 2-7 Value of Management Flexibility**

![Diagram of traditional NPV approach showing symmetric probability distribution of NPV with mode at expected NPV](Figure 2.7(a) is the traditional NPV approach which shows the potential symmetric probability distribution of NPV of a project using a standard valuation method. The passive/static NPV figure for such a project without flexibility would normally be equal to the most likely estimate as prevailing in practice under traditional valuation methods such as DCF. However, the introduction of flexibility including defer, expand, switch and abandon introduces potential upside benefits which enhances a project’s potential future value and results in skewness in the probability distribution of the expected values to the right (Yeo & Qiu, 2003). The value of a project is then NPV 1 (static value) + NPV 2 (the option premium associated with flexibility) as shown in Figure 2.7(b). In evaluating the profitability of a project, the expected NPV 2 captures the value embedded in flexibility because it recognises that real options enable developers to adapt their strategy in property development in the face of uncertainty in order to add value to projects (Yeo & Qiu, 2003). It is through options pricing technique that that the value of flexibility can be calculated separately and accounted for in valuation for property decision making. In general, most property development projects that are initially rejected
under DCF evaluation become financially viable and acceptable when evaluated through options framework due to the value of flexibility. Specific case studies are demonstrated in Chapters 5 and 6 of this dissertation.

2.6 Real Options/Flexibility

In Section 2.4, it was suggested that the current focus of literature dealing with uncertainties and risks, is through flexibility in buildings as a way of ensuring that developers of capital projects can retain rights to capitalise on upside opportunities and at the same time mitigate downside losses. Flexibility also encapsulates construction design of property development projects where property developers can exercise embedded flexibility in the development process to deal with uncertainties. This section of the dissertation discusses background to the development and evolution of real options or flexibility and its applications in different fields with emphasis on property development and related areas. It culminates in discussing areas of application and gaps in the literature. In this section, flexibility and real options are used interchangeably because they mean the same thing and where necessary, a distinction is given between real options “in” and “on” projects.

Options framework gained attention after the seminal work of Black and Scholes (1973) and Merton (1973) which formed the basis for options and derivative pricing. Myers (1977) argued that the value of a firm is dependent on the options to develop real assets and coined the term “real options” to mean the application of option pricing theory to the valuation of investments in “real” physical assets where value is attributable to managerial flexibility in decision making. This is to link together, financial and flexibility in management in order to enhance decision making in capital intensive projects (Myers, 1984). Therefore, real options theory is basically the application of option pricing theory to capital budgeting decisions involving real physical assets where value is attributable to flexibility.

2.6.1 Definition of Real Options/Flexibility

A widely used and accepted definition of real option is given by Copeland and Antikarov (2001, p. 5) as

“...the right, but not the obligation; to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time—the life of the option”
These actions to defer, expand, contract and abandon are flexibilities that can be capitalised upon under conditions of uncertainty to manage projects. Flexibilities or actions are also known as options embedded in capital projects. These flexibilities enable property developers to retain the right to make favourable future choices regarding property developments or investments (Broyles, 2003) and decide on the right course of action based on new information. Therefore, real options theory offers the potential to evaluate property development projects in a way that recognizes the existence of such flexibility and to determine the best way and timing to exercise flexibility to capitalise on upside opportunities and mitigate downside effects of uncertainties on project outcomes.

Guthrie (2009) stated that in a world of volatile market conditions, flexibility to change course due to the arrival of new information including slowing down, discarding and resuming an investment later can be extremely valuable. This is relevant to property development projects where there is an opportunity for developers to exercise rights to pause on the construction of a major development pending resolution of uncertainties, discard projects mid-way due to unfavourable market conditions and resume later or abandon a project entirely to salvage the value of a project under distress. Using a real options analogy to evaluate property development projects essentially means property developers understand the value of flexibility and its impact on property decision making. It is a flexible approach to making decisions in property development based on resolved uncertainties rather than depending on best guess estimates in financial modelling.

In this sense, instead of predicting future occurrences and incorporating those into a development yield/required rate of return which is usually the practice in property development financial feasibility analysis, it is better to prepare for uncertainties and develop strategies to deal with unexpected events. These flexibilities are evaluated as part of financial feasibility analysis. As a result, developers can better manage risks associated with a potentially weak market while also gaining the potential to capitalise on emerging opportunities in a strong market (Makhudu, 2011).

2.6.2 Terminologies in Real Options

Several terminologies and categorisation are associated with the theory of real options. Set out below are explanations for some of the terminologies used in real options. The list is not exhaustive but is sufficient foundation for the focus of the dissertation.
i. A put option is the right but not the obligation to sell a given asset in the future for a predetermined price called the strike price.

ii. A call option is the right, but not the obligation to buy an asset at a given time in the future at an agreed price.

iii. An American option can be exercised on or at any time before the maturity date.

iv. A European option can only be exercised on the maturity date.

v. An option whose value is based on another option is referred to as a compound option.

Source: Amram and Kulatilaka (1999)

2.6.3 When is Real Options Analysis Needed?

Amram and Kulatilaka (1999) list several situations that call for real options thinking. Below are some of the conditions that necessitate the use of real options;

i. ROA is needed when there is a contingent investment decision such as staging a development. No other approach can correctly value this type of opportunity because a subsequent stage is contingent upon outcomes of a previous stage.

ii. When uncertainty is large enough that it is sensible to wait for more information, avoiding regret for irreversible investment.

iii. When the value seems to be captured in possibilities for future growth options rather than current cash flow.

iv. When uncertainty is large enough to make flexibility a consideration. Only the real options approach can correctly value investments in flexibility.

v. When there will be project updates and mid-course strategy corrections.

In effect, real options analysis can be of immense benefit in these situations by incorporating these contingent decisions into a valuation. In property investments, volatility is used to measure uncertainty surrounding an expected return from a property project development and determine their potential impacts on investments. Volatility also has major impact on real option values and it is important to explain and demonstrate how volatility for ROV modelling is computed. Volatility is measured using standard deviation computed from historical returns of property investments (returns of specific real estate asset classes, e.g. residential, commercial and industrial).
2.6.3.1 Volatility

Volatility is a fundamental concept that underpins the theory of real options. It is the most important variable but difficult variable to estimate due to either lack of data on specific underlying assets or unavailability of historical returns on perfectly correlated assets. Copeland and Antikarov (2001) captures it correctly by suggesting that the volatility of gold is not the same as that of a gold mine. The importance of volatility cannot be overemphasized because as volatility increases, so do real option values. It is therefore an important measure for performing sensitive analysis of option values for projects. There are several methods that are used in computing volatility for property investments.

Firstly, volatility can be estimated from historical data of property returns. Another method assigns weight to the historical data in different ways depending on the timing of occurrence of specific observations within the historical data. For example, more weight is assigned to newer observations in data whereas older observations in data are given less weight to account for the non-constant nature of volatility in some methods and these methods are termed as both ARCH and GARCH. Lastly, there is implied volatility method that is used to compute volatility based on the assumption that observed prices of financial securities traded in the market (markets which are sensitive to property prices’ volatilities) are assumed to be proxies for the volatility (Guthrie, 2013). For example, the volatility of certain property investment trusts (REITs) can be used as implied volatility for real estate assets due to the impact of changes in values of REITs on such assets. Therefore, given a proven model such as the Black-Scholes (B-S), the implied volatility is computed as the level of volatility which sets the price predicted by the B-S equal to the observed price incorporating market expectations.

Because of its importance in ROV, several researchers have studied ways of computing it. For instance, Godinho (2006) analysed the existing procedures for applying a simulation method for calculating volatility, concluding that the methods will lead to an upward bias in the volatility estimate. Copeland and Antikarov (2001) presented a method to calculate the volatility parameter in ROA that adopts simulation to develop a hypothetical distribution of one-period returns in the absence of historical distribution of returns for an underlying asset. Vimpari and Junnila (2014a) also used the GARCH approach to estimate volatility for the valuation of an option to delay the sale of a residential project. The concept of volatility estimation of real option valuation has been extensively reviewed (Guthrie, 2013).
2.6.3.2 Risk Free Rate

Merton (1973), Copeland and Antikarov (2001) and Luehrman (1998) specified that the value of an option is a function of five variables: the value of the underlying asset, the exercise price or cost of project, the time to exercise or expiration of option, the volatility of the underlying asset and the risk-free interest rate. Thus, without the risk-free interest rate, computation of real option values may be impossible. The use of risk-free rate is primarily due to the risk neutral valuation approach adopted by ROV methods for valuing flexibility. Surprisingly, it is the variable that is not discussed greatly in academic literature on real options, though vital in computation of values associated with flexibility. Usually, the risk free rate is measured as the return on short-term securities such as 91-day US treasury bills or bonds (Husted, 2005). Due to differences in local dynamics, it is measured as the return on short term securities issued by the government of the specific country where the asset is located. As the risk free rate increases, the value of option increases (Copeland & Antikarov, 2001). Because the exercise price is paid in the future, as the risk-free interest rate increases, the present value of the exercise price decreases, hence increasing the value of the option itself. Therefore, it is one of the important variables for the computation of real option values for projects.

2.6.4 Typology of Real Options/Flexibilities

Several real options exist in capital intensive projects and this is corroborated by Paxson (2005) who further argues that flexibility is valuable. A typology of flexibilities existing in capital intensive projects has been developed to include flexibility to defer, contract, expand, temporary shutdown, abandon, switch input, switch output and compound option (Trigeorgis, 1996). The typology of flexibilities existing in capital intensive projects was adapted by Lucius (2001) for the development of property specific flexibilities. Lucius (2001) argued that real options can be distinguished in terms of flexibility options and growth options. Flexibility options include operative options to cope with a development project. For example, an option to defer, switch input, temporary shutdown, contract, abandon, expand, stage investment, switch output and compound options is embedded in a development project and can be used to cope with a project under conditions of uncertainty (Lucius, 2001). Furthermore, Lucius (2001) indicated that growth options involve strategic flexibilities at the highest level of management, for example portfolio acquisition or business expansion.
The next sub-section discusses the different typologies of options under the following headings: flexibility to defer; staging option; flexibility to alter operating scale (expansion and contraction); option to abandon (put option); flexibility to switch (input and output); growth options/flexibility; and multiple interacting options (compound options).

2.6.4.1 Flexibility to Defer

This type of flexibility is valuable in highly volatile markets where it may be optimal to invest at a later point in time resulting from learning new information about a proposed property development project. Flexibility to defer is defined by Trigeorgis (1995, p. 5) as analogous to an American call option on the gross present value of a completed property project’s expected cash flows with the exercise price being the required initial investment. As both uncertainty and irreversibility increase, the value of flexibility to defer increases, lowering the likelihood of embarking on a project by a developer (Folta et al., 2006). Depending upon the values of various parameters used in determining the value of flexibility to defer, the difference at the optimal exercise point between the developed value and the construction costs can be considerable (Williams, 1991). For example, a property development firm can defer the right to develop a vacant land pending improvement in property values in times of recession. When property development values are uncertain, flexibility to defer the start of a project to a later date has value which may potentially be greater than the cost of waiting. In order to determine whether to wait or commence a project, the developer compares lost operating income and holding costs from waiting, to the benefits of reducing the chance of an "incorrect" development decision (Holland et al., 1995). Since the embedded flexibility to develop never expires, a developer would only exercise to develop at the optimal time when developed property’s value, as determined by the difference between the present value of cash inflows and outflows exceed costs of development.

2.6.4.2 Staging Option

This type of option allows the option holder to implement a project using a step-by-step investment approach within a project to respond to unfavourable market conditions in order to capitalise on the upside potential and cap downside losses (Schulmerich, 2010). Essentially, having flexibility in decision making such as staging property developments allows developers to take advantage of favourable future opportunities. Staging flexibility ensures property developers are able to dynamically respond effectively to changes in the business environment.
against adverse market developments in an increasingly uncertain property market (Trigeorgis, 2005). Property development just like any irreversible investment activity is characterised by uncertainty and sequential activities occurring at different times. A notable feature of property development projects is decisions associated with cash outlays occurring sequentially over a period. It is therefore important to view the various stages as different components of a whole rather than as a single entity.

The firm’s investment problem is to select a contingent plan for rolling out these sequential and irreversible expenditures over time (Majd & Pindyck, 1987). As property development is characterised by sequentially staged approach, staging flexibility is embedded in the process. Dependent on the arrival of new information relating to market conditions and other factors that can negatively impact on a development project, a developer might alter the cash outflow schedule originally planned by either expanding or contracting the size of a project, better still simply stop the project midway (taking into consideration contractual and legal implications—purchase, finance and construction contracts) to forestall any anticipated losses (Majd & Pindyck, 1987). The staging of projects as a series of capital outlays over a period of time creates a valuable option to default at any given stage should the unexpected happen (Trigeorgis, 1995).

2.6.4.3 Flexibility to Alter Operating Scale (Expansion and Contraction)

This type of flexibility is embedded in property projects when there is an opportunity to alter a course of action during the process of development in response to market changes. High rise residential property developers can respond to favourable market changes by expanding the scale of a development project (subject to planning permit approval and alteration to signed contracts as required with attendant costs). In an unfavourable market, developers can reduce the scale of a development project. For example, a proposed development project can have about 50,000 square metres as the total lettable area upon completion. Due to changing market conditions, a property developer may decide to scale up by expanding the total leasable area of a project, but this requires an initial investment in flexibility in order to retain the right to exercise the option. As an opportunity emerges from uncertainties, a developer having this flexibility may choose a specific course of action in line with new information. If market conditions are unfavourable, the option expires (Barnett, 2005). In view of this, property developers having flexibility to alter course to salvage a situation when the unexpected happens can be valuable.
2.6.4.4 Option to Abandon (put option)

In prolonged unfavourable market conditions, a property developer has the right to abandon a development project mid-way and salvage its value. Copeland and Antikarov (2001) argue that flexibility to abandon is likened to a firm (developer) having the right, but not the obligation, to rid itself (him/herself) of a risky asset at a fixed predetermined price in future. The flexibility to abandon a development project is normally a put option because it is a right to dispose of an asset and the value of a development project can change substantially when abandonment flexibility is considered (Schulmerich, 2010). The value of an abandonment option is determined by analysing the difference between the cost of abandonment before completion of a development project and the cost at the time of completion. Since abandonment saves a portion of the total development cost, it is expected that all things being equal, expenditure incurred already should be lower than the total development cost to justify the abandonment option (Li et al., 2015). This is specific to project costs without consideration of potential costs of lawsuit, compensation etc. In any case, a prudent developer will consider all costs and compare to value before deciding on the abandonment option. If sunk costs are recoverable, property developers can have the flexibility to invest in different assets at different times and divest assets at will because downside economic losses are completely limited by the flexibility (Li et al., 2015). However, because investments in property projects are normally irreversible to certain degree, as irreversibility increases, exit value decreases and the option value of abandonment is reduced (Dixit & Pindyck, 1994).

2.6.4.5 Flexibility to Switch (Input and Output)

Switching flexibility is twofold: switching input and output. Schulmerich (2010) argues that real option comprises of the possibility to react upon changed market conditions by either switching inputs or outputs. In this sense, a property developer who invests in flexibility can alter the materials for a development project to ensure that there is an economic value capable of changing the fortunes of a distressed project. Similarly, switching output is mostly in context of changing the use of a development project. For example, in property development, a developer can decide to switch a hotel into a retirement village if market indicators are positive for such a switch. Switching input flexibility is generally a put option but switching output flexibility is deemed a call option. As compared to traditional financial techniques of project evaluation, real options analysis propose that the strategic value of switch input option increases with salvage value and future uncertainty (Berger et al., 1996, Myers & Majd, 1990).
This positive effect of switching option on investment propensity is particularly important to investment decisions concerning multi-stage projects (Chi & Nystrom, 1995; Schwartz, 2003).

2.6.4.6 Growth Options/Flexibility

Growth options embedded in property development projects are investments often made not only for immediate cash flows from a project but to serve as a platform on which future investment opportunities can be derived and capitalised for profit. Such future flexible investment opportunities intentionally created by developers are growth options. A flexibility exercised to create a future option based on initial investment is a growth option (Amram & Kulatilaka, 1999). Growth options are strategic flexibilities and as such they embed the advantage of generating lucrative future opportunities for developers. Property development firms can establish smaller branches in foreign markets with the aim of expanding later when conditions are favourable (Chang, 1995; Kogut, 1983) and these can be termed as growth flexibilities. This type of option is considered as a call option where an investor has the right but not the obligation to embark upon a course of action which is profitable in the future.

2.6.4.7 Multiple Interacting Options (Compound Options)

Multiple interacting flexibility is a combination of real options of the types described above. In practice, of course, they are the most common ones because property projects present themselves as a set of different flexibilities rather than a single option. Trigeorgis (1993a) suggest that managerial flexibility embedded in development projects typically takes the form of a collection of flexibilities. As a result, a developer considering investing in a development project has the option to defer an investment until uncertainty is resolved, stage investments and choose the optimal time to build, switch inputs and outputs when demanded, and abandon to salvage a distressed project.

The combined option value of all options embedded in a single project may differ from the sum of separate option values through their interaction (Trigeorgis, 1995). This is the non-additive principle of options interaction in irreversible investment projects such as property development as indicated by (Trigeorgis, 1993b). Therefore, incorporating such flexibility in property development is designed to give developers the right to choose the nature and timing of development based on quality information from the market. Flexibility affords developers opportunity to make informed choices in the future, with situational changes, to determine the optimal timing and scale prior to undertaking investments (Throupe et al., 2012).
In Summary, flexibility (design process delivery) allows developers to treat property development as an option to wait and see and develop property projects capable of mitigating loses and capitalising on potential future gains. As a result, flexibility allows developers to better manage uncertainties and risks associated with unfavourable market when property development commences, while also retaining the flexible right to benefit in a favourable market such as one with rising property values. However, these flexibilities in property development based on (Lucius, 2001) categorisation is incomplete because there are others embedded in sales, leases and structural flexibility that were omitted from the categorisation developed with a focus on property projects.

Furthermore, the specific stage in a property development process where flexibility is embedded and can be exercised is unclear from the categorisation given by Lucius (2001). Baldi (2013) also developed a conceptual model for categorising flexibilities in property development and focused on the construction stage of the development process only. The paper used a matrix-like approach to categorise flexibilities based on timing and scale of a flexibility. This categorisation did not consider the entire property development process and as a result, there is the need for a new model that captures all flexibilities embedded in property development projects from inception to completion. The aim is to have a visual aid to deepen the knowledge of practitioners and enhance adoption of ROA/ROV in practice.

2.6.5 Real Options “in” and “on” Projects

Flexibility has become an important concept in property, construction and infrastructural development leading to another conceptualisation. This conceptualisation focuses on flexibility embedded in both the process of design delivery of property development projects and structural flexibility of properties to adapt to changing market conditions. Wang and de Neufville (2005) referred to the general typologies such as defer, expand, abandon etc. as options “on” projects which are mostly concerned with the valuation of development opportunities to determine the viability of proposed property projects by delivering accurate value to make sound investment decisions. As a result, several applications of real options “on” projects are generally focused on computing values associated with flexibility embedded in projects and comparing same with NPV to determine option premiums for sound investment decision making. Several examples of ROA applications in property are expounded in Section 2.6.6.
On the contrary, real options “in” projects are flexibilities created by changing the actual design of a development project in order to achieve design flexibility to meet future demands from a structure (Wang & de Neufville, 2005). In view of this, Wang and de Neufville (2005) argued that accurate values associated with design flexibility are not important as compared to the specific flexibility that should be embedded in a property development project in terms of design delivery. In general, defining real options in practice “on” projects such as defer, expand, and abandon are quite straightforward, but it is very difficult to define real options “in” projects due to the variants of designs that can be embedded in a single project to make it flexible to adapt to changing conditions. Design delivery flexibility can be thought of as an inherent strategy during the process of residential property development when market conditions change. As a result, the determination of values associated with flexibility is also not straightforward as compared to the cost. This dissertation is focused on using ROA to compute values attached to flexibility in property development.

The literature on real options “in” projects is still growing, and this has been referred to as building flexibility. Building flexibility can be achieved through the introduction of mobile walls, flexible floor plates, new technologies, better planning methods and open building design (Vimpari et al., 2014) during the early design stages of property development. Building flexibility is not apparent and therefore requires conceptualization of uncertainties through critical analysis of design flexibility, determining input parameters, methodology and application for decision making. The body of techniques used to value flexibility in the deployment of technical systems such as property and infrastructure is called real options analysis (ROA) (de Neufville et al., 2006). In this dissertation, application of ROA to specific case studies will include real options “on” projects and real options “in” projects to expand the growing literature.

2.6.6 Real Options/Flexibility Applications in Property

The application of real options (flexibility) to real life cases in property development and investment can be grouped into different areas. Vimpari (2014) suggested the groupings into vacant land valuation, general application to property markets, building flexibility, lease contracts and technology investments in the property sector. In view of this, the different groupings and applications in property sector are explored in subsequent sections.
2.6.6.1 Land Valuation

Over the last couple of decades, aside from the derivation of differential equations for delivering real options solutions, several attempts have also been made to apply real options theory to real life cases to prove the applicability of the method in practice. Applications to land development can be found in the literature including studies by Titman (1985) who first studied flexibility application to land use decisions and used OPT to value land as an option. Clarke and Reed (1988) applied flexibility to land development under uncertainty and derived positive results compared to traditional valuation methods. Geltner (1989) used dynamic programming to evaluate flexibility in land development and suggested a model for pricing real options. Geltner (1989) explained that the theoretical weaknesses in the model makes it difficult to achieve practical application. As a result, there is the need to empirically test the application of the real options model to valuation and property decision making in practice.

Similarly, Williams (1991) applied ROA to property by valuing vacant land as an option. Williams (1991) derived a partial differential equation capable of determining the optimal density and time at which a developer may develop vacant land. The results of the study differed from solutions derived using standard valuation methods (DCF) leading to a conclusion that the real options approach delivers better results than the DCF. Thus, DCF is important for development valuation analysis but the does not incorporate the value of flexibility.

Quigg (1993) later extended the model of Williams (1991) by adding fixed cost to the total cost of construction and empirically tested ROA in practice. Using data on 2700 land transactions in Seattle, a mean option (time) premium of 6% of the theoretical land value was determined. Quigg (1993) concluded that valuation of urban lands should include option values. Capozza and Li (1994) also applied ROA to determine the intensity and timing of land development. By varying the intensity of development, Capozza and Li (1994) showed that intensity interacts with timing of development, taxes and project values. Chiang et al. (2006) studied embedded options in Hong Kong auctioned land prices by applying both hedonic pricing model and ROA. Based on a one factor contingent claim valuation model developed and tested by Sing and Patel (2001), it was found that embedded timing options in land development had an average premium of 28.75% for the office sector, 25.75% for the industrial sector and 16.06% for the retail sector. Leung and Hui (2002) examined embedded options in real estate projects in Hong Kong. Real option to defer embedded in the project was valued using a binomial option pricing
method. Yu et al. (2002) developed a real options model and used it to empirically evaluate options premiums associated with five selected “white sites” in Singapore.

In addition, Chiang et al. (2006) found that land auction prices have embedded option value in waiting to develop. Moreover, the option premiums calculated also had a positive relationship with implied volatility. They suggested that DCF cannot capture the value of options to defer, abandon, expand, contract, or switch that are available in property developments. A model was developed by Rocha et al. (2007) that determined the optimal strategy whether sequential or simultaneous to the development of a residential housing project in Rio de Janeiro. It was concluded that, the sequential strategy resulted in an uplift of the value of the project by 10% while limiting the exposure to risk in excess of 50%.

The study of Grissom et al. (2010) integrated option pricing approaches with land use decision in a case study of single and mixed use developments on same land. It was found that analysing development using real options framework was valuable as it impacted on the bidding price of land when different strategic options are adopted. Geltner and de Neufville (2012) demonstrated the value of horizontal phasing of an urban real estate development project using the certainty equivalence approach of the binomial option pricing method combined with Monte Carlo simulation analysis. Baldi (2013) adopted the binomial options pricing method to evaluate the options portfolio embedded in a greenfield development and found both the deferral and expansion options contributed about 16% and 8% respectively to the value of the development. A portfolio approach however revealed that a developer has the chance to increase the project value by 31.1% through an expansion strategy using the options framework as opposed to DCF.

Shen and Pretorius (2013) constructed an option pricing model for real estate development by considering and incorporating institutional arrangements, direct interactions and financial constraints. Through application of the model, the authors found that contractual covenants, positive synergies between properties and financial status of a firm, which enhance or restrict real flexibility embedded in development land, influence project value and investment timing.

Yao and Pretorius (2014) developed and tested a long dated American call option pricing model for valuing development land under leasehold. Using 10 case studies involving purchase, holding, converting and developing land drawn from Hong Kong, the authors analysed and tested for optimal exercise of the long-dated American call option. The findings showed a positive mean option premium value of +5.27% in the selected cases.
2.6.6.2 Property Lease Contracts

Grenadier (1995) developed a framework for pricing real options in lease contracts and showed that the model can determine the equilibrium lease rates for practically any type of lease and lease term. A generalized option pricing model was developed by Grenadier (1995) for pricing a wide variety of leasing contracts, including the option to cancel, forward leases and lease insurance contracts. One common clause, ‘an upward only review’ in UK leases has also been evaluated through the options framework by first considering case studies in the UK and analysing them from an international perspective (Ward & French, 1997, Ward et al., 1998). Buetow and Albert (1998) analysed the appropriate partial differential equation (PDE) which models an option to renew or purchase a property at the end of a lease.

Ashuri (2010) developed a real option model for the valuation of flexible leases with options to expand, contract and cancel using possible changes in rents and firm’s required space as sources of uncertainty. Findings from the study indicated a strong need for the use of real options in the signing of lease agreements by firms that face uncertainties in entering new markets with respect to space needs. Flexibility afforded a corporate tenant in the face of uncertainties is valuable and can only be determined using ROA. Whereas Sing and Tang (2004) used a multi-period binomial option pricing method to examine the default risk options in office leases, Sing (2012) evaluated embedded options in percentage lease agreements in the retail sector.

2.6.6.3 Building Flexibility

Another area of application of the theory of real options is the design of flexible spaces in property development. Justification of investments in flexible designs where an initial expenditure is required to retain an opportunity to capitalise on future changes in design of property developments is always problematic. On the flexibility to switch option, an application on a construction project has been evaluated by Trigeorgis (1993b) which concluded that the value of the flexibility to switch was almost 7% of the project’s gross value. Gann and Barlow (1996) argued that there is the need to incorporate greater flexibility in buildings to meet unforeseen changes in use after examining the potential use of redundant offices in the UK. Technical constraints on their own are rarely insurmountable but the cost of making necessary changes may often be higher than other choices such as demolition and new building (Gann & Barlow, 1996). It implies that determining values associated with flexibility
is not straightforward because the values are tied to future opportunities. Furthermore, Patel and Paxson (1998) evaluated switching real options for a leisure development in a restricted sequential time context and found positive results.

Leung and Hui (2002) evaluated several option types including the value of embedding the option to switch a part of a hotel on Hong Kong Disneyland project. It was found that the value of switching option was HK$107.4 million representing 7.7% saving of the loss value and 0.56% of the gross development value of the project. Even though the evaluation suggested that there was the possibility of losses, the switching option mitigated the total losses. Paxson (2005) also found similar results in an application of the switching option in property investments. Cheah and Liu (2005) evaluated several options including switching of fuel in a large infrastructure power project and concluded that the switching option of fuel between gas and naphtha overtime had great influence on the cash flow of the project and amounted to about 4.2% of the base NPV calculated for the project.

Greden and Glicksman (2005) developed a model capable of justifying expenses in flexible design of a property that could be renovated into an office block at a specified cost in the future. Both the binomial lattice technique and Monte Carlo simulation were employed in the valuation. The results showed that it was worth investing US$40 per square foot in initial investment expenses to acquire the right to renovate into an office space in future. This justified the need for practitioners to consider flexibility in initial designs that has the potential to respond to future changes better than subjective forecasts of the future.

Likewise, de Neufville et al. (2006) evaluated the flexibility of expanding a parking garage to meet future demand. It was argued that the value of flexibility added to the project was in excess of US $2.25 million. Guma et al. (2009) using four case studies in the US, demonstrated the potential value of vertically phasing a corporate real estate building. The study found that, vertical phasing is valuable because it is capable of limiting downside risks of corporate organisations through expansion. Fawcett (2011) indicates that a more systematic understanding of flexibility is offered by lifecycle options, which unify all aspects of flexibility and allow the value of flexibility to be quantified. Dortland et al. (2012) studied different kinds of flexibility and used qualitative analysis to argue that options and scenario analysis can aid in the management of uncertainties. Throupe et al. (2012) adopted a switch-option valuation analysis to compare the return on investment (ROI) for a building as planned or switching to a
different property mix conforming to allowable zoning codes. The authors suggested the use of options pricing to determine the exact time for development.

Cardin et al. (2013) demonstrated that design flexibility has practical implications on the property industry especially relating to development projects. The study adopted a flexible design approach by developing a catalogue of possible designs for complex property projects in the face of uncertainties emanating from market sources, regulations and technology. A case study was used to test the design catalogues and Cardin et al. (2013) found that the model recognised the value of flexibility and improves the economic life span of buildings as compared to standard benchmark designs for development projects. Cardin et al. (2013b) suggested ways of achieving design flexibility and argued that such simple, intuitive and efficient procedures can enhance life cycle performance of buildings.

Vimpari et al. (2014) explored how real options analysis can be used for valuing flexibility in a real retrofit investment case and found that investments in flexibility were profitable depending on the scenario analysed. Vimpari and Junnila (2016) argued that physical adaptability of buildings is important but current investment analysis using DCF does not incorporate enough information on physical asset characteristics which leads to long term loss of competitiveness and imprudent use of built environment resources. As a result, they proposed a theory that combines ROV, investment analysis and building component life-cycle design to formulate a conceptual framework for valuing life-cycle investments that incorporates flexibility in buildings.

2.6.6.4 Technology Investment

An emerging area in the property sector where ROA has been applied is technology investments in energy efficiency and building retrofitting. Greden et al. (2005) evaluated the flexibility of converting a naturally ventilated building into a mechanically ventilated building. Fleten et al. (2007) presented a methodology for evaluating investments in decentralized renewable power generation under conditions of price uncertainty. Results from a case using wind power generation for an office building indicates it is optimal to wait for higher prices than the net present value break-even price under conditions of price uncertainty. van der Maaten (2010) evaluated whether policy incentives to invest now, rather than tomorrow can be designed to compensate for any option value to defer. The findings indicated that subsidy programmes by the Dutch government properly compensates investors for the real option value.
they forego by exercising the option and investing in a solar hot water system. Ashuri and Kashani (2011) used ROA to evaluate “Solar Ready Buildings” that can easily adopt PV panels later in future at the optimal time by incurring initial investments and waiting until the right time. Hillebrand et al. (2014) applied ROA to a university building retrofit and found that the energy, ecological and economic efficiency evaluation shows that a generally preferred retrofit option cannot always be identified. Vimpali and Junnila (2014b) also applied ROA to evaluate green building certificates as real options and argued that real option valuation methods are appropriate to assess the monetary value and the uncertainty of a green building certificate.

2.6.6.5 Real Estate Markets

General applications to real estate market dynamics are found throughout the literature. Grenadier (1996) developed an equilibrium framework for strategic option exercise games with a focus on the timing of real estate development and explains why some markets may experience building booms in the face of declining demand and decreasing property values. Lai et al. (2004) used ROA to examine the risk-return relationship of the presale system of development and argued that presales prevent new developers from entering into a market. Wang and Zhou (2006) also derived a closed-form solution for an equilibrium real options exercise model with stochastic revenues and costs for several property markets including monopoly, duopoly, oligopoly and competitive markets. Lai et al. (2007) showed that developers’ exercise strategies can be affected by the size and the type of property markets using a real options model. Bulan et al. (2009) examined the extent to which uncertainty delays property investment and the effect of competition on this relationship. It was found that increases in both idiosyncratic and systematic risk lead developers to delay new property investments.

Fu and Jennen (2009) showed that the effects of real interest rates and the expected demand growth on hurdle rent become more negative when the market volatility is greater using real options framework. Ott et al. (2012) presented a real options model that estimates the optimal phasing and inventory decisions for large-scale residential development projects. Clapp et al. (2012) measured the value of the option to redevelop and found a positive association between option values and drift in house prices. Clapp et al. (2013) analysed the relationship between house price dynamics and option to rebuild or enlarge established dwellings. Results indicated that there was positive relationship between properties with high development potential and increased option values. Clapp et al. (2014) analysed the determinants of expansions and
contractions of shopping centres. Findings showed that expansions and contractions of gross leasable area are less likely for large shopping centres in the study area with greater uncertainty about property prices, suggesting that the option to delay has value.

Vimpari and Junnila (2014a) also evaluated an option to wait embedded in the active management of a residential real estate fund divestment. The option value derived was 6.6% which represented the value appreciation that would be achieved, should the multiple transaction strategy be adopted. Vimpari and Junnila (2014a) further argued that standard industry valuation approaches including DCF misses out on the value of this flexible approach to divesting a portfolio of assets in a real estate fund. In a more recent study, Geltner et al. (2017) empirically estimated development asset value index (DAVI) for commercial property and compared it with a corresponding traditional transaction price based hedonic property asset price index (PAPI) which has been corrected for depreciation within the same geographical real estate market. It was argued by the authors that the difference between the DAVI and PAPI reflects the realized value of timing flexibility embedded in land development from the options perspective.

These applications are important to demonstrate the potential of real options theory and its valuation models for the financial feasibility evaluation of property development projects and other embedded flexibilities. Unfortunately, real options theory and valuation still lacks practical adoption in Australia. Surprisingly, none of these case study applications used data from the Australian property market. As a result, a thorough literature search has revealed that despite the potential of real options theory, practitioners in the Australian property development market lack the evidence of practical applicability of ROV models for property development valuation. This is reinforced by Geltner and de Neufville (2012) who suggested that there should be practical applications of case studies from elsewhere around the world particularly the Asia Pacific region. de Neufville and Scholtes (2011) argued that ROV models are far from perfect, therefore, there should be extensive applications to improve the models.

Again, justification of investments in flexibility for risk mitigation is a new concept of which valuation is yet to be proven. It is important to test whether ROA can evaluate building flexibility to develop the required evidence to achieve practical adoption of ROA in practice. Besides, if embedded flexibilities have value and proven though case studies, there should be acceptance by the property development industry and the valuation community. Evidence of any flexibility concept acceptance among property practitioners in Australia is yet to be
investigated. Beyond the evidence from case studies and acceptance of flexibility by practitioners, factors that may serve as catalyst or inhibit adoption of ROA in practice is yet to be identified in the Australian context because practical adoption of ROA is still limited despite the numerous cases study applications from the US property market.

### 2.7 Summary

The Chapter focused on discussing key literature on property developments, uncertainties in property development and how uncertainties impact on the forecasts that are used for property valuation. The two main property valuation methods used for property development financial feasibility were discussed with emphasis on DCF which is the most widely accepted in practice. Furthermore, the inability of DCF to evaluate the value of flexibility embedded in tomorrow’s opportunities was examined with a conclusion that ROA is better suited for the valuation of flexibility. ROA has been discussed in detail especially the typologies of flexibilities, distinction based on real options “in” and “on” projects, terminologies and when options should be considered in decision making.

Several leading authors have applied ROA in the property sector which is used to establish the gaps in knowledge for meaningful contribution to the growing literature on RO. Despite the applications demonstrated by leading authors, practical application of ROA to residential property development projects has not found favour with practitioners. In order to deepen the understanding of property development practitioners and achieve practical adoption of ROA in the property sector, Vimpari (2014) suggested that the development of a model to serve as a manual for easy identification and quantification of flexibility in property development. Deficiencies in the classification developed by Lucius (2001) and the conceptualisation of real options during construction stage of a development project (Baldi, 2013) gives impetus to the development of another model for ease of identification of flexibilities and quantification of option values for decision making. This dissertation develops a classification of flexibilities embedded at different stages of property development in a flow network. Practitioners appreciate the property development process, therefore, it is argued that embedding flexibilities in the process of property development would enhance the identification of different flexibilities at different stages of a development and deepen practitioners’ understanding.

Furthermore, leading authors have suggested that more cases are needed to further prove the potential of ROA in the property sector in empirical settings as a viable alternative valuation
method (Geltner & de Neufville, 2012, Lucius, 2001, Vimpani, 2014). This dissertation evaluates three different case studies using ROA to test the practical application of the method using data from the Australian residential property development market. The benefit of the application is to deepen the theoretical underpinnings of the method by finding new results from a new property development market and deliver evidence needed to convince practitioners of ROA’s potential. The case studies are spread between options “in” and “on” property development projects to ensure a broad spectrum of application. These case studies are new applications because the author is unaware of any application of ROV techniques to residential property development valuations in Australia.

Lastly, in conformity with the direction of current research which is investigating ways of integrating ROA framework in mainstream evaluation of property development in practice, this dissertation aims to determine ways of achieving adoption of ROA in practice. This is the first attempt to elicit information from practitioners regarding a means of adopting the method in practice.
Chapter 3 Research Methodology

3.1 Introduction

An important aspect of any dissertation is the demonstration of how the research aims and objectives were achieved which assists to determine the fitness of the methodology for the study. Since methodological fit is based on objectives and research questions of a study, it is worthwhile re-examining the research questions of this dissertation and how they are aligned with the philosophical worldview and research methodology chosen to accomplish the aims of the dissertation.

Table 3-1 Research Questions and Approaches

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) What is the main approach to uncertainty and risk management adopted by Australian residential property developers?</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(II) How does RO theory improve uncertainty and risk management in residential property development?</td>
<td>Conceptual framework - Practitioners’ validation</td>
</tr>
<tr>
<td>(III) Using residential case studies, is RO theory supported in residential development projects, compared to conventional property development evaluation techniques?</td>
<td>Quantitative with selected embedded case studies</td>
</tr>
<tr>
<td>(IV) How would different property stakeholders justify investment in building flexibility for uncertainty and risk management in residential property development?</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(V) What factor(s) are required to integrate ROA models into residential property development financial feasibility evaluation?</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(VI) What are the potential barrier(s) to adoption of RO theory in practical decision making in Australian residential property development?</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
</tbody>
</table>

Source: Author, 2017

Table 3-1 shows the appropriate methodologies for answering the different research questions. Question (I) uses the qualitative semi-structured interviews to derive answers. Research question (II) adopt a conceptual framework approach to evaluate the superior risk management capability of RO theory over DCF. It further uses the discussion of results on the case study evaluations to augment the risk enhancement capability of RO theory. Research question III uses quantitative methodology with embedded case studies to examine the applicability of RO
models to Australian property developments. Lastly, research questions (IV)-(VI) adopt semi-structured face to face interviews to answer the questions.

Table 3-1 further shows that the dissertation is in two parts; quantitative and qualitative. In the quantitative part, the dissertation quantitatively determines the values of different types of flexibilities (real options both “on” and “in” projects) embedded in three different high rise residential property development projects. This will enable the determination of applicability of real options theory to high rise residential property development projects in Australia and deliver the evidence needed by industry practitioners for adoption of ROA for decision making. Due to the mathematical nature of models (ROV and DCF) for financial evaluation of high rise residential property development projects, the quantitative approach is well suited for the case study evaluations. Similarly, because the results from the case study applications embed risk management strategies, the discussion on the results from the applications will also answer the research question which seeks to unravel how RO theory enhances risk assessments as compared to DCF in high rise residential property developments in Australia.

After testing the applicability of RO theory in empirical settings, the dissertation also seeks to solicit the views of practitioners on adoption of real options theory in practice in the Australian residential property development sector. This is achieved through interviewing industry practitioners regarding issues needed to be addressed in order to make a case for the adoption and integration of ROA/ROV in mainstream financial feasibility evaluation of high rise residential property developments in Australia. The qualitative method best fits to answer research questions I, IV, V and VI on the requirements to achieve practical adoption, justification of investments in building flexibility and determination of potential barriers to adoption in practice. Therefore, the research strategy adopted for this enquiry is embedded mixed method design where the qualitative method is embedded in the quantitative method via case studies.

### 3.2 Research Design

Generally, a research design involves the plan a researcher uses to conduct a particular study. As supported by O'Leary (2014), research design is a plan that includes the methodology, methods and tools used for conducting a research. Moreover, philosophical assumptions or research paradigms, research strategy of enquiry and methods selected to complete a research are also included in a research design. Creswell (2014) described research design as a
framework of interconnectivity between research paradigms, research strategies and research methods. In Figure 3-1, a research framework proposed by Creswell (2014) shows the connection between the three main elements of a research framework.

**Figure 3-1 A Research Framework**

![Diagram of research framework with philosophical worldviews, strategies of enquiry, research designs, and research methods.]

There is a relationship between all the components of the framework, hence the choice of a philosophical worldview dictates the strategy of enquiry to use and likewise the research methods. For example, in Figure 3-1, postpositivist researchers believe in objectivism and as a result, studies that adopt positivism tend to use quantitative strategies. These strategies may include but not limited to the use of existing quantitative models or longitudinal studies. Since positivists are purely quantitative researchers, research questions are usually designed to measure a cause and effect or the impact of changes in certain factors or variables on another dependent variable. For example, the impact of changes in interest rates on home values.
Usually, data for quantitative studies are collected from either an existing database provided by third party institutions or via the use of survey questionnaires using large sample sizes. Data analysis is usually through statistics, interpreted and generalised to the entire population for the specific study. The validation stage of a quantitative study is achieved through a replication of the study to confirm an earlier result or generate new findings for further studies. This demonstrates the relationship between the different components in Figure 3-1 and how they are interconnected in a single research.

3.3 Research Assumptions and Methodology

Research has been influenced by several schools of thought that have become known as philosophical worldviews. These philosophical worldviews are also referred to as research paradigms. They are generally an orientation of a researcher or a group of researchers and their approach to finding answers to research questions and objectives. In this section, the dissertation focuses on giving a working definition of research, discusses the different research paradigms, positions the dissertation into a specific research paradigm and identifies a research strategy enquiry that best fits for executing this dissertation.

3.3.1 Research Paradigms

There are four main research paradigms or philosophical worldviews. This includes positivist or post positivism, transformative, constructivism and pragmatism (Creswell, 2014). Creswell (2014) suggested that a research paradigm is a general philosophical orientation about the world and the nature of research that a researcher brings to a study. These worldviews underpin the thinking and disposition of researchers and how the world is perceived by specific types of researchers. In describing different approaches to research in these various categories of philosophical worldviews, attention is paid to the salient characteristics of specific studies that employ each of these worldviews for research.

In Table 3-2, four research paradigms are delineated with their characteristics in order to guide their use in research. Creswell (2014) suggested that post positivism is associated with a deterministic set of assumptions, being reductionist and empirically obsessed. Constructivists on the other hand generally do not start with a theory but, inductively develops a theory out of making meanings about participants’ view of the world and it is generally qualitative. Whereas the advocacy and participatory worldviews argue that research must be conducted with political inclinations and tilted towards the marginalised in society, pragmatism as a worldview arises
out of actions, situations, and consequences rather than antecedent conditions, similar to post positivism but with additions of qualitative views (Creswell, 2014).

**Table 3-2 Research Worldviews and their Defining Characteristics**

<table>
<thead>
<tr>
<th></th>
<th><strong>Post positivism</strong></th>
<th><strong>Constructivism</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Determination</td>
<td>Understanding</td>
<td></td>
</tr>
<tr>
<td>Reductionist</td>
<td>Multiple participant meaning</td>
<td></td>
</tr>
<tr>
<td>Empirical observation</td>
<td>Social and historical construction</td>
<td></td>
</tr>
<tr>
<td>and measurement</td>
<td>Theory generation</td>
<td></td>
</tr>
<tr>
<td>Theory verification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political</td>
<td>Consequences of actions</td>
<td></td>
</tr>
<tr>
<td>Power and justice oriented</td>
<td>Problem-centred</td>
<td></td>
</tr>
<tr>
<td>Collaborative</td>
<td>Pluralistic</td>
<td></td>
</tr>
<tr>
<td>Change-oriented</td>
<td>Real world practice-oriented</td>
<td></td>
</tr>
</tbody>
</table>

Source: Creswell (2014)

The pragmatist worldview allows a researcher to combine the assumptions underpinning the other philosophical worldviews of research in a single study. Pragmatism worldview underpins this dissertation because it draws liberally from quantitative and qualitative assumptions to answer the research questions (Creswell, 2014). This worldview considers what works at a time based on the objectives and questions that are to be answered and generally uses the mixed methodology approach. Researchers focus on the research problem and adopts all approaches capable of answering research questions (Rossman & Wilson, 1985). It is argued that pragmatism is the main driver behind the mixed methods approach (Teddlie & Tashakkori, 2010). As the research objectives are the driving force behind the selection of assumptions for a study, the pragmatic assumptions are well suited to and therefore adopted for this dissertation because the research objectives fall into the domain of both post positivism and the exploratory domain of subjectivism. Moreover, due to the deductive and inductive nature of the research objectives, the pragmatist worldview, which can combine assumptions from different research worldviews is best suited for this dissertation.

Practical answers to the research problem and contributing to current knowledge are the main drivers of this dissertation, hence, the pragmatist research worldview is best suited for the dissertation. Therefore, in conformity to the pragmatist worldview which is deductive in nature, no theory or hypothesis is developed for the dissertation, but theoretical frameworks existing already (property development, DCF valuation techniques and real option theory) are used to locate the study within the relevant research scope chosen. Real option theory is used to solve
the research problem proposed and demonstrate how it enhances risk assessment. Also, the use of a qualitative technique to find answers to how real options theory can be integrated with existing property valuation techniques and adoption in practice, suits the pragmatist worldview.

3.3.2 Methodological Fit for Different Research Worldviews/Paradigms

Defined methodologies are associated with the different research worldviews identified in Table 3-2 and have different assumptions. Generally, there are three main research methodologies; quantitative, qualitative and mixed methods. While quantitative research methodology is grounded on the positivist belief of finding a single truth by using hypothesis, variables, statistics and some numerical approaches, it is criticized for lacking depth to answer real world questions (O'Leary, 2014).

Qualitative methodology on the other hand relies on subjectivism, social constructivism and interpretivism to derive knowledge by using multiple realities through a study of small number of in-depth cases (O'Leary, 2014). Creswell (2014) argued that researchers adopting qualitative methods seek to establish the meaning of phenomenon from the views of participants. Methods including case studies, thematic analysis, narration, ethnography and exploration are used by qualitative researchers. Qualitative methodology is criticised for being biased and highly subjective because researchers play active role in knowledge building (Creswell, 2014).

Mixed method is generally located within the pragmatic research paradigm with emphasis on adopting assumptions from both quantitative and qualitative. The main assumption is that combining both methods results in a stronger method for studying reality and hence, better outcomes. Furthermore, in a single study, mixed methods permits the study of different questions that are unrelated in terms of the two major approaches; qualitative and quantitative (Clark & Creswell, 2008, Creswell, 2014). Therefore, different research paradigms have different assumptions that dictate the appropriate methodology. It is important for researchers to choose the right methodology in tandem with the right research worldview.

Tashakkori and Teddlie (2003) established that epistemology delves into the relationship between the knower and the known (researcher and participant respectively). This relationship defines how a researcher relates to the finding of knowledge whether through objectivity or subjectivity. Generally, researchers who are influenced by the positivists/post positivists worldview (quantitative) to research belong to the objectivism epistemology whereas the social constructivists (qualitative) researchers believe in the subjectivism epistemology of research.
assumptions. Pragmatist researchers who are situated in the middle of both major strands of research approaches believe that epistemological assumptions exist in a continuum but not located in two opposing fields (Clark & Creswell, 2008). In this regard, the pragmatists are liberal in their stance based on epistemological assumptions in order to find the best answers to issues through the right methods. Objectivism epistemology which thrives on quantitative research design assumes that there is an existing social fact which is definable and quantifiable (Rist, 1975). Due to objectivism, a researcher is deemed separate and distinct from participants. Therefore, a researcher must objectively present findings from the perspective of participants without interfering. However, subjectivism assumes that there is a relationship between a researcher and participants, hence knowledge is co-constructed (O'Leary, 2014).

Pragmatists are problem centred, pluralistic and consequence action oriented researchers (Creswell, 2014). In view of this pragmatists generally endeavour to match research questions with the right approaches to yield right answers, rather than being stuck to a certain approach to research. Pragmatists focus on what works and advocate a mixed method approach to solving questions because of the assumption that a researcher plays a vital role in interpreting results from research (Tashakkori & Teddlie, 2003). Instead of researchers arguing about methods and their philosophical underpinnings, pragmatists consider all workable approaches to research, particularly, those that can answer research questions being studied. Since the research questions of this dissertation are both quantitative and qualitative oriented, mixed method is the most suitable approach. Creswell (2014) indicated that pragmatists generally look to the ‘what’ and ‘how’ to research based on the intended consequences of the research. Therefore, as mixed method utilises both subjectivism and objectivism (a combination of the two methods of quantitative and qualitative approaches), it is deemed to be best suited for this dissertation, hence mixed methods is adopted.

Table 3-3 details selected approaches chosen to answer the research objectives of the dissertation. Objective (I) and (II) for example adopts a literature review approach in identifying both building and building design flexibilities embedded in an entire property development process using long term investors as the unit of analysis. The exact stages in the entire property development process where these flexibilities are embedded were suggested and validated by practitioners. Objective III focused on using semi-structured face-face interviews to elicit the views of practitioners on the use of discount rate (required rate of return) to deal with risk and uncertainties. Conversely, objective IV adopted quantitative with embedded case studies using ROV models including Fuzzy Pay Off Method (FPOM), Binomial
Option Pricing Method (BOPM) and Samuel McKean Equation to evaluate the value of flexibilities embedded in selected high rise residential property developments in Australia. Finally, objectives (V-VII) sought to find means of integrating ROA/ROV in mainstream valuation practice because despite its potential, it still lacks practical adoption. This is achieved through face to face semi-structured interviews with key players in the Australian high rise residential property development and investment market. Further, the semi-structured interviews were used to determine potential barriers to the adoption of RO theory in practice.

Table 3-3 Research Objectives and Approaches

<table>
<thead>
<tr>
<th>Research objectives</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) To review and establish the nexus between real option theory, valuation and property development</td>
<td>Literature review</td>
</tr>
<tr>
<td>(II) To develop real option conceptual model for categorising flexibilities embedded in the property development process to enhance risk management</td>
<td>Literature review - Conceptual framework (validated by practitioners)</td>
</tr>
<tr>
<td>(III) To examine how Australian residential property developers currently deal with uncertainty and risks in feasibility analysis</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(IV) To apply real option models to feasibility evaluation of selected practical case studies using empirical data and to compare the results with conventional property development evaluation technique</td>
<td>Quantitative with embedded case study</td>
</tr>
<tr>
<td>(V) To suggest ways of justifying investment in building flexibility in Australian residential property development</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(VI) To evaluate the requirements for integrating real option techniques into property development decision-making</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
<tr>
<td>(VII) To determine any potential barrier(s) to adoption of RO theory in decision making in Australian residential property development</td>
<td>Qualitative- Semi-structured interviews</td>
</tr>
</tbody>
</table>

Source: author, 2017

3.4 Research Methodology (strategy/enquiry)

In determining the strategy of enquiry that best fits specific research, the primary concern is how a methodology can align with research questions and objectives resulting in the best opportunity to obtain useful answers in drawing valid conclusions. Methodology is defined as
the broad enquiry logic that directs the choice of specific research methods and is informed by conceptual positions common to mixed research method users (Tashakkori & Teddlie, 2010). In view of this Creswell (2014) suggests that the most important issue in determining methodological fit is the research questions and thinking about the method that offers the best opportunity to obtain useful answers in drawing valid conclusions. This dissertation uses a mixed research methodology. According to Johnson and Onwuegbuzie (2004, p. 17),

“Mixed methods research is formally defined here as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study”

Mixed method research is a combination of the two major approaches to research. In view of this, it draws on the strengths of the major approaches in addition to limiting their weaknesses in a single study. Clark and Creswell (2008) also suggested that mixed methods is a product of the pragmatist worldview and combines the two major research approaches. However, the combination of quantitative and qualitative methods occurs at different stages within a research and can be in any order, which is qualitative followed by quantitative or vice versa depending on the needs of the researcher and the research questions. The stage at which the mixture occurs within a research is also important because it is the step where subjectivism and objectivism manifest in research.

Mixed methods offer a logical and practical alternative as opposed to the positivists and subjectivists who are divided into two major strands of quantitative and qualitative respectively. It seeks not to restrict researchers to make a choice between the two major approaches of quantitative and qualitative but legitimises the use of multiple approaches in answering different research questions in a single research. Its characteristic of combining features of two major research approaches makes it adaptable to many research questions, and combinations of questions are best and most fully answered through mixed methods research (Johnson & Onwuegbuzie, 2004). Likewise, Edmondson and McManus (2007) suggested that methodological fit is best achieved by logically pairing different methods and the state of development of a particular theory. In other words, if a theory is matured and well applied in research, a quantitative method is best fit. A qualitative study then is applicable to a theory in its nascent stages of development. Mixed method helps to further develop a theory that is at the intermediate level. In general, mixed method researchers employ a research design that
combines quantitative and qualitative data to answer research questions in a single or multiphase study (Creswell, 2014, Edmonds & Kennedy, 2016).

Therefore, the exploration characteristics of the qualitative research method will be used to explore the real options method with embedded case studies in detail and its application to high rise residential property development projects in Australia, particularly in its risk management enhancement capabilities. Qualitative in the form of case study data possesses qualities such as holism, temporal extension, access to causality and an emphasis on meanings, which are of great value when investigating critical cases (Flyvbjerg, 1992, Yin, 2003). A precursor to the use of this particular methodology is a sound pre-understanding of the concepts and the theory (Robson, 2002, Yin, 2003). This sound understanding has been developed through classroom interactions on real options theory, attendance at presentations on practical issues in property development by local and international experts and discussions with instructors and supervisors.

3.4.1 Justification for Using Mixed Methodology

Hesse-Biber (2010) suggests that mixed methods are derived from an ontological perspective of a researcher. The ontological perspective of a researcher shapes a researcher’s philosophy or sets of philosophies regarding epistemology (nature of knowledge building) about basic questions including: who can know? and what can be known? Due to the extensive nature of studies using mixed methods, researchers need to examine other factors such as time constraints, funding, stakeholder interests, and serendipity when developing research questions. It is important for researchers to justify the choice of a specific methodology for carrying out research. Several reasons have been adduced by different researchers to validate the choice of mixed methods as strategy of enquiry. Johnson and Onwuegbuzie (2004) discussed that mixed method is an expansive form of research and therefore, it is inclusive, pluralistic, and complementary. Creswell (2014) suggested mixed methods researchers need to establish a reason and rationale for mixing quantitative and qualitative methods. Greene et al. (1989) suggested five main reasons for using mixed method in research design including triangulation, complementarity, development, initiation and expansion.

The expansion rationale is used to increase the scope of inquiry of a theory by choosing methods that most appropriately addresses issues from multiple inquiry components. In this view, it seeks to extend the breadth and range of inquiry by using different methods for different
inquiry components in a research. The research questions of this dissertation are of multiple 
enquiry, seeking answers to different enquiry components both qualitative and quantitative. In 
addition, the dissertation seeks to extend the breadth and scope of enquiry of real options theory 
by applying it to new case studies in the Australian high rise residential property development 
market and investigating requirements for potential adoption in practice. In view of this, the 
rationale for mixing methods in this study is one of expansion.

3.5 Method

Methods are specified strategies and procedures for implementing mixed method research 
designs (Tashakkori & Teddlie, 2010). This generally includes designs, sampling techniques, 
data collection strategies, data analysis and interpretation of findings to draw conclusions. As 
a result, this sub section is used to discuss the design chosen for the mixed methods research, 
the sampling techniques that are used to identify the participants for the interviews as well as 
the case studies, data collection strategies and instruments for data collection. Finally, the mode 
of analysing the two datasets to draw conclusions for the dissertation is also expounded.

3.5.1 Mixed Methods Typologies

There are several ways of classifying the different typologies of mixed methods. Johnson and 
Onwuegbuzie (2004) after studying the different publications on mixed research method 
designs suggested that the designs are based on a convergence between the mixed -model 
(mixing both datasets within or across stages in the research process) and mixed method 
(including a quantitative and qualitative phases in a study). Clark and Creswell (2008) merged 
all the different typologies into four major mixed methods; triangulation, embedded (nested), 
explanatory and exploratory.

Figure 3-2 provides a summary of the four mixed methods designs with variations. When a 
notation is capitalised (‘QUAN’), it indicates a priority to one method over another, in this 
case, quantitative over qualitative. In mixed methods research, qualitative and quantitative data 
could be equally prioritised (QUAN+QUAL), or one may be emphasised over another 
(example QUAN→ qual). When the ‘+’ symbol is used, it shows a concurrent form of data 
collection where both quantitative and qualitative data are collected simultaneously but when 
the symbol ‘→’ is adopted, it demonstrates a sequential form of data collection, with one part 
(for example quantitative data) building on the other (for example qualitative data).
In Figure 3-2, a matrix of the different research designs in mixed methods is shown in different quadrants. Generally, mixed method research design can be concurrent or sequential based on the data collection strategy or analysis adopted. If the two datasets are collected and analysed at the same time, it is termed as concurrent mixing. On the contrary, if the data and analysis are organised at different times, with one following the other, it is labelled as sequential. Quadrant 1 in Figure 3-2 shows a convergence of concurrent of equal status. This means the data collection for both quantitative and qualitative is organised simultaneously and the two different datasets are given equal status within the mixing. At the converging point of concurrent and dominant status, the mixing requires that one dataset is given priority over the other. Both are normally done to achieve triangulation at some point within the mixing (Clark & Creswell, 2008). At the meeting point of sequential and equal status, the datasets and analysis occur at different times and given equal strength in the utilisation of data to derive results. Normally, one dataset is collected and analysed followed by the other data set. Lastly, at the point where the sequential and dominant status meet, there are two main approaches to mixing. When the quantitative data is given prominence and collected first followed by qualitative data, the study is categorised as explanatory and when the reverse occurs, it is exploratory (Clark & Creswell, 2008). These are general approaches to mixed methods design.

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**Figure 3-2 Mixed Method Research Design**

<table>
<thead>
<tr>
<th>Time order decisions</th>
<th>Concurrent</th>
<th>Sequential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>QUAL + QUAN</td>
<td>QUAL → QUAN</td>
</tr>
<tr>
<td></td>
<td>QUAN → QUAL</td>
<td>QUAN → qual</td>
</tr>
<tr>
<td></td>
<td>QUAL + quan</td>
<td>QUAL → quan</td>
</tr>
<tr>
<td></td>
<td>QUAN + qual</td>
<td>QUAN → qual</td>
</tr>
</tbody>
</table>

Source: Johnson and Onwuegbuzie (2004).
The sequential explanatory mixed methods research design is particularly good for quantitative researchers because it gives priority to quantitative data and less priority to qualitative. In using the sequential explanatory mixed method design, researchers collect quantitative data, analyses that data, and follows it with the collection of qualitative data to serve as explanation for the results of the quantitative data. It is after both datasets have been analysed that the results of a study are integrated into findings. However, Clark and Creswell (2008) suggested that a researcher can also report findings from the two datasets separately and use a final discussion to bring both datasets together.

Apart from these basic typologies of mixed research methods identified, there are other advanced mixed methods. Creswell (2014) suggested them as embedded mixed methods, transformative mixed methods and multiphase mixed methods. The embedded mixed method integrates the collection of both quantitative data and qualitative data at the same time. As suggested by Creswell (2014), mixed method researchers have the freedom of choice to select methods, techniques, and procedures of research that best meets their needs and purposes. Therefore, this dissertation leverages on a sequential embedded mixed method design to answer the research questions. This could be deemed as a hybrid form of the four main typologies discussed earlier in this section where there is a combination of quantitative and qualitative data collection procedures using both embedded and sequential approaches.

The dissertation uses the case study approach to collect quantitative and qualitative data where the qualitative data is nested in the quantitative data on selected high rise residential property developments. Since the dissertation is primarily concerned with testing ROV applications, quantitative data includes property values (net development values upon completion), projected cost of developments, contingency budgets, discount rates, and duration of projects. While the quantitative data was being collected, qualitative data such as technical specification and areas of potential flexibility on the project were also collected from the high rise residential property developers. This information was used to perform the quantitative modelling of both DCF and ROV to compare the results. Furthermore, these embedded case studies were analysed, and the results presented on each of the case studies from both quantitative and qualitative perspectives. This is followed by semi-structured interviews conducted to elicit the views of participants on the integration of ROA/ROV in practice and how flexibility could be sold to long term investors after they are embedded in residential property developments.
In this case, the findings from the quantitative case study applications with embedded quantitative and qualitative analysis, are reported separately from the analysis of the semi-structured interviews. Later, a separate Chapter is used to integrate the findings from the case studies and the semi-structured interviews. This is similar to a suggestion by Clark and Creswell (2008) that a researcher can report the findings from two datasets separately and use a final discussion to integrate the datasets. Overall, the aim is to deepen the understanding of practitioners on ROA and its application in practice using empirical data in order to drive practical adoption for decision making. This is supported by Hesse-Biber (2010) who suggests that embedded study is used to enhance the overall understanding of a particular problem of interest. The dissertation leverages on the proposal by Clark and Creswell (2008) to present the results of quantitative application of ROV models to high rise residential property developments, uses it as a platform to sequentially conduct semi-structured interviews with property practitioners to determine ways of improving real options valuation in practice and integration with mainstream property development valuation methods.

Since the values attached to flexibility were determined through the quantitative applications, it served as the basis to examine the means via which flexibilities could be sold to long term investors in the property market. In summary, this dissertation uses sequential embedded mixed method approach as the proposed design. In the next section, the modes of data collection strategies, sampling techniques and data analysis strategies are discussed.

In Figure 3-3, the mixed methods design strategy is graphically displayed to explain the procedure for the research enquiry. It takes the approach of using the research questions to drive the type of research methodology (mixed methods research). Within the mixed research method is an embedded case study where quantitative data and some qualitative descriptive data on the case studies are collected. This is within the broad terms of quantitative data from industry reports, property developers who provided information on the case studies and other databases. Both datasets were analysed in a case study approach, results derived, and findings presented on all the three case studies. This is sequentially followed by the collection of qualitative data through face to face semi-structured interviews using the quantitative results and findings as the bases, data is analysed, results derived, and findings presented.

This occurs in the second phase of the dissertation. Subsequently, the findings are integrated into a single final discussion to draw conclusions for the dissertation and answer all the research questions for the dissertation. Therefore, while the quantitative embedded case studies take the
dominant position, the sequential exploratory approach supports it to expand the breadth of enquiry of ROA/ROV in the Australian high rise residential property development market.

**Figure 3-3 Mixed Methods Design Strategy**

![Diagram of Mixed Methods Design Strategy]

Source: Author, 2017
3.5.2 Case Study Research

The case study method is another practice-based research which fulfils the pragmatist worldview requirements. Case study research is a strategy which focuses on understanding issues related to single case settings (Eisenhardt, 1989). It allows investigators to focus on a “case” and develop a holistic and real world perspective (Yin, 2014), which is the main aim of this dissertation to develop evidence of ROA applicability to evaluation of flexibility embedded in high rise residential property developments. Flyvbjerg (1992) posits that practical rationality is understood through case studies of practical relevance.

This dissertation uses a case study approach to examine the practical application of real options theory to high rise residential property developments in Australia. In this dissertation, three cases are selected, and the case study approach is adopted for evaluating them to determine profitability. This is similar to how the respective property developers evaluated the projects. The author then proposes a real option approach for re-evaluation of the project and compare the results to determine the practical application of ROV models to property projects. The use of the case study method allows researchers to collect data and develop evidence needed to answer research questions. A holistic view of the dissertation is also achieved through case study methods (Robson, 2002). Kyrö (2013) argued that the case study method allows for an intensive analysis of a specific case. According to Yin (1994) it is appropriate to use cases when testing a theory that is well formulated such as real options theory.

In selecting a case study, researchers can either choose a single case or multiple cases. Single case can either be embedded or holistic whereby the embedded study adopts multiple units of analysis. In some cases, researchers may have to choose between single cases and multiple case studies. This is because evidence from multiple case studies are more compelling than single case studies (Yin, 2014). It is acknowledged that multiple case studies can be time consuming and require significant resources. In the interest of research robustness and validity of conclusions, multiple cases are used in this dissertation despite the potential challenges. The dissertation evaluates three case studies to determine the practical applicability of ROA in real life-settings using empirical data. Besides, there is also multiple units of analysis to ensure that a broad spectrum of stakeholders is included in the study.

Real options theory is applied to multiple cases to analyse the values attached to flexibility in building process design delivery and structural flexibility to justify investments in flexibility
for future benefits. The main aim of this dissertation is to test real options theory using empirical data to expand the theoretical dimensions of ROA/ROV in practice because adoption has been slow in industry and particularly in the property industry in Australia. It is the case study approach that offers the opportunity to test ROA in a real life context resulting in proper understanding (Yin, 2003). Specifically, the difficulty of applying real options theory to empirical case studies in property has been documented (see Lander & Pinches, 1998, Oppenheimer, 2002). It will therefore be important to apply the theory to new cases and to extend the theoretical framework and expand its breadth of application to develop the theory further.

Robson (2002) indicated that for a case study design, questions such as “How?” is addressed properly instead of “What?” and “Why?”. This is supported by Yin (2014) who also argues that questions such as “How?” are normally answered by case study research. Since the research questions of the dissertation follows this format, the case study approach fits the study. Two of the case studies are chosen from existing developments and the last case study is a proposed development yet to be initiated at the time of writing the dissertation. They were selected through theoretical sampling to ensure that they are relevant to the dissertation (Glaser & Strauss, 1967).

RMIT University provided industry connections to obtain data from high rise residential property developers and leading stakeholders within the Australian property industry. Both quantitative and qualitative data were retrieved from practitioners to aid in the financial modelling and qualitative analysis. Hence, the quantitative approach with embedded case studies and qualitative data collected sequentially was the most suitable method for answering the research questions. Furthermore, the findings from the dissertation were not intended to form theories based on statistical generalization but do provide analytic generalizations and information needed for decision making by property practitioners. The data and methods of assessment in this dissertation were mainly quantitative embedded case studies in a multiple unit of analysis and qualitative data from face to face semi-structured interviews. In the next sub-section, the data collection strategies are discussed in detail.

3.6 Data Collection Strategies

In using mixed method research, Johnson and Turner (2003) stated that a fundamental principle that must be adhered to on the part of researchers should be to collect multiple data using
different strategies, approaches, and methods in such a way that the resulting mixture or combination is likely to result in complementary strengths and non-overlapping weaknesses. Therefore, an effective use of this principle is a major justification for the use of mixed methods research because the product of the combination of different methods will be superior to the use of a mono method (Johnson & Onwuegbuzie, 2004).

3.6.1 Types of Data

Different types of data are collected by researchers for different purposes in a research project. The research questions generally determine the type of data needed to fulfil the aims and objectives of a research. Tashakkori and Teddlie (2010) emphasised that methodological principles generally underpin the conduct of research. It is the research questions that determine the specific methods to be used and the sort of data collection strategy suitable for a particular research objective. Generally, the type of data collected, will determine the sort of analysis and the interpretation of the findings that will emerge from the data.

Qualitative data on the other hand examines emerging trends in data, uses open ended questions and collects data through interviews, documents analysis and audio-visual sources. The analysis of qualitative data was executed using texts and figures. Its interpretation is achieved through themes and patterns that emerge from the data. Data collected can be both predetermined and emerging in mixed method research. Both open and close ended questions are allowed, therefore, it results in multiple forms of data requiring multiple forms of analysis and cross data interpretation of findings.

Table 3-4 summarizes the discussion on the data collection and the type of analysis adopted for different sets of data during research depending on the methodology of choice. Creswell (2014) suggested that the quantitative data are predetermined, instrument-based questions are developed for surveys, to collect data on performance, census and through observation. In addition, quantitative data are mainly analysed using statistical procedures and the interpretation is also similarly executed using descriptive statistics.

As already indicated, this dissertation uses mixed method research design, therefore, both qualitative and quantitative data are collected. As a result, the analysis of the two datasets are executed separately and combined into a single discussion in Chapter Nine. Even though the analysis of the qualitative data is not executed using statistical analysis, some descriptive statistics such as graphs and percentages are adopted.
Table 3-4 Table of Quantitative, Mixed and Qualitative Methods

<table>
<thead>
<tr>
<th>Quantitative</th>
<th>Mixed</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-determined</td>
<td>Both pre-determined and emerging methods</td>
<td>Emerging methods</td>
</tr>
<tr>
<td>Instrument based questions</td>
<td>Both open and closed ended questions</td>
<td>Open-ended questions</td>
</tr>
<tr>
<td>Performance data, attitude data, observational data, and census data</td>
<td>Multiple forms of data drawing on all possibilities</td>
<td>Interview data, observation data, document data, and audio-visual data</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>Statistical and text analysis</td>
<td>Text and image analysis</td>
</tr>
<tr>
<td>Statistical interpretation</td>
<td>Across data base interpretation</td>
<td>Themes, patterns interpretation</td>
</tr>
</tbody>
</table>

Source: Creswell (2014, p. 17)

3.6.2 Sources of Data/Evidence for Case Study Research

One of the most important consideration in research is the sources of data for a study. The case study method uses extensive sources of data collection including documentation, archival records, interviews, direct observation, participant observation, physical artefacts, films, photographs, video tapes, life history and ethnography (Marshall & Rossman, 1989, Voss et al., 2002). Yin (2003) also identified six commonly used sources of evidence for collecting information on case studies including documentation, archival records, interviews, direct observation, participant observation and physical artefacts. Some studies may adopt a single source of these evidences for completing studies, but a very good study combines some of the sources in a single study for better results and validity enhancement (Stake, 1995, Yin, 2003). This dissertation uses documentation, archival records and interviews to collect data needed for building evidence to support findings and conclusions.

3.6.2.1 Documentation

Documentation as a source of evidence can be numerous and varied. This includes letters, diaries, journals, emails, memos, announcements, minutes of meetings, site studies, administrative documents and other written reports on particular cases executed previously (Creswell, 2014, Eisenhardt, 1989, Yin, 2003). The accuracy of such reports and documents must be checked to ascertain the veracity of the claims in the documents. This is due to the fact
that some documents might have been edited before storing them in the archives. Yin (2003) suggested that a relevant reason for using documents in case study research is to corroborate and augment evidence from other sources.

It is important to ensure that documents that are related only to the project are reviewed else, unrelated data may be used in drawing conclusions for a study making the validity questionable. One weakness of using this method is that pertinent information on a project may be confidential, hence protected (Creswell, 2014). Documents on the case studies were reviewed to determine the history behind these projects, technical and financial appraisal were also retrieved from the documents on the project. The document analysis proved to be very useful source of information as the developers who supplied the documents expected the researcher to sift through to determine information relevant to the dissertation. As result, detailed information about each of the selected case studies was available and retrieved for analysis.

3.6.2.2 Archival Records

An archival record is also one of the sources of evidence for collecting data on a case study. It is generally defined as documents and information received and accumulated by an organisation in the conduct of business and they have been kept largely due to their continuing value (Ellis, 1993). Generally, archives include computer files, service records, maps and charts, personal records and survey data (census records, data on market performance). Due to problems with accuracy of the archival records, they are normally used with other sources of evidence for case study research such as interviews and documentation. In this dissertation, archival records were combined with interviews and documentation to collect relevant data on the case studies.

It is argued that archival data though is historically oriented, but it can add empirical depth to research by generating new data which enables verification of existing data from other sources (Welch, 2000). This dissertation resorts to archival data in the form of longitudinal data from statistics on property market performance to be able to value flexibility attached to property projects. Furthermore, because some of the case studies have already been completed, the evaluation took a step back in time to execute a realistic evaluation. As a result, there was the need to use archival data, both specific to the projects and general to prevailing economic conditions at the time when the projects were at inception stage.
Secondary data in the form of statistics on property returns, long term average of risk free rate, costs of construction, and data on property prices were collected as part of the dissertation. The sources included publicly available property reports from recognised institutions including Australian Property Institute (API), CoreLogic RP Data, Reserve Bank of Australia (RBA), Property Council of Australia (PCA) and Australian Bureau of Statistics (ABS). Data on time series property returns were collected to be able to calculate volatility of property investments and average property return over the period. In addition, computer files that were supplied in Microsoft Excel format from the project developers are all classified as archival data and were used in this dissertation. Furthermore, RMIT University has access to the databases of CoreLogic RP Data, PCA, ABS and Property Investment Research (PIR). These sources were used to retrieve data for the study.

3.6.2.3 Interviews

Interviewing is a method of collecting qualitative data by using open ended questions to elicit information from interviewees on a number of topics, themes and questions (O'Leary, 2014). The fluidity of the interviewing process is important to ensure that interviewees feel as informants and freely give information. In view of this, Yin (2003) posits that it is important for a researcher to maintain the main line of enquiry during a research interviewing process and at the same time asking actual conversational questions in an unbiased manner to obtain required information. The conversation is generally guided by a set of predetermined questions that serve as a guide or a strict proof material for the interview depending on the type of interview chosen for a research enquiry (Easton, 1995).

Generally, questions used for interviews are crafted from themes or topics of interest in case studies that a researcher is studying. The questions are formulated to address research questions and objectives of a study. Interviewing questions are grouped into two; open ended and closed ended questions. Open ended questions generally allow respondents the opportunity to give a broad range of answers on issues in response to questions whereas closed ended questions offer very limited opportunity for participants to give alternate answers to questions (Runeson & Höst, 2009). However, most case study researchers use open ended questions for obtaining information. Further, interviewees may be asked to propose insights into case studies sometimes to build on it for further enquiry. Interviews were adopted to complement the other sources of data for this dissertation. It was an opportunity for practitioners to contribute to the dissertation and ensure that the findings of the dissertation were practical.
Robson (2002) identified three main types of interviews; fully structured, semi-structured and unstructured. This dissertation adopted face to face semi-structured interviews to elicit information from participants. In face to face semi-structured interviews, there is generally an already prepared set of questions, but the researcher is not bound to follow the questions in an orderly manner. The researcher has the opportunity to ask further probing questions that emanate from the answers provided by respondents. Runeson and Höst (2009) suggested that development of the conversation dictates the order of the questions that are asked. This method allowed for extensive and in-depth exploration of the case studies and on flexibility in general and how values attached to flexibility are likely to be determined from practitioners’ perspective. In view of the use of face to face semi-structured interviews, the researcher had the opportunity to ask further probing questions and obtained rich in-depth knowledge on the cases to draw conclusions for the dissertation after evaluation.

Specifically, the interviews were conducted to achieve the following objectives:

i. Assessing if the discount rate or all risks yield can capture all risks in the Australian high rise residential property development and investment sector (both traditional risks and newly emerging risks);

ii. Determine how ROA can provide the justification for investments in building flexibility for risk mitigation in practice;

iii. Consider the receptiveness and acceptance of ROA/ROV models among property practitioners;

iv. Examine the requirements for integrating ROV models into practical financial feasibility analysis of property investments and developments;

v. Determining whether beyond the limited proven case studies and technicalities of ROV models, there are other barriers to adoption in practice.

These sub-objectives fall within the overall objective of achieving practical adoption of ROA in practice and determining how flexibility can be justified to long-term investors to drive investment in building and building design flexibility. It is argued that developers are likely to embed flexibility in high rise residential property development projects if there is demand from investors, and investors would also invest if values would be ascribed to flexibility.

An interview guide was used in the process of interviewing participants. There was a single interview guide for all the different groups of participants selected for the study because these different participants depend on similar financial models to evaluate the financial feasibility of
projects. As a result, developing different interview guides was unnecessary. The interview guide was composed of 18 questions that were grouped under three main headings:

- Information about participant;
- Current financial evaluation methods for property development and investment and real options analysis/method;
- Potential integration into mainstream valuation techniques, acceptance of flexibility by stakeholders and barriers to adoption for decision making in practice.

In collecting the qualitative data, the researcher used an audio recorder provided by RMIT University’s audio-visual department and transcribed into text format for further analysis.

In order to develop insights into the robustness of the questions and potential to elicit the right information, a pilot study was undertaken to determine areas for potential improvement. Bickman and Rog (2008) argued that pilot studies in qualitative research are important to develop an understanding of the concepts being studied, especially when the available knowledge on the concept and theory is limited. In Chapter Two, the literature review revealed that the number of academic papers on flexibility in property development from the Australian property development market was limited. This is compounded by the inadequate knowledge of practitioners on the valuation of flexibility. As a result, it was important to conduct a pilot study with a small group of potential participants to determine whether the questions are meaningful or required some modification in order to derive the right information from participants.

### 3.7 Sampling Techniques

Generally, the target group of people at whom a study is directed forms the population of a study. In this regard, the population of any research comprises many people. For example, in this dissertation, the population is made up of stakeholders in the Australian residential property development market, specifically, property valuers, development managers and analysts, investors, and financial and property advisors or consultants. Since it was impossible to study the entire population, a sample was chosen out of the population to represent the entire population. Therefore, the process of selecting a few from a bigger group to use their views to generalise for the entire population is referred to as sampling.
There are two main approaches to selecting a sample from a population; random sampling and non-random sampling. Random sampling refers to an unsystematic way of selecting participants from a population (O'Leary, 2014). Therefore, each member of the population has an equal chance of being selected. Different types of random sampling include simple random sampling, stratified sampling, systemic sampling and cluster sampling. On the other hand, in non-random sampling, the selection is largely not dependent on probability (O'Leary, 2014). Hence, it is sometimes referred to as non-probability or purposive sampling. Under the non-random sampling, there are three main types including purposive sampling, snowball sampling and volunteer sampling.

Using mixed methods as the method of research enquiry, specific sampling methods have been identified by Tashakkori and Teddlie (2009) to include sequential sampling, parallel sampling and multi-level sampling. The sequential sampling refers to the use of the first phase sampling approach to inform the second phase sampling approach. This can be either probability sampling followed by non-random sampling. This dissertation leverages a quantitative with embedded case study approach followed by a semi-structured interview with participants. As such, there is a combination of the different sampling approaches to obtain the needed information.

The dissertation adopts the general probability sampling for the quantitative data of property returns, costs and values over a period and purposive sampling technique of the non-random sampling strategy for the face to face semi-structured interviews. The purposive sampling is used to choose experts who have worked on these cases or have executed projects for the interviews to understand flexibility, its valuation, integration and sale to long term investors in the industry from their perspective.

The probability sampling technique adopted for the quantitative data has the potential of ensuring that there is large enough data to enable analytical generalizations of the data to the population. Besides, every single member of the population has an equal chance of being selected to represent the population, hence a better choice for the large quantitative data. DCF and ROV are characterised by mathematical formulae for deriving results to confirm or refute the potential of ROV models for the evaluation of flexibility in practice. The selection of participants was based on certain criteria including level of experience, qualification, position in organisation and responsibilities. Selected participants were well experienced and conversant with the use of property valuation models and decision making in property
development and investment. The purposive sampling technique ensured all participants had knowledge of the subject area leading to very rich and an in-depth response to the interview questions.

To ensure a balanced representation of views, participants were grouped into valuers, long term investors, property advisors (financial and property) and property developers as attached in Appendix F (participant’s matrix). There were three participants each from developers and valuers, and two stakeholders each from the large investors, property consultants/researchers and financial advisors. This resulted in 12 key stakeholders who were interviewed for the dissertation. As opposed to quantitative research, qualitative research tends to use very limited number of participants because of the in-depth nature of the data (O'Leary, 2014). The twelve (12) participants chosen follows similar recent studies (Vimpari, 2014) who used ten (10) participants for similar case study research in property and flexibility analysis.

The participants were selected through a meticulous analysis of the most active property companies in the Australian residential property market. Purposively, the participants selected were in senior roles such as development directors (where final decision-making occurs) or in ownership of their organisations as private practitioners. Others were also senior partners in the respective organisations, thereby ensuring that those with a certain level of pedigree and knowledge participated in the research. Therefore, views expressed by participants were based on sound knowledge, experience and good judgement ensuring a high level of reliability in the data, resulting in valid findings and conclusions.

In qualitative research, O'Leary (2014) indicates that there are no specific rules governing the sample size for a particular research. However, in cases where purposive sampling is used, it is typical to encounter small sample sizes (Teddlie & Tashakkori, 2009). The participants represent about five key sub sectors within the Australian high rise residential property development market. The interviews were conducted until the researcher realised that there is repeatability of information coming from participants even within the same group. Thus, at the saturation point, the interviews were completed as suggested (Small, 2009). These key stakeholders in their daily activities provide valuable information in the form of residential property market dynamics, demand and supply trends and other financial metrics to developer-investors in their quest to develop properties for profitability.
3.8 Data Analysis

This dissertation adopted a mixed method research design. As a result, two forms of data were collected; quantitative and qualitative. This implies that data analysis also has two approaches because quantitative and qualitative datasets are analysed differently. The mixed methods research design requires that at some point in a study, the two datasets are integrated. This can be at data collection stage, data analysis or discussion of findings.

Teddlie and Tashakkori (2009) argues that since quantitative research is generally deductive, outcomes from quantitative data analysis are used for testing and prediction. DCF and ROV financial modelling requires quantitative data and the outcomes are also numerical in nature. The argument of this dissertation is to test the application of ROV models to evaluate values attached to flexibility in high rise residential property developments which fits the deductive argument. Quantitative data analysis is generally executed through statistical techniques; inferential or descriptive.

In this dissertation, descriptive statistics is used for the quantitative data analysis apart from the financial models adopted for evaluating the values of flexibility. Descriptive statistics used to process the raw quantitative data into a form required for DCF and ROV financial modelling include mean property returns, standard deviation, percentages, and graphs. This follows the general approach to quantitative data analysis in ROA and property development research to have comparable outcomes in relation to existing literature. Software including Microsoft Excel and Palisade Corporation’s Decision Analysis Suite were used for the financial modelling and computing the descriptive statistics. ROV models chosen for the financial evaluation are Fuzzy Payoff Method, Certainty Equivalence of Binomial Option Pricing Method and Samuel McKean Equation with a detailed discussion on each of the ROV models expounded in Chapters 5, 6 and 7 respectively.

Qualitative data was categorised based on themes and analysed using thematic analysis with embedded quotes from participants to support the researchers’ interpretation of participants views expressed during the interviews. Transcripts obtained from the audio transcription were coded based on themes using the qualitative software, NVivo version 11. After analysing the two datasets, they were combined into a single discussion to answer the research questions.
3.9 Ethics Approval

As part of RMIT University procedures for conducting a research project, ethics application was lodged in October 2015. The project was granted ethics approval in November 2015 after amendments were done at the request of the ethics committee (a copy of the ethics approval is attached in Appendix A of this dissertation). Subsequently, the interview questions were tested in a pilot study phase between February 2017 and March 2017. Five participants were used in the pilot study; one each of developers, investors, valuers, property advisors and financial consultants. The author and the research supervisors at RMIT University knew these professionals. The comments from the pilot study were used to amend the interview guide questions into a final document for the face to face semi structured interviews.

The interviews occurred between March 2017 and May 2017 at the participants’ place of work or choice. Generally, the interviews lasted for an average of 45-60 minutes each, covering a wide range of issues regarding risk management in Australian residential property development through flexibility analysis, acceptance of ROA/ROV in practice and requirements for integrating ROV models in residential property development decision making in Australia. To de-identify the participants and protect their anonymity, the researcher assigned identifiers to the various stakeholders who participated in the interviews. The identifiers aided in coding the responses from the participants for reporting and analysis. Through both RMIT University’s and researcher’s supervisor’s industry network, interview participants were identified for the research. In collecting the qualitative data, the researcher used an audio recorder provided by RMIT University’s audio-visual department and transcribed into text format for analysis. Transcripts obtained from the audio transcription were coded based and in analysing the data and answering the research questions, quotes from the interviews supported the arguments of the researcher.

3.10 Summary

This Chapter focused on examining the appropriate methodology for the dissertation. It began with the determination of a research plan which includes a framework of interconnectivity between the epistemology of knowledge, research strategy and the methods for completing the dissertation. After analysing the research questions and the objectives thereof, it was realised that the research questions fall within both the positivist and subjectivism worldviews of both the quantitative and qualitative major strands. In view of this, the pragmatist worldview which
is flexible in its approach to methodology choice and capable of adapting to a combination of questions from both quantitative and qualitative was suited for this dissertation. In line with the pragmatist worldview, the mixed method approach was selected as the best choice of research strategy to answer the research questions with the aim of expanding the breadth of enquiry of ROA in high rise residential property development sector in Australia.

The mixed method approach has many typologies for answering research questions and the choice of a specific typology is generally influenced by the purpose of adopting the mixed method whether triangulation, complementarity, development, initiation or expansion. In this dissertation, the reason for choosing mixed method design was to expand the breadth of enquiry of real options in property development. This is achieved by adopting the embedded case study approach with multiple unit of analysis via the real options framework. As a result, the methodology is mixed method research with embedded case studies.

Due to the mixed method approach, both quantitative and qualitative was collected for the dissertation. Quantitative data in the form of time series of property returns, construction costs, potential development values and required rates of return were all sourced from various databases and developers. Quantitative data specific to the case studies was rather sourced from document analysis, informal discussions, and archival records. Qualitative data on the other hand was collected via face to face semi-structured interviews using twelve (12) participants. As already indicated, the interviews were conducted until the researcher realised that there is repeatability of information coming from participants even within the same group. Thus, at the saturation point, the interviews were completed as suggested (Small, 2009). Theoretical sampling technique was used to select the case studies. Whereas participants for the qualitative data were selected using purposive sampling, data for the quantitative modelling was selected via probability sampling technique. Quantitative data analysis adopted Excel and Decision Analysis suite software, but qualitative data analysis was executed via thematic analysis using NVivo software.

Finally, the process of obtaining data and the type of analysis adopted for the dissertation was discussed. This included how the two datasets are finally integrated to form a single coherent argument to achieve the objectives of the dissertation. In the next Chapter, the findings from the literature review are used to develop a conceptual framework for identifying real options at different stages of the property development process and submitted to practitioners for validation. The framework serves as a visualisation tool for practitioners to use to deepen their
knowledge on flexibilities in property development and to also adopt them for decision making in practice.
Chapter 4 Systematising Real Options in Property Development: A Conceptual Framework

4.1 Introduction

In Chapter One, an objective of this dissertation was to develop a conceptual framework for systematically categorising flexibilities embedded in the process of property development. The overall goal in the development of the conceptual framework is to further extend the theory of real options to ensure that, practitioners understand and adopt the method in practice. Besides, the framework is developed to serve as a manual to aid practitioners in identification and understanding of flexibilities embedded in property developments. The application of option pricing theory to the valuation of flexibilities in property developments has been examined in the literature and the contribution of leading authors, particularly in the property and construction sectors has been established.

The mathematical complexity of ROV models limits the ability of practitioners in the property sector to understand real options theory fully, which stifles practical adoption of ROA techniques. In view of this, the main aim for the examination of the different types of flexibilities within the property development process is to connect the different types of flexibilities to the property development process to construct a conceptual framework for systematisation and easy identification by practitioners. This has the potential to deepen the understanding of practitioners for potential practical adoption for decision making.

A key feature of flexibility is that it creates economic value by generating future decision rights (McGrath et al., 2004). Some of these rights are flexible decisions embedded in real estate development projects at different stages of a project’s life cycle. It is therefore argued that the presence of these flexibilities add value to projects and must be captured by property valuation methods. Trigeorgis (1993a) examined and suggested real options as wait/defer, expand, switch (input/output), abandon, growth, contract and compound options. Based on this, Lucius (2001) also identified property specific flexibilities to generally include reduction, delay, compound and growth. Baldi (2013) has also developed a conceptualisation of flexibilities in property by concentrating on only the construction stage leaving other options unaccounted for in the framework.
4.2 Four-Stage Property Development Process

Property development is a staged activity. Reed and Sims (2015) argued that there are eight stages in property development based on the event sequence approach. The stages include initiation, evaluation, acquisition, design and costing, permissions, commitment, implementation, and let/manage/dispose. For the purposes of this study, the eight-stage approach which is widely accepted is grouped into four; initiation, design, construction and marketing.

Figure 4-1 Modified Real Estate Development Process

This is based on critical examination of the stages where flexibilities are embedded in the process of property development for the purposes of the conceptual framework. In Figure 4-1, the eight stage property development process (Reed & Sims, 2015) have been organised into four stages including initiation, design, construction and marketing. The main reason for the reorganisation is to enable the grouping of flexibilities according the stage in which such flexibility occurs in the property development process. Some flexibilities are naturally embedded in property projects and others must be created by developers. As a result, there is the need to reorganise the property development process to fit flexibilities to aid the development of the conceptual framework.
The initiation stage of a project as discussed in section 2.2.3.1 includes all activities including generating different ideas for project execution and screening them to select the probable option capable of producing an acceptable rate of return for developers. It involves scanning through the specific property market to determine market dynamics for the proposed project for selection and implementation. Since this stage is the beginning of a project, the size of a project in terms of serving the supply needs of a specific market is determined. This offers the opportunity to determine the exact space needs to be served in that specific market. To this end, property developers can strategise and think about possible flexibilities to embed in the project at this stage. For example, constrained by zoning and other regulatory factors, a developer could decide to halt a proposed scheme due to unfavourable market or may delay pre-sales to capitalise on increasing property values.

At the design stage, when a developer is satisfied with the proposed scheme and financial feasibility, the entire structure is designed for implementation. At this stage, it is argued that a developer still retains the right to flexibly manage a project by embedding strategies such as expansion and switching options. Since the opportunity exist to embed flexibility, developers can work on several design catalogues as proposed (Cardin et al., 2013) and select the most appropriate for execution.

When construction starts, developer loses all opportunities to embed flexibility into a project because after thoughts may not be part of the original designs, as such, implementation may be impractical. At this stage, any embedded flexibility that is matured could be capitalised upon for profitability or may be embedded for future opportunities. For example, if during construction a developer realises that the expansion strategy could be capitalised upon, this could easily be executed without any serious modifications because it’s part of the original design. Otherwise, the opportunity is embedded until such a time in future when necessary. It is instructive to note that there are several flexibilities that could be embedded in a project during construction if they are considered at the design phase.

At the marketing stage, developers have the chance to consider several ways of disposing of a project depending on objectives. Despite this, developers have the chance to dynamically manage the sale and lease of assets through flexible contracts that offer the chance to capitalise on upside opportunities in the market. For example, upward review contracts based on market dynamics could be a flexible way of capitalising on emerging opportunities. Similarly, a
piecemeal approach to sale of units in a residential development affords a developer an opportunity to capitalise on upside opportunity that may emerge due to high demand.

4.3 Real Options Embedded in Property Development

Using the four-stage property development process in Figure 4-1, there are several flexibilities embedded in property projects. At the initiation stage, a developer may decide on the timing of a development as an option to achieve optimal profit. This allows a developer to decide whether to wait and invest or commence execution depending on economic conditions in the property market at the time. Furthermore, a developer may decide to calculate the value of a land for development as an option whose value is dependent on the price of the potential asset to be built on the land. There is also the staged investment option which is used by developers to pre-empt the changes in market conditions to decide the next course of action.

The operating option is the flexibility afforded to developers to change development strategy mid-course to adapt the use of buildings easily during a downturn in a market, for example, converting residential to student accommodation etc. This occurs during the designing phase of a property development scheme. Flexibilities including the right to expand a project later when market conditions are favourable or to respond to uncertainty in future demand for space in an area is valuable. At the same time, an input switch is also possible at the construction stage.

Once construction begins, a developer may decide to stage a property development project, create an opportunity to retain the right to contract, shut down temporarily, switch output or abandon the project entirely in an unfavourable market. Growth options, which includes the right to acquire the option to increase the project scope, flexible approach to sales to increase the value of assets over time, usage of flexible leases to maximise profitability in favourable markets and limit losses.

4.4 Conceptual Framework

A conceptual framework is developed and proposed for identification of options at different stages of the property development process (see Figure 4-2). The framework is a combination of the stages and the different types of options embedded in the property development process forming a four-quadrant diagram with a circle in the middle to capture all possible real options embedded in a single property development project. Again, the types of flexibilities whether
put or call has been shown in the diagram. These different types of flexibilities embedded in a single development project can serve as a strategic tool for managing a project to maximise potential payoffs and mitigate risks.

Figure 4-2 Conceptual Framework for Real Options/Flexibilities in Property Development

4.4.1 North West Quadrant

In Figure 4-2, stage 1 represents the initiation phase of a project and is the intersection of the initiation stage and the types of flexibilities embedded at that stage for a property developer. In this quadrant, the flexibilities identified are the waiting option which is a call-like real option to defer. The deferral options include both deferring the starting of construction and presales to resolve uncertainties around property prices. This can help maximise return and prevent an imminent loss in the face of uncertainties. This is important for investor-developers who hold assets as part of a portfolio and manage those assets as a way of diversifying their portfolio or for high returns. It may be difficult for trader developers due to the requirement of presales before securing funding for commercial banks for development.
4.4.1.1 Defer/Waiting Options (option to defer)

The deferral option allows a developer of a property project to alter the starting date of a proposed development scheme. This type of flexibility is embedded at the early stages of a property development process. Deferring a decision to embark on a property development project denotes the developer's ability to postpone a development in order to resolve uncertainties surrounding key variables such as cash flows, costs, interest rates and technicalities in order to make an informed decision regarding irreversible property development.

In view of this, variables in a financial feasibility model that impact greatly on property development profitability are examined in the light of uncertainties, a waiting period lapses for these uncertainties to be resolved over a period before commencement of a development. The overall effect is to ensure a level of certainty in the input variables to minimise risks associated with development. The option of waiting to develop is needed to make a good decision concerning an investment and to avoid losses in the face of uncertainties. This type of flexibility is present at the initiation and on completion stage of a development project. For example, during the sale of a completed development of a residential project, a developer can treat the full project as a portfolio of single apartments and dynamically manage the sale of the apartments with respect to timing of sales to capitalize on the upside potential in the market based on favourable market conditions.

This has been demonstrated by Vimpari and Junnila (2014a) using a case study of a residential real estate portfolio divestment strategy of a closed ended fund that had reached the end of its life span. Also, an example is where a developer may hold a piece of land for a period before actual development work is started especially when a market forecast is unfavourable. In such a case, a developer has the right to hold the land for as long as possible until the payoff from a development is profitable as compared to the cost of exercising the flexibility to build. This is dependent on the period allowed for a developer to delay construction after acquiring a planning permit. However, if the proposed construction meets the zoning regulations, a developer then has an infinite/perpetual call option on the land in question, subject to specific conditions including changes in market conditions, holding costs, capital raising and contractual obligations.
The option of waiting to invest is generally valued as a perpetual/infinite American call option without dividends because the developer may exercise the right to build at any time and would not receive cash inflows during the waiting period. This is subject to specific conditions including changes in market conditions, holding costs, capital raising and contractual obligations. Titman (1985) used a binomial option pricing approach to value vacant lots as perpetual American call options on the land. Titman (1985) found that, the option to wait adds value to the land and is the main reason for the large undeveloped tracts of land in urban areas. The option of waiting/defer is naturally embedded in property development projects.

In a conceptual framework by Baldi (2013), the option of waiting was deemed to be a deferral but an up scaling type of flexibility. The findings of Baldi (2013) corroborates the conceptual framework in this study because the waiting option is present in property development and is a call like option as well in this dissertation. However, the waiting/deferral option is at the initiation stage of the development process as shown in Figure 4-2.

4.4.2 North East Quadrant

The second stage of the conceptual model as shown in Figure 4-2 is the north-eastern quadrant. Flexibilities embedded at this stage include expansion, flexible designs and switching inputs. These types of flexibilities are call-like options because they give a developer the right to acquire more assets but not the obligation to execute it in development context. The explanation of a call option in the literature review confers a right but not the obligation to buy an asset. For example, the expansion option gives a developer the opportunity to expand a project in a favourable market but such a developer is under no obligation to do so.

4.4.2.1 Expansion Option (alter operating scale)

Property development firms and developers holding this type of flexibility can expand the size of a development project after an extra investment is incurred on the actual estimated initial capital expenditure. This flexibility is generally incorporated into projects from the beginning to capitalise on them in future. The expansion of a property project is in the form of scale expansion (increasing volume) and scope expansion (implementing follow on steps). The expansion option in most cases is profitable for developers with projects located in central business districts (CBD) where land is scarce and for corporations that envisage expanding in future but face uncertainties regarding the total future space requirements.
The expansion option retains the ability of a developer to increase both the volume and scale of a proposed project when market conditions are favourable based on an initial extra expenditure for future expansion. Scope expansion in terms of follow on developments can be in the form of increasing the number of floors of a project or the total size in terms of square metres of a project. Scale expansion in property projects can also be in the form of adding to the stock of the portfolio of properties especially if demand picks up in locations where a developer owns land already for example in the CBD.

Therefore, during the designing stage, a developer can deliberately incorporate the expansion option and wait for the opportune time to expand either the volume or scope of a project. For example, high rise apartments and offices can be built with the intention of expanding later. Embedding flexibilities in such projects require developers to proactively design columns and slabs to support the intended future expansion. Therefore, in future, a developer can take advantage of rising property prices by expanding a project due to the embedded expansion option. Applications of the expansion option in property can be found in the works of (Childs et al., 1996, de Neufville et al., 2006). A case study on vertical expansion has been examined (Guma et al., 2009) and expansion flexibility is generally a call-like option.

The expansion flexibility has been identified in property and construction (Lucius, 2001) and conceptualised (Baldi, 2013) which agrees with the findings of this dissertation. Baldi (2013) argued that the expansion flexibility is an immediate up scaling call-like real option in property, however, this dissertation considers the expansion flexibility to occur at the design and construction stage. It is not immediate in terms of time within the current conceptual framework as was proposed by Baldi (2013) but a flexibility that offers value over time as uncertainties are resolved and favourable conditions evolve in the property market.

The expansion flexibility is embedded at the designing stage because a developer has to design the strength of slabs and columns to be technically capable of supporting future expansions. This gives a developer the right to capitalise on upside potentials when market conditions are favourable or organisational expansion requires the exercise of such an option. Long term office, residential and retail developers/investors can take advantage of the expansion flexibility to capitalise on emerging opportunities. This is especially important for central business district developments that attract high demand but limited supply of land for new projects. Holding expansion flexibility both in terms of volume and scale can be financially
prudent. It is embedded at the intersection of both the call option and the design stage in Figure 4-2.

4.4.2.2 Switching Inputs

At the design stage of a property project, flexible designs involve the ability of a development in progress to adapt to the use of different input materials for cost minimisation and profit maximisation. The switching input can be in the form of changing the components of a specific property project to low cost materials that achieves the same level of building quality. In this regard, the total cost of a project is reduced as against the expected revenues and hence an increase in the expected payoff. The switching input flexibility does not necessarily mean downgrading the quality of a project. For example, due to cost efficiency, some developers or corporate organisations may decide to switch from tile floors to timber or carpeted floors in order to achieve long term benefits associated with cost effectiveness. It is important to emphasise that, private projects where presales have been agreed already may require some changes to contractual agreements before there can be input switching as opposed to projects that are intended to be held as part of a portfolio.

It is via real options framework that such decisions that have long term implications can be examined. Literature on real options valuation of this type of option is scarce. However, the identification of switching input real flexibility in a conceptual framework has been studied by Baldi (2013) as being an up-scaling call-like option. In this dissertation however, it is embedded at the designing phase of a property development project and it is a call like real option as shown in Figure 4-2.

4.4.2.3 Operating options

The emphasis of operating options is on the value of flexibility in designing and implementing strategic real estate projects. Flexibility in property projects give firms and developers the chance to adapt positively to the changing economic environment to deal with uncertainties. Therefore, development activities are structured in such a way that property projects can respond appropriately to changes in the economic environment based on efficient internal layout configurations.

Flexibility denotes the usage of internal space by an organisation and how the walls, space layout, floor plans, slabs and columns have been designed to accommodate future changes.
Because these changes come at a cost, it is important for organisations to determine future space needs and financial benefits before incorporating flexibility into property development projects. If flexibility will not support the current or future organisational activities, such investment in flexibility is unnecessary because no value would be added to a project. For example, the ability to turn an office into a conference room by dismantling the internal layout with ease, which can be refitted after use as a conference can be valuable. This is important due to emerging trends in office layout and tenant demands where flexibility has become a common need of corporate tenants. Furthermore, other emerging trends such as co-working spaces demand internal layout efficiencies because that is relevant to the operations of tenants. In property and construction literature, some leading authors have determined value attached to flexibility using specific case studies. Greden et al. (2005), Greden and Glicksman (2005), Vimpari et al. (2014) have all valued flexibility in different forms and concluded that flexibility adds value to property projects. Even though these findings corroborate the identification of flexibility and its added value in property projects, this dissertation is the first to include it in a conceptual framework at the designing phase of a property development and are generally call-like options. They are embedded at the intersection of design stage and call option in Figure 4-2.

4.4.2.4 Switching Outputs

Depending on market conditions at the time, investments in certain property assets may be profitable as compared to others. For example, there are cases in the property market when investments in residential apartments may offer higher returns as compared to hotels. In such a case, the flexibility to switch the use of a development project from apartment to hotel in this case is switching output and is valuable to mitigate risks and improve upside potential. The switching output flexibility is exercised in future only when its expected payoff is higher than the capital required for exercising the flexibility. In property projects, switching output has been found to be valuable based on changes in the market conditions but was not immediate (Throupe et al., 2012). In a conceptual framework and categorisation, Baldi (2013) and Lucius (2001) identified this type of flexibility in property. The dissertation under consideration categorises the switching output option at the construction stage in Figure 4-2 and it is a call-like option because the outcome seeks to increase the output of another property asset.
4.4.3 South West Quadrant

Stage 3 of the conceptual model is the nodal point of construction and put options in Figure 4-2. During the construction stage, a developer has a choice to adopt the contraction option, temporary shutdown, switching output and entire abandonment of a project. These flexibilities to contract the size of a project, shut down temporarily or abandon a project completely are all put-like real options due to their reduction nature. They are used to mitigate downside losses temporarily while waiting for a favourable market conditions, but the abandonment flexibility seeks to close a project entirely to salvage some of its value. Complete abandonment happens due to a persistent unfavourable market or lack of demand for a specific property asset.

4.4.3.1 Temporarily Shutdown

The flexibility to temporarily shut down is generally important in situations where property markets are in a downturn, for example, during the financial crisis. During such unfavourable conditions, prudent developers can temporarily postpone new developments and put on hold development projects already in progress until a later date when the development may become profitable. In this instance, the ability of a developer to make flexible managerial decisions that can add value to a project via limiting downside losses and retaining an unlimited upside potential has enormous value. This flexibility is typically applied by the manufacturing industry where production can be halted for a while and re-opened later.

In property development real option literature, studies on the flexibility to temporary shutdown is limited. A typical example can be a developer stopping the construction of new office developments when property market conditions are unfavourable and continuing later when demand surges upward. For example, during the global financial crisis, many development projects were halted due to reasons such as unavailability of finance and low demand for property. Literature on the valuation of this type of flexibility in property is limited. The temporary shutdown flexibility is a put-like real option and this dissertation has captured it in a conceptual framework as shown in Figure 4-2.

4.4.3.2 Contraction Option (alter operating scale)

The contraction option is a flexible approach to managing projects by cutting down the size of a project in the face of market downturn. In this regard, developers who begin projects in anticipation of high market net absorption rates can use this as a managerial tool to cut down
losses by scaling down project sizes in tandem with demand. This is in the form of reducing the size of a project (for example, staging and land subdivision) to affect expenditure on a project in the face of changes in market conditions. In the conceptual framework in Figure 4-2, the contraction flexibility is at the intersection of construction and put options. It is a put option because it is a tool to reduce the size of a project which is in line with the option pricing theory because put options are deemed as reduction of assets in bad times in a market. The determination of the contraction option is in line with the findings of Lucius (2001) and Baldi (2013). However in a conceptual framework, the contraction options are embedded at the construction stage as opposed to being a general downscaling put-like real option as identified (Baldi, 2013).

4.4.3.3 Abandonment or Termination Options

Abandoning a project would mean an organisation attempting to cut losses from a failed project by discarding a project to salvage its value. Generally, it is possible for some development projects to experience periodic price volatility from the economic environment. Shutting the construction of a development temporarily suggest management’s confidence that the project may be viable in future. The exercise of flexibility to abandon is a permanent closure of a project without the intention to revisit it. This is done to close projects that do not have the potential to become profitable in future. It may be argued that no developer pursues a project with the intention of abandoning it midway but conditions from the economic environment may necessitate drastic action to salvage some of the value of a development.

In such cases, the value of the flexibility to abandon is important to ensure that some value is retained by a developer. A decision to abandon a project is highly dependent on the current profit envisaged from a development as against the salvage value that can be received from a development should the developer decide to divest it midway through the project execution. During the financial crisis as an example, several firms decided to abandon development projects and sold off their acquired lots in order to salvage some of the invested capital.

In property and construction, the abandonment option has been valued by Ke et al. (2007), Myers and Majd (1990) to have an added value to projects. In property development projects, Baldi (2013) found the presence of abandonment flexibility in a conceptual framework and suggested that it is a put-like downscaling option. The real option to abandon
identified in this dissertation also corroborates the finding of (Baldi, 2013) and (Lucius, 2001) but treats it as a put-like real option which occurs at the construction stage in Figure 4-2.

4.4.4 South East Quadrant

The fourth stage is dedicated to the marketing of a development after completion. This is necessary in cases when a developer defers presales or could not complete 100% sale of the development during the process. On the other hand, a development can be held as part of a portfolio of properties. A developer has two main choices; to flexibly manage the lease agreements with potential tenants to keep the upside potential or flexibly manage the sale of the remaining part of a development to increase the value thereof by selling according to prevailing values in the market at any point in time rather than a fixed price per unit over the entire period of the sale process.

4.4.4.1 Flexibility in Leases and Sales

At completion of a development, depending on the investment strategy of a developer, there is a right to either sell or hold and manage the completed property as part of a portfolio. In the event of a sale, a choice can be made between unit sales or a complete sale. Unit sales is a flexible call-like deferral option where prices of apartments can increase with time as compared to a single complete sale. In this regard, a developer can dynamically manage and increase the value of apartments put on sale with respect to time because of the volatility associated with property prices. This form of flexibility embedded in the sale of property assets was demonstrated and valued by Vimpani and Junnila (2014a). The application to a practical case validates the argument of this dissertation that, the flexibility in sales can be a valuable option and must be captured by the real options conceptual framework. Even though flexibility has been captured in real estate options literature, this specific type of flexibility has been documented in a conceptual framework in the real estate development process for the first time in this dissertation in Figure 4-2.

Completed developments can be held as part of a portfolio of properties under the management of a developer. Holding developments open flexible leasing options to a developer for profit maximisation in changing market conditions. For example, upward review only leases can be beneficial to keep upside potential of uncertain cash flows while at the same time limiting downside losses in times of downturn in a market. Such flexible leases have been identified and valued (Ashuri, 2010, Cho & Shilling, 2007, Grenadier, 1995, 2003, Sing, 2012, Sing &
(Tang, 2004, Ward & French, 1997, Ward et al., 1998) and corroborate the findings of this dissertation. Flexible leases was not identified in the conceptual framework of Baldi (2013) making this the first time incorporation in a conceptual framework in the property development process.

4.4.5 Middle Circle

The circle in the middle of Figure 4-2 represents the aggregate of all the flexibilities that are embedded in the property development process based on a staging or phasing strategy of an entire development. This is referred to as compound option and it’s a combination of both call and put-like options. In most real-life property development projects, the required capital investment is not incurred as a single upfront outlay because different stages occur at different times. It is in the form of a circle to suggest that it is present at all stages of the property development process because beginning from land acquisition to marketing of a completed project, a development can be staged.

4.4.5.1 Staging Investments (time to build)

Staging property development is one of the prominent flexibilities in property because property development is a staged activity. A simplified four stage approach to construction begins from preparation of the land for construction, construction of sub-structure, construction of super structure and roof and finishes. In this sense, a property developer can stage the total process of construction and mitigate risks due to changing conditions in the business environment.

Staging real life projects as a series of capital outlays over time creates valuable options to continue or "default" at any given stage should the price of property assets be higher or lower than expected (Trigeorgis, 1993b). Therefore, each stage is deemed as an option on the value of the next stage because, initial capital outlay for preceding stages serves as the exercise price to acquire the right to develop the next stage. The staging flexibility gives a developer the right but not the obligation (depending on sales/leasing and funding contracts) to develop in the next stage of a project should conditions in the market prove unfavourable. At the same time, developing a specific stage gives a developer the right to subsequently develop the next stage if conditions are favourable in the market. In view of this the staging flexibility is generally embedded throughout the process of a property development project. Staging also presents a series of different types of flexibilities such as expand, contract, shut down or abandon entirely
within a single project. The resultant effect is real options that are both calls and put mixed together in a single property development activity.

When these real options are embedded in a single property development project, they are referred to as compound option. For example, in property development, a developer may acquire a piece of land and prepare it for property development. If conditions in the market are favourable in such a way that the payoff from the development exceeds the costs, the developer has the right to develop the land and make profit, otherwise defer the development until a later date. During construction, a developer can pursue a strategy of dividing the development into phases and build. Such strategy offers an alternative of discarding a subsequent stage when conditions are unfavourable or executing the development when conditions are favourable in the market. The above strategy also results in a process of risk mitigation where a developer after building the first phase may decide to continue or stop execution/implementation depending on the market situation at the time.

The compound option is positioned at the middle of the quadrant in Figure 4-2 suggesting its presence at all stages of the development process and has a combination of both call options and put options. Even though it is an aggregate of all the real options embedded in a project (options on projects), Trigeorgis (1991) argues that there is a non-additive principle, hence the combined value of all the flexibilities is not necessarily the sum of the individual flexibilities due to interaction. Therefore, summing the individual real options without proper treatment of the interaction can overestimate the value of a compound real option embedded in a project.

4.5 Real Options as a Strategic Tool for Property Development under Uncertainty Conditions

The discussion suggests that all these types of flexibilities can be used as tools for managing projects actively for better decision making at the right stages of the property development process. This is dependent on a developer understanding the strategic importance of adopting flexibilities as a tool for decision making. In practice, because different types of flexibilities are embedded at different stages of the property development process, these flexible decisions can be captured in a process/flow network format shown in Figure 4-3 beginning from initiation of a project until marketing/disposal/let.

In Figure 4-3, the diagram begins with the initiation stage where a developer acquires a site for property development, but due to uncertainty, the waiting flexibility is triggered to resolve
uncertainties. As the waiting period is endured, a developer gathers information on the prevailing market conditions for the specific property project intended to be developed on the site. At the end of the waiting period, if conditions in the market are favourable, a developer evaluates the profitability and starts construction. At this stage of construction, it is further argued that the staging flexibility where property development projects are divided into phases can be adopted. If market conditions are not favourable after the waiting period, a developer may decide to hold the land as an opportunity to develop in future.

Some developers may however choose to develop under conditions of uncertainty as an entry strategy into a new market. For example, a developer may purchase land in a market downturn awaiting favourable market conditions before starting construction. Similarly, under such a circumstance it is argued that a developer adopts the staging strategy whereby the first phase can be developed initially and based on the success or otherwise, a decision can be made for future development.

In a favourable market, if a property development project is successful during the first phase as shown in Figure 4-3, then it serves as an option based on which the project can be expanded to meet increasing market demand. The expansion flexibility is dependent on the planning permit and a developer’s foresight to make provision for the expansion by building the foundations stronger than required initially to be able to capitalise on future favourable market conditions. This is also applicable to all systems that make a project functional in terms of walls, reinforcements, lifts, slabs, columns and other services.

Project inputs and outputs can also be switched depending on market demand for specific property assets. Project input switching may not be difficult as most contracts between property developers and investors/buyers are generally embedded with similar contractual clauses. The output switching flexibility is generally dependent on the flexibility a developer has in changing the use of a specific land in relation to planning permit. This means that developers ought to make provision for such changes during planning permit approval process to make switching output possible without unnecessary objections. In view of this, it is argued that similar uses such as hotels or serviced apartments may be contemplated to locate close to residential zones making it easy to switch as compared to retail, commercial or industrial property. As a result, planning permit approval process should incorporate potential future switching flexibility.
Figure 4-3 Real Options as Risk Management Tool for Property Development

- **Initiation stage**
- **Design and Construction stages**
- **Marketing stage**

Source: Author, 2016
On the other hand, if a developer is unsuccessful after the first phase as shown in Figure 4-3, a decision can be taken to exercise the flexibility of temporary shutdown, contraction or an outright abandonment of a project to salvage the value of the land and other related assets if a project has no possibility of generating profits in the future. The abandonment option is important in cases when the land value and other related assets may be valuable as compared to developing the land. During the global financial crisis, some developers abandoned their projects due to lack of demand for property products.

Upon successful completion of a development, a developer can use a dynamic sales strategy approach to dispose of the units (assuming an apartment). It is argued that putting the whole apartment structure on the market (all the units in case it is an apartment building) has the potential to decrease the price of the units due to excess supply. Therefore, a sequential release of apartment units in specific quantities based on demand can be a dynamic sale strategy to maximise profit and mitigate risks. Furthermore, flexible leases have been mentioned in case a developer is willing to hold a completed development as a portfolio as demonstrated in Figure 4-3. A developer retaining the right to adjust contract rent in line with changing market rents can keep the positive upside potential for a developer whiles limiting potential downside losses.

The valuation of these flexible rights (real options) that add value to property developments is based on the option pricing techniques. For example, the approach of developing a distribution of values from which expected asset values are calculated can be executed through the binomial option pricing model, finite differences, normal distribution via Black Scholes model, the use of geometric Brownian Motion (GBM), Monte Carlo Simulation (triangular, normal, Poisson diffusion etc) and the fuzzy payoff method. Again, dependent on the type of flexibility under consideration, a specific model may be required for valuation.

In Table 4-1, ROV models that have the potential to ensure that practical adoption of ROA for project evaluation and decision making is achieved are provided. The three main methods that are practitioner oriented are provided in addition to the flexibilities that can be used to evaluate them. In some cases, there is the need to combine two ROV models to derive the expected future payoff for particular types of options. For example, evaluating a project that has demand uncertainty may require the projection of demand using Monte Carlo simulation and evaluating the pay off with the binomial option pricing method. Staging flexibility can be evaluated by using either the fuzzy payoff method or binomial option pricing method. Land development option requires the use of flexibility or Samuelson-McKean formula for evaluation. This is
especially significant as the different real option types require varied models and approaches for evaluating due to the stochastic movement of asset prices embedded in the models.

Table 4-1 Real Options in Property Development, Features and Evaluation Models

<table>
<thead>
<tr>
<th>Stage in development process</th>
<th>Characteristics</th>
<th>Preferred Option valuation model for evaluation</th>
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<tbody>
<tr>
<td>Initiation stage</td>
<td>Land value</td>
<td>Call option</td>
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<tr>
<td></td>
<td>Waiting option</td>
<td>Call option</td>
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<td></td>
<td>Flexible pre-sale contracts</td>
<td>Call/put options</td>
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<td>Samuelson-McKean/Binomial method</td>
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<td>Binomial option pricing method</td>
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<td>Design and Construction</td>
<td>Expansion</td>
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<td></td>
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<td>Binomial /Fuzzy payoff method</td>
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<td>Staging</td>
<td>Switch output</td>
<td>Call option</td>
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<td>Samuelson-McKean /Binomial method</td>
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<td></td>
<td>Switch input</td>
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<td>Temporary shutdown</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Binomial option pricing method</td>
</tr>
<tr>
<td>Marketing and Sales</td>
<td>Dynamic sales</td>
<td>Call option</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Binomial lattice method</td>
</tr>
<tr>
<td></td>
<td>Flexible leases</td>
<td>Call /put options</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Binomial lattice method</td>
</tr>
</tbody>
</table>

Source: Author, 2016

There are several ROV models that have been developed by leading authors for the valuation of flexibility. However, most of these ROV models are applicable to flexibility under specific contexts. The preferred ROV models detailed in Table 4-1 are based on their general applicability to several cases in empirical settings as selected through the literature review. Besides, it is argued that these models are more transparent in application compared to other partial differential equations used for the valuation of flexibility/real options. Since transparency has been argued to be an important consideration by practitioners before potential adoption, the table becomes a reference point for practitioners to select models that are capable of valuing selected flexibilities. It is the binomial option pricing method and the fuzzy payoff methods that can achieve practical adoption due to their transparent projection of future values.
for valuation like the DCF technique. The Binomial option pricing is based on simple algebra with probability, making it easy to use by practitioners. The fuzzy payoff method on the other hand is based on scenario analysis that is likened to sensitivity analysis already used by practitioners. As a result of familiarity among practitioners and simplicity, coupled with transparent triangular distribution, it is argued that practitioners may consider it for decision-making. These ROV models have been explained and used to evaluate some real options embedded in property development in Chapters 5, 6 and 7.

In summary, Figure 4-2 has demonstrated that the different types of flexibilities such as defer, contract, expand, switch and abandon are all embedded in the property development process. However, there are other types of flexibilities that had not been captured by any conceptual framework including flexible designs (operating options), flexible leases and flexible sales of completed developments. These flexibilities though have been proven to have value, are now captured in a conceptual framework serving as a visual aid to deepen the understanding of practitioners and developers. This fills the gap proposed by Lucius (2001) that there was no systematic categorisation of real options making it difficult to identify the exact location of real options in property investments and development. Similarly, this contributes to the literature on flexibilities in property using the conceptual framework to categorise the different real options in a systematic approach based on the property development process. This also extends practical application of different types of flexibilities at different stages of the property development process by property practitioners and developers as a way of strategically managing projects for long term benefits.

After laying the theoretical foundations of real options by first substantiating the impact of uncertainties and irreversibility in property developments, it is argued that, together, uncertainties and irreversibility must be the driving force behind the relevance of flexibility in property developments. In view of this, the dissertation has outlined the importance of the different categories of flexibility (real options) as strategic tools for property developments in Figure 4-3, thereby expanding the possibility of practitioners using the knowledge of real options techniques to better manage projects. This is captured from inception of a project until the marketing stage in a flow network. It is argued that ROA has the potential to mitigate risks of development through strategic initiatives such as reducing the size of a development to cut losses and abandonment to salvage value. If uncertainties surrounding a project are envisaged to resolve and result in a positive market outlook, a temporary shutdown pending a favourable market can be adopted to manage development projects. Based on the conceptual framework
in this dissertation, practitioners have a much better understanding and guidelines to evaluate the practical application potential of real options theory and techniques in property development. Furthermore, practitioners have valuable insights regarding the types of real options they should focus on at different stages of the property development process.

In subsequent Chapters, the dissertation focuses on the use of some ROV models provided in Table 4-1 to evaluate some flexibilities using case studies. This is important because authors including Oppenheimer (2002) and Lander and Pinches (1998) have suggested that it is generally difficult to use ROV models for the evaluation of property projects. It is therefore relevant to use practical cases in real life settings with empirical data to evaluate some of the flexibilities (real options) using the options framework to provide the evidence needed for adoption of ROA/ROV models in practice. The choice of practical case studies in an empirical setting is premised on the fundamental objective of giving practitioners further evidence to support the adoption of ROA/ROV for decision making.

There are three case studies evaluated using ROV models in this dissertation:

- staging option;
- option to delay; and
- switching output option.

The results of the evaluations are presented in Chapters Five, Six and Seven to demonstrate the practical application of ROV in Australian residential projects. The ROV models enumerated in Table 4-1 have been explained in detail in Chapters Five, Six and Seven as part of the financial modelling.
Chapter 5 Case Study 1-Staging Option Using Fuzzy Pay Off Method (FPOM)

5.1 Introduction

This Chapter focuses on the first application of ROV model to residential property development case study using empirical evidence with the aim of determining if ROV methods are applicable in practice within the Australian residential property market. This is one of three case study applications demonstrated in this dissertation. Although a number of authors have suggested that the ROV methods are difficult to apply in practice (Lander & Pinches, 1998, Oppenheimer, 2002), the application will either confirm or disprove such long held notions of technical complexities of ROV methods in the property sector. Furthermore, due to the lack of practical adoption, Vimpari (2014) and Geltner and de Neufville (2012) suggested the need for more applications of ROV models to empirical cases from different property markets to prove their practical application in the property and construction sector.

*Flexibility to stage*

Firstly, this dissertation adopts the staging option as a flexible strategy and uses the real options framework (fuzzy payoff method-FPOM) to evaluate the viability of a residential development project located in Melbourne, Australia. It focuses on staging (horizontal) the process of acquiring the land and the construction of the entire development project. This type of real option gives a developer the flexibility to develop a project in a phased approach, thereby affording the opportunity to delay or abandon some phases of a project in case there is an unfavourable market during implementation.

In summary, this Chapter considers the application of real options theory/valuation to specific case study project and compare the outcome with the results of DCF. The aim is to determine which of the two methods deliver superior outcomes for property development decision making under uncertainty. The results are used to discuss the potential of real option theory in enhancing uncertainty analysis in residential property development. The result further gives the evidence needed to support the adoption of ROV to property projects in practice.

5.2 Evaluation of Staging Options on Residential Project

Several residential property development projects may be rejected due to the use of the DCF approach for evaluating the financial viability of projects because flexibility is not incorporated
into the evaluation. Particularly, projects of substantial size could be rejected because such projects require significant initial capital outlay which could render feasibility analysis not viable. Besides, some parts of a project may not be viable and hence affect viability of an entire project. For example, a project that requires acres of land for development may need substantial funding to pay for the land before other necessary costs (construction, contingency, holding and statutory fees) are considered. As a result of the significant sum required initially before actual construction commences, using the DCF technique for evaluating the financial viability of such a project may deem it economically unviable. Thus, the DCF technique of evaluation with its measures of profitability including NPV will reject such projects because the initial capital outlay can cause the entire project to become unviable during feasibility analysis.

Having the flexibility to phase a residential development project through both staging the acquisition of the land and the construction can both be beneficial to a developer and lead to projects becoming economically viable. Staging flexibility allows a developer to break down a project into phases and incrementally increase its size with time as uncertainty resolves and market conditions become favourable. Staging flexibility is naturally embedded in residential property developments and developers can capitalise on it to transform an economically unviable project from to deliver positive outcomes.

A possible argument is that property development projects that are staged can be evaluated using DCF. Even though this is true to an extent, the actual benefit of the staging option where parts of a project can be abandoned in the future, as a strategy is not incorporated in the DCF framework. DCF is unable to incorporate the phases of staged projects as single phases of a complete whole, whereby some phases can be abandoned during market downturns. It passively assumes that, phases of a project will be executed by developers irrespective of changes in market conditions. However, in the real options framework, phases of a development project are treated separately from other phases and are evaluated as such in the financial feasibility analysis. Therefore, phases of projects that are not viable are not captured as part of the profitability analysis because the staging gives developers the opportunity to abandon unviable phases due to unfavourable market conditions.

The staging flexibility allows a developer to undertake a residential project in phases and retain the opportunity to either delay or abandon some stages if the market turns unfavourable in the future. The potential of a developer to be able to execute a project in phases confers both call and put options on a project which can be very valuable to developers. When market conditions are favourable at a specific time during the life of a project, the particular stage becomes
profitable and developers can take advantage and develop. However, when a specific stage is unprofitable due to market conditions, a prudent developer will discard that specific stage of development. In that regard, a developer retains the right to either delay, hold or abandon the unprofitable phase of the overall project but develop other profitable phases if possible, subject to planning permission. Basically, the flexibility to stage ensures that phases that are profitable are executed and unprofitable stages are either delayed until further information is available or abandoned entirely.

5.2.1 Description of Large-Scale Residential Case Study

The large-scale residential development project has been completed and hence the discussion is more of a historical nature than future oriented. The project is in Melbourne and for confidentiality purposes, the name of the project is undisclosed. It is close to a highway that links the location to Melbourne’s central business district (CBD). The location is an established residential area in the eastern part of Melbourne.

Figure 5-1 Land for the Staging Option Residential Development Case Study

Figure 5-1 illustrates the land is rectangular making it easy for laying out the residential development. The site for the development was approximately nine (9) acres and boasts some important amenities including a University, three Tram stops and bus stops that are all adjacent to the development, attractive locational qualities for the potential investors and occupiers (students). In addition, several shopping centres are located nearby. This attracts demand to the development because it is an important consideration for future occupiers in their choice of
To conceal the location of the project, the amenities are not shown in Figure 5-1. Upon completion of the project as shown in Figure 5-2, the development had about 240 units of apartments and town houses of varying sizes, designs, finishes and number of car parks. About 50% delivered in four medium density buildings and the balance as houses on different sized parcels of land.

**Figure 5-2 Completed Development**

As displayed in Table 5-1, total gross floor area (GFA) of town houses for the entire residential development was approximately 27,000m² whereas net floor area (NFA) had a total size of about 22,109m².
Table 5-1 Information on Average Townhouses

<table>
<thead>
<tr>
<th>Houses</th>
<th>Total GFA (sq.m)</th>
<th>Total NFA (sq.m)</th>
<th>Total houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 bedrooms</td>
<td>5,279</td>
<td>4,370</td>
<td>23</td>
</tr>
<tr>
<td>4 bedrooms</td>
<td>13,662</td>
<td>11,064</td>
<td>74</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>8,132</td>
<td>6,676</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>27,072</td>
<td>22,109</td>
<td>123</td>
</tr>
</tbody>
</table>

Source: Adapted from developer’s data, 2016

This included 3, 4 and 5 bedroom townhouses with various car park configurations and bathrooms. Details of the number of bedrooms are shown in Table 5-1. The houses have open plan kitchens with European kitchen appliances, dining and lounges which offer entry onto a private backyard. There are separate toilets for master bedrooms, laundry and a remote-controlled garage for either one or two cars depending on the design specifications. Some houses have a spacious sundeck area for family entertainment with extra driveway, front and landscaping.

5.2.3 Features of the Apartments

Regarding the units in the four medium-density apartment buildings, a summary of information is provided in Table 5-2. Accordingly, the total GFA and the NFA of the apartments were 13,082m² and 9,254m² respectively. Each of the buildings was composed of a basement car park, ground floor, different number of units, varying sizes, designs and shapes.

Table 5-2 Information on the Medium Density Apartments

<table>
<thead>
<tr>
<th>Apartments</th>
<th>Total GFA (sq.m)</th>
<th>Total NFA (sq.m)</th>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 1</td>
<td>2,885</td>
<td>2,011</td>
<td>24</td>
</tr>
<tr>
<td>Building 2</td>
<td>3,573</td>
<td>2,459</td>
<td>32</td>
</tr>
<tr>
<td>Building 3</td>
<td>2,888</td>
<td>2,211</td>
<td>29</td>
</tr>
<tr>
<td>Building 4</td>
<td>3,736</td>
<td>2,572</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>13,082</td>
<td>9,254</td>
<td>119</td>
</tr>
</tbody>
</table>

Source: Adapted from developer’s data, 2016
5.2.4 Data on the Case Study Project

The application of real options theory (flexibility) to this case study was based on stepping back in time to the year 2009 when the project was at the inception stage and the developer was contemplating on whether to proceed with the land acquisition and development. Payments were deferred until the year 2010 when the development layout of the site and the building designs had all been completed. All data used in the case study were supplied by the developer.

The developer needed to evaluate the financial feasibility of the project to determine viability and whether to execute or abandon the project. In most of these large-scale residential projects, developers normally do pre-sales before construction commences to mitigate impact of uncertainties. This strategy is common among residential property developers engaged in land banking in Australia. High rise residential property developers primarily use pre-sales as a risk management tool to mitigate potential downside risks from uncertainties because developers are yet to fully accept the idea that uncertainties can have positive impact on profitability, hence, the need to retain the flexibility required to capitalise on future opportunities. Besides, pre-sales can cause loss of potential future revenue to residential developers if residential property prices rise in future, albeit locked in contracts protect the developer’s downside when property values fall. In view of this, residential property developers require strategies that can deal with uncertainties better. One strategy proposed and evaluated in this dissertation is staging flexibility.

To do a realistic financial feasibility evaluation, a key issue at this point was to determine the approach to execute the development based on whether a proper financial feasibility evaluation could be done. It was therefore important at the time to examine the strategy to develop the project. One important question is whether the whole project should proceed at once or be staged? If it could be staged, how many stages may be appropriate and was the DCF evaluation the appropriate tool for evaluating the staging flexibility embedded in the development? The reason is that the staging flexibility has value that must be accounted for in the financial modelling. Without accounting for it, the project’s value would be underestimated. Besides, current financial models such as the dominant DCF is inappropriate in evaluating flexibility.
Table 5-3 Data on Costs and Revenues for the Development (All Figures in $AUD)

<table>
<thead>
<tr>
<th>Year</th>
<th>Item</th>
<th>Cost</th>
<th>Sales</th>
<th>Net Cash flow</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>All payments deferred to 2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design and approvals</td>
<td>$3,202,340</td>
<td>$0</td>
<td>-$3,202,340</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Part Payment of land 10%</td>
<td>$3,022,386</td>
<td>$0</td>
<td>-$3,022,386</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land development, demolition and marketing</td>
<td>$8,417,108</td>
<td>$0</td>
<td>-$8,417,108</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Balance of land payment 90%</td>
<td>$27,201,476</td>
<td>-</td>
<td>-$27,201,476</td>
<td>-$41,843,310</td>
</tr>
<tr>
<td>2011</td>
<td>1st set of townhouses (53 houses)</td>
<td>$12,328,235</td>
<td>$41,210,600</td>
<td>$28,882,365</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apartment building 1 (24 units)</td>
<td>$4,781,572</td>
<td>$11,395,000</td>
<td>$6,613,428</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apartment building 2 (32 units)</td>
<td>$5,897,465</td>
<td>$14,470,000</td>
<td>$8,572,535</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goods and Service Tax</td>
<td>$3,769,060</td>
<td>$0</td>
<td>-$3,769,060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance</td>
<td>$1,902,293</td>
<td>$0</td>
<td>-$1,902,293</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selling</td>
<td>$2,364,383</td>
<td>$0</td>
<td>-$2,364,383</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>$609,256</td>
<td></td>
<td>-$609,256</td>
<td>$35,423,336</td>
</tr>
<tr>
<td>2012</td>
<td>2nd Set of townhouses (61 houses)</td>
<td>$16,132,919</td>
<td>$51,159,500</td>
<td>$35,026,581</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apartment building 3 (29 units)</td>
<td>$5,399,637</td>
<td>$12,401,000</td>
<td>$7,001,363</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GST</td>
<td>$3,769,060</td>
<td>$0</td>
<td>-$3,769,060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance</td>
<td>$1,902,293</td>
<td>$0</td>
<td>-$1,902,293</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selling</td>
<td>$2,364,383</td>
<td>$0</td>
<td>-$2,364,383</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>$609,256</td>
<td></td>
<td>-$609,256</td>
<td>$33,382,952</td>
</tr>
<tr>
<td>2013</td>
<td>3rd set of townhouses (9 houses)</td>
<td>$2,214,197</td>
<td>$7,075,000</td>
<td>$4,860,803</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apartment building 4 (34 units)</td>
<td>$6,469,764</td>
<td>$14,777,000</td>
<td>$8,307,236</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GST</td>
<td>$3,769,060</td>
<td>$0</td>
<td>-$3,769,060</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finance</td>
<td>$1,902,293</td>
<td>$0</td>
<td>-$1,902,293</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selling</td>
<td>$2,364,383</td>
<td>$0</td>
<td>-$2,364,383</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contingency spent</td>
<td>$646,411</td>
<td>$0</td>
<td>-$646,411</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Post settlement</td>
<td>$679,466</td>
<td>$0</td>
<td>-$679,466</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Holding</td>
<td>$688,577</td>
<td>$0</td>
<td>-$688,577</td>
<td>$3,117,849</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$122,407,274</td>
<td>$152,488,100</td>
<td>$30,080,826</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Profit / Net Development Value</td>
<td>$30,080,826</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Development Margin/Margin on cost</td>
<td>24.57%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from developer’s data (2016)
In Table 5-3, the data provided by the residential developer for the project is presented. A 10% part-payment of approximately $3 million was paid for the land initially (all payments are in Australian dollars). The total cost of the land was approximately $30,223,862 and the remainder being paid at the end of 2010 when it was determined that planning permission was successful. Table 5-3 also shows the revenues and costs obtained from the development project with detailed specific costs and times those revenues occurred. The total cost and revenue for the project were approximately $122 million and $152 million respectively.

Table 5-3 indicates that the development strategy was to proceed at once with the construction and sales taking a period of five (5) years but without any provision for mid-course strategy in case there is an unfavourable market or decrease in demand. Discussions with the developer indicated that the development was supposed to proceed at once without any flexibility/optionality. Therefore, the total cost of the land was paid at the commencement of the project without considering any optionality or flexibility to abandon some phases of the project when the need arises in future. The financial feasibility evaluation analysis also laid credence to the absence of optionality, as there was no in-built strategy to deal with changing economic conditions in the property market during the execution phase of the project. Therefore, the financial feasibility evaluation assumed a static approach to the apartment development. However, the developer suggested that there was active management of the project until completion. This sheds light on the active management style adopted by developers on one hand, and the inappropriate use of the DCF to evaluate such developments on the other hand without accounting for the value of flexibility. Apparently, this is due to the inability of DCF to incorporate flexibility in financial feasibility evaluation.

Even though the data from the developer suggested that the land was released and developed in stages, the financial feasibility evaluation of the project itself was not based on the staging approach. Table 5-3 displays financial analysis of project returns and indicates that the developer made an undiscounted profit of approximately $30 million and this represents a development margin of about 24.6%. According to the developer, this return on investment is greater than the average expected development margin from high rise residential property developments which are known to be between 15%-20% for the Australian residential property development sector.

However, it would have been erroneous on the part of the developer to use simple development margin because it does not account for the time value of money. Therefore, there was the need to consider the time value of money in addition to risks and uncertainties attributable to
inevitable market forces. The developer’s decision to execute the project was based solely on the development margin and any change in market conditions could have had serious financial consequences. It is therefore appropriate to use DCF technique which accounts for time value of money and risks using required rate of return (discount rate) for evaluation. In practice, most developers use DCF in project evaluation due to its acceptance by the industry as already indicated in the literature review. Moreover, it is embedded in Estate Master, which is a popular property development financial feasibility evaluation software in the Australian property development sector.

5.3 DCF modelling (base case scenario of 10.23% required rate of return)

In this section, the DCF approach which can account for the time value of money and capture risks and uncertainties in residential property development through required rate of return is adopted to evaluate the project and compare the results to the development margin. Firstly, a base case scenario of the project is evaluated using the DCF technique and the data given by the developer. In executing the financial analysis using the DCF technique, it was assumed that the developer proceeded with the project at once without any opportunity to delay or abandon some phases of the project in later years because of an unfavourable market. This means there is irreversible commitment to the project and lack of flexibility to alter plans mid-course during the development. Mid-course strategies (flexibilities) are important in extremely volatile property markets where there are movements in property values in tandem with changes in mostly economic and other value driving factors. Using DCF technique in equation 5-1,

\[ NPV = -I + \sum_{t=1}^{n} \frac{CF_t}{(1 + r)^n} \]

Where \( n \) = period for the development

\( CF_t = \) net cash flow at period \( t \)

\( r = \) required rate of return (reflecting the riskiness of development)

\( I = \) the initial investment outlay for the project (costs)

The development period is 5 years, a cost discount rate of 2.5% (long term inflation target of the Reserve Bank of Australia), cash flow discount rate of 10.31% calculated based on data from returns on residential property from Core Logic RP Data. Since the development is composed of units and houses, it is important to account for both in determining the discount
rate. Data from RP Data suggests that investment in housing and units have a stable annual return of 10.68% and 9.4% respectively. These returns include both capital growth and rental return, therefore ensuring that the potential total return is used in modelling. Capital growth was calculated as the compound annual growth rate in median price, comparing the median price of property sales in the preceding 12 months to the median price of properties sold in the same 12-month period 5 years ago, based on 222 property sales. The rental return is however calculated as the median advertised rent as a percentage of median price, based on 275 property rentals and 109 property sales over the preceding 12 months. The required rate of return is then calculated as a weighted return using the weight of the two developments (units and houses in terms of value) in the overall project. Therefore, required rate of return is given by equation 5-2,

$$ R = W_u R_u + W_h R_h $$

Where

$R$ = required rate of return for discounting cash flows

$W_u$ = weight of units (in value) as a percentage of the overall development

$R_u$ = stable annual return on investments in units

$W_h$ = weight of houses (in value) as a percentage of the overall development

$R_h$ = stable annual return on investments in houses

The weight of the value of houses and units in the development were calculated to be 65% and 35% respectively. Together with the returns from respective investments in houses and units, the required rate of return was estimated to be 10.23% which was used in discounting the cash flows for the residential development project to account for time value of money, risks and uncertainties. Even though the 10.23% required rate of return seems low for residential developments, it is argued that it is appropriate for base case evaluation because that is the prevailing rate of return from historical property returns.

**Table 5-4 Required Rate of Return Computation (Weighted Return)**

<table>
<thead>
<tr>
<th>Weight/Return</th>
<th>Houses</th>
<th>Units</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weights</td>
<td>65%</td>
<td>35%</td>
<td>100%</td>
</tr>
<tr>
<td>Return</td>
<td>10.68%</td>
<td>9.40%</td>
<td>20.20%</td>
</tr>
<tr>
<td>Weighted return</td>
<td>6.96%</td>
<td>3.27%</td>
<td>10.23%</td>
</tr>
</tbody>
</table>

Source: Author, 2016
As shown in Table 5-4, the required rate of return was calculated as a weighted return of investments in both houses and units. The weights were based on the respective values of units and houses in the total development value, costs and revenues data for respective years were supplied by the developer for the financial feasibility evaluation.

Table 5-5 Results from DCF Modelling for Base Case Scenario

<table>
<thead>
<tr>
<th>Input</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Cost</td>
<td>$41,843,310</td>
<td>$31,652,264</td>
<td>$30,177,548</td>
<td>$17,366,108</td>
<td>$1,368,043</td>
</tr>
<tr>
<td>Revenue</td>
<td>$0</td>
<td>$67,075,600</td>
<td>$63,560,500</td>
<td>$21,852,000</td>
<td>$0</td>
</tr>
<tr>
<td>PV Costs</td>
<td>$41,843,310</td>
<td>$30,880,258</td>
<td>$28,723,425</td>
<td>$16,126,158</td>
<td>$1,239,379</td>
</tr>
<tr>
<td>PV Sales</td>
<td>$0</td>
<td>$60,850,585</td>
<td>$52,310,358</td>
<td>$16,315,176</td>
<td>$0</td>
</tr>
<tr>
<td>NPV@10.23%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$10,663,589</td>
</tr>
<tr>
<td>IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.70%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

After evaluating the financial feasibility of the residential development project, the NPV and IRR for the project would have been $10,663,589 and 16.18% respectively as shown in Table 5-5. The results indicate that the development margin calculated on the cost of the development would have been about 8.7%, which is lower than the estimated development margin of 24.57% calculated initially, because of the effect of time value of money. This level of profitability is deterministic in the sense that it assumes conditions in the market will be steady until completion of the large scale residential development project. Since the costs and revenues are uncertain, it is important to perform sensitivity analysis to determine the impact of changes in various inputs on the outcome (value) of the project and the potential profitability. Besides, the development did not account for optionality (flexibility) existing in the project in terms of phasing, which can maximise the gross realisable value of the project for the developer. In view of this, a sensitivity analysis is performed in the next section to determine the impact of potential changes in input parameters on financial outcome of the development project. Variables that are highly uncertain are also determined through the sensitivity analysis.

5.3.1 Sensitivity Analysis

Since no model perfectly predicts future market conditions, it is important to examine the impact of changes in input variables on the financial viability of the residential development project. One approach adopted by industry and practitioners to examine the impact of changes
in input variables on development profitability is using sensitivity analysis. Sensitivity analysis is the process of changing the input variables in a DCF model to determine their impact on the profitability of a specific project. In practice, several analysts and property investment decision makers use this process to evaluate risks and uncertainties by ascertaining the most sensitive variables in a model and their potential impact on profitability. The reason is that several variables may have different impacts on profitability of a development. Therefore, selecting variables with the greatest impact allows developers more focus and ensures effective risk assessment.

In contemporary property practice, practitioners use Palisade Decision Suite software which has TopRank and other tools such as @RISK embedded in it as one of the leading industry software for performing sensitivity analysis and simulation. As a result, TopRank was used to perform sensitivity analysis for the case study project. An output from TopRank after running sensitivity analysis is a tornado graph. It uses bars for comparative analysis between different inputs in a DCF model and determines the impact of changes in such variables on profitability of projects.

**Figure 5-3 A Tornado Graph for Base case NPV Scenario**

The tornado graph in Figure 5-3 shows the most sensitive variables in the DCF model for the base case scenario of financial feasibility. The revenue input is the most sensitive and has the
greatest impact among the four variables because it has the longest bar. This is evident in the outcome of a 10% variation in the revenue on the NPV as shown in Table 5-6.

**Table 5-6 Sensitivity Analysis of Minimum Outcome for Base Case Scenario (-10%)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input name</th>
<th>Output value</th>
<th>Input value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Revenue</td>
<td>-$2,253,167</td>
<td>$137,239,290</td>
</tr>
<tr>
<td>2</td>
<td>Cost</td>
<td>-$1,183,322</td>
<td>$134,648,001</td>
</tr>
<tr>
<td>3</td>
<td>Discount rate (revenue)</td>
<td>$8,738,203</td>
<td>11.25%</td>
</tr>
<tr>
<td>4</td>
<td>Discount rate (cost)</td>
<td>$10,352,036</td>
<td>2.25%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

A 10% downward variation in revenue has the effect of rendering the project financially unviable because this results in a minus NPV at $-2,253,167. Similarly, a 10% upward change in the cost has the potential effect of reducing the NPV figure to $-1,183,322 suggesting that the developers will make losses under such a circumstance. Changing both discount rates for revenue and costs had the effect of reducing the potential profitability of the project. Thus, the impact from changes in the discount rates for both cost and revenue is insignificant as far as financial feasibility is concerned.

**Table 5-7 Sensitivity Analysis of Maximum Outcome for Base Case Scenario (+10%)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input name</th>
<th>Output value</th>
<th>Input value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Revenue</td>
<td>$23,650,073</td>
<td>$167,736,910</td>
</tr>
<tr>
<td>2</td>
<td>Cost</td>
<td>$22,580,228</td>
<td>$110,166,547</td>
</tr>
<tr>
<td>3</td>
<td>Discount rate/revenue</td>
<td>$12,712,909</td>
<td>9.21%</td>
</tr>
<tr>
<td>4</td>
<td>Discount /cost</td>
<td>$11,042,193</td>
<td>2.75%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

The outcome of a 10% upward change in the most sensitive input in the financial model would be positive gains for the developer. Such a change in revenue, cost (which reduces in this case by 10%), revenue discount rate, and cost discount rate would yield an NPV of $23,650,073, $22,580,228, $12,712,909, and $11,042,193 respectively as shown in Table 5-7. The indication is that there can be upside potential associated with the project, hence, the developer should pay attention to these opportunities, prepare and retain the opportunity to capitalise on them as market changes, rather than focusing on the downside losses alone.
5.3.2 DCF Modelling (worst-case scenario using 20% required rate of return)

In a worst-case scenario, five years was used for the modelling (including year zero) as presented in Table 5-5. In the modelling, the cash flows and costs are discounted at a rate of 20% and 5.5% respectively. The 20% used for cash flow analysis is appropriate because that is the maximum required rate of return accepted by many developers in the Australian property development market (variations might exist for individual cases). Construction costs are normally discounted based on construction price index (CPI). The 5.5% used for cost discounting is the highest construction price index recorded using data spanning about 25 years. These values are upper limits to demonstrate the worst-case scenario in case of unfavourable market conditions. These two different rates were used for the costs and revenues because it was assumed that the income cash flows were also riskier than the costs cash outflows. This is also augmented by the views of practitioners because the costs are always agreed between developers and contractors and subject to changes as agreed within the contract document. However, revenues are uncontrollable by developers and can deviate significantly in the property market from those anticipated.

After the financial feasibility analysis of the worst-case scenario, NPV and IRR for the project would have been AUD$-2,069,925 and 18.65% respectively as shown in Table 5-8. Table 5-8 shows the total period of development is 5 years and revenues were estimated to occur in 2011, 2012 and 2013.

### Table 5-8 Results of DCF Modelling for Worst Case Scenario (-10%)

<table>
<thead>
<tr>
<th>Input</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Cost</td>
<td>$41,843,310</td>
<td>$31,652,264</td>
<td>$30,177,548</td>
<td>$17,366,108</td>
<td>$1,368,043</td>
</tr>
<tr>
<td>Revenue</td>
<td>$0</td>
<td>$67,075,600</td>
<td>$63,560,500</td>
<td>$21,852,000</td>
<td>$0</td>
</tr>
<tr>
<td>PV Costs</td>
<td>$41,843,310</td>
<td>$29,979,413</td>
<td>$27,072,018</td>
<td>$14,755,623</td>
<td>$1,100,964</td>
</tr>
<tr>
<td>PV Sales</td>
<td>$0</td>
<td>$55,896,333</td>
<td>$44,139,236</td>
<td>$12,645,833</td>
<td>$0</td>
</tr>
</tbody>
</table>

| NPV@20%                   | -$2,069,925 |
| IRR                       | 18.65%     |

Source: Author, 2016

However, the costs were spread until the end of the project in 2014. The resultant effect is that the project would have been rejected initially and possibly abandoned by the developer forever.
because of NPV rules of decision making. Similarly, the IRR for the project was lower than the required rate of return sought by the developer, which indicates a rejection of the project.

5.3.3 Sensitivity Analysis for Worst Case Scenario

In Figure 5-4, a tornado graph is presented to show the most sensitive variables in the DCF model for the residential project in a worst-case scenario. In a tornado graph, the length of the bar indicates the level of impact of a change in a specific variable on the profitability of the project. Figure 5-4 has four variables; total cost, revenue, cost and revenue discount rates suggesting that they are the most sensitive variables in the DCF model for the residential project. For instance, the total cost bar is the longest and occupies the top position suggesting that it is the most sensitive variable in the DCF model. This is followed by the revenues, cost discount rate and revenue discount rate showing their level of sensitivity in the DCF model. Therefore, any variation in cost would have had the greatest impact on profitability. Similarly, a variation in the revenues would have impacted on the project’s profitability heavier than a similar variation in the cost and revenue discount rates.

Figure 5-4 A Tornado Graph of NPV for the Project in Worst Case Scenario

Table 5-9 depicts that a 10% decrease in total cost would have improved profitability to approximately $9.5 million, thereby changing an unprofitable project into a viable development. Similarly, a 10% increase in total revenue would have increased profitability to approximately $9 million but below the impact of potential cost variation.
Table 5-9 What-If-Analysis Summary for NPV Output (10% downward variation)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input name</th>
<th>Output value</th>
<th>Input value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total Cost</td>
<td>$9,405,143</td>
<td>$110,166,547</td>
</tr>
<tr>
<td>2</td>
<td>Revenue</td>
<td>$9,198,144</td>
<td>$167,846,910</td>
</tr>
<tr>
<td>3</td>
<td>Discount/Revenue</td>
<td>$1,040,297</td>
<td>18.00%</td>
</tr>
<tr>
<td>4</td>
<td>Discount Rate/Cost</td>
<td>-$1,374,002</td>
<td>6.05%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

In addition, 10% decline in the revenue discount rate would have improved profitability to approximately $1 million from its original NPV figure of about $-2 million.

Table 5-10 What-If-Analysis Summary for NPV Output (10% upward variation)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input name</th>
<th>Output value</th>
<th>Input value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total Cost</td>
<td>-$13,545,122</td>
<td>$134,648,001</td>
</tr>
<tr>
<td>2</td>
<td>Revenue</td>
<td>-$13,338,123</td>
<td>$137,329,290</td>
</tr>
<tr>
<td>3</td>
<td>Discount rate/Revenue</td>
<td>-$5,033,433</td>
<td>22.00%</td>
</tr>
<tr>
<td>4</td>
<td>Discount Rate/Cost</td>
<td>-$2,777,751</td>
<td>4.95%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

In Table 5-10, should the total cost have escalated by 10%, the resultant effect would have been a further decline in profitability to around $-13.5 million. This demonstrates the magnitude of the total cost variable in the DCF model in either case of potential increases or decreases. A 10% decrease in revenue would have had a resultant effect of decreasing profitability to approximately $-13.3 million. An increase in the revenue discount rate by 10% on the other hand would have decreased profitability to about $-5 million. This supports the IRR argument that a discount rate of 18.65% has the potential to make the project break-even but any discount rate above it would render the project unviable. However, since the developer was not willing to compromise on the expected return, it was not likely that there would have been a reduction in the required rate of return. The cost discount rate presented an interesting result because whether the rate was increased or decreased by 10%, the project would have remained unviable at both around $-2.7 million and $-1 million respectively. As a result, there would have been major losses for the developer should any of the negative scenarios have occurred. The developers would not have had the chance to alter the development strategy as there was no
flexibility considered from the inception of the project. Therefore, uncertainty assessment
cannot be reduced to sensitivity analysis because it does not mitigate the negative impact of
unfavourable market condition on profitability. Similarly, the use of required rates of return do
not account for risks and uncertainties properly as demonstrated through the DCF modelling.
Upside potential associated with the development in a favourable market couldn’t be captured
by the developer because of the static approach of DCF evaluation without any embedded
flexible strategy. Downside losses such as bankruptcy due to an unfavourable market cannot
be compensated for by required rate of return.

Even though sensitivity analysis gives a developer insight into the impact of some important
variables in financial modelling, it does not affect the decision of developers in executing a
project or otherwise because project acceptance hinges on a single point NPV estimate. At best,
the sensitivity analysis is good for communicating uncertainties in property development but
not to deal with these uncertainties in a way that are incorporated in the decision making of a
developer. It is these uncertainties in revenues and costs and how to deal with them in
residential property development that is at the centre of the current dissertation. As argued,
DCF uses required rate of return as a means of dealing with risks and uncertainties associated
with property developments.

The results of the financial modelling of the residential development project and the sensitivity
analysis in Figure 5-3 and Figure 5-4 indicate that the required rate of return does not present
a true picture of the magnitude of risks and uncertainties associated with development projects
because the size of potential losses cannot be compensated via a set required rate of return.
Generally, the use of discount rate/required rate of return does not capture the potential of
capital losses resulting from project failures. Besides, DCF framework does not incorporate the
technique for modelling the stochastic process of cost and asset price changes under conditions
of uncertainty. Even in the base case scenario, changes in the revenues had a substantial impact
on the financial viability of the development, hence it is important to model such changes and
embed the flexibility to deal with uncertainties rather than assumed discount rates. Since
flexibility has value, it is important to account for it in the financial feasibility evaluation.

5.4 Real Options Modelling

As shown in the sensitivity analysis for base and worst-case scenarios, variations in the cost
variable had the greatest impact, followed by the revenue variable in the DCF model. In
addition, the discount rates for both cost and revenue in both best and worst-case scenarios also had varied impacts on the profitability outcome of the development project albeit upside gains and insignificant losses as compared to the impacts from variations in both costs and revenues on the project. In Table 5-5, it is evident that if the developer had chosen to develop the whole project at once based on the use of NPV and IRR as decision making rules of the DCF technique, the development project was viable in the base case scenario. However, the development was unviable in the worst-case scenario as shown in Table 5-8 and may have been rejected. Due to risks and uncertainties, there is the possibility of changing some aspects of the development project during execution based on market dynamics and prospectively incorporating flexibility into the projects. For example, should uncertainties result in cost escalation and property value decline, the base case scenario may also become unviable as demonstrated in Table 5-6.

In addition, the developer would have incurred losses should the worst-case scenario have occurred during the execution phase of the project without any flexible strategy to salvage the project. Therefore, without considering all future possibilities and developing a flexible strategy to deal with uncertainties, unfavourable changes in uncertain input variables could have had serious financial consequences on the project. As a result, a more realistic model of financial evaluation of such a large-scale urban residential project would be a staging option where the development could be divided into phases. By doing so, some of the phases could have been abandoned (given appropriate contracting embedded with flexibility) during unfavourable market conditions or expanded due to capitalise on emerging upside opportunities over time during the financial evaluation to make an informed decision.

In view of this, any attempt at re-evaluating the residential development project must focus on how uncertain inputs can be captured in the financial modelling. This is the superiority of real options theory to combine flexibility (strategy) and finance theory to evaluate capital projects based on flexibility afforded a developer to make strategic mid-course changes to the execution of projects. Such strategic flexibilities add value to projects and must be evaluated, else realisable value of projects would be underestimated. In real options modelling, the information for both base and worst-case scenarios are used to re-evaluate the project in a flexible phasing approach separately, to capture the potential value of flexibility in phasing the development project. The results are compared to that of DCF to determine the method with superior results for property development decision making.
Due to the large size of the land (9 acres), the initial capital outlay for the development was very substantial ($30,223,862) as shown in Table 5-3. The size of such a development makes it imperative for the developer to consider uncertainties including changes in property prices which can affect potential revenues and hence profitability of the development. This is important because of volatility in property markets including middle ring eastern Melbourne (location of project) residential property sub-markets. For example, Figure 5-5 displays the changes in property values over a period of 10 years in the middle ring eastern Melbourne area for both houses and units. The graph shows the movement of property values for established houses and units with intermittent rises and falls over the period.

**Figure 5-5 Capital Growth of Established House Prices of Suburb from 2007-2016**

Beginning from 2007-2009 inclusive, Figure 5-5 shows a rise and fall pattern which is possibly due to the financial crises period. However, from 2010 until 2013, the graph demonstrates a steady level of property values for both houses and units. After 2013, property values for both houses and units started increasing sharply and have continued unabated for houses until 2016, but units in apartment buildings have recorded a decrease in prices in 2016. This demonstrates

Source: Author, 2016 (data from RP Data)
the risks and uncertainties associated with property developments in this specific property sub-market.

A key issue for the development is the project financial modelling and how uncertainties may impact on the project during the execution phase. Since the bulk of the initial cost was the land cost, it is argued that the developer stages the project by dividing the development into four phases. As a result, the developer would only have to pay for the part of the land needed at a specific phase of the project at a time rather than irreversibly committing to the whole project by purchasing the land out right and spending all resources on the development immediately as suggested by DCF technique. The developer should acquire only an option on the land to continue the development as and when a specific phase is viable. Obviously, the options on the land adopted by this case example seek to push considerable risks to the land vendor. Naturally, the vendor would seek higher land value than an outright purchase because of extra holding cost for each period of delay, potential increases in land value during delay of phases of the development, risk to the vendor that the developer does not prosecute the options, leaving the vendor with a smaller and relatively less valuable parcel of land and a value for the option for the vendor to hold the land for the developer. Thus, the developer will forfeit the amount paid for the option in the event of abandoning some phases of the development due to unfavourable market conditions. Naturally, there will be cost escalation of both the land and development cost due to the staging of the project. This is modelled as part of the cost evolution of the development using the real option model in this case study.

The effect of staging is that it reduces the amount of capital outlays required at different stages of the development process. By dividing a large development project as in this case study into phases, the developer obtains flexibility which can be used to alter course when there are unfavourable market conditions in the future during the process of development. The staging flexibility affords a developer the opportunity to also delay or abandon some phases of the project when uncertainty poses challenges and decide the exact time to start the project. This flexibility is valuable in property developments and must be evaluated in addition to the deterministic DCF value to produce a proper profitability outcome for the project.

5.4.1 Modelling Uncertain Sensitive Variables

The value of flexibility is contingent upon changes in the most uncertain variables in the financial modelling; costs and revenues. These changes are inevitable during the development
process of the residential project and are responsible for triggering the flexibility to delay, expand or abandon a project by a developer using the real options analogy. In the real options framework, uncertain variables are modelled using specific stochastic processes based on an assumption of how changes occur with regards to the uncertain variable. Some of these stochastic processes have resulted in the use of the random walk theory of the geometric Brownian motion, simulation methods and partial differential equations. Some of these distributional approaches have been used in evaluating the values of flexibility embedded in property developments.

The Fuzzy Pay Off Method (FPOM) has been developed to support the already existing models of real options but it uses a different stochastic process in its approach to deal with uncertain variables. The FPOM uses a practical approach of deriving three variables of maximum, most likely and minimum values for dealing with a specific uncertain variable. As a result, the uncertain variable is modelled in such a way that developers can account for all possible future values of an asset. In practice, the maximum, most likely and minimum values are developed by analysts based on their expertise, judgement and experience thereby making it practical. Developers and analysts already consider these maximum, most likely and minimum values in their decision making but do not incorporate them in financial modelling for determining potential profitability. Real options approach considers all these possible values in calculating the single mean that represents a project’s potential profit and computes real option value that denotes the value attached to flexibility of staging the project, in addition to the deterministic results from the DCF technique.

5.4.2 Data and Methodology for Real Options Modelling

The two most sensitive stochastic variables of costs and revenues were modelled based on discussions with the developer as to how best the company considers changes in uncertain inputs in a DCF model. Data on estimated property prices in 2010 when the project was about to begin was provided by the developer and compared with data from Core Logic RP Data, a company trusted for property data services in Australia. It is evident that the developer was slightly optimistic in their price assumptions and this also posed a risk because any deviation from estimated revenues and costs could have been very detrimental to the financial success of the residential development.
Data on property values for ROV was sourced from RP Data using the location of the development as a guide to obtain specific information. Sourcing data from the development area was also necessary as property development is a localised business and demand is specific to locations. General discussions with developers revealed that though the Melbourne property market has experienced growth in property prices, some suburbs have experienced decline. This demonstrates the importance of using the actual local data as opposed to the aggregate data for the case study project location. Analysts (especially development analysts) must be conscious of the optimistic assumptions of property developers because aggregate values may not always reflect the reality. The over optimism of the analyst coupled with uncertainties made it imperative for the consideration of all possible outcomes in the evaluation of financial viability of the project to avoid potential future losses.

The developers indicated that the prices of the different properties (apartments and units) were quite differentiated due to the diverse finishes and features of each house and unit in the residential development. As a result, using a single price per square metre to represent the potential revenue on a square metre basis is unrealistic and would have either underestimated or overestimated the revenues. Thus, the revenues were estimated based on how many of the units/houses were expected to be sold at a specific price and in a specific year during project execution. In view of this, the total revenue was determined by summing up the projected values of all the units and houses to determine the total revenue for the year 2010 when the project was initiated.

In determining the revenues for the maximum, most likely and minimum scenarios, property prices for the different types of apartments and units as shown in Table 5-1 and 5-2 were searched from Core Logic RP Data database. After the search, first, second and third quartile property prices of the different property types were calculated to denote minimum, most likely and maximum prices respectively. These three sets of values formed the initial projection of the different property values (revenue scenarios) in 2010 and based on the total number constructed, the total revenue for a specific year was determined.

The second part of the modelling was the representation for the stochastic process of the property values for the ROV. As property prices are known to increase with capital growth \((g_p)\) of assets, data on capital returns of residential property as an asset was sourced from Core Logic RP Data to use it as a proxy for the stochastic process of the potential future property value evolution of the residential development (units and houses). The developer agreed with
this proposition because in practice, developers normally use capital growth to predict the changes in the values of property assets. The data on capital returns of property was for a 10-year period from 2006-2016 representing fairly the price changes that have occurred in the market over a decade. The 10-year historical data can serve as a base for computing cap rate for three quartiles to represent the different scenarios for predicting future price changes and revenues thereof. Table 5-11 shows the quartile figures from upper quartile to lower quartile. Upper, median and lower quartiles from capital growth data as calculated and shown in Table 5-11 were used to represent maximum, most likely and minimum property prices and revenues respectively.

The use of quartiles is important especially when dealing with statistical data analysis. The different quartiles split the data into meaningful parts of lower level values, median or middle level values and upper quartile for high level values which is a clear resemblance to the scenario approach being used in the FPOM. Therefore, the quartiles ensure better representation of the values in scenario analysis for calculating real option values using the FPOM.

**Table 5-11 Yearly Capital Growth Rates (2006-2016)**

<table>
<thead>
<tr>
<th>Quartiles</th>
<th>Units</th>
<th>Houses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper</strong></td>
<td>10.45%</td>
<td>14.55%</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>7.20%</td>
<td>6.70%</td>
</tr>
<tr>
<td><strong>Lower</strong></td>
<td>3.95%</td>
<td>3.28%</td>
</tr>
</tbody>
</table>

Source: Author, 2016 (data provided by RP Data)

Data on capital returns for both units (apartments) and houses were sourced and used to compute the different values for the different quartiles. For example, whereas the upper quartile for units was 10.45% p.a., houses recorded an upper quartile of 14.55% p.a. over the ten-year period as shown in Table 5-11. Similarly, the median for the units and houses were 7.20% p.a. and 6.70% p.a. respectively. Lastly, Table 5-11 shows the lower quartile for both units and houses as 3.95% p.a. and 3.28% p.a. respectively. These were used to model the price evolution of the residential project over the entire duration of the development project.

The cost data on the other hand was given by the developers as at the time the project was about to begin, and it included the land cost, other costs such as demolition, service infrastructure, construction costs, marketing and advertising, sales commissions, financing, goods and service tax, holding costs, planning permissions, professional fees and approvals. Since the project is
assumed to be developed in stages, payment for costs of materials and other construction costs are also staggered and assumed to also increase with time. As a result of potential increases to future costs due to the staging approach, data on consumer price index was sourced from the Australian Bureau of Statistics (ABS). Consumer price index was used as a proxy for the stochastic process of the costs because prices of goods and services are generally agreed to increase in line with the rates of inflation in Australia. Using data spanning a period of 25 years from 1990-2015, the lower, median and upper quartiles were calculated to be 2.99% p.a., 4.38% p.a. and 5.75% p.a. respectively. The lower, median and upper quartiles were used to generate the distribution for minimum, most likely and maximum costs respectively for the ROV modelling.

The potential increase in land value during delay has already been factored into the stochastic evolution of the cost over time in calibrating the three scenarios. Since the developer is placing an option on the land, there is the need to account for the cost of the land options in the total cost of the project. Using data provided by the developer, a cost of $344,288 was calculated to be the extra holding cost which the developer must bear in delaying some phases of development by extending the timing for two years. The cost of the option is assumed to be 5%, 10% and 15% of the land value for the three scenarios, respectively. This results in a total extra cost of $1,469,288, $2,594,288 and $3,719,288 for the minimum, most likely and maximum scenarios, respectively. These extra costs were added to the initial cost of the project to derive the total cost which was used for evaluating the value of staging flexibility.

5.4.3 The Value of Staging Flexibility

In Table 5-5, the DCF modelling shows an irreversible commitment to the project, and even though the projected revenues and costs are uncertain, they are deemed to be deterministic estimates. If the developer adopts DCF and uses the NPV decision rule as a basis to justify execution or rejection of the project, the development would have been rejected initially. Therefore, consistent with economic theory, should the developer assume an irreversible commitment to the project as projected in Table 5-5, the project is not financially viable. The reason is because DCF does not account for optionality/flexibility in the residential development project in terms of flexibility to delay, expand or to abandon some stages of the development mid-course when conditions are unfavourable. In practice however, a developer may elect to abandon a project mid-course to salvage some value should a development prove unviable due to changes in market dynamics. Developers usually have exit strategies embedded
in their approach to development should the unexpected happen. There are several flexible opportunities to either delay, abandon the project or simply the developer can decide exactly when and how the project should proceed during execution. The value of staging flexibility embedded in the residential project is evaluated using this case study from a real options perspective.

In order to do a realistic analysis and proper evaluation taking into consideration all the uncertainties (positive and negative) and staging flexibility, the valuation should account for the value of the staging optionality that exists in the project. Even though the cash flow shown in Table 5-5 denotes a sort of staging, it does not consider the stochastic process of property value changes that affect estimated revenues, hence potential profitability. In ROV financial modelling, the horizontal staging option was the most appropriate because it was a large-scale project planned to be completed in 5 years and fraught with numerous uncertainties. Besides, the planning permit also placed restrictions on the density of the development, hence the horizontal staging was appropriate as compared to the vertical phasing.

A realistic model that mimics reality of the development is that the developer stages the project by dividing the entire development project into four phases over six years to complete in 2016 with intentional delays after completing each phase for uncertainty resolution before proceeding with the next phase. After completing each phase, the developer uses the following year to analyse the market and ensure that uncertainties are resolved before commencing the next phase. As a result, the developer is assumed to be rational and will not commence a phase when there is uncertainty surrounding a specific phase of the project. This flexibility is valuable in property development and must be accounted for in the valuation in addition to the deterministic DCF value to produce the right numerical information for decision-making. Therefore, the financial modelling assumed a starting point in 2010 and completed in 2016 and compared the results to the value derived by the DCF method which used a single-phase development approach for the financial evaluation on which basis, the developer executed the project. As some stages are delayed, obviously property prices and costs may also be either increasing or decreasing while waiting for uncertainties to resolve. As a result, the revenues (for different scenarios) for the subsequent years were generated by using the capital growth rates.

The staging approach assumed that the project can begin in the year 2010 as originally scheduled and finished in 2016 because some stages are pushed forward due to delays. Part
payment for the land, planning approvals and land development are all completed within the year 2010. Construction of the first stage is also assumed to begin in the latter part of year 2010 and completed in 2011. As the developer assumed to sell all the units and houses completed after each phase, it was also assumed in the modelling that the developer can attain this level of sales after completing each phase starting from the year 2011. It is also assumed that buyers would settle after completion of the construction of their respective dwellings.

Using Equation 5-3,

\[ TR_s \times (1 + g_{vs})^n \]

Equation 5 – 3

where \( TR_s \) = total revenue for specific scenarios (maximum, most likely and minimum)

\( g_{vs} \) = capital growth for specific scenarios (maximum, most likely and minimum),

\( n \) = period for the property price growth (year 1, year 2, year 3, etc),

the distribution of total revenues for different scenarios were generated over a period because prices for previous year serves as the base for projecting the subsequent years’ potential revenue for the number of assets planned to be developed in a particular year. Thus, the distribution of potential total revenues for the specific years’ during which construction is scheduled to take place was developed using the capital growth rates for the three scenarios; maximum, most likely and minimum. These revenues for the specific years’ of completing phases of the construction (2011, 2013 and 2015) were discounted at a rate of 10.23% and 20% for the base and worst-case scenarios to demonstrate the impact of potential changes in exogenous variables such as interest rates on the financial viability of the project.

Therefore, after the first phase, the project was assumed to be delayed until the following year before development commences again for the next phase and this resulted in the development project lasting for seven (7) years in total as compared to the initial deterministic approach of the DCF modelling which was scheduled to last for five (5) years. Similarly, the costs were also projected to increase during the life of the project. In each year that the project is delayed, there is potential increases in prices of goods and services which also directly affects the cost of the project. At the start of the project in 2010, the cost figures given by the developer were used as the base line cost but the distribution of figures for the subsequent years was generated using construction price index as a proxy for price changes in goods and services. This is an
acceptable rate to use to predict future construction costs in Australia and it is agreed that it fairly represents price changes by the industry, according Australian Bureau of Statistics.

Using Equation 5-4,

\[ TC_s \times (1 + CPI_s)^n \]

**Equation 5 – 4**

where \( TC_s \) = total cost for specific scenarios (maximum, most likely and minimum)

\( CPI_s \) = consumer price index for specific scenarios

\( n \) = the period for the construction cost within the overall development period,

the different scenarios for the cost was generated and each of them discounted at a rate of 2.5% and 5.5% respectively for both base and worst-case scenarios. The CPI however was adopted as the rate for discounting the base cost because the ABS suggests that it is primarily used for pricing contracts and as an indexation. After discounting both the revenues and the costs, NPV was calculated for the different scenarios (maximum, most likely and minimum) in both cases; base and worst-case scenarios. The different NPV scenarios for each case (base and worst) were used in the FPOM to compute the possibilistic mean NPV, the success ratio/factor and real option value for both scenarios which are used to present the discussion and results section.

### 5.4.4 Methodology

This section provides an exposition on how the FPOM was used to derive the values needed for presenting the results and further analysis. In financial evaluation of projects, analysts normally use scenario planning approach to present uncertainties and risks associated with specific capital projects. FPOM uses different NPV scenarios based on the scenario planning approach in financial evaluation to determine the value of flexibility embedded in capital-intensive projects. The FPOM takes its roots from the Datar-Mathews method (Mathews et al., 2007), which uses probabilistic approach to compute real option values from a payoff distribution of NPVs generated from a Monte Carlo simulation. The management of uncertainty using a probabilistic approach in the Datar-Mathews method was substituted by fuzzy set theory (Zadeh, 1965) to deal with uncertainty in the FPOM (Collan et al., 2009). The idea was to decrease uncertainty assessment to fewer scenarios that are manageable in practice because there are so many factors impacting on property developments, therefore modelling all those factors is nearly impossible. Reducing uncertainty to fewer scenarios allows analysts
to focus on the most important variables that have the greatest impact on profitability of property developments.

In the fuzzy set theory, different propositions or scenarios have a degree of membership in a set, i.e. membership is 0 (complete non-membership), 1 (complete membership) or a value between 0 and 1 (an intermediate degree of membership) (Zadeh, 1965). Based on these three types of degrees of membership in the fuzzy set theory, uncertainty was projected into minimum, most likely and maximum (Collan et al., 2009). The three scenarios are treated as triangular fuzzy numbers in the FPOM and form a triangular payoff distribution. In the triangular payoff distribution, the most likely scenario is given a complete membership, the minimum and maximum scenarios are given complete non-membership and other scenarios between have intermediate degrees of membership. Based on the information on the scenarios and degrees of membership, a triangular payoff distribution, which is ‘a graphical presentation of the range of possible future pay-offs the investment can take’ is deduced (Collan, 2012). These scenarios are usually used in property investment and development analysis in the property and construction sector to analyse risks and uncertainty.

In this regard, the most likely scenario NPV calculated was assigned a complete membership of the fuzzy set and the minimum and maximum scenarios have a complete non-membership. The complete membership suggest that the most likely value is recognised as the best possible value to occur from the range of values possible as far as the residential development project is concerned. All other scenarios were then assigned the intermediate degree of membership of the set of range of values for the valuation purposes because those values are deemed to fall between the maximum and minimum values. These three scenarios were used to generate a triangular pay-off distribution for the large scale residential development project. The triangular pay off distribution generated represented the range of all possible future payoffs for the development (Collan et al., 2009) and the real option value was calculated from the distribution of values.

Firstly, there is the need to calculate the possibilistic mean, which represents the positive side of the triangular payoff distribution before calculating the real option value. For the mathematical computation of the possibilistic mean, due to the two different evaluations using required rates of return of 10.23% and 20% (base and worst case), there are two different equations for the computation. In the base case of 10.23% discount rate, the payoff distribution is partly above zero (0), so that zero (0) is between the minimum possible NPV and the best
guess NPV; and most likely value is above zero (0) but the distance between the most likely NPV and minimum NPV is below zero (a-α) < 0 < a). The possibilistic mean which represents the mean of the positive side of the triangular distribution is therefore given by Equation 5-5;

$$E(A_+) = a + \frac{\beta - \alpha}{6} + \frac{(\alpha - a)^3}{6\alpha^2} \quad \text{Equation 5 – 5}$$

On the other hand, in the worst-case scenario of 20% discount rate, the payoff distribution for the residential project was partly above zero so that, zero is either equal to the most likely NPV or between the most likely and the maximum NPV possible within the range of values. In that case, a < 0 < a + β meaning a greater part of the triangular distribution has negative values. The possibilistic mean is given by equation 5-6;

$$E(A_+) = \frac{(a + \beta)^3}{6 \cdot \beta^2} \quad \text{Equation 5 – 6}$$

where

a = most likely (ML) scenario NPV

β = distance between ML scenario NPV and maximum (MAX) NPV

6 = a constant in the formulae for computational purposes

α = distance between ML NPV and minimum (MIN) NPV

Collan et al. (2009) argued that when the whole fuzzy number is greater than zero, ROV is the fuzzy mean of the fuzzy number and when below zero, the value of ROV is zero. The ROV measures the potential of the development project to be successful in terms of profitability and it incorporates the value of flexibility. It is the ability of the ROV method to evaluate the potential value associated with flexibility in property developments under conditions of uncertainty that makes it superior to the DCF technique. The ROV of staging flexibility using FPOM is given by equation 5-7;

$$ROV = \frac{\int_{-\infty}^{\infty} A(x)dx}{\int_{-\infty}^{\infty} A(x)dx} \times E(A_+) \quad \text{Equation 5 – 7}$$

where

ROV = real option value
\( A \) = the fuzzy NPV,

\( E(A_+) \) = the fuzzy mean value of the positive side of the NPV,

\[
\int_{-\infty}^{\infty} A(x) \, dx = \text{the area below the whole fuzzy number } A \text{ and}
\]

\[
\int_{0}^{\infty} A(x) \, dx = \text{the area below the positive part of } A.
\]

The possibilistic mean is the single number that takes into consideration the whole shape of the triangular distribution. Thus, the computation is based on all possible values both negative and positive within the distribution and including the maximum and minimum values. The maximum value being the upside ceiling and the minimum value being the downside floor. All other values that fall outside these boundaries are assumed to be unattainable or impossible.

5.4.5 Results and Discussion of Staging Real Option Valuation (base and worst cases)

The results on key real option valuation indicators are presented and merged with the discussion. Firstly, the results of ROV for the base case scenario that has a discount rate of 10.23% is discussed. Subsequently, a discussion of the worst-case scenario that adopted a discount rate of 20% to discount the cash flows is presented. Results from both scenarios is compared to the outcomes from their respective DCF models to determine the option premium and discuss how real option modelling enhances uncertainties and risk assessment in residential property development. In discussing results from ROV, firstly, Table 5-12 shows the different inputs used in FPOM of ROV, the values and their meanings.

Table 5-12 Range of NPV Scenarios (Base Case Scenario 10.23% Discount Rate)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Meaning</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>Distance between ML NPV and MIN NPV</td>
<td>$24,659,541</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Distance between ML NPV and MAX NPV</td>
<td>$55,235,569</td>
</tr>
<tr>
<td>( a )</td>
<td>Most likely (ML) Scenario NPV</td>
<td>$9,385,647</td>
</tr>
<tr>
<td>( a-\alpha )</td>
<td>Minimum (MIN) Scenario NPV</td>
<td>-$15,273,894</td>
</tr>
<tr>
<td>( a+\beta )</td>
<td>Maximum (MAX) Scenario NPV</td>
<td>$64,621,216</td>
</tr>
</tbody>
</table>

Source: Author, 2016
The minimum, maximum and most likely NPV's possible for the residential development project under the base case evaluation are evident. In addition, other variables such as the distance between points within the triangular distribution are also displayed.

Results on the maximum, minimum and most likely values are presented to show the potential of the residential development project to be successful as shown in Table 5-12. It is evident that both the maximum and most likely NPV values are positive at $64,621,216 and $9,385,647 respectively, but the minimum NPV is negative. Therefore, majority of the values within the range of possibilities are positive. This suggests that the residential project has a greater chance of being successful financially. The consideration of the range of figures means that the developer has a better appreciation of the potential value path of the residential development and has incorporated all possibilities (based on the maximum and minimum values possible) in the financial evaluation. It also demonstrates the overall profitability potential of the residential development project as the positive side of the triangular distribution outweighs the negative part resulting in an asymmetric value distribution. Thus, a better appreciation of the potential profitability of the overall residential development as compared to the DCF evaluation which considers a single point estimate. This is illustrated in the triangular distribution in in Figure 5-6.

Figure 5-6 Triangular Payoff Diagram with Values (Base Case Scenario)
Aside the developer having the opportunity to examine the range of possible values from the different scenarios under specific market conditions, the computation of the actual profitability of the project accounts for all the positive and negative values, making it a better alternative to the DCF which presents a single estimate of the profitability potential of the project under steady market conditions.

Again, the range of figures for the base case scenario (10.23% discount rate) is demonstrated graphically by the triangular payoff diagram in Figure 5-6. With the payoff diagram, a proper analysis of all possible values (profits) that can be achieved during implementation of the development is considered at the inception of the project. It ranges from a minimum of $-15,273,894 to a maximum of $64,621,216 and the most likely value of $9,385,647. All the range of figures that fall within the triangular distribution are used to compute the mean NPV to represent the most probable value for the payoff from the project under the base case scenario. Because the positive side of the triangular distribution is bigger than the negative side, it results in an asymmetry of values which increases the profitability potential of the development. The computation of the expected profit from the development therefore is affected by the positive side and outweighs the negative side resulting in a value that highly represents the profitability potential from a range of all possibilities.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Meaning</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>Distance between ML NPV and MIN NPV</td>
<td>$20,349,822</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Distance between ML NPV and MAX NPV</td>
<td>$44,928,943</td>
</tr>
<tr>
<td>( a )</td>
<td>Most likely (ML) scenario NPV</td>
<td>-$7,944,729</td>
</tr>
<tr>
<td>( a-\alpha )</td>
<td>Minimum (MIN) scenario NPV</td>
<td>-$28,294,551</td>
</tr>
<tr>
<td>( a+\beta )</td>
<td>Maximum (MAX) scenario NPV</td>
<td>$36,984,214</td>
</tr>
</tbody>
</table>

Source: Author, 2016

In Table 5-13, results on the maximum, minimum and most likely values are presented to show the potential profitability of the residential development project in a worst-case scenario. Contrary to the base case scenario, it is evident that in the worst-case scenario both the minimum and most likely NPV figures are negative at $-28,294,551 and $-7,944,729 respectively, but the maximum value is positive. This indicates that most of the fuzzy NPV values within the range of possible values are negative. In other words, the development project
has a greater chance of failing than being successful financially. This is a better appreciation of the potential profitability of the overall residential development as compared to DCF evaluation which considers a single point estimate. Moreover, the developer can examine the different scenarios and envisage how much the development is worth under different conditions in the market at specific stages of the project, making it a better alternative to DCF.

The triangular distribution in Figure 5-7 also graphically shows the relationship between the upside and downside potential of the project in a worst-case scenario of 20% discount rate. The un-dotted solid vertical red line on the right side in Figure 5-7 is the boundary between negative values on the left side and positive values on the right side. The left side of the triangle is bigger than the right side, indicating that the number of potentially negative values for the development are greater than the positive values resulting in an asymmetry in the payoff. The shape of the triangular distribution also suggests that the profitability potential is low and is a very risky project due to the size of the negative area of the triangle.

**Figure 5-7 Triangular Payoff Diagram with Values (Worst Case Scenario)**

![Triangular Payoff Diagram](image)

Source: Author, 2016

It is obvious from Figure 5-7 that the shape of the negative side (beginning from 0 towards the left of the triangular distribution) is bigger than the positive side of the triangular distribution (beginning from 0 and moving towards the right side). This reinforces the argument that the residential development project is very risky to execute should changes in market conditions warrant the adjustment of the discount rate to 20%. Because the downside is bigger than the upside, the riskiness of the project is clearly observed by the developer graphically, rather than the use of an assumed required rate of return as a means of dealing with risks in the DCF.
technique. Because the downside potential outweighs the upside potential, the value computed to represent the profit considers the size of the negative side. The difference between the minimum and the maximum NPV figures results in a wider pay off triangular distribution as in Figure 5-7.

**Table 5-14 Results for Real Option to Stage (10.23% discount rate)**

<table>
<thead>
<tr>
<th>Profitability measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum NPV</td>
<td>$64,621,216</td>
</tr>
<tr>
<td>Best guess NPV</td>
<td>$9,385,647</td>
</tr>
<tr>
<td>Minimum NPV</td>
<td>$-15,273,894</td>
</tr>
<tr>
<td>Mean NPV</td>
<td>$14,481,652</td>
</tr>
<tr>
<td>Real option value</td>
<td>$13,949,148</td>
</tr>
<tr>
<td>Success Factor</td>
<td>93%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

Under conditions of boom and stable market which is the base case scenario, the development can potentially have a maximum value of about $64,621,216 and a most likely value of $9,385,647 as shown in Table 5-14. However, if economic conditions are unfavourable in the property market, the potential profitability decreases to a loss of $-15,273,894. Thus, even though the project promises to return a profit, there is an element of potential loss that needs to be considered by the developer. The asymmetry in the payoff is also evident in the most likely figure computed as it skews towards the positive side of the triangle and greater than the single point estimate of the NPV as computed using the DCF technique. Moreover, the mean NPV which considers all possibilities in terms of the negative and positive values is also greater than the NPV given by the DCF technique at $14,481,652. This indicates about 35.8% change in profitability on cost. These values are based on the consideration of all possible range of values without the flexibility (ROV) embedded in the residential development.

**Table 5-15 Results for Real Option to Stage (20% Discount Rate)**

<table>
<thead>
<tr>
<th>Profitability measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum NPV</td>
<td>$36,984,214</td>
</tr>
<tr>
<td>Best guess NPV</td>
<td>$-7,944,729</td>
</tr>
<tr>
<td>Minimum NPV</td>
<td>$-28,294,551</td>
</tr>
<tr>
<td>Mean NPV</td>
<td>$-4,176,818</td>
</tr>
<tr>
<td>Real Option Value</td>
<td>$1,947,961</td>
</tr>
<tr>
<td>Success Factor</td>
<td>47%</td>
</tr>
</tbody>
</table>

Source: Author, 2016
Table 5-15 presents the results from the real options modelling under worst case scenario of 20% required rate of return. The maximum value possible in a highly favourable market using the discount rate of 20% is $36,984,214, the most likely value is -$7,944,729 and the minimum value in a downturn market is -$28,294,551. Table 5-15 also illustrates the difference between the minimum and the maximum NPV figures possible for the project. This exhibits to the developers the potential values possible for the project and how changes in the market can impact on the residential development. As a result, the developers can develop strategies capable of dealing with such unforeseen contingencies. Thus, a transparent means of visualizing risks associated with the proposed residential development, rather than the use of a discount rate to represent risks. The mean NPV which calculates the potential profitability based on possible range of figures is -$4,176,818 which indicates that the project is highly risky. Furthermore, the negative mean NPV suggest that most of the values under the triangle are negative.

The mean NPVs realised from both the base and worst-case scenarios are an improvement on the values realised from the DCF technique. This implies that the consideration of the possible range of figures is important in the computation of potential profitability associated with residential development projects. Of course, the riskiness of a project is examined from the perspective of a specific developer because different developers have unique risk tolerance profiles, and this does not in any way suggest that the project should be abandoned. In practice, a developer may see such a project as an opportunity to build a very good reputation in the industry, recycle capital or utilise resources with a sunk cost. However, developers can clearly decide with the knowledge of the potential consequences. Since risks have been factored into the uncertainty treatment of the different scenarios, the developer can decide to capitalise on emerging opportunities associated with the project development in future.

Such a change is possible due to the uncertainties associated with property values that fluctuate within the property market and the potential associated with the upside of the triangular distribution. Thus, in an upside market, the project can become viable and must not be rejected based on the negative outcome only. This is the rule of DCF technique which makes decision making in property that relies on future values of assets problematic and myopic. Therefore, it can be argued that considering the financial evaluation of projects using a range of figures is realistic and captures the potential associated with projects better than using a single point estimate of DCF. On the other hand, the size of the positive side of the triangular distribution with high values indicates the positive upside potential associated with the project under
favourable economic conditions in the property market. The result from the base case scenario indicates a profitability potential of 13.89% on cost, which is higher than the value achieved from the use of DCF technique for evaluation at 8.71%. Thus, the DCF underestimates the profitability potential of projects due to its inability to consider the overall future potential of the project and capture the upside opportunities within the valuation framework. With a long-term strategy, developers stand the chance of retaining the potential to capitalise on these opportunities when they emerge in the property market. Thus, the treatment of uncertainty need not be fixated on only the downside outcomes, but also the ability to capitalise on upside gains in the property market.

Moreover, the success factor or ratio gives an indication of the future possibility of the residential development project to result in profitability. It is the positive side of the triangular distribution divided by the whole distribution, thereby evaluating the success based on the whole range of possibilities. This success ratio demonstrates to the developer as to the potential of the project to realise profit. In Table 5-14 and Table 5-15, it is evident that the success ratio is about 93% and 47% for base case and worst-case scenarios respectively. This means that under highly favourable conditions, the project has a high expectation of being successful and under unfavourable conditions, the chances of the project’s success reduce, yet with some level of expectation to succeed. The success ratio can’t be computed using the DCF technique because the DCF does not incorporate the potential of achieving a specific target return or missing such a target. This is based on the positive potential associated with development projects which can unfold under conditions of uncertainty in a constantly dynamic economic environment. In addition, the success ratio supports the execution of the project as opposed to the fuzzy mean NPV under the worst-case scenario and gives much better results in the base case scenario. Any developer using the fuzzy pay off method can examine financial feasibility of projects from different metrics embedded within the technique such as the mean fuzzy NPV, success ratio, possibilistic mean and ROV.

Lastly, the most important value is the real option value which was calculated to be $1,947,961 for the residential project in Table 5-15 in the worst-case scenario. In the base case scenario, the ROV is calculated to be $13,949,148. The real option value represents the potential of the project to be profitable using the flexible strategy of the staging approach to the residential development project rather than developing all at once under the DCF approach. It is this form of strategic analysis, combined with a specific stochastic process in the form of different scenarios for the financial evaluation that renders the DCF unrealistic in its approach to
evaluating staged development projects. Even though the mean NPV under the worst-case scenario is negative, it does not suggest that the project is worthless and must be abandoned. The success ratio indicated that the project has about a 47% chance of becoming financially successful.

The calculated ROV of the worst-case scenario represents about 2.13% profit on the undiscounted cost of the residential development project. Even though the 2.13% is by no means a high profit to the developer, it denotes a major improvement on the initial value derived from the application of the DCF technique which suggested the project was not financially viable. In view of this, it can be argued that the DCF undervalued the residential development project because without the ROV, the value of the project would have been deemed to be the negative NPV of $-2,069,925 and rejected. Under the base case scenario, the ROV is 11.40% on the undiscounted cost of the residential project resulting in a 2.7% option premium which was missed the by DCF method. This demonstrates the value in the flexibility embedded in the staging strategy for the residential development. Through staging, developers are assumed to initiate development of phases that are profitable and abandon phases that are unprofitable. As a result, the staging allows the developer to mitigate prospective losses during the process of development. The FPOM realistically modelled this flexibility and incorporated them in the valuation rather than assuming a static approach to the management of the development project.
Figure 5-8 graphically displays the value path of the different fuzzy NPV scenarios under the base case scenario of 10.23% discount rate. It is evident that the value path for both most likely and maximum scenarios are above the break-even point over the entire four phases of the project indicating that the project will be financially successful, should conditions in the market remain either steady or very favourable as predicted. These phases have been shown as stages 1, 2, 3 and 4 in Figure 5-8. However, the minimum scenario is closer to the break-even point for the first two phases but the third and fourth phases are below zero, indicating that project is bound to make losses in unfavourable market conditions. Even though the third phase suggests that the project is bound to make losses in a minimum scenario, the combined effect of the maximum and most likely scenarios ensure that the mean NPV computed from all possible values including the minimum scenario, is positive to result in a profitability potential for the project.

Thus, indicating to the developer to execute the project due to the potential upside gains associated with the project. Despite the consideration of all scenarios in the computation of the ROV, the flexible strategy of phasing the development allows the developer to abandon a
specific phase mid-way through the development should the minimum scenario occur. Because the developer can limit the quantum of capital sunk into the project at different stages of the development, there is limitation on the losses that can be incurred when faced with a minimum scenario. However, the upside potential remains open and can be capitalised on at any time during the life of the project.

The importance of the flexibility to alter strategy mid-way into the implementation of the residential project is evident in the evolution of the fuzzy NPV scenarios plotted in Figure 5-9 in the worst case of 20% discount rate. The vertical movements depicted in Figure 5-9 for all the different fuzzy NPV scenarios in the worst case are due to the staging approach where development costs are incurred in a specific year before revenues are received from sales of the completed part of the development in the following year. An important observation is that the years during which the revenues are received, the fuzzy NPV’s are positive except for the minimum scenario which is negative throughout the period of development as shown in Figure 5-9 with downward pointing arrows for years 2011 and 2013.

**Figure 5-9 Graphical Presentation of Fuzzy NPVs for Payoff Method (Worst Case)**

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Source: Author, 2016
It can be observed that the first two phases in both the most likely and maximum scenarios of the development project are all viable developments for stages 1 and 2, but the most likely scenario turns negative in stages 3 and 4 as shown in Figure 5-9. The minimum scenario is negative for all stages of the residential development project, suggesting that the project is bound to make losses in an unfavourable market. In a stable market, which is the most likely scenario, the project has the potential to break even during the first two phases but could potentially result in losses at the third phase. These are shown as downward and upward arrows respectively in Figure 5-9. This is an important observation because the developer has the flexibility to develop the first two phases which are economically viable and either postpone or abandon the last phase which is not viable. This has the potential to reduce the total cost of the development, hence bringing down the overall potential losses and increase the ROV value further. In this case study, should the developer have adopted the abandonment of the last phase, the firm would have saved an amount of about $17 million in construction costs from the development in addition to salvaging the value of the remaining land at the prevailing market value. The cost of abandonment would have been the land option paid to the vendor to hold onto the land for the developer.

Even though this proposal of maintaining options on the land at the early stages of the development has considerable risks of increased costs, paying this amount to cap downside losses may certainly better than the full impact from potential unfavourable market because, in the event of defaults at settlement of a specific phase of the development, the risk is limited to the losses at that specific phase. Thus, holding costs and cost for the option of holding onto the land may be far lower than the potential losses that would have been incurred in the event of developing the entire project at once. Moreover, in an unfavourable market, potential decline in land values could also be averted with the optionality analysis.

The graphical presentation of the potential NPV figures for the project in both base and worst-case scenarios enhances risk assessment as the developer can choose to develop as and when the market is favourable based on strategic analyses. Besides, the developer can choose to wait until uncertainty is resolved during the years when the option to delay is still embedded in the project before starting construction when it is viable. This ensures that the upside potential is retained while at the same time the downside losses are mitigated in case property values fall. In effect, based on the ROV for both base and worst-case scenarios, the developer has a single financial metric which considers all the range of possible values based on which a development
decision can be made. However, it must be stated that this needs to be interpreted alongside the flexibility to alter course when uncertainty strikes during implementation of the development.

The FPOM relies on fewer scenarios as a representative to project uncertainties, and this analogy has been recognised by Cardin et al. (2013) as a way of ensuring practicality of uncertainty assessments in design flexibility. The three scenarios in the FPOM are illustrative of a range of likelihood plausible for analytical purposes in practice and broadly sufficient to aid a more informed analysis of financial evaluation of phased residential property developments in general and risk management thereof. As the scenarios are fewer, it enhances the practical usability of the FPOM model for financial evaluation as compared to a wider distribution that may not be manageable by stakeholders in practical applications. In the FPOM, the valuation of option values is fused into the different scenarios, resulting in a payoff that captures salient possibilities resulting from uncertainties. Even though similar scenarios could be generated using the DCF framework, the scenario values achievable are not factored into the computation of the single-numerical value representing the future payoff of the property project in the DCF framework.

Despite the FPOM application embedded with a staging flexibility offering superior results than developing the whole project at once, as assumed by the DCF framework, the importance of presale in risk mitigation in the DCF, for example, cannot be discounted. In terms of risk mitigation, presales allow developers to secure potential purchasers before construction begins, thereby eliminating risks of lack of demand after completion though defaults at settlement could still occur. It also serves as a requirement for attracting debt funding from commercial financial banks and reduces borrowing costs for the project in question. Deferring some of the presale contract agreements with prospective occupiers to capture the value associated with upside opportunities if there was enough equity to begin the project could have ensured higher profitability in a market where property values are on the rise. Better still, if due to requirements of debt funding there was the need for pre-sales as is prevalent in practice, a flexible contract that allowed the developer to make upward adjustments to the initially agreed value of the individual units during presales in line with current market prices after completion would have been plausible to benefit from the future upside opportunities.

As indicated earlier, there is growing attention of literature on real options. Mostly, models adopted in evaluating case studies are based on probability analysis and differential equations (Black-Scholes model and binomial option pricing method), which have been deemed
mathematically complex and difficult to apply. In the FPOM, the projection of uncertainty in three scenarios without the necessity of probability analysis and computation of volatility seems to produce a simple and straightforward tool for calculating ROVs. Similarly, the adoption of NPVs for all three scenarios as input values in the financial evaluation of the residential project resonates with practitioners. As practitioners are familiar with scenario analysis, it can facilitate adoption of the FPOM in practice quicker than the other models deemed as mathematically complex. Moreover, using the FPOM does not require any form of special expertise because based on expert judgements and approximations, the different fuzzy NPV scenarios can be calibrated in Excel and the ROV can subsequently be computed. As the FPOM is readily adaptable by way of using data from DCF, including NPVs from the different scenarios as input parameters, it increases the practical appeal of the method. To this end, the FPOM, if given prominence in the literature especially in practical case study applications, has the potential to achieve practical adoption.

In this case study, the focus was on the staging flexibility embedded in a large-scale residential property development project. It basically reflects the risks associated with the staging flexibility in the sense of increased costs during the phases when the project is delayed pending the resolution of uncertainties. There is, therefore, risk mitigation through the staging flexibility because the developer is assumed not to initiate the development of a specific phase unless it is profitable. Besides, in reality, the developer can exercise the option to contract the scale of the project if market conditions warrant so. Therefore, the losses are capped to the cost of the option used to secure the land until the waiting period lapses. In this case, the risk is passed on to the vendor in consideration of the payment for the option of holding onto the land for the developer.

On the other hand, the upside opportunities associated with the staging option cannot be over emphasised because, during the period of delay, the value can reach up to the maximum value possible, leading to higher than expected profits. Some specific phases of the residential project can also be expanded to capture rising demand for residential properties if market conditions are favourable. The results for this project and the risks considered are obviously limited to the adopted flexibility: staging option. The risk profiles examined in this paper relate to variability in the value of the residential development project upon completion due to uncertainty resulting from market forces. It is possible that property projects with different risk profiles and uncertainty sources may deliver different results using the FPOM. Similarly, a different flexible strategy such as expand or defer with a different data set from a different city in Australia can
also result in new findings. Even though the strategy adopted for this case study has been
effective and delivered results superior to the DCF, any analysis must be done on a case-by-

For practitioners both in Australia and around the world, this may be a new tool/ technique for
evaluating the profitability of property developments coupled with the use of staging strategy.
It is accepted that property practitioners are conservative in their approach to analysing
profitability and risks. However, it is important for property practitioners and other property
decision-makers to note that the volatile nature of property markets in the twenty-first century
presents both risks and opportunities that are highly unpredictable and require flexibility to
adapt to uncertainties, as events unfold in property markets. It is the flexibility to delay, stage,
expand, switch, temporarily shut down or abandon a project that has the potential to mitigate
downside losses while retaining the positive potential of property projects. Moreover, it is a
realistic approach to evaluating projects because rational developers do not execute projects
knowing that a project is bound to fail. The reality is that there is no accuracy in predicting the
future values of property development, but, through these flexible strategies, developers can
best prepare against unforeseen risks and uncertainties in property development and deal with
them as they unfold.

5.5 Summary

The main purpose of applying ROA/ROV on a case study is to empirically evaluate the
applicability of ROV models to Australian residential property developments using empirical
data. The aim is to achieve practical adoption of ROV models in property development
decision making. Vimpari (2014), Geltner and de Neufville (2012) and de Neufville and
Scholtes (2011) suggested that there is the need for more practical applications of real options
techniques using new data to empirical test the applicability of ROA/ROV and improve the
practical adoption of these techniques. This study provides the evidence of the technique’s
applicability to empirical case studies in property and construction sector, with a focus on
residential property developments in Australia.

The results derived from the application of FPOM to the staging flexibility supported the
argument that ROA and ROV methods can quantitatively produce broad data and numerical
information for valuing flexibility embedded in property development projects. It was indicated
that the use of FPOM enhances risk assessment in property development project evaluation. It also delivers superior results because in both the base and worst-case scenarios, FPOM captured about 11.4% and 2.7% respectively of the value that was missed by the DCF technique. Therefore, the value in flexibility which was dependent on uncertainty is captured by the FPOM but overlooked by DCF technique.

The success ratio provides a rationale for enhancing risk assessments in property development because the success ratio evaluated the possibility of achieving profitability. The base and worst cases had 93% and 47% success ratios respectively. The success ratio enhanced the economic assessment of the property project using a range of figures to determine the chances of financial success of a development project. In effect, using the ratio, the developer may decide to accept the project based on risk profile especially in the worst-case scenario which would have been discarded under the DCF technique using NPV rules of decision making.

Furthermore, ROA and ROV results are from the use of a wide-ranging data in the form of generating a distribution from a range of figures. This range of figures captured all the possible uncertainty associated with the project both downside and upside in the form of scenario analysis which is already used in practice by property practitioners. This resulted in a transparent approach of representing risks and uncertainties and calculating the mean NPV out of the range certainly improves decision making compared to the deterministic single point estimate of the DCF. The method is also quite straightforward and does not require the computation of volatility and the use of probability; making it easier to use by practitioners than other ROV models that are based on probability theory.

Finally, the method also justified the evaluation of flexibility as a strategy for implementing property development projects and the value that flexibility adds to project valuation and ensures that potential profitable developments are not discarded. The staging of the residential development project enhanced risk assessment and justified the phasing approach by suggesting that some parts of a project could be viable and hence implemented, whiles other stages may not be viable and can either be delayed or abandoned. Such flexibility provides different opportunities to developers and helps to avoid imprudent decisions. Moreover, in the worst-case scenario, metrics such as the success ratio and the ROV delivered different results that supported the acceptance of the project due to future upside potential.

For the local and overseas developers, this may be a new tool/technique for evaluating the profitability of residential property developments. It is accepted that property practitioners are
overly conservative in their approach to analysing profitability and risks. However, it is important for developers to note that the volatile nature of property markets in the twenty first century presents both risks and opportunities that are highly unpredictable and require flexibility to adapt to uncertainties as events unfold in property markets. It is the flexibility to delay, stage or abandon a project out rightly that has the potential to save developers from losses. Moreover, it is a realistic approach to evaluating projects because no prudent developer will execute a project knowing the potential of failure is imminent. The reality is that there is no accurate means of predicting the future precisely, hence, it is through such flexible strategies that developers can best prepare themselves against unforeseen risks and uncertainties in property development and deal with them as they unfold.

The findings of this case study application are similar to studies conducted by leading authors (Geltner & de Neufville, 2012, Guma et al., 2009, Rocha et al., 2007) in property development elsewhere in the world. The major difference between this case study and earlier studies is in the real option method that was adopted for the evaluation of an actual property development project. The real option method used by all the leading authors in evaluating staging flexibility involved the assignment of probabilities, use of Brownian motion and computation of volatility to represent the different uncertainties in the specific case studies evaluated. For example, both Guma et al. (2009) and Geltner and de Neufville (2012) used Monte Carlo simulations combined with binomial lattices. However, the use of the FPOM did not require the computation of probabilities or use of Brownian motion to generate the distribution of range of values for the residential development project. It adopted the capital growth as a proxy for representing uncertainties in revenue and a rate for the uncertainties in costs based on available statistics, making the application very direct and simpler for practitioners. Data was provided by the developer including payment periods, costs and project execution, except information that have been clearly specified as coming from other sources including private and public databases.

A major contribution of this case study to the real options literature is the demonstration that the FPOM is applicable to a staging flexibility using empirical data. It therefore gives evidence to support the adoption of real options theory for evaluating case studies in practice. Since the FPOM was found to be simpler, direct and transparent in its approach to the treatment of risks and uncertainties in residential property development, the issue of complexity of computation associated with the models is no longer a barrier in practice. Furthermore, this was a horizontal staging flexibility application and not a vertical phasing application making it the first
application of FPOM to horizontal phasing of a residential property development project in an empirical context. The originality of this application is the use of the FPOM which has not been tested for its application to a real life case study particularly relating to the horizontal staging real option in property and construction sector.

The FPOM can be extended to other options embedded in real estate projects such as switching output, expand, defer, abandon and temporary shutdown which are yet to be evaluated using this new methodology. As the FPOM resonates with practitioners and uses the DCF results as input data, it has the potential to become the model for practice and as such should be explored further on other case studies in the real estate sector. Further research can be applied to case studies where developers build and hold the assets as part of their portfolios. The case study had presales of the residential development so consideration was given to timing for settlements, ensuring a bulky amount of revenue after each development. It will be interesting to see the results of real options evaluation using rental projections as revenues after development is completed as compared to DCF evaluation. In this case study, the stochastic process adopted cap rates from the location of the project. It is possible to find different means of representing uncertainties other than the use of cap rates. Lastly, since this was a private project, the discount rate for the revenues was both conservative and high at 10.23% and 20% respectively. The method can be tested using data from a corporation which is developing for example an office for their own corporate use.
Chapter 6 Case Study 2-Evaluation of Option to Delay in a Brownfield Residential Development

6.1 Introduction

Property development projects are undertaken under conditions of uncertainty. As a result, the financial feasibility evaluation of property projects can be fraught with uncertain inputs that can impact on outcomes. These outcomes guide developers in decision making regarding the execution of projects. As a result, some projects that may be viable in the future are rejected based on such single point estimates. With a strategic tool such as delaying the start of a project until uncertainties surrounding some input variables in the evaluation model are resolved, same projects can become viable. The importance of tomorrow’s strategic opportunities embedded in development projects arising from changes in the values of assets overtime can be valuable consideration.

Option to delay

The option to delay is among the strategic choices available to developers in the face of uncertainties concerning financial project outcomes. In the real estate and construction sector, accounting for uncertainties in property development evaluation means that, developers must examine all possibilities capable of occurring in the market as far as development projects are concerned. Knowing that such uncertainties are uncontrollable, developers must be proactive in dealing with risks and uncertainties through such strategic tools as delaying the start of a project until a time when market conditions are favourable for development. As a result, the option to delay is a strategic tool that developers can use to mitigate risks in the face of uncertainty and at the same time retaining the upside potential of development projects.

This case study is a residential apartment development located in the northern part of Melbourne, Australia. The real option under consideration is the flexibility to postpone a project to another date when uncertainties are resolved, also known as the option to delay or waiting to invest. This type of real option allows a developer to hold on to projects that have the potential to be economically viable in the future rather than rejecting and abandoning them based on the DCF framework propositions. This case study is financially evaluated using the certainty equivalence approach of the binomial option pricing method (CE-BOPM) to demonstrate the transparent evolution of future asset values on which developers can intuitively make decisions to develop certain projects. This case study project is the second application
and different from the others in terms of location, flexibility embedded in the project and ROV model for evaluation.

In the literature on real options in real estate, the delay option is generally used to evaluate the optimal timing of a real estate development activity and demonstrate the value in waiting. It is invariably linked to the irreversibility of real estate development because once a developer commits to a particular project, the option to delay and its option value are lost. It is one of the most commonly evaluated real options in the real estate and construction sector as the ownership of a piece of land confers on the owner a perpetual right to develop the land bearing in mind the restrictions on planning. However, the application of real option tools and techniques to the evaluation of this type of real option has differed considerably based on the choice of case study and its dynamics such as assumptions of stochastic processes, data requirements and context.

Generally, the main purpose of examining the value of an option to delay is to maximise the financial outcome of projects for developers based on the evolution of future property values and their uncertainty. The logic behind the application of financial options to real estate is that, investments in real estate assets give developers a right but not the obligation to a stream of future cash flows which are discounted to present value to determine the viability of investments. In view of this, potential changes to either sales revenues or rents can affect the financial outcomes of developments. The rule of thumb is that, a developer must invest today only if the net present value of the development is high enough to compensate for giving up the value of the option to wait (McDonald & Siegel, 1986). Therefore, unless the present value of the development is greater than the real option value, the rational developer would not execute a development project today.

6.2 Case Study Description

The North Melbourne apartment development project was nearly completed at the time of evaluating the real option value and writing the dissertation. At the time of sourcing data and information on this case study, the developer was involved in settlement with the occupiers pending final handover to various owners of respective units in the apartment building. The discussion on this case study will show how DCF was used in decision making concerning execution of the project and how real options analysis of delaying the development alters the decision based on the financial evaluation outcome. The residential project is in North
Melbourne along a major arterial road that links the Melbourne CBD and the Tullamarine airport.

**Figure 6-1 Site for the Apartment Development Project**

Near the location is the CBD (9 kilometres), Carlton, North Melbourne and Royal Park and several major retail precincts and other amenities that are important for city living. The exact location of the land is not shown in Figure 6-1 to protect the confidentiality of the developer. The site is rectangular and supports the development of residential apartments without difficulties with an approximate size of 1,045m². It was brownfield site which was acquired by the developer for the project.

Figure 6-1 displays the site close to a Hospital and walking distance to leading Universities, Royal Park and Queen Victoria Markets. Students studying at the universities located close to the site may be attracted to the apartment complex due to its proximity. Tram stops and bus stops are all a block away from the site and serves as a major attraction to investors and owner occupiers of residential properties. Moreover, several convenience shops are also located very close to the site serving as a driver for the choice of location by households. The proximity of the development to the city and all the amenities required for city living were beneficial considerations assisting the prospects of a successful financial outcome.
6.2.1 Features of the Apartment Building

The total number of apartments was 143 in a mix of 1 and 2-bedroom apartments that were targeted at the investor market and 2 bedrooms plus study and 3-bedroom apartments targeting owner-occupiers. The design of the development also incorporated basement car parking for most of the units. On information provided by the developer, the total GLA for the apartment tower is approximately 10,040m². This is composed of approximately 8,600m² internal area for units (bedroom, living room, and kitchen etc.) and about 1,250m² of space for external area such as balconies for the units and other outdoor areas. The developer, in collaboration with the architects adopted an open plan layout interior design for the units. The living rooms were designed to have high ceilings to give the units natural lighting. The kitchen area is very large and furnished with modern European appliances together with a dining area that makes it suitable for multiple uses. The double-glazing windows and doors also ensures energy efficiency and prevents noise penetration from surrounding private activities and especially from the nearby major arterial road. There are also solar panels installed. Furthermore, there are two main green areas in the apartment building: the roof top garden shared by all tenants and the private green space for those who enjoy privacy.

Figure 6-2 Completed Apartment Building

Source: ABC (2016b) (building is similar to case study, actual building not shown due to confidentiality)
Figure 6-2 shows a completed apartment block of a scale similar to the subject property. It shows a distinctive quality apartment designed with investors and owner-occupants at the centre.

**6.2.2 Data on the North Melbourne Case Study Project**

The data for the project was supplied by the developer and was relied upon as true information for the evaluation of the case study. These estimates were provided by the developer as at the time that the residential development project was initiated until the completion. The application of the option to delay the development will be based on stepping back in time to the year 2012 when the project began. At that time, the developer had the choice to defer the project until market conditions appeared favourable to start the project.

An important issue for consideration by the developer was to determine whether the project was financially feasible or otherwise, based on the current costs and future revenue estimates. In most of these high-rise residential projects, developers normally do presales before construction starts. The presales offer security to the developer, mitigate risks and attract funding from financial institutions for the development.

The viability of development projects is affected by several market factors outside the control of the developer, which can affect the feasibility of projects during the development process. Some projects may also not be viable at the time of inception, but changes in market conditions can result in those same projects becoming financially feasible in the future. As a result, developers and analysts need to consider the potential of such projects becoming viable in the future during financial evaluation to avoid discarding prospectively viable projects.

Data for the project as supplied by the developer is presented in Table 6-1. The project was scheduled to end in early 2016 after beginning in the year 2012. The table displayed indicates that the expenditure on the project was expended in tranches to match cash outflows. The cost component included construction costs, professional fees for design, statutory fees for planning and permissions and land holding costs which were all staggered throughout the duration of the development. The total development costs were around $77.5 million and the expected revenues were an undiscounted sum of around $84 million as shown in Table 6-2. The net cash flows for respective years are also shown in the Table to depict the profits that were expected after sale of the units.
Table 6-1 Data on Costs and Sales Revenue for Project

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
<th>Revenue</th>
<th>Net Cash flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>947,479</td>
<td>0</td>
<td>-947,479</td>
</tr>
<tr>
<td>2013</td>
<td>3,631,143</td>
<td>11,635,000</td>
<td>8,003,857</td>
</tr>
<tr>
<td>2014</td>
<td>16,206,006</td>
<td>68,155,000</td>
<td>51,948,994</td>
</tr>
<tr>
<td>2016</td>
<td>27,536,944</td>
<td>63,700</td>
<td>-27,473,244</td>
</tr>
<tr>
<td>Total</td>
<td>77,565,292</td>
<td>83,791,300</td>
<td>6,226,008</td>
</tr>
<tr>
<td>Profit</td>
<td>6,226,008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margin</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from developer’s data, 2016

In deciding as to whether to execute the project or discard it, several measures of profitability are adopted by developers. This includes the actual profit value (the difference between the development value after completion and the costs associated with the development). There is also the development margin, which is the profit on cost and is expressed as a percentage value. As these profitability measures do not account for the time value of money, they are problematic in their evaluation of profitability of developments because developments take several years to complete. For example, the case project took four years to complete, therefore any analysis that does not incorporate the time value of money can be inaccurate. The DCF technique is widely used and accepted because it considers the time value of money and makes provision for risks associated with the development using an assumed discount rate sought by the developer.

Table 6-1 demonstrates the financial analysis of the project returns displayed and shows that the developer made an undiscounted profit of around $6 million. This amount represents 8% development margin for the developer. The use of this metric for measuring profitability is problematic because it does not account for the time value of money nor the risks associated with the development. Table 6-1 also indicates that the construction of the development was not divided into stages but proceeded in one stage. It took a period of four years from inception until completion and handing over to investors or owner occupiers.

The developer’s decision to execute the project was predominantly based on the development margin. Any changes in market conditions could have been financially catastrophic for the developer and risks of the development were not accounted for properly using the discount rates. It is therefore important to use the DCF technique that can capture the time value of
money and risks using a discount rate to evaluate the project to determine whether it would have supported the decision by the developer to execute, hold or disregard the project.

6.3 DCF Modelling

As stated already, the DCF approach is the most widely used in property development evaluations. The main measures of profitability in using the DCF are the IRR and NPV. These two measures of profitability have specific rules that developers use to determine the viability of investments. For example, a negative NPV implies that the developer should reject the project and a positive NPV figure suggests that the project is profitable and should be executed. This technique is used to evaluate the project and compared with both the development profit and margin to determine whether the project is worth executing. In conducting the financial analysis using the DCF, it is assumed that the developer proceeded with the project at once without any opportunity to delay the project in later years in case there was an unfavourable market. Obviously, this is an irreversible commitment to the development and lacks flexibility. Such an irreversible commitment to property development results in the loss of option of waiting to invest which can be valuable in the face of uncertainties.

In the modelling of the DCF valuation, the number of years used for the development project was five (5) years as the project started in 2012 and ended 2016. This is shown in Table 6-2 and the cash flows and costs are discounted at a rate of 15% and 4% respectively. These rates were given by the developer as the rates for discounting revenues and costs respectively when using the DCF, though subject to changes based on market conditions. The 15% represents the hurdle rate for the developer before executing a project and the 4% is for discounting costs due to the time value of money in terms of time for construction.

These two different rates were used for the revenues and costs because the developer suggested that the cash flows are always riskier than costs. The rationale behind the use of these different rates by the developer was that costs are always agreed between the developer and the builder but subject to changes as agreed within the contract document, hence there is a degree of control over the costs. Some contracts such as the design and build exonerate developers from all risks of construction because developers transfer risks to the builders. In that sense, the developer’s risks as far as construction costs are concerned is very minimal.

On the contrary, revenues are uncontrollable by developers and fluctuate in the property market. The developer calculated the 15% as the hurdle rate to cover risks of the development
in addition to returns on equity used for the development. The 15% also falls in the range of prevailing rate for residential developments within the Melbourne property sub market according to the developer. Therefore, discount rate of 15% was used to discount the potential revenues to be received from the development.

Using the DCF model in equation 6-1

\[
NPV = -I + \sum_{t=1}^{n} \frac{CF_t}{(1 + r)^n}
\]

Where \( n \) = period of the development

\( CF_t \) = net cash flow at period \( t \),

\( r \) = discount rate reflecting the riskiness of the development

\( I \) = the initial investment outlay of the project (costs).

**Table 6-2 DCF Modelling and Results**

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>947,460</td>
<td>3,631,142</td>
<td>16,206,027</td>
<td>29,243,744</td>
<td>27,536,920</td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>0</td>
<td>11,635,009</td>
<td>68,155,006</td>
<td>3,937,605</td>
<td>0</td>
</tr>
<tr>
<td><strong>PV of Costs</strong></td>
<td>947,460</td>
<td>3,491,482</td>
<td>14,983,383</td>
<td>25,997,582</td>
<td>23,538,674</td>
</tr>
<tr>
<td><strong>PV of Revenues</strong></td>
<td>0</td>
<td>10,117,399</td>
<td>51,534,976</td>
<td>2,589,039</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sum of PV of Costs</strong></td>
<td>68,958,581</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sum of PV of Revenues</strong></td>
<td>64,241,413</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Present Value</strong></td>
<td>-4,717,168</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRR</strong></td>
<td>9.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from developer’s data, 2016

The modelling adopted 5 years for the development horizon starting from 2012-2016. The revenues for the project were estimated to be at market levels and were projected to be received in the years 2013, 2014 and 2015. As usual, the cost is spread across the development period because at the inception, costs are limited to the minimum amount in order to ensure that, the costs are kept under control until full commitment to the project is assured. As a result, the lowest of costs from Table 6-2 occurred in 2012 during the inception of the development and steadily increased as the project progressed and started declining when it was on the verge of completion. The costs and revenues were discounted at a required rate of 4% and 15% respectively to obtain the present values, which aided in the computation of the NPV. Data on the actual costs and revenues projected for the development were those supplied by the
developer. All the inputs were used in the modelling and resulted in an NPV and internal rate of return (IRR) for the project of around $-4,717,168 and 9.1% respectively as shown in Table 6-2. As the NPV computed was negative, the resultant effect is that the project would have been initially rejected and abandoned by the developer because based on the NPV rules of decision-making, negative NPV projects should be rejected. Similarly, the IRR for the project was lower than the investment return sought by the developer at 15% and this would have led the developer to reject the project outright. The two measures of profitability of the DCF technique are all indicating that the project would not be financially successful.

However, there is a potential for the development to become viable due to changes in market conditions in the future. This is one of the premises on which DCF has been criticised because it is unable to evaluate tomorrow’s opportunities that are important in strategic decision making (Myers, 1984). Thus, there is the possibility of the market changing to turn today’s unviable projects into financially feasible projects. As a result, it is important to consider tomorrow’s opportunities in evaluating development projects because such opportunities have value and are strategic in nature. Since the DCF has inputs that are susceptible to variations leading to deviations in profitability levels, it is important to examine the most sensitive inputs into the DCF model and how changes in these variables affect profitability of the investment. These inputs include the costs, revenues and the discount rates used for both the costs and revenues. These inputs will serve as the basis for the modelling of the project within the real option framework because the values of real option on projects are determined by the uncertainty surrounding these inputs.

### 6.3.1 Sensitivity Analysis

Sensitivity analysis is the approach widely adopted by developers and other practitioners in the property industry to evaluate the effect of potential changes in the various inputs into the DCF model on financial feasibility of development projects. The use of sensitivity analysis though important in conveying to developers on the potential gain and loss the developer may incur from unexpected changes in any of the input variables (mostly costs and revenues), but it does not form part of the numerical analysis needed to justify investments into development projects. Thus, the decision by an investor to commit to a project is solely based on the single NPV figure and it’s supporting decision rules. In essence, the sensitivity analysis is just for information purposes.
In practice, there can be several variables in a DCF model with varying levels of impact on the profitability of developments. For example, the costs, revenues, discount rates (both costs and revenues) and demand for a project are all uncertain with potentially varying impacts on profitability of developments. Therefore, choosing the input variables with the greatest impact on financial feasibility of projects enable developers to give attention to the most important variables in a DCF model. Recent practices in the property industry include the use of TopRank software (from Decision Analysis suite) as a primary tool for performing sensitivity analysis. In view of this, TopRank software was used to perform sensitivity analysis for the case study residential project to determine the impact of potential changes. After performing sensitivity analysis using the TopRank software, two main diagrams emerged as output results; a tornado diagram and the spider graphs. The tornado diagram is adopted for the discussion of the implications of changes in the inputs of the DCF model because of its ease of visualisation and comparisons among variables.

**Figure 6-3 Tornado Graph of Sensitivity Analysis**

![Tornado Graph of Net Present Value](source: Author, 2016)

Figure 6-3 is a tornado graph showing the most sensitive variables in the DCF model for the residential apartment project and their potential impact on profitability. There are four main variables; (i) total cost, (ii) total revenue, (iii) revenue discount rate and (iv) cost discount rate in order of their potential impacts. The total cost input has the most impact on profitability in case of either favourable or adverse market conditions on the project using a 10% variation.
The tornado graph displays the most sensitive inputs on top, followed by the less sensitive variables in an orderly manner. In this way, the cost is on top because it is the most sensitive input, followed by the revenue, discount rate for revenue and discount rate for cost in order of potential impacts on profitability (NPV). The length of the bars representing the inputs also demonstrates the impact of changes in a specific variable on the NPV. Therefore, the impact of cost variation in either a favourable or adverse market conditions will be greater than similar changes in potential revenues and both the discount rate for revenues and costs. It must be stated that the revenue variable’s impact was seen to be closer to the cost variable as can be seen from the tornado graph based on the length of the two bars. However, the discount rates for both cost and revenues did not have a major impact as compared to the total cost and revenue. For example, the impact of the revenue and cost discount rates on NPV was very low as seen in the graph.

**Table 6-3 What-If-Analysis Summary Output NPV (Minimum Case)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input Name</th>
<th>Value</th>
<th>Value</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost</td>
<td>85,321,821</td>
<td>-11,613,026</td>
<td>-146.19%</td>
</tr>
<tr>
<td>2</td>
<td>Revenue</td>
<td>75,412,170</td>
<td>-11,141,309</td>
<td>-136.19%</td>
</tr>
<tr>
<td>3</td>
<td>Discount rate/cash flow</td>
<td>16.5%</td>
<td>-6,264,696</td>
<td>-32.81%</td>
</tr>
<tr>
<td>4</td>
<td>Discount rate/costs</td>
<td>4%</td>
<td>-5,514,511</td>
<td>-16.90%</td>
</tr>
</tbody>
</table>

Source: Author, 2016

The minimum scenario of the sensitivity analysis is shown in Table 6-3 and based on a 10% downward variation in revenue, revenue discount rate and cost discount rate, there is a likely minimum NPV value of $-11,141,309, $-6,264,696, and $-5,514,511 respectively. However, on the cost side, because the output results show the minimum NPV values to be obtained, the construction cost was increased by 10% to determine its effect on NPV in a minimum scenario. For a 10% increase in construction cost, the NPV would have been $-11,613,026. The greatest impacts on the NPV for the project would have come from the cost and revenue variations.

**Table 6-4 What-If-Analysis Summary Output NPV (Maximum Case)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input Name</th>
<th>Value</th>
<th>Value</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost</td>
<td>69,808,763</td>
<td>2,178,690</td>
<td>146.19%</td>
</tr>
<tr>
<td>2</td>
<td>Revenue</td>
<td>92,170,430</td>
<td>1,706,974</td>
<td>136.19%</td>
</tr>
<tr>
<td>3</td>
<td>Discount rate/cash flow</td>
<td>13.5%</td>
<td>-3,108,287</td>
<td>34.11%</td>
</tr>
<tr>
<td>4</td>
<td>Discount rate/costs</td>
<td>4%</td>
<td>-3,932,838</td>
<td>16.63%</td>
</tr>
</tbody>
</table>

Source: Author, 2016
The maximum scenario NPV of 10% upward variation is presented in Table 6-4. Based on a 10% upward variation in revenue, the NPV increased from about $-4.7 million to around $1.7 million for the developer. A 10% reduction in the revenue discount rate did not result in the NPV changing to become positive. It remained at around $-3.1 million irrespective of the 10% reduction in the rate suggesting that it’s impact on the project is not significant in terms of financial feasibility. Thus, whether upward or downward adjustment to the revenue discount rate, the NPV would have still been negative and the project rejected. The cost discount rate also had a significant impact because a 10% downward change, resulted in an NPV of $-3.9 million, thereby reducing the negative NPV.

The cost component would have however increased the NPV from around $-4.7 million to around $2 million upon a 10% downward variation in the total cost of the project. For most developers, the upward variation will probably be an incentive to develop and capitalise on such an opportunity. Similarly, from the real options perspective such an uncertainty should rather inform developers about the potential of the project due to uncertainties. Thus, there is value in uncertainties and should developers analyse developments and take into consideration the potential of today’s unviable projects to become financially feasible, some projects might not be abandoned based on the static DCF analysis.

Even though sensitivity analysis is used to measure the impact of changes in potential variables on profitability, such changes are not factored into the decision making by developers. Favourable conditions in the market can change the profitability of this case study project in future which was not identified by the DCF ignored. The positive value in uncertainty is also disregarded by DCF analysis and rather treats uncertainty as only a risk factor using an assumed discount rate. Therefore, it is only developers that are prepared to take advantage of positive changes in the market that can reap the positive benefits in time by developing a strategy capable of capitalising on upside potential of development projects.

For a developer who is making decisions regarding execution of development projects, it is generally agreed that they are mainly concerned with the downside of uncertainties and risks resulting from unfavourable markets. However, there can be upside potential associated with projects resulting from favourable changes in market conditions and it is developers who are proactive in their approach to the management of development projects who can capitalise on these changes to their benefit. This is one of the pillars of real options theory to adopt strategies that can aid developers in capturing upside potentials of developments while limiting the possible downside losses.
In summary, developers must adapt to changing situations in the market and develop realistic approaches to project evaluation. Of course, no rational developer will execute a project knowing that the project is bound to be unsuccessful financially. However, in practice, developers sometimes hold on to projects for a period before execution when uncertainties are resolved. In this sense, it is important to evaluate all possibilities available in terms of the project values over a suitable period that a developer can hold a project until uncertainties are resolved. As a result of holding and calculating the numerical value that represents the project’s profitability from that range, all possible values both in the up and down state would be factored into the financial analysis. In the next section, real option methodology is used to evaluate the option to delay embedded in this real estate project and compare with the DCF to determine the outcome.

6.4 Real Option Modelling

The results from the sensitivity analysis in section 6.2.5 indicated that all the inputs were sensitive and had varied impacts on the profitability albeit the most sensitive inputs in the DCF model were the cost component, followed by the revenues. Even though the cost input was more sensitive than the revenues, the ultimate impact of changes in market conditions is on the profitability (value) and as such the concern of developers is generally on the revenue input and not the cost. Discussions with the developer suggested that most of the development projects are executed under the design and build contract that transfers construction risks to contractors. For property analysis, the impact of all variables is examined on the potential value because the value of a project is the single numerical component that ultimately determines whether a project will be executed or abandoned.

The DCF results imply that the project was not viable at the time the developer was contemplating on starting the project. Again, the location of the project was also full of similar developments making it highly competitive to achieve the desired levels of demand and sale prices for the apartments as estimated. Despite all these uncertainties, there is the possibility of positive changes in the property market in future that can turn the project into a viable one. This is the shortcoming of the DCF model which fails to consider tomorrow’s opportunities in property development. Thus, consideration was not given to the potential of the project to be profitable in future due to changes in the economic environment through the flexibility of delaying the time for commencing the project until the development would be worth executing after uncertainties are resolved.
In view of the existence of tomorrow’s opportunities embedded in property development projects, it is argued that any attempt at evaluating the project must focus on how uncertainty surrounding the inputs can be captured in the modelling to reflect the true potential of the development and its associated opportunities. Thus, uncertainty being limited to the use of discount rates is insufficient and does not capture the true potential of the existing opportunities embedded in the project that unfolds through the stochastic evolution of project values.

Real option framework suggests that developers can choose from specific strategies to deal with uncertainties in projects including the option of waiting to invest/delay the start of a project until uncertainties are resolved. Such an option is important in situations when developers are sceptical about future economic conditions or potential of a development. Similarly, projects that are not viable at present may have the potential to be profitable when deferred until a future time. Such a strategy relies on the evolution of the values of real estate assets and costs to determine the future potential of such projects. Thus, the determination of the potential of a project to become viable in future is dependent on the range of values the asset can assume in future as compared to the future costs. The real options framework combines strategy and a range of values to the computation of viability of future projects. Such strategic flexibility of waiting to invest adds value to property developments and must be evaluated and accounted for in determining viability of property investments.

The real options framework has been proposed as a tool for maximising returns on investment and ensuring that projects that have financial potential are not abandoned in the face of uncertainties. The values of embedded options such as waiting to invest/delay that are tied to uncertainty can be captured only within the real options framework using a range of figures rather than static estimates from the DCF modelling. The same logic of irreversibility of property development is embedded in this case study because once the developer starts the project, the opportunity to defer is lost forever.

The importance of this embedded option of waiting to invest cannot be overemphasised because in the real estate sector, there is illiquidity and depending on the size of project and location, there can be challenges with demand. As this project was located on the fringes of the CBD, the option of waiting to invest until uncertainties are resolved can be valuable because of the uncertainties with property values and demand. Thus, in analysing the profitability potential of this project, the embedded option of waiting to invest should be accounted for in making strategic decisions of committing to the project or otherwise.
6.4.1 Data and Methodology for Real Options Modelling

In this section, the focus is on discussing the data used for evaluating the embedded option to delay in the residential real estate project. Modelling a real option requires several inputs such as costs, values, volatility, risk free rate, and rate of return. On property values, data on estimated property values of different types of apartments in 2012 when the project was about to begin was provided by the developer and compared with data from Core Logic RP Data (suppliers of residential property data in Australia). After comparisons between the two datasets, it was discovered that the projections of the developer were at market values albeit strong optimism from the developer based on presales achieved. Therefore, the data provided by the developer was used in the modelling. Data on different values for different units (1, 2 and 3 bedrooms) were accessed and summed up to arrive at the gross realisable value possible for the project at $83,791,300 (but rounded to $83.7 million for simplicity of modelling). This value served as the starting point for the modelling of the option to delay.

6.4.2 Volatility

Since the values of real assets fluctuate differently in different property markets, it is important to consider these uncertainties of value fluctuation in the modelling. In property investment decision making, volatility is used to incorporate risks and uncertainties associated with real estate values in the binomial tree. The volatility also has substantial impact on option values and it is important to explain and demonstrate how the volatility for the modelling of the value evolution in the binomial tree was determined.

Volatility usually denotes a measure of uncertainty of the return realised on an asset (Hull, 2009). Generally, there is a correlation between the volatility and returns sought by investors in specific assets, because the higher the risks and uncertainties, the higher the returns sought by investors and vice versa. The uncertainties and risks in real estate are measured using standard deviation computed from historical returns of real estate investments (returns of specific real estate asset classes and in this case residential (units) property returns).

Different methods are available for computing the standard deviation of real estate returns. Whether the volatility measure is related to current levels of uncertainty or future levels of uncertainty, the computation is done by using historical data of real estate returns. Apart from estimating volatility from historical data of real estate returns, other methods assign weight to the historical data in different ways depending on the timing of the occurrence of specific
observations within the historical data. For example, more weight is assigned to current observations in data whereas older observations in data are given less weight to account for the non-constant nature of volatility in some methods.

One potent method for computing volatility by assigning weight to account for non-constant nature of volatility is the Autoregressive Conditional Heteroskedasticity (ARCH). Using ARCH to estimate volatility, analysts assign weight to newer observations in the historical data as well as long run variance of the returns of real estate investments of the specific underlying real estate asset to be built. A variation of the ARCH is the Generalised Autoregressive Conditional Heteroskedasticity (GARCH 1,1) model, which also further assigns weight to the variance rate of the previous period in the historical returns data being analysed.

The GARCH (1,1) is given by

\[ \sigma_n^2 = \gamma V_L + \alpha \mu_{n-1}^2 + \beta \sigma_{n-1}^2 \]  

Equation 6 – 2

Where

\[ \sigma_n^2 \] = estimated variance for time \( n \)

\( \gamma \) = the weight assigned to the long-run average variance rate

\( V_L \) = long-run average variance rate

\( \alpha \) = weight assigned to log run average return

\( \mu_{n-1}^2 \) = long run average return of residential property investments (specifically units in apartment buildings)

\( \beta \) = weight assigned to variance of the previous period

\( \sigma_{n-1}^2 \) = variance of the previous period.

In the modelling of the real option to defer in this case study, the future volatility of residential real estate investments (units in apartment buildings) was calculated using the GARCH (1,1) model and was computed to be 6.79%. Residential property investments (units in apartment buildings) historical data spanning a period of 10 years from 2005-2015 for the North Melbourne area was applied. The 6.79% was used in the binomial model to calibrate the value tree of the project for computing the real option value.
6.4.3 Risk Free Rate ($r_f$)

Another important variable needed for the real option valuation of the option to delay is risk free rate of return ($r_f$). In the real options modelling, consistent with the risk neutral valuation assumption of the option pricing theory, the risk-free rate is used to compute the present value of option values on the residential development after calibrating the value evolution. In this case study, the risk free rate adopted was the average rate for a 10-year Australian government bond, which was computed to be 2.45% (RBA, 2016a) on the date of valuation.

6.4.4 Consumer Price Index

Consumer price index measures the movement in prices of goods and services over a period. In Australia, the Australian Bureau of Statistics publishes information on the consumer price index which is used in the pricing of numerous contracts including some construction contracts. Since it measures the movement in prices of goods and services, it was used as a proxy for generating the distribution of potential increases in development costs over the period of delaying the project. The Australian Bureau of Statistics provides data on the consumer price index which was sourced and used to compute the figure that was an average of 2.38% (ABS, 2016) per year based on a 10 year period.

**Figure 6-4 Australia Consumer Price Index**

![Consumer Price Index 2000-2016](image)

Source: Adapted from data from ABS, 2016
Figure 6-4 displays the consumer price index in Australia over a period of 10 years. It can be observed that the values fluctuate with the market. For example, the major trough in 2008-2009 demonstrates the effects from the global financial crisis (GFC). It also shows a rise and fall pattern which means that it is affected by the general economic conditions in the wide market especially during the GFC where there is a trough. Therefore, using the consumer price index as a proxy for changes in construction prices is reliable. The Australian Bureau of Statistics has indicated that, this is the rate used by contractors and builders to determine changes in construction contract prices.

6.4.5 Modelling Uncertain Variables (Value and Cost)

The valuation of an option to delay is dependent upon changes in the uncertain variables resulting from market conditions in the respective property market where the real estate asset is located. Because changes in market conditions are unavoidable, developers should have the flexibility to delay projects that are not viable today until a future time when the project can be re-evaluated to determine its financial viability. Developers can also hold onto projects over a period purposefully and wait to capitalise on favourable market conditions later. However, determining the potential of such projects to become financially viable can only be evaluated using the real options framework. The sensitivity analysis in section 6.2.5 indicated that cost and value were the most sensitive variables, therefore these two are considered as the uncertain variables that need to be modelled using specific stochastic processes to determine the possible range of future values and how they affect profitability of the development.

6.4.6 Costs

Even though development costs fluctuate due to varying factors, the developer was emphatic that they use the design and build type of contract that transfers risks of cost variation to the contractors. However, because the delay option is normally initiated by developers who are owners of projects, there is the need to consider changes in costs due to renegotiation after a period of delay. Thus, the total construction cost for the project was around $77.5 million as given by the developer and shown in Table 6-1 at the inception of the project. This value was adopted as the initial cost for the project.

As the cost of development is stochastic, building a model for a delay option requires that provision is made for growth in the cost component (development cost). The consumer price index is used by the Australian government to track changes in construction costs over a period.
It is therefore assumed that, the cost component of the residential apartment project increases based on consumer price index in Australia which has already been calculated to be 2.38%.

Since construction cost rarely experiences reduction, it is assumed to follow a steady rise over the period that will be used to calibrate the cost component of the binomial tree. Therefore, it is assumed that construction prices have a stochastic process of the form

\[ C_{n+1} = C_n \times (1 + CPI_{avg}) \]

Equation 6 – 3

Where

\( C_{n+1} \) = development cost of the next period in the binomial tree

\( C_n \) = development cost of the current period

\( CPI_{avg} \) = average of 10-year consumer price index

In summary, whereas the stochastic process for the value of the residential project is based on up and down movements with specific probabilities converging in a normal distribution, that of the construction is a steady rise in the cost over the specified period for the modelling of the option to delay. Thus, the fluctuation of the construction cost is linear but that of the value is undulating.

### 6.4.7 Modelling the Value Evolution (Binomial Tree)

In the certainty equivalence approach of the binomial option pricing model, the value tree evolution is deemed dependent on the capital growth in the respective real estate market and of the form

\[ gv = \frac{(1 + r_v)}{(1 + y_v)} - 1 \]

Equation 6 – 4

Where

\( gv \) = the expected annual growth in the value of the units in apartment buildings

\( r_v \) = expected annual total return on investments in units in apartment buildings

\( y_v \) = the net rental yield on investments in units in apartment buildings
In this case study, the average of annual total return and average rental yield of residential real estate investments in North Melbourne was calculated to be 10.2% and 5.53% respectively using a 10-year data from 2005-2015 sourced from Core Logic RP Data.

In modelling the asset tree, at any point in time during the evolution of the residential project’s value, it is assumed that there are only two possible state values of the project: either an upward \((u)\) movement with probability \(p\) or a downward \((d)\) movement, with probability \(1-p\), where \(p\), \(u\) and \(d\) are given by:

\[
p = \frac{(1 + r_v) - d}{u - d}
\]

\[\text{Equation 6 – 5}\]

\[
u = 1 + \sigma \sqrt{T/n}
\]

\[\text{Equation 6 – 6}\]

\[
d = \frac{1}{u}
\]

\[\text{Equation 6 – 7}\]

Where

\(\sigma_v\) = expected annual volatility of returns on residential property investments (units)

\(T\) = the total time in the binomial tree (in years)

\(n\) = the total number of periods within the tree making \(T/n\) a fraction of a year within any single period in the binomial tree.

Defining the current value of the residential project as \(V_t\), then the value of the project in the next period in an up movement \((u)\) is defined as

\[
V_{t+1}^{up} = \frac{uV_t}{1 + y_v}
\]

\[\text{Equation 6 – 8}\]

Similarly, a down movement in the next period can also be defined as

\[
V_{t+1}^{down} = \frac{dV_t}{1 + y_v}
\]

\[\text{Equation 6 – 9}\]

Using these two equations, the potential values of up and down movement of the residential apartment project were derived and used for the computation of expected values and option values thereof. The extent of up and down movements are calibrated in such a way that, together with the volatility and time, it results in a normal distribution of a range of values as the estimated discrete time periods approaches the limit \((\infty)\) (Geltner et al., 2007). This process of
up and down movement is repeated until the end of the process of constructing the binomial tree depending on the period for deferring the project. In this case study, the period of deferring the project was assumed to be 1 year (12 months) because developers have limited time to begin development after presales, otherwise clients are legally allowed to cancel presale contracts.

6.4.8 Model and Real Option Value (ROV) Computation

A computation of the option values based on the certainty equivalence approach of the binomial option model assumes that developers are rational and would execute the project as soon as the value of the residential apartment exceeds the construction cost to the extent that it is justified to give up the option of waiting to invest. Thus, the option to delay is treated as an American call option on the right to develop the vacant brownfield land which was acquired for this project. The effect is that, the developer of this project has the right to start the project at any point in time within the 1 year of deferral if the project is deemed profitable at that point in time.

The costs of developing a brownfield site can also be higher than a green field site, hence affecting the potential profitability. After calibrating the model and determining the potential values of the residential project at each node of the tree, then through a backward induction process of iteration from the final nodes, potential payoffs (option values) from the real estate development at earlier nodes are calculated from the final nodes. These option values are discounted at the risk free rate based on the no arbitrage assumption of the risk neutral valuation (Geltner et al., 2007).

Defining that the binomial tree calibrated in Figure 5.2.6 as being made up of rows and columns where the $j^{th}$ column represents the number of periods after today’s observable market value of the residential project, $j$ has values of 0,1,2,3 ..., $n$. Similarly, the $i^{th}$ row represents the number of down movements of the value of the residential apartment project starting from the present observable value, $i = 0, 1, 2, 3, 4,..., j$. A combination of a row and a column defines a particular “state of the world” for the project’s value over $j$ periods into the future (Geltner et al., 2007). The potential value of the residential project in a specific state $V_{ij}$ can be derived in the form of a tree of asset values based on $u$, $d$ and $p$ as defined already in Equations 5.2.5, 5.2.6, and 5.2.7 respectively.
Therefore, the certainty equivalence equation for evaluating the American call option to delay on the residential apartment project is given by Equation 6.10 below

\[ C_{i,t} = \text{MAX} \left[ V_{i,j} - K_j, \frac{(pC_{i+1,j+1} + (1-p)C_{i+1,j+1}) - (C_{i+1,j+1} - C_{i+1,j+1})}{1+r_f} \right] \]

Equation 6-10

Where

\( V_{i,j} = \) Value of the underlying asset at period \( j \), with \( i \) representing the total number of down outcomes out of \( j \) periods

\( K_j = \) Construction cost at period \( j \), corresponding to \( V \) at the same period

\( C_{i,j} = \) Value of the option (land price) at period \( j \), with \( i \) representing the total number of down outcomes (corresponding to the movement of \( V \)) out of \( j \) periods

\( p = \) the probability of an up movement and \( r_v, \sigma_v, T, n \) and \( r_f \) are as already defined.

These parameters were used in the certainty equivalence approach of the binomial option pricing method to derive the expected values and the American call option values to develop thereof in this case study.

**6.5 Results and Discussion**

The section focuses on discussing the result from the modelling of the value tree and the cost tree over the 12-month deferral period. The result will be compared to that of the DCF model based on the NPV and the IRR to determine which of the methods derived superior results. Afterwards, conclusions will be drawn based on the outcome of the comparisons. Figure 6-5 displays the potential cost evolution during the period of deferral of the residential real estate project. As the market dynamics keep changing, prices of goods and services also keep changing affecting construction prices. In modelling the cost component of the project, it was assumed that, it increases linearly with respect to the average of the consumer price index over a 10-year period which was 2.34%. The result is that, the development cost for the residential project during the deferral period (12 months) would increase from the initial estimate of around $77,570,000 to about $79,430,000.

The linear nature of the development costs and the increases are shown in Figure 6-5 and the cost figures in the binomial tree are the same at every step within the 12-month period. The
cost figures are same in every state of the world because they are assumed to increase at same rate at every step (state of the world) in the tree. In practice, hardly do construction costs decrease, thereby supporting such an assumption. As the market dynamics keep changing, prices of goods and services also keep changing affecting construction prices. The result is that, the development cost for the residential project during the deferral period would increase from the initial estimate of around $77.5 million dollars to about $79.43 million as shown in Figure 6-5. The linearity of costs evolution of the development can also be seen in Figure 6-5 because the cost figures increase at the same rate at every step in the tree.
Figure 6-5 Binomial Tree of Costs for the Apartment Project Over a 12-month Period of Delay

<table>
<thead>
<tr>
<th>periods(j)- (months)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>down moves (i)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>77.57</td>
<td>77.72</td>
<td>77.87</td>
<td>78.03</td>
<td>78.18</td>
<td>78.34</td>
<td>78.49</td>
<td>78.65</td>
<td>78.80</td>
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Source: Author, 2016
Figure 6-6 Binomial Tree of Value Evolution of Apartment Project Over 12-Month Period

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Source: Author, 2016
The value tree of the potential values of the apartment from the commencement of the deferral period to the end of the 12 months is displayed in Figure 6-6. After 12 months of deferral, the potential value of the apartment project increases from the initial value of around $83,790,000 to a highest possible value of around $100,100,000 in case there is a favourable market. However, in an unfavourable market, the potential value of the residential project decreases to a possible minimum of around $62,810,000. Between the maximum possible value and the minimum possible value are other potential values that can be realised from the development. This leads to the development of a range of values from which real option values can be calculated to represent the potential value of the asset in future (12-month period). Thus, the method considers a range of values rather than a single point estimate for evaluating viability of real estate projects. The value tree shows the recombination of the lattices as theorised by the binomial option pricing theory which requires the lattices to recombine after every up and down movement.

**Figure 6-7 12-Month Value/Probability Graph of the Apartment Project**

As explained earlier, the certainty equivalence approach of the binomial option pricing method value tree leads to the development of a normal distribution of values as displayed in Figure 6-7. It demonstrates the potential values of the apartment development project and the respective probabilities of achieving a specific value during the deferral period. It ranges from a lowest of
about $63 million to a highest possible value of about $100 million. The lowest possible value in a market downturn in the North Melbourne real estate sub-market over the 12-month period of deferral would be around $63 million with a probability of 0%. Whereas the highest value possible of around $100 million has a probability of 2%, the most likely value of around $89 million has a probability of 25% of occurring. Even though only the minimum, maximum and most likely values are discussed for simplicity, computation of the real option value which represents the potential of the project to return profit considers the range of all possible values as shown in Figure 6-6 from $63 million to $100 million with varying probabilities of potentially occurring.

The real option method considers a range of values rather than a single point estimate for evaluating viability of real estate projects thereby enhancing the financial viability assessments. Figure 6-6 displays the potential value evolution during the period of deferral of the residential real estate project and Figure 6-7 shows the resultant range of values as normal distribution from which a single value can be calculated to represent the potential financial return from the development. The value tree in Figure 6-6 also shows the recombination of the lattices as theorised by the binomial option pricing theory which requires the lattices to recombine after every up and down movement.

Because the value of the residential project changes differently from the development costs, the potential associated with the project is obvious in the sense that changes in value is greater than changes in development costs. Therefore, there is no correlation between value change and development cost change, which ensures that the positive changes in value are not offset by similar increases in development costs. Thus, a strategy such as a deferral until such a time that the value is potentially high enough to warrant starting development is critical in financial project evaluation.

After a deferral period of 12 months, the residential project must be executed before the developer can realise the value from the development. The data given by the developer indicated that the execution period was 2 years. In view of this, the values and the costs should be discounted to account for the period of construction. This is achieved via the use of present value formula to discount the values and costs in the binomial tree.

Having a forward claim on the residential project’s development cost and value in Figures 6-5 and 6-6 respectively at the end of the 2-year construction period, the true value of the development can be determined, and the effect of time value of money factored into the
evaluation. The reason is that though the values in Figures 6-5 and 6-6 represent the potential values for both costs and values, the value would only be realised after the 2-year construction period. In discounting, the time was 2 years for the period for both costs and value, the discount rate adopted for the values was the total return for residential property investments (10.23%). The cost discount rate was however the risk-free rate of 2.45% due to the lower risks associated with the costs.

Figure 6-8 displays the potential values of the residential real estate project after discounting the values for 2 years which is the period of construction. After calculating the present values, the potential maximum value decreased by approximately 10.5% from $100.10 million to $89.64, the most likely value possible was reduced by 10.44% from $89.09 million to $79.78 million and the minimum value possible declined by 10.42% from $62.81 million to $56.25. The cost discounting resulted in a reduction of around 0.14% which was lower than decreases in the value component. The reduction in the values and cost is due to the discounting factor which has the effect of reducing the values and costs to account for time value of the profits associated with the investment. Obviously, because the values and costs change with the discounting, it changes the real option value and the exact timing a decision should be made for construction of the project to commence. This result would have an impact on the decision of any prudent land owner or developer in deciding when to execute the residential project.

Using Equation 6-10 and the present values of both costs and revenues from the project as shown in Figure 6-8 and 6-9, the American call option on the project was determined to be $0.29 million at present as circled in Figure 6-10. This was achieved through the backward induction process of iteration and the risk neutral valuation. This real option value is relevant in the decision making of the property developers of this specific project because it is compared to the value of the project today to determine the optimal time for the development. Thus, the decision to exercise the American call option is based on the value of the option at each node by comparing its continuous value and current pay off from exercising it at each node in the binomial tree. The option is only exercised when the current pay-off is greater than the option value of continues holding it and the timing is optimal at that point.
### Figure 6-8 Present Value of Forward Claim on Cost of Apartment Project (2-year Construction Period)

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Source: Author, 2016

### Figure 6-9 Present Value of Forward Claim on Value of Apartment Project (2-year Construction Period)
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Source: Author, 2016
A comparative analysis of the real option value and the DCF value indicates that, the real option value is positive thereby suggesting that the project has the potential to be financially feasible whereas the DCF results suggest that the project should be rejected due to the negative result. At present, the $0.29 million payoff is less than the real option value of continuously holding, so the optimal decision is to hold onto the option to develop until the pay off is greater than the option value. The pay off value currently accounts for about 0.37% of profits on cost of the development which would have been an incentive for the developer to execute the project as compared to the DCF valuation results. However, it is not the optimal time for development to commence because the real option value is higher than the benefit cost ratio (pay off) embedded in the binomial tree for decision making, hence exercising the option is not financially prudent. This demonstrates the potential of the real option method in the evaluation of capital projects.

DCF method suggested that the project should be rejected and abandoned, but real options method suggests that the project should be held over a period of 1 year and there is a potential for the project to become financially viable at that time for construction to commence. Because it is an American call option on the residential project, the project could be commenced at any time within the one year of deferral. As a result, different decisions concerning exercising the option or holding it may be taken by the land owner/developer at specific times during the waiting.

The computation of the real option value using the binomial option pricing method embeds a specific timing for development which is the boundary line or optimal point for development to commence. This timing for development indicates the optimal time at which it is prudent for a developer to give up the option of holding onto the project and commence construction to capitalise on the potential profitability. The optimal timing for the development project to commence is given by the ratio of current Value and construction cost ($V_{i,j}$/$K_j$). This boundary equation is known as the construction benefit cost ratio (hurdle ratio) and must be high enough to trigger optimal development of the project instantaneously. At that point, the benefit cost ratio is higher than the value of giving up the option premium (value of waiting to invest). Therefore as shown in Figure 5.2.10, at nodes where the benefit cost ratio is higher than the option value and the premium, the corresponding optimal decision as shown in Figure 6-11 is to exercise the option to develop immediately. At specific nodes where the hurdle ratio (benefit cost ratio) is less than the option value computed at specific nodes as shown in Figure 6-10, the corresponding optimal decision at that node in Figure 6-11 is to hold on to the option embedded in the development until uncertainties are resolved.
Figure 6-10 Real Option Values at Respective Nodes During the Deferral Period

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**Key**

○ = Positive real option value but not optimal, so hold option

□ = Positive real option value and optimal, so exercise option

Source: Author, 2016
Figure 6-11 Possible Decisions at Respective Nodes During the Deferral Period

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Key: **exer** means exercise the option immediately

*Hold* means hold until uncertainties resolve

Source: Author, 2016
Figure 6-10 displays the different nodes and the option values resulting from exercising at that time. The optimal decisions concerning the residential development project at specific nodes have also been shown in Figure 6-11. An example as shown in both Figure 6-10 and 6-11, node (0,1) in month 1 has an option value of $0.46 million which is positive but the optimal decision at that node is of holding onto the development. It can also be observed in Figure 6-10 that some nodes have positive option values, but the decision at the corresponding node is to hold onto the option. Because the hurdle ratio between the cost and value is not high enough justifying commencing development or giving up the value of waiting to invest. Nodes (1,6), (1,7) and (2,5) all have positive option values but the corresponding optimal decision is to wait because the option is not in the money to warrant exercising at that time. These nodes are circled in Figure 6-10 for demonstration and their corresponding optimal decisions are shown in Figure 6-11.

However, starting from month 5 until month 12, it is a blend of optimal decisions of exercising the option immediately to develop the land and holding onto the option to develop land. It can be observed that some nodes including (0,5), (0,7), (0,12) are all indicating optimal times for exercising the option to develop immediately because the option is in the money. The nodes are shown in squares for demonstration. At these nodes, the payoffs are high enough to justify giving up the option of holding. Holding onto such options at these states of the world is not optimal. For example in month 5 which is the first optima decision point to exercise the option, the payoff at that point is $2.58 million which would account for 3.3% profits on the undiscounted costs of the development, hence profitable to initiate development as shown in square in Figure 6-11. The decision therefore is to exercise immediately because the payoff is higher than the option of holding on for the future.

Other nodes similarly have positive values but the corresponding optimal decision is to commence development immediately because the option value and the option premium exceeds the benefit cost ratio, suggesting that the option is deep in the money and must be exercised. Nodes (0,11), (0,12), (1, 12) are all suggesting that the option is deep in the money and must be exercised immediately. It was found out that the option value is highest at the maturity point, supporting the standard option pricing theory that, American options generally should not be exercised earlier than the maturity date.

The developer has the right but not the obligation to wait until the 12-month period is over before commencing the development. Should the developer decide to wait until the 12-month
period is over, in the up state in the binomial tree which is the favourable market condition, the option value is $10.33 million accounting for about 13% of the value on the undiscounted sum of the costs. This value is far above the DCF value which suggested that the project has negative returns and must be rejected. This real option value demonstrates the profitability potential associated with the project and the value of managerial flexibility embedded in the development project. Thus, such active management of the project by deciding to hold on to the project over a specified period until uncertainties are resolved can enhance the financial viability of property development projects which DCF misses in financial evaluation.

In the down state which represents unfavourable market over the 12-month period, the developer has the option of abandoning the project without any commitment and salvage the land value. The real option values mapped to zeros (0.00) in Figure 6-10 shows that the developer under such a circumstance will either hold on for a while or reject the development when the waiting period (12 months) is over. In view of this, developers are not assumed to passively commit funds to a project but rather, are active and would decide on the fate of projects as the market changes. This enhances the risk assessment of property development projects because in a down state, developers have the right not to execute projects that are likely to fail and in the up state, similar rights are available to developers to capitalise on upside opportunities. The real option strategy to defer aids developers in evaluating projects that have future potential and at the same time embeds a strategy capable of mitigating the downside risks associated with property developments.

Given that the results of the real option valuation using the certainty equivalence approach of the binomial option pricing model is positive, the project should be accepted and deferred over a period until when the option value and its premium exceeds the benefit cost ratio. Thus, the real option value of $0.14 million today is not high enough to justify giving up the value of waiting to invest and commencing development today. This flexibility to defer a project and commence later when market conditions are favourable was ignored by the DCF framework. The results from the application of the real option model suggests that such contingent decisions would be made by developers as uncertainty in market conditions resolve and reduce the risk exposure of project developments while retaining the upside benefits or potential for developers. Therefore, the real option model realistically evaluates projects and ensures that the value of managerial flexibility such as the ability to delay a project is captured in financial feasibility evaluation as opposed to DCF. The results coupled with the transparent evolution of the binomial tree demonstrates to the developer the potential associated with the project for a
better decision making unlike the use of discount rates that are determined via individual knowledge of a developer.

Naturally, these decisions would be taken by the developer only if the up and down movements of the value and costs are realised in the real world as modelled. An important observation from the application of the real option model to this case study is that, the developer should not abandon the project based on the results of the DCF model. Rather, developers should explore opportunities for flexibility and evaluate projects based on their actual potential by considering the whole range of figures because that can improve decision making in property development. In addition, it is also dependent on the ability of the developer to delay the project over the said period time.

In most cases, developers engage in pre-sales before commencing residential developments. This obviously limits the ability of developers to delay projects because clients may be impatient and lead to cancellation of pre-sale contracts. However, in situations where developers have the potential to delay projects without legal consequences or cancellation of pre-sale contracts, then the option to delay can be valuable in the financial evaluation of projects. The brown field development adopted in this case study is also important in the sense that, project costs are escalated by cleaning of brownfield lands and demolition before commencing development. This naturally affects the potential profitability of development projects. Therefore, real options modelling deriving positive results for the project demonstrates the potential of the method in capital projects evaluation to a large extent.

Baldi (2013) used the binomial option pricing method to evaluate a green field real estate development project located in Italy. Results from the study indicated that, the real option model valuation derived higher values than the DCF model in two separate phases of construction where the option to delay was considered. Before construction, the deferral option accounted for 26% of total value and 13% after stage 2 when the delay option was evaluated. However, the Baldi (2013) study was on a greenfield development which has no cost of cleaning land before development as compared to the brownfield development.

Recently, Vimpari and Junnila (2014a) used the binomial option pricing model to evaluate the flexibility embedded in the divestment of a residential real estate fund that had come to the end of its lifespan. It was found that the option to delay added about 6.6% to the total value of the apartments should the fund manager have decided to adopt the flexible strategy of selling the apartments. All these studies demonstrate the value of the real option evaluation models to
decision making in the real estate sector especially in the face of uncertainties. The certainty equivalence approach of the binomial option pricing model was adopted in this case study which is able to incorporate the cash payout in the form of rental yield losses during the deferral period as opposed to the model used by Baldi (2013) and Vimpari and Junnila (2014a). This model uses the actual observable returns of real estate investments (rental yields, capital growth, and risk free rate) to calibrate the binomial tree and derive the results. The brownfield site for the development of the project is also new to the literature and adds to the body of knowledge in the sense that previous studies have focused on property developments on green field sites.

6.6 Summary

The aim of applying the certainty equivalence approach of the binomial option pricing to the residential real estate project was to evaluate the applicability of the real option model to a real estate project in a real life environment. The option evaluated is the option to delay/waiting to invest which is generally used to determine the optimal timing of real estate developments and the value embedded in such flexibility. It was argued that the real option models are applicable to real life settings of real estate projects evaluation and that contingent decisions upon changes in market conditions must be factored into project profitability analysis.

Two main methods were used to examine the financial feasibility of the project; DCF technique with measures including IRR, NPV and development margin. This was followed by the use of the CE-BOPM real option model to determine the financial viability of the project after delaying the start of construction for a year. Within the context of this project, the use of NPV and IRR suggested that the project must be rejected due to potential losses. Thus, DCF approach for this project assumed a static position to the extent that the project profitability was fixed despite possibility of changing market dynamics which the developers could capitalise on in future to change the fortunes of the project. The developers could not incorporate flexibility strategies to mitigate losses or capitalise on upside opportunities because DCF is incapable of valuing flexibility. As a result, though DCF can evaluate projects in steady environments, under conditions of uncertainty, it misses the value of flexibility. The use of IRR as a measure of profitability though popular has numerous issues such as inability to account for a proper rate under conditions of cost variability of projects. It also lacks compatibility with NPV decision rules. It was discovered that, the main tool for real estate project financial
evaluation (DCF) is unable to capture the flexible value embedded in the active management of projects such as a deferral strategy until uncertainty is resolved.

ROV on the other hand embedded a natural flexibility to delay the project for one year to observe potential changes in the market. These potential changes, both upside and downside, were captured as part of the ROV modelling. This mimics reality to the extent that property developers would naturally halt all development activities related to a project that is deemed unprofitable during the course of a development and not discard it. For projects that are yet to commence, developers would naturally hold onto the land pending changes in market conditions for execution. This is directly opposite of what DCF technique prescribes as a decision-making approach to unprofitable projects where such projects are outrightly rejected. Furthermore, ROV considered all possible future outcomes of profitability of a project, as shown in this case analysis as opposed to the DCF approach which uses a single line numerical value to determine profitability. The CE-BOPM is an algebraic expression requiring basic understanding of arithmetic and probability, thereby, making it easier to use by practitioners as compared to other ROV models that use complex differential equations. In its approach to financial feasibility evaluation of projects, it visually projects the value evolution of the specific property development project. As a result, practitioners can understand the mechanics behind the model for proper comprehension. It therefore provides a better alternative to existing valuation models for practitioners because it can incorporate other qualitative aspects of projects into property development feasibility evaluation.

The real option model however, provided a rationale for contingent decision making through the valuation of projects by considering a range of values rather than single point estimates. By doing so, the potential associated with projects can be holistically evaluated for better decision making in real estate developments. In this case study, the real option value of $0.14 million was found to be associated with the project, which was missed by the DCF model. Therefore, property developers and analysts should acknowledge the value of waiting to invest in decision making concerning property developments. Should the developer decide to wait until the 12-month period is over before commencing the development, the real option value is $10.33 million representing about 13% profit.

It is unclear as to why developers and property practitioners do not acknowledge the value of flexibility in their project analysis especially when it adds value to the profitability analysis and enhances risk assessment by capturing the upside potential and limiting the downside losses. The certainty equivalence approach actually uses the real observable values of real
estate developments in terms of returns, capital growth and rental yields to project the value evolution of real estate development values and risk neutrally calculates the potential capital gains over the deferral period from the range of possible values. The transparency of the binomial tree coupled with the range of values provided the developer of this case study and analysts of the project with a better understanding of the future possibilities concerning profitability of the project and possible implications on development decisions.

Finally, the choice of whether to start the development in the middle of the deferral period when the real option value and its premium justify the commencement of construction or waiting until the end of the period when the value is highest is dependent on the developer and the implications of the decision. In some cases, unnecessary delays may create a situation where clients who might have purchased some of the units off plan may lose interest leading to cancellation of pre-sale contracts. However, should the developer have the chance to hold onto pre-sale contracts until the end of the 12-month deferral period, the construction should only begin at the end of the waiting period because the value of the option is highest and optimal at that point, which is a characteristic of an American call option that should not be exercised earlier than the maturity date. Naturally, these decisions will be made by the developer depending on their risk profiles and ability to hold on to projects until either the optimal time for development or the maturity of the option is reached.
Chapter 7 Case Study 3-A Switching Output Option Application to a Mixed-Use Development

7.1 Introduction

Due to the emergence of potential future opportunities and risks in volatile property markets, it is pertinent for property stakeholders, especially developers and investors who are at the forefront of property practice to develop strategies capable of dealing with such unforeseen situations in the market. Several strategies have been developed through real options framework to capitalize on future opportunities, while limiting downside losses of potential property developments. These strategies include defer when market conditions are unfavourable, expand when market conditions are favourable, abandon when markets are completely in a down-turn, and switching options to take advantage of opportunities when demand increases for specific property assets. The evaluation of these strategies is based on the uncertainties surrounding a specific development and an investor making a conscious effort to mitigate risks through any of these specific strategies.

Switching Output Option

The third case study in this dissertation is a mixed-use development project. The case study is used to evaluate the value of a switching output option from a ground floor retail to a co-working office space to demonstrate the value of flexibility. The switching flexibility evaluation is quite limited in property literature and this application will determine whether ROV is applicable to property projects or otherwise in that specific context. The application seeks to either justify investments in flexibility or disprove it because determining values attached to flexibility is not straightforward. This case study used the Samuelson-McKean equation to evaluate the switching flexibility and compared with results from the DCF technique to provide justification for flexibility investments.

The switching option embedded in property developments and investments confers the flexibility of altering the input or output of a final product. Decisions of such a nature are generally based on changes in economic/market conditions in the property market. Thus, when economic conditions change unfavourably for one asset, a change from a specific use of the asset to a different use that has high demand can result in better upside gains for an investor/developer. For example, an investor, through the output switching option can change the final product of a development project instigated by the investor from one use to another
or to a mixed-use building. An apartment building can be converted into a hotel, a warehouse into a factory premise for manufacturing, and a retail space into an office space.

Switching options are grouped into two; input switching and output switching. Input switching denotes where an investor chooses to alter the input material of a development to maximise return margin, especially in times when costs of proposed inputs are higher than estimated without compromising on quality. The switching input option within the property and construction sector ensures flexibility to adjust decisions regarding price changes in input prices of construction materials and other equipment. For example, a development project can be constructed with steel, concrete or wood depending on prices of these input products at the time of construction without compromising on the quality and integrity of the structure. Similarly, the outer (shell) part of a structure can be constructed by using bricks, stone, concrete or glass depending on affordability and project objectives to maximise profits.

Similarly, the output switching is also for maximising returns on investments, however, it is a flexibility embedded in a property asset that makes it possible to alter the use of a building to take advantage of favourable markets for a specific use and mitigate against losses in case demand for a specific asset class decreases. Output switching generally deals with the flexibility of altering the final product of property development, for example from an originally planned hotel to serviced units of apartment. Output switching option requires upfront initial investments in flexibility to have the opportunity to capitalise on the output option in future when necessary. Uncertainties surrounding occupancy rates, rent levels and risks of competition require that investors can switch output when a specific asset class is not performing well in the market.

Studies on practical application of ROV methods to switching output in property development in the property literature are limited. One study evaluated the switching output from hotel to apartment in the USA (Throupe et al., 2012). In the current case study however, the switching output valuation is a combination of switching from a retail unit to an office space and an apartment into a studio apartment for students. This is because several mixed-use buildings (apartment with ground floor retail) are under development in the location which can potentially lead to downward pressure on demand resulting in low occupancy rates. The switching output option can serve as a risk management tool for mitigating risks during low demand for a specific real estate asset class.
7.2 Case Study Description

This mixed-use development project is under construction in Melbourne and therefore the proposed switching output can be incorporated into the project from inception should the investor decide to integrate it in the development now or later when market conditions warrant the switching output. The location of the mixed-use development is North Melbourne, Australia, close to the Melbourne CBD (about 1.2kms) and referred to as one of Melbourne’s most walkable neighbourhoods because almost all amenities are within a walking distance.

**Figure 7-1 Site for Mixed-Use Development Project**

There are similar apartment buildings with ground floor retail outlets already in existence in the area making it convenient for residents to shop around the location. As indicated by the red arrow in Figure 7-1, the site is rectangular and supports the development of residential apartments with ground floor retail without difficulties with an approximate land size of 1,045m². This site was on two separate titles as a brownfield site which was acquired by the investors and merged into a single site for the development. The site for the development project is displayed with a bold red arrow.
Figure 7-1 also displays the site close to Hospitals and a walking distance to University precinct, retail shops and other important amenities. The triangular area on the other hand in the middle is where major healthcare facilities are located. The rectangular land area on the right-hand side of Figure 7-1 is the location for a university and other services. All these amenities are important in the decision of households’ choice of housing location. Apart from these amenities, there are several tram and bus stops within the area, Melbourne Zoo and parks for families and other important transport connections. Moreover, several shopping centres such as IGA express, other neighbourhood retail shops, and 7/11 chain of convenience shops are also located quite close to the site in similar buildings. Furthermore, Errol Street which is a major shopping strip filled with several shops and cafes are also about 6 minutes’ walk from the location of the development. The rectangular area close to the bold downward pointed arrow has several buildings like the proposed development with retail units on the ground floor. This poses potentially very stiff competition for the development.

Because of the proximity of the proposed development to the city and all the amenities mentioned, the development had every potential to be financially successful. The total number of apartments was 164 in a mix of 1, 2 and 3-bedroom units primarily targeting young professionals and families that enjoy city living but would want to avoid the noise of downtown city life. There are 2 penthouses for high end luxurious living with excellent views of the city. The 2 penthouses are on the top two levels with private lift, outdoor terrace, swimming pool and high specifications to meet the needs of luxurious living in the city. The units in the apartment had either a balcony or a deck and storage. The development project incorporates a gym, rooftop terrace, landscape garden for relaxation and outdoor dining for occupiers. It is posited that young professionals enjoy downtown city living but young families preferring city living is quite a stretch of an assumption. This makes the financial success of the development project concept uncertain.

The development is 50.2 metres high, spread over 15 levels including the basement and lower ground floors with 100 and 115 bicycle and car parking spaces respectively. The retail space is about 880sqm to serve as an entertainment/eatery/lifestyle space for the occupiers and other residents living in the area. The basement car parking for most of the units was considered beneficial to long term value growth prospects. The luxe interior design of the building incorporates stone bench tops for the kitchen areas, high-end cabinets in all kitchens, steam ovens, washers and dryers, glass splashbacks, timber floors and double-glazing windows for energy efficiency and noise reduction purposes.
There are large bedrooms and living rooms fully furnished with European appliances, gas, air-conditioning, day-light dimming system for energy savings and other energy efficient heating and cooling systems. Consistent with the energy efficiency policies of the Australian government as enshrined in the building codes, the electrical appliances in the building were all energy star appliances and the whole building was designed to meet the requirements of energy efficiency. In summary, the development project had all the needed characteristics to be financially successful as far as the developer/investor is concerned.

### 7.3 Data on the Project and Location

The investor who instigated the project intends to hold onto the building as part of a portfolio of properties after completion due to the anticipated profitability potential of the project. As a result, the investor planned to lease it out to occupiers including young professionals, young families, and students. The investor is a large property fund that primarily invests in residential development, hold the completed developments over the entire life of the fund and dispose of the portfolio after the end of the investment period of the fund.
The concept of young professionals choosing an apartment located away from the city centre is not proven as most young professionals enjoy the city life. Young families on the other hand are not natural occupiers of Australia’s inner-city apartments given amenities such as schools, parks and other facilities are generally not located in the centre of the city. Safety and exposure to adult culture are also likely influencers for parents with younger children in their dwelling selection process. Students typically cannot afford the luxurious living in such an apartment that lacks a student village lifestyle. In view of these reasons, the financial success of this concept of apartment in such a location could be very challenging.

Table 7-1 Data on the Mixed-Use Development Project

<table>
<thead>
<tr>
<th>Units</th>
<th>Quantity</th>
<th>Size in sq.m</th>
<th>Net Rent($AUD)</th>
<th>Total rent p.a($AUD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bedroom</td>
<td>82</td>
<td>52</td>
<td>$360p/w</td>
<td>$1,236,560</td>
</tr>
<tr>
<td>2 bedrooms</td>
<td>80</td>
<td>65</td>
<td>$480p/w</td>
<td>$1,614,080</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>2</td>
<td>95</td>
<td>$670p/w</td>
<td>$56,264</td>
</tr>
<tr>
<td>Retail</td>
<td>4</td>
<td>220</td>
<td>$410/sq.m./p.a</td>
<td>$360,800</td>
</tr>
<tr>
<td>Total</td>
<td>164+4</td>
<td>10,534</td>
<td></td>
<td>$3,267,644</td>
</tr>
</tbody>
</table>

Source: Investor, 2017

In Table 7-1, the total number of apartments was 164 and 4 retail spaces. It is about 10,500 sq.m with an average size of 1, 2 and 3-bedroom apartments being 52 sq.m, 65 sq.m and 95 sq.m respectively. The 4 retail spaces have 220 sq.m each, making a total of 880 sq.m. Net rents for the residential part and the retail sections can also be seen in Table 7-1. According to Core Logic RP Data, the median gross rents in North Melbourne for 1, 2, and 3 bedrooms were determined to be $360 per week (p/w), $480p/w and $670p/w respectively (Savills, 2016). Retail leases are normally on net; therefore, the landlord is not responsible for outgoings. The net rent per annum for the retail part was $410/sq.m (Savills, 2016). As a result, in the DCF modelling, the residential gross rents are subject to outgoings, but the retail rents are not subject to outgoings.

7.4 DCF Modelling

The investor had to evaluate the financial feasibility of the project to determine whether it was viable to proceed or abandon the development entirely. For such projects with a long-term horizon, industry practitioners agree that DCF is the most suitable technique for evaluation. This is despite the numerous criticisms levelled against DCF as an investment evaluation technique. Specifically, when uncertainties are inherent in a specific investment activity, DCF
technique is unable to incorporate the stochastic process of asset price changes into the financial evaluation. It is a static model that does not consider the positive potential of flexible strategies that can capture upside gains and limit downside losses in future due to uncertainties. As a result of the acceptance of DCF among property industry practitioners, the mixed-use development is evaluated using the DCF to derive results and use the NPV rules to decide whether it is worth executing the project or rejecting it initially. Later, the ROV model is used to evaluate a dynamic flexible strategy embedded in the project and compared the results with that of DCF to determine which method produces superior/better output.

DCF evaluation technique is given by Equation 7-1 as,

\[
NPV = -I + \sum_{n=1}^{10} \frac{NOI_1}{(1 + r)^n} + \frac{NOI_2}{(1 + r)^n} + \cdots + \frac{NOI_t}{(1 + r)^n}
\]

Equation 7 - 1

Where

\( I \) = the initial investment into the development of the mixed use

\( n \) = the respective year in which a revenue is received until year 10 (standard practice)

\( t \) = time a specific net operating income from rents is projected to be received by the investor

\( r \) = the required discount rate expected by the investor

\( NOI \) = the net operating income expected from the development at a specific time

The investor however forecasts to have occupancy levels of the residential apartment to be about 97% based on occupancy rates achieved by similar developers in the Melbourne area. The optimism stems from the fact that similar apartment developments in the location in the recent past have generally been successful. However, these apartments pose competition to the current development which can negatively impact on its financial success. Besides, the localised nature of property demand makes it imperative to use data related to the location rather than aggregated data. As a result of the competition and the localised nature of demand in the property sector, the North Melbourne average of 5% vacancy (JLL, 2016b) is adopted for the residential part. The retail part has a different vacancy level which was determined to be 6.2% (Colliers, 2016). Therefore, a weighted average vacancy rate was calculated based on square meters (size) of each type of space to arrive at a total vacancy rate of 5.3% for the entire building and used in the DCF modelling.

Rental growth levels are based on long term inflation target of the Australian government as set by the Reserve Bank of Australia. The long term target of inflation is between 2%-3%
(RBA, 2016b) which is set to encourage stability in the economic system of the country. A mid-point of 2.5% was adopted for the rental growth in forecasting potential future rents because it falls within the projected long term inflationary target of the RBA which is used as a benchmark for CPI. This is in conformity with industry practice where rents are increased to reflect anticipated changes in economic conditions and market performance of property assets over a period.

The required rate of return (discount rate) sought by the investor was determined to be 10.5% and this is similar to returns received on residential property investments in Melbourne. The rate was derived from an average of 10-year data on total return for property investments (units) in the North Melbourne area where the property is located. As a result, the 10.5% was used as the discount rate for evaluating the financial feasibility of the entire development and as compensation to the investor for the potential risks associated with the investment. The rate of return is that of the market level and was adopted for the evaluation using the DCF to derive the NPV for decision making.

The NOI was determined to be income from the investment net of all expenses including vacancy and collection losses, operating expenses, maintenance, capital adjustments and leasing costs. The NOI for year 1 for the financial feasibility analysis was determined to be $3,078,723 and was indexed to the rental growth rate of 2.5% per annum. Afterwards, the present values of the NOI’s from years 1-10 were calculated, and the initial investment subtracted from the total of the present values to determine the NPV and IRR for decision making regarding the execution or initial rejection of the mixed-use project.

The ownership and holding of such a development comes with costs that cannot be passed on to tenants. Generally, landlords are responsible for outgoings such as body corporate fees, council rates, insurance, letting fees, advertising and property management fees. Since data on outgoings and maintenance are generally confidential and so unavailable, the researcher resorted to local real estate agents and other experts who have information on these outgoings because they regularly act on behalf of landlords and have very good knowledge of potential costs. Discussions with, and information from several local real estate agents resulted in the collation of data on both outgoings and maintenance on similar apartment units on sale in the neighbourhood where the project is located. The data obtained from the local agents was used to calculate the potential outgoings and maintenance rate which were approximately 10% and 5% of gross rent respectively. These rates were assumed to be the prevailing industry rate and
adopted as the potential outgoings and maintenance rates for the evaluation of the project. The rates do not include electricity, water, and gas costs.

Generally, capital adjustments, renovation and updating are needed at specified intervals to ensure that the property is kept in a tenantable state to also keep the value of the investment. Capital adjustments was assumed to occur at 5-year intervals based on industry knowledge from the investors and was at a rate of 5% of potential gross income for that specific year in which capital adjustments is scheduled to occur. Because this is a new property, it is assumed that capital adjustments may occur at 5-year intervals, which are in the 5th year of the investment and before selling the units in the apartment building after the investment horizon in year 10.

The total initial investment is determined to include all costs that must be incurred to acquire the development after completion. The total initial investment required for the mixed-use project was $46,047,500 as was partly supplied by the investor and partly computed using the Rawlinson’s construction guide. This amount is assumed to be fully funded via equity sources and hence, no finance costs in terms of interest payments were assumed. A cost/sq.m of $3,235 and $1,550 were used for the residential and retail parts respectively as sourced from the Rawlinson’s construction guide. The construction cost/sq.m was multiplied by the total size of the respective spaces (residential and retail) to arrive at the total cost for the construction of two different parts of the mixed-use building. The other costs (land costs, professional fees etc.) supplied by the investors were added to the total construction costs to arrive at the initial investment. This was determined as the total amount needed to acquire the right to own the building and take the stream of cash flows from leasing the building. This cost is used as the initial investment for the calculation of the NPV for decision making at the initial stages of the development.

The resale value of the apartment building after year 10 was determined via the use of direct capitalization where a net maintainable net operating income of $3,890,304 (year 11) was divided by a weighted average capitalisation rate of 5% to arrive at $77,806,084. In disposing of the building, the investor will incur selling costs which needs to be accounted for in the profitability analysis. Information from the investor indicates that about 5% of the total resale value is normally the cost incurred on both marketing and payment of commission to real estate agents. In view of this, a selling cost of 5% was calculated based on the resale value after year 10 and deducted from the resale value to arrive at the net proceeds after resale of $73,915,780. The present values of all the net cash flows for respective years from year 1-10 were calculated.
This resulted in a total present value of $47,236,941 which is the total potential value for the project to the investors. The initial investment was deducted from the total present value to arrive at the NPV for the project, which represents the profitability for the investment.

7.4.1 Results from DCF

Two main measures of profitability are adopted when DCF technique is the choice of financial evaluation for property investments. These two measures are the net present value (NPV) and the internal rate of return (IRR). Firstly, the NPV for the project was calculated to be $1,189,441 as shown in table 7-2. Based on the NPV decision rules, the project should be accepted immediately because the financial analysis indicates that the investors will make profit. Similarly, the potential initial yield for this project was calculated to be 6.9% as depicted in Table 7-2. This level of initial yield is in the range of a 10-year average rental yield for the North Melbourne area where the project is located, suggesting that the project is financially feasible. The initial yield is used by investors to determine whether an investment project can return desired outcomes at the initial stages of the investment to cover annual expenses.

Table 7-2 Profitability Measures for the Mixed-Use Development Project

<table>
<thead>
<tr>
<th>Profitability Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Present Value</td>
<td>$1,189,441</td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>11.5%</td>
</tr>
<tr>
<td>Initial Yield</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

Source: Author, 2017

Lastly, IRR is another measure of profitability for investment projects, hence was used to determine the financial feasibility of the mixed-use project. The rule states that if IRR for a project is greater than the minimum required rate of return by an investor, a project should be accepted. The IRR calculated for this project is 11.5% which is 1% higher than the 10.5% minimum required return sought by the investors for the project as shown in Table 7-2. As a result, it can be concluded that this project has the potential to be profitable and should be accepted because all profitability measures are indicating that the project has a chance to be financially successful. However, changes in the input variables in the DCF model can have a negative impact on the profitability and therefore, the results must be interpreted with caution as the variables are highly susceptible to variations from the exogenous economic environment. Through sensitivity analysis, highly variable inputs with negative impacts can be examined.
7.4.2 Sensitivity Analysis

The DCF modelling for this case study proved that the decision to execute a property investment project by the investor is principally based on single point forecasts for all the major inputs. These assumptions are inaccurate and rely on the expectations of project analysts about future economic forecasts regarding profitability and financial success of projects. Besides, they are only forecasts of potential performance of the residential property market which has an impact on the development project by extension, hence any prognosis must be executed with caution as predictions can deviate from reality leading to serious financial consequences.

Due to uncertainties surrounding DCF input variables, it is important to examine the impact of their changes on the financial success of the mixed-use development project. Through sensitivity analysis of the uncertain inputs, the impact of their changes can be determined via the use of industry approved software such as TopRank of the Palisade Decision Suite. This will enable the determination of most uncertain inputs with greater impacts that should be the focus for the financial modelling. Therefore, all the inputs including rents, occupancy rate, discount rate, capitalisation rate, rental growth rate, outgoings rate, maintenance costs, and initial investment are all examined through the sensitivity analysis.

Figure 7-3 Sensitivity Analysis of Uncertain Variables
In the sensitivity analysis output diagram in Figure 7-3, the length of a specific bar indicates the sensitivity of the variable in the DCF model and the impact changes in the variable have on the NPV (profitability). As shown in Figure 7-3, the occupancy rate is the most uncertain variable and with the greatest impact. This is followed by the potential annual rent receivable by the investors from the project. Another sensitive variable is the initial investment needed for the project or in this case, the initial amount needed to acquire the project upon completion. Even though after payment of the initial investment by the investor any change in this variable won’t be impactful, it is important to discuss it because of its enormous impact should the investor incur higher cost than projected.

The last two sensitive variables are the discount and the capitalisation rates. Since the accepted/required discount rate for investment is generally determined by investors, it can either be increased or decreased by this specific investor depending on perceived level of risk associated with the investment project. The capitalisation rate however is an exogenous variable that is determined through the interaction of the forces of demand and supply in the property market. As a result, changes in this rate can have substantial financial ramifications for the investment.

Table 7-3 What-If-Analysis Summary for NPV (Minimum Scenario)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input Name</th>
<th>Input Value</th>
<th>Output Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Occupancy rates</td>
<td>85.2%</td>
<td>$-4,651,302</td>
</tr>
<tr>
<td>2</td>
<td>Rent p.a</td>
<td>$3,566,088</td>
<td>$-3,534,253</td>
</tr>
<tr>
<td>3</td>
<td>Initial investment</td>
<td>$50,652,250</td>
<td>$-3,415,309</td>
</tr>
<tr>
<td>4</td>
<td>Discount rate</td>
<td>11.6%</td>
<td>$-2,157,401</td>
</tr>
<tr>
<td>5</td>
<td>Cap rate</td>
<td>5.5%</td>
<td>$-107,425</td>
</tr>
</tbody>
</table>

Source: Author, 2017

Table 7-3 displays the impact of potential changes in the input variables on the profitability of the investment in a minimum case scenario. In order of ranking, the occupancy rate comes first due to its impact on profitability in case of changes. For example, a 10% downward change in occupancy rate from 94.7% to 85.2% has a potential impact of resulting in a negative NPV of $-4,651,302 rendering the investment financially unviable. This is similar to all the other variables because a 10% downward change in rent, initial investment, discount rate and capitalisation rate has a potential impact of resulting in negative NPVs of $-3,534,253, $-3,415,309, $-2,157,401 and $-107,425 respectively. Therefore, the investors should be cautious in their extreme optimism regarding the potential profitability of the investment.
Table 7-4 What-If-Analysis Summary for NPV (Maximum Scenario)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Input Name</th>
<th>Input Value</th>
<th>Output Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Occupancy rate</td>
<td>100%</td>
<td>$4,458,284</td>
</tr>
<tr>
<td>2</td>
<td>Rent p.a</td>
<td>$4,358,552</td>
<td>$5,913,135</td>
</tr>
<tr>
<td>3</td>
<td>Initial investment</td>
<td>$41,442,750</td>
<td>$5,794,191</td>
</tr>
<tr>
<td>4</td>
<td>Discount rate</td>
<td>9.5%</td>
<td>$4,872,716</td>
</tr>
<tr>
<td>5</td>
<td>Cap rate</td>
<td>4.5%</td>
<td>$4,215,462</td>
</tr>
</tbody>
</table>

Source: Author, 2017

In favourable property market conditions, changes in the sensitive variables are likely to increase the potential profitability of the investment. An increase in the value of all the sensitive variables from the base values has the potential of resulting in profitability. For example, if the occupancy rate increases to 100%, there is the likelihood of the investment returning an NPV of $4,458,284. Likewise, a 10% increase in rent, initial investment, discount rate, and capitalization rate all have the likelihood of producing an NPV of $5,913,135, $5,794,191, $4,872,716 and $4,215,462 respectively and these are all shown in Table 7-4.

This suggests that uncertainties associated with capital investment projects do not only mean that investors should be concerned with the downside effects of uncertainties but, such risks and uncertainties also open upside opportunities that can be captured with some embedded strategic flexibilities. Therefore, investors of this project should consider the potential future changes in property market conditions that can have positive impacts on the project and how such opportunities can be captured rather than being fixated only on the downside effects of uncertainties.

7.5 Issues with the Project

A project of such magnitude is certainly not devoid of risks and uncertainties just like any property development activity. As a result, it is pertinent to review the development project and discuss issues that may impact negatively on the project, based on which a strategy can be developed to mitigate losses. In Figure 7-1, the competition in the area for the development posed by similar projects was highlighted to put into perspective, the potential risks and uncertainties the development is exposed to in terms of expected demand, which can affect estimates for the investment. For example, the ground floor retail with apartments on top floors have similar developments spread all over the area with similar targets (investors and owner occupiers) and it is estimated that there are about 700 apartments under construction in the area.
which are scheduled to complete around the same time as the subject development in 2018 (Urban Melbourne, 2015).

The competition in the area is likely to put a downward pressure on demand, occupancy rates and rents which can negatively affect the profitability of the investment as projected. In this regard, any deviation of actual rent levels from estimated values could render the development financially not feasible. For example, Mr. Robert Mellor, managing director, BIS Oxford Economics in responding to questions from ABC news suggested that there is subdued market and the recent housing boom was over (www.abc.net.au). This implies that the possibility of a downside change in the residential market was very high due to decline in house prices during the middle of year 2017 through to year 2018. Therefore, it was important for the residential developer to embed a strategy into the project to deal with such eventualities.

These issues concerning the investment are also supported by statistics from JLL, a leading global property company that tracks the performance of several property assets in different property markets globally, including Melbourne. The statistics indicate that the vacancy rate in the inner Melbourne area within a 4km radius including the North Melbourne area increased within the first quarter of 2016 when the development project was under marketing to 4.3% for apartments and it is the highest vacancy across the eastern seaboard in Australia (JLL, 2016b). The report further suggests that year on year sales volumes have declined by 8.2% across inner Melbourne and coupled with an estimated supply of about 21,170 (under construction) apartments excluding those under marketing and approved plans which are scheduled to be completed in 2021, there is a greater possibility of oversupply of units of apartments in future.

The uncertainty and sentiment in the market regarding supply and demand had led to a significant decline in development sites within the inner Melbourne area (JLL, 2016b). In view of this, it is important for the investor who has a long-term interest in the project to develop a flexible strategy to prepare for future uncertainties in the market. Flexibility in the design of the building can enhance the building adaptability to a different use when demand for a specific use decreases in favour of another use. For example, in this project, due to the uncertainty surrounding the apartments, the investor can incorporate a strategy to convert the apartment section into student studio units to take advantage of the ever-rising student population in Melbourne. Similarly, the retail space can be converted into coworking space for use by different firms.
7.6 Real Option Modelling

Real options as flexible rights but not obligations, confers flexibility on developers/investors to dynamically manage projects to mitigate losses and capitalise on future potential associated with changes in prices of specific property assets. Regarding this project, it is proposed that the investor incorporates a switching output option that can serve as a strategy against fluctuating values of residential property and the risks identified such as competition, downward pressure on rents, low demand and optimistic occupancy rate. The incorporation of such a dynamic strategy of switching output flexibility when demand for the units in the apartment building decreases can serve as a strategy against potential losses. The developers would have an opportunity to switch the use of the development from residential units to studio for students and other private occupiers and use both car park and the ground floor retail space as a creative office for young professionals who are demanding flexibility in their working life style. This can mitigate against future risks facing the project due to competition, market risks and unrealistically optimistic rents.

7.6.1 Switching Proposal

It is proposed that the mixed-use development is switched from one use to another but remain as a mixed-use building. The units in the apartment building could be switched to Student Studio Accommodation (SSA) and both car park and the retail area could be converted to an office (coworking space) for different firms because the retail part can be partitioned into 4 different spaces or be combined into a single shared coworking space. In Table 7-5, it is proposed that the 1-bedroom units of space of size 50 sqm could be embedded with the flexibility of being able to redesign and reconfigure to become a 2-bedroom studio unit for students with each having a size of 25 sqm (bedroom = 9, bathroom = 5.5, living area 10 sqm). The average size of SSA unit in Melbourne is about 25 sqm and similar SSAs have been developed by the University of Melbourne and other private firms with similar sizes that have proven to be very successful with demand exceeding supply. Similarly, the 2-bedroom units can also be converted into 3-bedroom SSA with 2 bathrooms and an open plan living area with a kitchen at a total size of 65sqm should the flexibility be embedded in the design of the development from inception stage. The 3-bedroom units on the top floor can also be converted into 5 units of SSA rooms based on their sizes which are about 90sqm. In Table 7-6, it is proposed that both the retail and car park areas should be converted into offices such as
coworking spaces with an opportunity for creative spaces that have gained popularity within the Melbourne property sub market due to the high demand for such flexible spaces.

In Table 7-7, the switching output and the details of the resulting number of spaces after the switching and the rents are displayed. The number of spaces has increased from 164 to 414 for the SSAs. This is due to the conversion of the spaces and reduction in the per square metre foot-print per space, hence increasing the quantity of units. The retail space is to be converted into an office that can be combined/separately let to tenants. The potential gross rent from the SSAs and commercial part (offices) is estimated to be $6,673,680 and $415,360 respectively. Therefore, the total potential gross rent estimated is $7,089,040 which is the sum of rents from both SSAs and the commercial part of the apartment building. The office rent was computed using the RLB as a guide to be the average rent for suburban offices in Melbourne.

Switching of the retail and car park space to office spaces would require extra investment into flexibility because the area must be fitted out to meet the general standards of offices in the Melbourne market. The general fitting out of the space to resemble a modern office space would require investment but fit-out for purpose of the tenants is not considered in the extra investment required to switch because of differences in tastes and preferences of different companies. Similarly, the residential part of the development would require the construction of new non-load bearing partitioning walls to turn them into SSAs. The SSAs would also require the provision of facilities such as furnishing the apartment with TV set, study desk, chair, dining table and chair and other kitchen items such as knives, set of cutlery, kettle, and other items necessary for satisfying the requirements of SSA within the Melbourne student housing property sub-market. Therefore, switching output option would require the initial investment and extra amount for the conversion of the units into SSAs.
Table 7-5 Switching Output Table for Residential Part of the Mixed-Use Project

<table>
<thead>
<tr>
<th>Residential Apartment</th>
<th>Student Studio Accommodation (SSA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Units</td>
<td>Current size</td>
</tr>
<tr>
<td>1 bedroom</td>
<td>25sq.m</td>
</tr>
<tr>
<td>2 bedrooms</td>
<td>65sq.m</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>90sq.m</td>
</tr>
</tbody>
</table>

Source: Author, 2017 (Adapted from data provided by Investor and other third-party websites)

Table 7-6 Switching Output Table for Commercial Part of the Mixed-Use Building

<table>
<thead>
<tr>
<th>Commercial Part (Coworking spaces/consultancy/ and car parking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space type</td>
</tr>
<tr>
<td>Retail</td>
</tr>
<tr>
<td>Car park</td>
</tr>
</tbody>
</table>

Source: Author, 2017(Adapted from data provided by Investor and other third-party websites)
# Table 7-7 Switching Output Table and Projected Rents for Different Spaces

<table>
<thead>
<tr>
<th>Units</th>
<th>Total</th>
<th>Switch output</th>
<th>After switch</th>
<th>Total after switch</th>
<th>Gross rent p/w</th>
<th>Total/gross p.a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bedroom</td>
<td>82</td>
<td>Studios (2 rooms)</td>
<td>2</td>
<td>164</td>
<td>$310</td>
<td>$2,643,680</td>
</tr>
<tr>
<td>2 bedrooms</td>
<td>80</td>
<td>Studios (3 rooms)</td>
<td>3</td>
<td>240</td>
<td>$310</td>
<td>$3,868,800</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>2</td>
<td>Studios (5 rooms)</td>
<td>5</td>
<td>10</td>
<td>$310</td>
<td>$161,200</td>
</tr>
<tr>
<td>Total</td>
<td>164</td>
<td></td>
<td>414</td>
<td></td>
<td>$930</td>
<td>$6,673,680</td>
</tr>
</tbody>
</table>

## Commercial Part (Coworking spaces/consultancy/ and car parking)

<table>
<thead>
<tr>
<th>Space type</th>
<th>Quantity/size</th>
<th>Switch output</th>
<th>Quantity</th>
<th>Size/quantity</th>
<th>Rent</th>
<th>Total gross rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>880sqm</td>
<td>Offices (combined)</td>
<td>1</td>
<td>880sq.m</td>
<td>$236/sq.m/p.a</td>
<td>$207,680</td>
</tr>
<tr>
<td>Car park</td>
<td>115 spaces</td>
<td>Offices (combined)</td>
<td>1</td>
<td>880sq.m</td>
<td>$236/sq.m/p.a</td>
<td>$207,680</td>
</tr>
<tr>
<td>Total p.a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$415,360</td>
</tr>
<tr>
<td>Total for whole building</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$7,089,040</td>
</tr>
</tbody>
</table>

Source: Author, 2017 (Adapted from data provided by Investor and other third-party websites)
7.6.2 Justification for the Proposal

Over the last decade, Australia has become an attractive destination for international students due the offering of high quality education. Besides, Australia is ranked very high among Western countries in terms of quality education and a popular destination to study sitting currently in fifth place behind countries such as USA, UK, Germany and France (Department of Education and Training, 2015). The popularity of Australia as a destination for international students in higher education institutions has resulted in an increasing number of new international students causing increasing demand for SSAs. For example, there was 9.7% growth in population of international students in higher education during the 2015/2016 academic year and Victoria had the highest proportion of international students coming into Australia during the year 2016 (JLL, 2016a). Most cities in Australia are also adjudged internationally as world class cities offering safer communities to live and work. For example, Melbourne has been adjudged as the most liveable city in the world for 6 consecutive times including 2016 (ABC, 2016a).

According to JLL, the SSA market has changed from a high level of strata title ownership into a full institutional asset class as part of a portfolio of some institutional investors and there is the willingness to increase allocation to SSA in portfolios (JLL, 2015). Despite these efforts to improve supply to reduce the acute shortage of SSA in Australia, particularly Melbourne, there is still a shortage. In Melbourne, JLL estimates that the full time student population is 234,844 but the number of student beds available is about 19,188 (JLL, 2016a). Therefore, there is substantial gap between supply and demand that can be capitalised upon during market downturn in the residential property market. Consequently, there is about 90% of the market that needs to be served by market players, hence the proposal is likely to succeed. To do this, the investor must acquire the flexibility to convert the residential units into SSAs via planning permission and flexible internal layout arrangements to be able to easily adapt the use of the building when the need arises in future at the design stage of the project.

The suggestion that the retail space be transformed into a co-working space is also premised on the growth seen in the number of co-working spaces springing up in Melbourne in recent times. Due to advancement in technology and structural changes in population and the economy, the way corporate offices are used is changing. For example, traditional offices such as the cellular and hive office models are being replaced by more agile flexible workspaces that are interactive, technology enabled and encourage collaboration among the space users.
(Knight Frank, 2016). It is estimated that there are about 100 operators of coworking spaces as at Q2 of 2016 in Melbourne alone since the first flexible coworking space was opened in 2007 and has recorded a 43% growth between 2013-2015 (Knight Frank, 2016). On the outlook for the coworking spaces, a key finding from a survey conducted by Knight Frank suggests that 61% of the operators plan to expand their operations in 2016. This is in anticipation for future growth of the sector and therefore, embedding a switching output strategy in the investment has the potential to benefit the investors and serve as a strategy against risk of potential downside changes in the property market. Thus, when growth in the coworking sector is manifested, the investors has the embedded right to capitalise on the opportunity.

In order to have the flexible right that is embedded in the investment project as suggested, the investor has to spend extra amount of money for that kind of flexibility. Justifying extra investments in flexibility is usually difficult because the value of the embedded flexibility is contingent upon positive changes in the property market. Again, this cannot be justified through the DCF framework because it is incapable of incorporating the stochastic processes that characterise asset value evolution that changes the expected value of an asset. Thus, it is incapable of valuing flexible decision rights that have value in property projects and investments.

7.7 DCF Evaluation of the Switching Option

The switching proposal was evaluated using DCF technique to determine whether the conversion was financially feasible, or the investor should maintain the original design. Several assumptions were put into the DCF evaluation of the switching option of the mixed-use project. This includes a vacancy rate of 15% for studios and 10.4% for offices (coworking spaces) as obtained from JLL industry researchers and the Property Council of Australia (IPD) respectively. The 10.4% vacancy rate is for offices in general but because the coworking spaces fall into the office category, it was assumed that it is affected by conditions in the general office market.

Furthermore, it was estimated that the operating expenses for the whole structure is about $3,500 per student bed (unit) and includes cleaning and maintenance of the other parts of the building as given by JLL researchers who provide updates on the student accommodation sub-market in Australia. The cleaning and utilities for the office space however is assumed to be the responsibility of the coworking space tenants in conformity with industry practices. Based on information received from JLL, management fees, sinking fund for capital adjustments, and
agent’s fees for selling the development after the investment horizon is 6%, 4%, and 4% respectively and were used in the DCF evaluation.

As indicated in Table 7-7, the potential gross income (PGI) from the switching output is $7,089,040. The PGI was indexed to the CPI of 2.5% per annum to cater for uncertainties in the rent levels. After accounting for the vacancies in both spaces (coworking and studios) and all the expenses indicated, the switching output of the mixed-use building has a NOI of $3,990,564 in the first year. The NOI in the final year of the investment and a weighted average capitalisation rate of 5.6% were used to compute the resale value. Afterwards, selling costs of 5% of resale value was deducted and present values of all the net cash flows for respective years calculated. The computation resulted in a total present value (including the resale value) of $56,123,026 which represents the total value of the switching output from the original plan to the proposed plan based on static DCF model.

A discount rate of 12.5% was adopted for the computation of the present value of the NOIs and the resale value. The discount rate is the weighted average of a 4-year data on returns on investment in SSAs and a 22-year data on discount rates on office investments. The weightings were calculated based on the rent contribution from the different spaces in the mixed-use building. The 4-year data is because SSA investments were rare until recently, and in Australia, it is JLL that began publishing information on it quite recently.

The extra investment needed for the structural changes in the building to allow for the switching output was given by the investor as about $7,600,000 for the partition walls, new bathrooms, painting etc. and facilities such as kettles, TV’s, kitchen wares, bed frames, mattresses, desks, and chairs. This implies that the total cost to be incurred after switching is $53,654,547. This amount is deducted from the total value (total present value) of the undeveloped mixed-use building to determine the NPV.

Therefore, the NPV for the switching output is $2,468,479. Since the NPV is positive, the implication is that the project should be accepted and executed. Furthermore, the switching output has an IRR of 12.95% which falls within the limit of the required rate of return for the investment and based on the rules of IRR as a measure of profitability, the investor should accept the project and switch the output. However, the difference between the discount rate and the IRR is only 0.45%, indicating that a 1% increase in the discount rate can render the project financially unviable. On the other hand, the discount rate exceeds the conservative average of around 10% for most mixed-use developments within the Melbourne residential
property market. In view of this, it can be safely argued that if a similar rate of 10% was adopted for the original plan as in the switching output case, the potential profitability may be higher than the original plan. As a result, the switching is still better than the original plan.

7.8 Methodology for Real Options Modelling

Even though the DCF framework demonstrates that the switching output is better than the original plan, the switching flexibility is used as a strategy against risks if the original plan is financially unsuccessful due to changes in the economic environment. Such variability can only be evaluated using a stochastic process which captures the potential changes and its associated impact. The switching is contingent upon the occurrence of a specific situation in the property market which negatively affects the original mixed-use plan and positively impacts on the financial feasibility of the proposed switching to student housing with coworking space on the ground floor. Having the strategy of potentially switching the output confers a perpetual American call option on the investor to execute the flexibility and receive the potential incomes from the switching.

One of the closed loop solutions that has received a great deal of attention in property literature for the evaluation of perpetual call option is the Samuelson-McKean Formula (Samuelson, 1965). Paul Samuelson and Henry McKean in 1965 originally developed this formula for the pricing of perpetual American warrants. This was adapted to suit the development of vacant land because the ownership of an undeveloped vacant land confers a perpetual call option to develop on the owner. Thus, treating the legal right to the undeveloped vacant land as a perpetual American call option without maturity/expiration; the owner can develop the land at any time in the future.

This formula has been suggested by leading researchers such as Geltner et al. (2007) to be suitable for valuing property and land development flexibilities, and it is similar to that of McDonald and Siegel (1986) which was used for the valuation of option of waiting to invest. The model is based on similar assumptions as the Black-Scholes model for valuing options. However, this model extends the assumptions to cater for the exercise of the option at any time during the life of the option (American option) and cash payouts for the underlying investment (building). This is important in property decision making because this assumption makes it possible to adopt the model for the valuation of options on real estate assets as there is rental payout for property investments which may be lost by a developer during the waiting period.
The Samuelson-McKean equation is given by:

\[ C = (V^* - I) \left( \frac{V}{V^*} \right)^\beta \]  

Equation 7 – 2

Where

\( C \) = The value of the call option

\( V \) = the current value of the investment

\( I \) = the initial cost required for the investment in addition to the cost of switching from its current use to the proposed use

\( \beta \) = the option elasticity

\( V^* \) = the hurdle value of \( V \) and it is the optimal timing for the immediate exercise of the option to invest at that time and is given by

\[ V^* = I \times \frac{\beta}{\beta - 1} \]  

Equation 7 – 3

and the option elasticity \( \beta \), is given by

\[ \beta = \frac{1}{2} - \frac{r - y}{\sigma^2} \sqrt{\left( \frac{r - y}{\sigma^2} - \frac{1}{2} \right)^2 + \frac{2r}{\sigma^2}} \]  

Equation 7 – 4

Where

\( r \) = the risk-free interest rate

\( y \) = annual net rental income cash yield for the switched mixed-use building

\( \sigma^2 \) = expected annual volatility of underlying mixed-use property

This call option model of land development is used to determine the optimal time for a developer or decision maker to execute a specific development project taking into consideration all possible outcomes in future. This model supported the evaluation of several flexibilities in development which are American-like options because land ownership for example confers an indefinite right on the owner to choose when to develop.

7.8.1 Data for Real Options Modelling

Annual net rental income cash yield \( (y) \) for the specific property asset, in this case for the switching option. Because the switching incorporates two different property asset classes, the
current cash yield is computed based on a weighted average of rental yield from the two asset classes. The weights of the two asset classes in the computation of the rental yield are based on the revenue potential from the specific asset class within the mix. The revenue from the SSAs and the coworking space was calculated and used to derive the weighting for each of the two asset classes. A 22-year average rental return for investments in offices sourced from IPD (Property Council Australia) and a 4-year average rental return for investments in SSAs sourced from JLL was calculated. The weights of the two different asset classes (SSAs and offices) based on their revenue potential and their respective average rental returns was used to calculate a weighted return for the project. Therefore, the annual rental return of the project is given by

\[ WR = W_1R_1 + W_2R_2 \]

Where

\( WR \) = the weighted rental return/income for the development

\( W_i \) = the weight of space i within the building based on revenue potential

\( R_i \) = average rental return for the space i within the building

Using equation 7.5, the weights of the two asset classes in the project and their average rental returns based on data sourced from JLL and IPD/PCA, the weighted average rental return for the mixed-use project was calculated to be 7.3% and was used in the computation of the value of the flexibility to switch the building as and when the market is favourable for switching.

### 7.8.2 Investment Required for Switching Option (Cost)

Since the output switching flexibility requires that the investors spend an extra amount to serve as the exercise price for embedding the switching output flexibility, there is the need to calculate the total amount required for the investment for switching. This will be the original investment required and the extra investment needed to switch the building from the original mixed use of apartments and retail to office space and SSA units for students and other potential tenants.

This is given by

\[ I_2 = I + E_x \]

*Equation 7 – 6*
Where

$I_2$ = Initial investment for the mixed use after switching

$I$ = Initial investment before switching

$E_x$ = Extra investment needed for the switching

In this dissertation, the new cost after the switching was calculated based on discussions and revisions of the plans with the investor (developer) to fit the switching option proposed for the development. After revising the plans to fit the purposes and the necessary changes, the extra investment needed for the switching was $46,047,500 + $7,600,000 = $53,654,547.

### 7.8.3 Current Value

The current value of the building project is also important in the computation of the real option value based on which the switching option can be evaluated financially. Generally, the current value of the development project is calculated as the market value at the time of initiating the development. In this dissertation, the author assumes the market asset disclaimer (MAD) assumption which stipulates that the current prices of assets are observable in the market and can be determined. Using the direct capitalisation method which is

$$V = \frac{NOI}{i}$$  \hspace{1cm} Equation 7 - 7

Where

$V$ = Current value of the mixed-use development

$NOI$ = Net operating income for the first year

$i$ = Capitalisation rate for the investment (weighted cap rate)

Based on the switching option proposal, and with same assumptions and inputs from the DCF, the current value of the mixed-use development is estimated to be $65,379,068. This is via the use of the direct capitalisation method where a net maintainable rent of $3,989,069 is divided by the weighted capitalisation rate of 6.24%. Afterwards, capital adjustments and other incentives, selling costs and essential upgrades were deducted from the amount to realise a value of $58,918,322. This value serves as the initial value for the real option valuation of the switching application.
7.8.4 Volatility

Volatility in the model is to ensure that the risks and uncertainties associated with property investment is included in the computation of real option values. In property investments, volatility is used to measure uncertainty surrounding an expected return from an asset and determine their potential impacts on investments. The volatility also has major impact on real option values and it is important to explain and demonstrate how the volatility for the modelling of the value evolution was determined. Volatility is measured using standard deviation computed from historical returns of property investments (returns of specific real estate asset classes and in this case residential property returns and office returns due to the switching).

There are several methods that are used in computing volatility for property investments. Firstly, volatility can be estimated from historical data of property returns. Another method assigns weight to the historical data in different ways depending on the timing of occurrence of specific observations within the historical data. For example, more weight is assigned to newer observations in data whereas older observations in data are given less weight to account for the non-constant nature of volatility in some methods and these methods are termed as both ARCH and GARCH. Lastly, there is implied volatility method that is used to compute volatility on the basis of the assumption that observed prices of financial securities traded in the market (markets which are sensitive to property prices’ volatilities) are assumed to be proxies for the volatility (Guthrie, 2013). For example, the volatility of certain property investment trusts (REITs) can be used as implied volatility for real estate assets due to the impact of changes in values of REITs on such assets. Therefore, given a proven model such as the Black-Scholes (B-S), the implied volatility is computed as the level of volatility which sets the price predicted by the B-S equal to the observed price incorporating market expectations.

In this dissertation, the volatility of the mixed-use development is calculated using the historical returns of property investments of the mixed-use development. This is achieved by calculating volatility for each of the two separate spaces in the mixed-use development (residential and offices) and a weighting is assigned to each of the two volatilities for the computation of the actual volatility for the entire mixed-use development. The volatility of a specific use (space type) is given by

\[
\sigma_1 = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \mu)^2}
\]

\textit{Equation 7 – 8}
Where

\( \sigma_1 = \) the standard deviation of the specific use or space

\( N = \) the number of observations in the data

\( x_i = \) an observation in the data sample

\( \mu = \) the mean for the sample data

The volatility for the studio part was calculated to be 6.9% using data from JLL and that of the office was 3.5% based on data from IPD/PCA. The actual volatility of the mixed-use project however, was based on a weighted volatility. Therefore, actual volatility for this case study is given by

\[
V = W_1 \sigma_1 + W_2 \sigma_2
\]

*Equation 7 – 9*

Where

\( V = \) the overall volatility for the mixed-use project

\( W_1 = \) the weight of the studio part of the mixed-use development

\( \sigma_1 = \) volatility of the studio part of the mixed-use development

\( W_2 = \) the weight of the office part of the mixed-use development

\( \sigma_2 = \) volatility of the office part of the mixed-use development

### Table 7-8 Volatility Computation for Mixed-Use Development

<table>
<thead>
<tr>
<th>Mixed-Use Part</th>
<th>Weight</th>
<th>Volatility of Part</th>
<th>Volatility of Mixed-Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>5.9%</td>
<td>3.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Studio</td>
<td>94.1%</td>
<td>6.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>10.3%</td>
<td><strong>6.6%</strong></td>
</tr>
</tbody>
</table>

Source: Author, 2017

As shown in Table 7-8, the volatility of the different parts of the mixed-use building was calculated with weights, based on their revenue contribution and added to arrive at the volatility for the mixed-use building as a whole. Therefore, the volatility estimate was 6.6% and was used in the ROV of the switching output flexibility.
7.8.5 Risk Free Rate

Another important variable needed for the ROV of the switching option is risk free rate of return (r). In the ROV and consistent with the risk neutral valuation assumption of the option pricing theory, the risk-free rate is used to compute the present value of call option values because the risks are factored into the volatility which changes with respect to time within the continuous time model of the Samuel-McKean equation. The risk free rate adopted was the average rate for a 10-year Australian government bond, which was computed to be 2.45% (RBA, 2016a) on the date of the ROV for the switching output flexibility.

7.9 Results and Discussion

This section is dedicated to the discussion of the results and its implications for property practitioners and how the ROV results can be used in decision making. Firstly, it is important to compare the results of the original design of units of apartment with ground floor retail using DCF model and the option to switch to SSAs with both the ground floor and car park space converted to coworking space. Results from the initial DCF analysis of the original design of the mixed-use project indicated that the original plan was financially viable. The potential profitability was estimated to be around $1,189,411, an initial yield of 6.9% and an IRR of 11.5%. Based on the results, the developer would have executed the project because of the future potential profitability.

All the measures of profitability suggested an immediate development of the project in its originally proposed design. The suggestion to proceed immediately with the project is in spite of the numerous uncertainties that have the potential to render the project financially unviable during the investment horizon. As a result, even though the financial viability was positive, the investor did not consider the impact of future changes in the market (either upside or downside) in the financial viability analysis which can have serious implications on the viability of the investment during the investment life time. Thus, an unfavourable market would have rendered the project financially unsuccessful.

The proposed switching was also evaluated using the DCF technique. The NPV for the switching output is $2,468,479 which is about a double of the NPV for the original plan. The result is despite the higher discount rate used for the evaluation of the switching proposal as compared to the original proposal. Secondly, the IRR for the switching proposal is higher (12.95%) than the original idea (11.5%), hence the investors may decide to choose the
switching proposal instead of the original idea subject to planning permit approval. Similarly, the initial yield that is used by investors and practitioners to determine initial profit levels was higher in the case of the switching proposal at 7.4% as compared to the original idea of 6.9%. Using the DCF analogy and decision-making rules in both cases, the original and switching proposals are both financially viable albeit the switching proposal produces higher returns for the investor. If the main objective of the investor is for profit maximization, the obvious choice is the strategy that delivers the best returns, and in this case, it is the switching proposal that should be executed. However, it is also possible that the investor may be developing to diversify a portfolio and may have other reasons of instigating the development. In such a case, the investor may choose to develop the original idea of apartment with retail but keep the switching option as a strategy to be pursued in future as a buffer against possible downturn in demand for residential properties. Obviously, this is a decision to be made by the developer depending on the risk-return profile and strategic objectives.

Since the switching proposal was proposed as a strategy against risks, it is important to examine it in the context of immediate exercise of the switching option and future potential to act as a buffer against potential losses. The hurdle rate/value ($V^*$) which triggers immediate exercise of the decision to switch the output was determined to be $84,479,938. This implies that, until the total value of the proposed switching is equal to $84,479,938, the switching should not be executed by the investor. Thus, in future during the holding period of the investment, should the hurdle value/rate of the switching proposal be achieved, there is an immediate trigger to exercise the option of converting the residential units into SSAs. However, because the total value of the switching proposal at present is lower than the hurdle value, the switching proposal becomes an embedded flexible strategy of waiting to invest when the timing is right.

The real option value associated with the switching option was determined to be $11,481,445 which is the payoff from investing in the switching option and exercising it at the right time. However, the value can only be realised upon waiting until the right time when the value of the switching proposal is equal to $V^*$ which is $84,479,938. Because the real option value is positive and suggests profitability, an upfront investment to retain the flexibility to switch output to the new proposal in future is acceptable and justifiable. For example, in this case study, the extra cost of flexibility to switch from the original plan of units of apartments with a retail on the ground floor to SSAs with an office space on the ground floor is justified because the total amount needed to switch the original design to the switching proposal is lower than the future pay-off (option value), hence ensures a positive payoff for the investor.
The real option value associated with the flexible switching output flexibility was determined to be $11,481,445 which is the payoff from investing in the flexible switching output option and exercising it at the right time in future. This value is compared to the extra cost of embedding the flexibility to determine the payoff associated with the extra investment. A positive payoff is an indication of future profitability and a negative payoff is an indication of losses. Since the extra investment was $7,600,000, the payoff is $3,881,445 representing the potential profit from the flexible investment. Thus, an upfront investment to retain the flexibility to switch output to the newly proposed design in future is acceptable and justifiable through the ROA framework because the payoff from the investment is positive and higher than the extra initial investment.

It is plausible to argue that if students are “forced” to live in apartments due to shortage of SSAs, weekly rent levels for apartments will increase leading to the development of more apartment buildings by developers to capitalise on the profits thereof. Besides, student accommodation is less expensive. However, the switching flexibility is beneficial because it increases the rent per square metre of space for the student accommodation and hence, the total profitability. For example, in the case study under consideration a 1-bedroom apartment of 25sqm has a net rent/sqm of $14.4 whereas the same size of space when switched can have 2 SSA’s with a combined net rent/sqm of $17.4. This is similar for all the other rental spaces (2 and 3 bedrooms units when switched into 3 SSA’s and 5 SSA’s respectively). As a result, the switching is likely to deliver better profitability/return than the apartment. Moreover, the switching flexibility can also serve to diversify the portfolio of the investors as they have a long-term horizon for this investment. Thus, a downturn in the apartment market would be offset by switching to student accommodation in future with ease due to the embedded option, thereby mitigating the overall risk associated with the investment.

The switching flexibility has the potential to offer affordability which is an important consideration in student rentals. In student accommodation, the rent paid includes other bills such as electricity, water and gas, whereas these bills are paid by occupiers in apartment buildings. As a result, students find it cheaper as compared to renting from the private market. Living in student apartments offer the necessary privacy as adults which is lost when students share accommodation in an apartment building. This feature of student accommodation makes it a sought-after option by students. The switching flexibility therefore is mutually beneficial to both the developers and students, hence the developer embedding it in the design phase of the investment and capitalising on it in future as a risk mitigation strategy is reasonable.
The application of the switching option to a real-life case study suggests that investors and other practitioners can adopt this strategy and use it in their investment analysis when facing uncertainty regarding future demand, vacancy, rents and property values in decision making. The nature of property investments, particularly the difficulty of prognosis, durability and illiquidity of the assets require the use of strategic initiatives to deal with unforeseen impacts of uncertainties arising from imperfect information on profitability of investments. Because property as an asset class is durable and has a long-term investment horizon, it is important that strategies such as switching output are embedded in the investment analysis from the inception of a project. This ensures that investors can capitalise on the upside opportunities in the property market while at the same time limiting downside losses. The switching output strategy proposed and evaluated can serve as a strategy against potential losses should demand for houses and retail decrease because of changes in the economic environment necessitated by exogenous factors beyond the control of the investor.

The switching option serves as a potential upside opportunity for the investor involved in this project to the extent that a downturn in the apartment market triggers an immediate switch to safeguard against high vacancy. As the market for student apartments is in its early stages of development, the switch may also serve as an entry strategy for the investor-developer in case it becomes necessary to venture into the development of student apartments in future. The students on the other hand will benefit from having privacy and decreased rents as compared to renting apartments and living with strangers in some cases.

In the development of student housing, universities are mostly involved either as owners (manages the property in their student housing system) or advertises these student apartments on behalf of developers. This is a means of attracting local and international students. For example, RMIT University advertises/promotes private student apartments such as Urbanest, UniLodge and Student Housing Australia on their website. Since the development is closer to University of Melbourne (5 minutes’ walk) and RMIT University village (3 minutes’ walk), the investor can seek the future involvement of these two universities in terms of disposing of the building to the university at the end of the investment horizon. This is plausible due to the continuous expansion and attraction of international students to Australia every year. By doing so, the developer basically creates an option to sell (to a capable potential client-the university) when the need arises. Thus, an exit strategy is created by the investor awaiting the right time to exercise the option. However, if in the future universities involved are unwilling to acquire the development due to downsizing or dwindling student numbers, the investor can sell the
units individually to private property investors or to a strategic investor. This is prevalent in the student housing market in Australia because currently, most of the units in student apartments are owned by individual investors on strata title.

The use of volatility as measure of risk and uncertainty associated with the investment presents a direct way of dealing with risks rather than the use of discount rates to indirectly represent risks as in the DCF technique. Besides, the use of discount rates as a measure of risks does not capture the magnitude of all risks that investors have to grapple with in property developments and investments. In view of this, the real options framework that directly treats uncertain variables and includes all possible future scenarios of their possible impacts as far as the investment is concerned seems to be much better in its approach. This improves the financial evaluation decision making of investors and other stakeholders in property sector.

Option pricing techniques have been used in property and construction sector to evaluate case studies from different property markets under different contexts. Obviously, what works in one geographical market may not work in another geographical market. In view of this, the case study under consideration has delivered initial results of the switching output application from the Australian property market and demonstrated the applicability of options valuation techniques to a case study in empirical settings. Especially, the conversion of the units in the apartment building to SSAs combined with a coworking space is new in the literature and will add up to the existing body of knowledge on switching output application. Findings from a single switching output application found in the literature was also positive albeit timing was not optimal for the exercise of the option (Throupe et al., 2012). The current study differs from this earlier study in terms of the proposed switching application and the geographical context of the case study.

In practice, it is possible that developers, valuers, investors and other property stakeholders may be implementing or have implemented this in the past. For example, discussions with practitioners revealed that some conversions of hotels to apartments have taken place in Queensland, Australia in the past. Also, some practitioners may be contemplating on implementing some of these strategies in their investments in one way or another. It is possible practitioners may be doing so without using the right technique, considering that DCF is the most widely used technique and ROV models are relatively new and yet to be accepted as a decision-making tool. This application therefore comes as an important demonstration of the use of options pricing techniques in the property and construction sector in the Australian
property market and delivers further evidence needed to support the adoption of the option pricing techniques in practice.

### 7.10 Summary

The case study under consideration has used the option pricing technique to evaluate and justify investments in the flexibility of embedding an output switching option, in a practical investment project that can serve as a strategy against potential future risks of vacancy and decreased demand for the mixed-use project. The originally proposed investment was an apartment building with units, ground floor retail and a car park. It was argued that the proliferation of similar developments has the potential impact of negatively affecting demand, hence the investors needed to have a flexible strategy to deal with future uncertainties that could render the project financially unviable at some point in time in future.

The switching output option was proposed as a possible flexible strategy to embed in the investment from the inception of the project to serve as a risk management tool during the life of the investment. In view of this, the investors had to spend extra amount to embed the flexibility of being able to convert the units into SSAs in future with coworking space on the ground floor. Because such decisions can only be justified contingent upon a specific situation occurring during the investment period, the DCF framework could not be used to evaluate contingent decisions. The real options valuation technique developed by (Samuelson, 1965) was used to evaluate the switching output option.

Results and findings indicated that the switching output option can serve as a risk management strategy which can aid an investor to alter course mid-way through an investment horizon when market dynamics impact negatively on a specific investment asset class. The comparative analysis between results from DCF and option pricing techniques resulted in objective analysis of the financial feasibility evaluation of the present case study and enhanced the profitability and risk analysis of the investment project. In this case study, it was found out that, the switching output option can double the profitability of the investment at the optimal timing of exercising the option to execute the switching application. Moreover, extra expenses in executing the switching output was deemed necessary because the option value far exceeded the cost of exercising the option at the optimal time. However, because the timing is not right, the investor should wait until the value of the proposed switching far exceeds the hurdle ratio to justify exercising the option.
The reality is that most practitioners do not recognise the value of these embedded options in property investment and development projects primarily due to the conservative nature of property practitioners and the relative paucity of evidence to support the adoption of ROV method in practice. The ability of practitioners to identify and evaluate all possible flexibilities embedded in a development or an investment project is important and can enhance investment decision making of practitioners. Especially, during the designing phase of a project, investors can embed such flexibility with the intention to capitalise on emerging opportunities in the property market to maximise profits due to changes in the economic environment while at the same time limiting downside losses.
Chapter 8 Integrating Real Options Theory into Practice: Requirements and Challenges

8.1 Introduction

To achieve practical adoption of ROA/ROV in the Australian residential property development sector, it is pertinent to solicit the views of leading property practitioners who are ultimately the likely users of ROA theory and ROV models. Chapter 8, which is the qualitative stage of the dissertation, covers the views expressed by industry practitioners on flexibility in residential property development and their thoughts about practical applications of ROV models. Such expert opinions have been sought through face to face semi-structured interviews. This Chapter is used to present, analyse and discuss the responses obtained from the interviews. Based on the responses, the researcher makes inferences and draws conclusions to fulfil the aims of the qualitative stage of the dissertation.

The major aim of this Chapter is to seek further insights into the preconditions required before practitioners adopt ROA for decision making in residential property developments in Australia. This qualitative section is important because the extant literature on ROA/ROV has focused primarily on quantitative derivation of models for valuing specific property options. As a result, this dissertation is a study that uses qualitative approach with a focus on the Australian residential property development sector. This Chapter is also linked to the quantitative section that focused on using ROV models for the valuation of options embedded in Australian residential property development projects because it was argued that perspectives of practitioners who are ultimate users of ROV is important to achieve practical adoption. Though prior research has suggested that it is generally difficult to apply ROV models to practical case studies (Lander & Pinches, 1998, Oppenheimer, 2002), the quantitative stage of this dissertation has demonstrated the practical application of ROA/ROV models to Australian residential property developments and investments thereby, challenging such notions. Besides, such notions came from studies conducted about two decades ago which may not be relevant today due to new developments in the property industry and technological advancement with regards to the use of software for decision making which are embedded with powerful algorithms. Furthermore, new ROV models that are simpler to use in practice have been developed. Besides, both the existing and new ROV models are compatible with existing software such as spreadsheet application making them easier to use in practice. However, practical adoption of ROV models is still very limited in the Australian residential property development sector as
it is still yet to be fully understood by practitioners. In view of this, there is the need to consider expert opinion on potential application of ROV models in the Australian residential property industry by way of determining the requirements for integrating them into mainstream residential property developments and investment decision-making analysis. Emphasis is on the use of ROA for identifying flexibility as a strategic tool for risk management in residential property development and ROV models to produce the single numerical outcome of financial feasibility analysis used in Australian residential property development and investment decision making.

The qualitative stage is based on a face to face semi-structured interviews aimed at determining why practitioners are still fixated on the use of discounted cash flow technique for evaluating the profitability of Australian residential property developments despite several criticisms against it. Furthermore, discount rate as a risk measure has also been criticised as offering a myopic view of risks. Therefore, as to whether a specific required rate of return (discount rate) is enough to capture all risks in Australian residential property development should be referred to practitioners. The face to face semi-structured interview was chosen as the main tool for qualitative data collection as it enables asking of further probing questions based on answers given earlier by a participant. As a result, it allowed the researcher to clarify unresolved issues during the interview process and to receive explanations to pertinent questions and viewpoints expressed by participants.

Since the development of the conversation dictates the order of the questions that are asked (Runeson & Höst, 2009), the face to face semi-structured interviews allowed for an extensive and in-depth exploration of the objects that were being studied. This method was also chosen because it permitted the research to focus on a specific unit of analysis (Yin, 2014). As a result, the researcher focused on a particular unit of analysis that ensured the understanding of the topic from the perspective of participants. Again, the researcher developed an understanding of how and why participants arrived at a particular viewpoint. The qualitative face to face semi-structured interviews broadly examined the potency of discount rate as a risk management tool, how ROA enhances risk analysis and requirements for integrating ROA/ROV into Australian residential property development decision making. To achieve this aim, these set of sub-objectives premised the qualitative face to face semi-structured interviews in this dissertation:

i. Assessing if the discount rate (required rate of return) or “all risks yield” can capture all risks in Australian residential property developments and investments (both traditional risks and newly emerging risks).
ii. Determining how ROA can provide justification for investments in flexibility for risk mitigation in practice.

iii. Considering the receptiveness and acceptance of ROA/ROV models among property practitioners.

iv. Examining the requirements for integrating ROV models into practical financial feasibility analysis of flexibility in property investments and developments.

v. Determining whether beyond the limited proven case studies and technicalities of ROV models, there are other barriers to adoption in practice.

In this phase of the research, judgements and prior knowledge of the researcher played a vital role in analysing the information provided by the key research participants. Analysing qualitative data requires researchers to apply their judgement and prior knowledge to extract key findings to draw conclusions using responses from participants. This is supported by Teddlie and Yu (2007) who argue that judgements and professional knowledge of researchers/participants can provide the best information to achieve the objectives of a qualitative research. Therefore, the researcher consulted key stakeholders in the Australian residential property market including investor-developers, property investment advisers, financial advisers and property valuers for their views regarding the research questions. The representativeness of the selected participants ensured adequate coverage of the Australian residential property market thereby capturing salient views of practitioners in the research.

There were three participants each from developers and valuers, two stakeholders each from the investors, property advisors and financial advisors. This resulted in twelve key property participants and their views are paramount in this part of the dissertation. These participants are grouped into property developers (space providers or suppliers), property investors (capital providers for development and hold onto developments after completion) and property consultants responsible for providing advisory services on a range of issues for property developers for decision-making including valuation and financing. In Figure 8.1, the two broad categories of participants are shown as leading property practitioners and property consultants. Whereas the leading property practitioners are grouped into property developers and investors, the property consultants comprise property valuers, property advisors and financial advisors.

Three participants were selected from a large development company, large fund developer and small independent developer to represent the developers. There were two investors including a representative from real estate investment trust (REIT) and a large superannuation fund. The distinction between developers and investors is based on whether the aim of a development is
to sell developed units or hold completed units in a property portfolio. Generally, investors hold onto units developed as opposed to developers who dispose of completed development projects, albeit some hold for a relatively shorter period.

**Figure 8-1 Semi-structured Interview Plan**

In Figure 8-1, property consultants comprise of three valuers, two property advisors and two financial advisors. Figure 8.1 shows a further break down of the composition of valuers into practitioners with global focus, local focus (Australia based but working in a company) and independent property valuer (Australia based but in private independent practice). The two (2) property advisors comprised of one with a global property advisory focus and a local property advisor in order to capture the views of practitioners on flexibility both locally and abroad. Similar to the property advisors, there were two (2) financial advisors albeit both practicing in Australia only. The property advisors included a local independent financial advisor and one working in a bank. The property consultants provide valuable information and advice to
property developers for decision making as to whether to invest in a project or discard a proposed project. As a result, property developers rely heavily on information and advice from the property consultants before deciding on executing a project. Similarly, any advice or suggestion to use ROA/ROV may likely emanate from the property consultants before developers might consider adopting it for decision-making. Therefore, accepting and using ROA/ROV could be dependent on the advice offered by property consultants.

The researcher used single interview guide (as shown in appendix B) for all participants because the questions covered all aspects of flexibility in property development, which is similar for most practitioners in the property industry. Besides, the questions sought to elicit similar information from all participants, hence, there was no need for different interview guides for diverse stakeholders. The researcher also adopted the use of visual aids to explain the concept of ROA and ROV to participants. There were two visual aids; firstly, a diagram showing a tower divided into stages demonstrating vertical staging in a residential development project. The second diagram showed a calibration of the binomial option pricing model to demonstrate the distributional approach used in ROV models for computing the single numerical information needed for decision making in residential property investment and development. This was to assist participants to use visualisation to appreciate the concept of ROA as a flexible approach to development and ROV as the model for capturing potential future opportunities and mitigating possible risks emanating from uncertainties. The visual aids are attached in appendixes C, D and E of this dissertation. The visual aids also demonstrated the difference between ROV models and DCF technique in their approaches to profitability determination.

After transcription of all the interviews from audio format into text, the data was cleaned, processed and stored in a word document for further analysis in NVivo. All the data was imported into NVivo as Microsoft Word files due to compatibility with the NVivo software. The NVivo is a platform for organising and storing data for easy retrieval for analysis. It has other functions that aid in data analysis. One such function is the auto-coding, which was used in re-organising the text data into groupings with similarity for thematic analysis. The auto-coding process aided in grouping the text data from the participants based on themes in the interview guide and by type of participant.

Pertinent information contained in the text data without belonging to specific themes were also identified through the auto-coding process, which became additional themes in the analysis. The themes from the interview guide, in addition to those unravelled through the auto-coding
process formed the main headings for the thematic analysis. Embedded within the headings in NVivo were categories and sub-categories related to the headings. Text data linked to these headings and to specific type of participants (for example valuers, developers etc) were grouped together. This resulted in an organised data based on themes, embedded with the views from different groups of practitioners. In analysing the data, views of individual groups (participants) were considered in addition to a cross case (cross groupings) analysis. A conclusion was drawn for each theme based on the views of all participants. Quotes from the text data in NVivo were used to support the views of the researcher on the various themes presented and discussed in the analysis similar to a property development research paper (Higgins & Moore, 2015). These views are from the researcher’s own interpretation and judgement of the text data based on theoretical propositions and practical experience. The NVivo software helped in organising the data in a systematic way for better coding and thematic analysis.

Subsequent to the introduction of this Chapter in section 8.1, the next section 8.2 is dedicated to analysing and reporting the use of discount rate as a measure of risks in DCF financial modelling. Section 8.3 is used to examine how practitioners can justify investments in flexibility to other stakeholders in their organisation. The rationale was to determine if flexibility when introduced to practitioners would appear consistent with logical Australian property development/investment decisions. This was also to analyse the predisposition of practitioners to accept ROA and ROV in practice because if they can justify the expenditure (knowing that the values attached to flexibility are realised later in the life of a project) then acceptance may not be difficult. In section 8.4, the receptiveness of ROA and ROV among industry practitioners is examined to determine whether RO theoretical propositions may be accepted. Section 8.5 deals with the requirements needed for practical integration of ROA and ROV propositions into investment and development decision making in the Australian residential property market. Lastly, section 8.6 is dedicated to exploring potential barriers that may affect the adoption of ROA and ROV models in practice due to specific circumstances relating to the residential property market operations in the case study area. A summary is provided to capture the salient parts of the entire Chapter in section 8.7. The data analysis was executed based on professional groupings on individual bases and further augmented with cross case analysis to improve the depth of the analysis.

To examine how property practitioners are dealing with risks and uncertainties, risks were grouped into two. Firstly, traditional risks that denote movements in quantitative variables used
in analysing feasibility of Australian residential property developments. Secondly, other risks and uncertainties associated with development projects that are not quantifiable such as value appreciation opportunities, technical variations, flexibility and adaptability of buildings, and long-term performance of residential development projects in housing portfolio of investor-developers.

8.2 Accounting for Risks in Property Development

8.2.1 Discount Rate as the Main Risk Measure (Changes in rents, demand, supply, interest rates, property values and costs of development)

Financial feasibility evaluation of Australian residential property developments and investments has an inextricable link to the choice of discount rate (which is normally the required rate of return) because it is an important consideration in the decision making of developers and investors in accepting or rejecting a development proposal. Similarly, risks and uncertainties associated with specific Australian residential property developments determine the accepted required rate of return that developers would expect to achieve from a project. Simply detailed as the relationship between risk and return, the classic statement that the higher the risk, the higher the required rate of return and vice versa in finance theory holds in the Australian residential property development/investment sector. The required rate of return (expected return) is normally used as the discount rate for development financial feasibility evaluation (Geltner et al., 2014).

The widely accepted method of financial feasibility evaluation in practice is the DCF and it incorporates a required rate of return that denotes a discount rate. The required rate of return which is adopted as the discount rate incorporates a risk premium and hence, the direct relationship between risks and required rate of return. Theoretically, this is the proposition by numerous researchers in the property sector. Since there is a direct relationship between risks and the choice of a specific rate of return, participants were required to examine whether the choice of a required rate of return is enough to capture all potential risks and uncertainties in Australian residential property development. The participants suggested that it is not able to capture all the risks and as a result, there are other means of representing risks and uncertainties in property development.

Inferring from information gathered from the participants, there is an indication that investors and property advisors believe that required rate of return is somewhat important in capturing
risks in Australian residential property development but ultimately not the main thing in driving their investment/advisory decisions.

“Well it can be, in determining what is the appropriate IRR, we do, look it sounds very simple but in terms of profit and risks, we will look at the planning risk if you like, the construction risk and the realisation risk” (Large Superannuation Fund).

“Not really. We do but, mainly in estate master, we identify key risk and we will apply a key number to that from the contingency to it” (Large Fund Developer).

Among the valuers, there seems to be a split in responses. One of the valuers argued that the use of the discount rate is the only means of capturing risks.

“I think that it's really the only way of capturing all the risks; there is no other way. I mean because at the end of the day, you are making a call on where these are going” (Global Property Valuer).

This may be because the participant represented a global property valuation company that focuses on international best practices. The two other valuers suggested the discount rate used in valuation is able to capture risks to some degree but not entirely. Thus, the discount rate is not the only measure for risks but there are other ways of making provision for risks in the process of determining financial feasibility of Australian residential property developments/investments in the residential sector. In assessing the values of potential residential developments and advising clients’ in making decisions regarding acceptance and execution of projects, other factors play key role.

“Well it is not the only one you will use”. So, it is significant, and it is one of the drivers we have got, and we can use to change the outcomes, but it is not the only one” (Independent Property Valuer).

“No, I think you, you try and build in all those different risks so you're obviously making an analysis on various components, and yes you have to make a single number, but you will analyse various factors within that. So, you are determining one number, but you are making a whole range of assumptions looking at a whole range of variables” (Local Property Valuer).

The property advisors and more importantly, the developers who are the main players in initiating projects and executing them indicated that the discount rate cannot capture all risks
and as such, they do not use it alone as a measure of risks. In some cases, it is not even considered in the decision-making process.

“No, not at all. At the end of the day, valuation is not just the number. So, it is not just about the number. It is about the amount of supply that is in the market in that particular area and is that going to compete against your development and the environmental risks associated with the site and yes, they will play a part in that number. But it is certainly not the measure of all risks and uncertainties” (Global Property Advisor).

“So, but to understand how to appropriately price future risk into investment return, there is a difference between how it is done and theoretically how it should be done. I think you will actually find when you talk to most developers, most will not use IRR, they will not use a discount rate” (Local Independent Financial Advisor).

“I actually doubt that we do put any financial value on the risk. It's not to say we may pump the cap rate by a couple of points to say listen, we think if this risk come into fruition it will have this impact” (Large Fund Developer).

“No, no it can't, because at the end of the day, that metric is only a measure of a cash flow. If that does not occur, your cash flow changes, your metric shift. The thing with development is it is dynamic. You aren't able to lock away all your risks” (Large Development Company).

This finding is contrary to the theoretical suggestion that expected risk premium (risk component of discount rate) is proportional to the amount of risk (development risks) developers perceive to be involved in residential property developments (Geltner et al., 2014). Developers suggested that they do not even adjust the discount rate to reflect changing perceived risks during the process of development. Probably, the most important of all is the revelation from the financial advisor that most developers might not even use the discount rate to represent risks and profitability. Furthermore, the financial adviser stated that there is a mismatch between theory and practice. There is therefore a knowledge gap or possibly practitioners have found a better way to represent risks in financial models as opposed to theoretical suggestions. In summary, the responses suggest that required rate of return (used as discount rate in DCF modelling) is not used as a measure for risks. Besides, profitability is determined by a dollar value on either cost or development value of a project. It can safely be argued that risk in property development is managed differently in the Australian residential property development sector as compared to general theoretical suggestions.
8.2.2 Dealing with Risks as Opportunities (views on Shortened Lease Lengths, Future Proofing, Flexibility of Buildings, Value Appreciation Opportunities and Potential Technical Variations)

Movements in key variables affecting financial modelling in Australian residential property developments are expected and as such, analysts involved in the Australian residential property development sector always make provision for those factors in financial models for their negative impacts. However, analysts hardly make provision for potential positive gains from these factors via active management of projects by foreseeing potential future opportunities to capitalise on them. For example, a delay in presales of a residential development project may be deemed as negative occurrence and hence a risk. On the contrary, delaying the sale of some units in a residential development project over a period could generate extra revenue above forecasted values and profits due to rising property values. Even though such a positive outcome could occur, delay is a risk and not opportunity in most financial models. This raises the issue of whether all occurrences in the property market are risks or opportunities.

Similarly, changing trends in the property market such as shortened lease lengths, building flexibility and value appreciation opportunities may be profitable to business and not pose risks necessarily, if property practitioners are proactive in dealing with such issues. During periods when the rental market is increasing, shortened lease lengths are regarded as opportunities because developers and investors have the chance to increase rents. Due to value appreciation opportunities and fluctuations in demand for specific properties, flexibility of buildings capable of adapting to changing market conditions can be valuable.

The views provided by the practitioners suggested that value appreciation opportunities may occur but due to debt funding requirements, it may not be entirely possible to engage in opportunistic options as they carry risks which financiers may not be willing to fund. As a result, such analysis cannot be quantified and incorporated into financial modelling as potential opportunities to capture. In some cases, trader-developers even prefer a 100% presale of residential projects before commencement due to the dynamic nature of the Australian residential property development market. The indication was that if investor-developers would want to incorporate flexibility, then they would have to fund it.

“You will typically find in the market place most developers require a certain level of presales for a residential building before they commence construction as well as before they apply for debt finance. A lot of financiers will want you to have a certain level of
On the issue of ensuring that projects are future-proofed to meet future requirements, some Australian residential property investor-developers consider it as a way of being competitive in the market as compared to other competitors believing that they may be able to attract more occupants to their building and retain them. Depending on a specific situation in the property market, shortened lease lengths can be an opportunity. Again, future proofing a building by spending extra today only goes a long way to ensure that a building does not become functionally obsolete after a few years of construction when there is disruption from digital revolution for example. Since flexibility considers a long-term view of investments/developments by embedding flexibility in residential property developments in general, participants answered questions on their views concerning these non-traditional risks in development (perspective of owners).

“Building technologically future-proofed as much as possible so things like communication system in building, we will make sure it's 5G enabled from when 5G is the norm. No one can predict the future accurately but as best as we can, it's both for our benefit as well for the occupants but we want to have a building that we can compare ourselves with our competitors” (Large Fund Developer).

Technical variations during the process of development may be possible depending on the stage of development and the willingness of the client to pay for the additional cost for the variation. This is an accepted practice in the industry that whoever asks for variations in design bears the cost of the changes. As far as long-term investor-developers are concerned, the final product of building design is obvious from the beginning as this is a requirement from the council for the planning permit. As a result, technical variations as opportunities are time bound and based on specific dynamics of Australian residential property developments.

“We always would go into a situation where we have a prescribed outcome we're expecting. It'll be on a case-by-case request, and we'll have a look at what that means from a potential cost point of view and therefore say, well, if you want that change, it's an additional cost and therefore will cost you this for that change” (Large Development Company).

On the other hand, some of the participants viewed these non-traditional risks as opportunities depending on the analysis conducted by practitioners and their view of the market at that
particular point in time during valuation. This is dependent on the views, observations and experience of the specific practitioner interpreting whether a particular issue poses a risk or an opportunity to the owner of a specific asset under consideration. It was evident that practitioners with exposure to other international property markets where ROA theory is gradually being accepted as a decision-making tool are thinking alongside flexibility.

“So, my view is that those items can only be balanced against what the Valuer thinks, that the opportunity in the asset is balanced against its risks. Does it have more downside risks or more upside risks or more upside opportunities I suppose” (Global Property Valuer).

“So, I think in addition to these you kind of got to know where you are in the market at any one time and that’s really how you balance that out. You’ve got to come up with an independent view of what that might be and how people are interpreting that issue” (Global Property Advisor).

The global property valuer expressed the view that non-traditional risks might actually be opportunities, which is the main proposition of ROA theory where favourable changes in property market can actually have upside benefits. Thus, valuers may be examining flexibility qualitatively but without the use of appropriate tools and techniques for the valuation of such potential future opportunities because the dominant method of valuation (DCF) is incapable of capturing the stochastic process attached to the evolution of property asset values.

“Yeah, I think it is two things. It’s about the practitioner’s view about how that building is made in future needs and if it’s obvious; for example, you’ve got a small floor plates and the trend is towards larger floor plates” (Local Property Valuer).

In essence, the local property valuer also indicated that depending on prevailing trends, which is also a time point in the market, flexibility could be valuable if embedded in a building. Thus, embedded flexibility would allow the owner of a building/development to switch to capitalise on emerging opportunity. The valuer who would analyse embedded flexibility during the process of valuation using a subjective opinion would largely determine the value associated with flexibility. As a result, the practical adoption of ROA by the Australian property industry is greatly dependent on the opinion of valuers on flexibility.
8.2.3 Contingency as the Risk Management Tool for Potential Uncertainties and Risks

If the required rate of return (discount rate), which is a known measure of risks in property development, is in practice not what developers are using, then a probing question was how are risks in residential property development captured entirely? This elicited important information in the form of how different developers tackle risks using contingency. Indeed, property development is dynamic and very risky. Developers are normally aware of risks such as movements in property values during construction and hence capture them in risk analysis during financial feasibility modelling.

“So, all developers understand risks and how we price it is by looking in the model and setting appropriate contingencies for the key areas in the model which is subject to movement” (Small Independent Developer).

“So, we spelled it out to the board, here's what we know about the risks, here's what we don’t know about them and how we've allocated an interest contingency on that project to deal with it. And we then get that built into the financial model” (Large Fund Developer).

Others are unforeseen and occur only after execution has begun. It was determined that developers generally divide the process of development into three for risk analysis purposes: planning risks (before construction starts), construction risks (during construction) and realisation risks (potential risks of default at settlement). Within these three stages are different activities that have risk implications on the project.

“Look it sounds very simple but in terms of profit and risks, we will look at the planning risk if you like, the construction risk and the realisation risk” (Large Fund Developer).

Therefore, several line items (project areas where risks occur in the three stages) with their associated risks are priced into the total contingency budget for the project. As a result, contingency serves as a way of absorbing the potential effect of unforeseen and known risks on expected profits.

“The only relationship between the risks and the value is the amount of contingency that we will put in the project to cover those risks” (Large Fund Developer).

“We price risks into our model in terms of contingencies. That is contingency against key risk that we carry through construction” (Large Development Company).
“And then you’ve got to price it, price the uncertainties and risk. You can price that generally into like a contingency. If they price it in (contingency), and you make your hurdle return, and you use that contingency then you keep your return, if you don’t factor it in, you have to use your money and your return goes down” (Local Independent Financial Advisor).

The views of participants are unanimous in the use of contingency as a way of dealing with potential risks and uncertainties. The responses suggest that this approach is pervasive in the Australian residential property development sector and that all stakeholders and practitioners are aware of the use of contingency to deal with risks and uncertainties. Therefore, contingency provides a safe way for dealing with known and unknown risks within the Australian residential property development sector.

An important finding is that the contingency budget is prepared in such a way that each risk foreseeable is analysed and a specific amount built into the costing of the project referred to as line items. As a result, as far as investor-developers in the Australian residential property development market are concerned, contrary to the view that required rate of return (discount rate) captures risks in Australian residential property developments, it is rather contingency that is adopted. Therefore, in dealing with risks in Australian residential property development, a definite amount is allocated to specific foreseeable and unforeseeable possibilities, which forms part of the financial feasibility modelling. Again, contingency is neither set as a percentage of the construction/development cost nor as a percentage of various parts of the development cost (Tseng et al., 2009). Rather, it is based on an analyst’s subjective view of the negative impact of specific risk on a residential development project, which is set as a dollar value allocated to specific potential occurrences in the development cost.

8.2.4 Emerging Opportunities and Risks after Project Commencement

Since real option is about capturing the latent value of assets contingent upon changes in the Australian residential property development market, one aspect considered is the examination of emerging opportunities during execution of a residential development project. Particularly in the Australian residential property market, due to relatively high liquidity (frequency of transactions), prices tend to change regularly. Since most residential developers who hold assets normally lease them before and during construction, pre-leasing serves as a tool for risk mitigation. As a result, developers normally miss opportunities associated with favourable changes in the residential development market. In times when the Australian residential
property development market is experiencing growth with increasing prices, investor-developers have the potential to hold onto stock for a reasonable period and capitalise on rising rents. Similarly, during pre-sales of residential development, developers can deliberately hold onto some of the stock and wait for an opportunity to benefit from a favourable upside in the market. In practice however, developers prefer a 100% sold off or leased development compared to holding stock in anticipation of favourable changes in the market because of the impact of unforeseen uncertainties and risks. For example, a response by a large investor-developer on risk mitigation was

“If for example you’ve got a 100% pre-commitment on a project you’ve wiped out that risk, haven’t you?” (Large Superannuation Fund).

Suggesting that pre-sales can deal with risks completely, despite operational and settlement risk. However, some other participants admitted that there is still settlement risk that can affect the total realisation from a residential development at the time of leasing or settling because there can be defaults with preleased/pre-sold contracts. Therefore, even though pre-sales and pre-leasing serve as risk mitigation, it is not wholly beneficial to developers as potential upside benefits are also lost in the process. Besides, the impression that pre-sale is the panacea for risk mitigation is not entirely accurate due to the presence of operational and settlement risks during the process of development.

“We have been in situations where the market has been rising right? So those contracts that we signed up today, we should have held back 50% of the stock because the prices were taking off through the course of construction” (Local Property Advisor).

This implies that flexibility can potentially change the profitability dynamics of a residential development project. More importantly, for the penetration of ROA and ROV into the Australian residential property development industry, the views of practitioners about risks and uncertainties as opportunities in the residential development market could be crucial. Some of the practitioners argued that it is generally part of business and property development risks to miss opportunities after the start of a project. For example, a local property advisor argued that

“Yeah, so the market has gone up. But as a developer, you don’t have control over that. Yeah, that’s just the risk in doing development” (Local Property Advisor).

This corroborates the literature in terms of accepting movements in key variables as risks and not opportunities (Loizou & French, 2012, Peiser & Frej, 2003). The developers particularly explained that the challenge is the ability to respond to these favourable changes in the market
in time to capture the benefits and to incorporate such opportunities in development feasibility analysis. This suggests that even though developers are aware of potential opportunities that emanate from value changes in the property market after a project has commenced, they generally accept that it is difficult to take advantage of the opportunities.

“Quickly go and buy another block of land then quickly start developing another one so you can get more money” (Local Property Advisor).

“We started selling the apartments and were selling an even mix of one and two-bedrooms. In the first building of 30, the one-bedrooms moved quickly. All right, we will put more one-bedrooms in building two. Guess what? They did not move quickly in building two. Two-bedrooms moved quickly in building two. You've already predefined the design, so unfortunately the difficulty in those matters is that before you go to market to start selling and start construction, you have to define the outcome” (Large Development Company).

Evidently, flexibility is valuable because rigid designs are not adaptable to fit changing trends easily. Should flexibility be embedded in projects, developers can respond to market dynamics with respect to changing market conditions faster. Moreover, even if it is possible to delay present decisions in expectation of better opportunities, the investors believed that capitalising on opportunities today makes a huge difference as compared to waiting due to future uncertainties.

“But to be honest, we would pin our heels back and try and get that 50% sold. It is better to have the contractual commitments rather than holding onto the units” (Large Superannuation Fund).

This implies that property development decisions can be delayed when losses are imminent. However, to delay pre-sales/pre-leasing in expectation of rising property values might pose risks which Australian residential property developers and investors are not willing to accept. In effect, if there is the chance to secure contractual agreements, the general view is that it is much better than holding onto stock in expectation of rising property values in future and capitalizing on the upside benefits. This may be due to the use of pre-sales/pre-leasing as a risk management tool in the Australian residential property development sector and for securing funding.
8.3 Justifying Initial Expenditure in Flexibility: is Flexibility Valuable? A Case of Vertical Residential Development

In ROA, flexibility of buildings is significant to the long-term performance of assets. Embedding flexibility in Australian residential development projects requires that investor-developers spend an upfront initial capital expenditure. Since decision making in Australian residential property developments and investments require approval from an investment review committee in most companies (except probably the small independent companies), there is the need to justify such expenditures. To this end, the research sought to determine how practitioners (participants) could justify the plausibility of such an investment in flexibility to these committees that have oversight responsibilities. Generally, participants agreed that it is valuable to embed flexibility in Australian residential property development, however, with concerns regarding the cost. For example, during development of high-rise residential apartments, developers generally suggested that having such a cost sunk into a foundation basement means tying up potential profits into a completed development awaiting the opportune time to capitalise on favourable market, which is quite difficult to appreciate in practice because they require profits to remain active in business. As stated by one of the largest residential developers,

“...there is a cost obviously. It’s impacting on the performance of just doing this (building to a certain level which may not be viable)” (Large Superannuation Fund).

A property advisor also similarly argued that,

“because there is so many infrastructures that goes into them. If we start selling houses and building flexibility into them, that will become very capital hungry before you see money back, your money will go for long term” (Local Independent Financial Advisor).

The issue about flexibility and residential developments seems to centre on the conflict between developer objectives and the time needed for real options embedded in residential developments to mature within the residential property development market. In practice, most Australian residential property developers are typically in a “come in and get out” sort of business where it is organised as a production of units and does not consider the long-term perspective. As a result, developers with a short-term view of the property market are sceptical about the prospects of embedding flexibility, which may pass on to the next owner without appropriate value ascribed to it during sale. Thus, there is scepticism among short-term Australian property developers as to whether the market will accept the value associated with
flexibility. Moreover, they do not know if independent valuers who have the mandate to do valuations would ascribe any value to flexibility. This is captured in the words of a large fund (investor-developer) as,

“I will be happy to see that I could get some value ascribed to the undeveloped portion. So, the air rights (high rise apartment’s vertical case study) if you like” (Large Superannuation Fund).

“That cost today will be sitting on the job at the end of the day, sitting there to carry forward to eventually make money when you think it's the right time to do that as an investment, sitting on the book. It is like a dollar for a right. You pay dollars you get a right” (Large Development Company).

Long-term investor-developers who instigate and hold completed residential property development projects in Australia were quite positive about flexibility as it offers a chance to capitalise on favourable market opportunities in future. It was evident from the interviews that these long-term investors seek flexibility themselves in some aspects of development. For example, flexibility in building designs for updating and meeting technological changes in the market.

“Building technologically future-proved as much as possible so things like communication system in building, we will make sure it's 5G enabled from when 5G is the norm” (Large Fund Developer).

Thus, they actually seek flexibility and prepare for the future in some respects. Unsurprisingly, the investor-developer suggested that a decision of this nature would be determined by comparing cost against profit, signifying that profitability is the main issue. On the contrary, it signals the lack of depth in the analysis performed by practitioners in investment decision-making in Australian residential property developments because comparing cost against profits is a simple cost-benefit analysis without considering the potential changes in prices in future. Likewise, the time value of money was not considered in the value determination of flexibility from the responses provided by investor-developers. Thus, investor-developers consider neither the time value of money nor the stochastic nature of some key financial variables and their impact on potential profitability of Australian residential property developments. For example,
“Well it will be the value against the cost. From my perspective, it will be the value against cost but the valuers interpretation is also important because they provide an independent opinion assessment of property” (Large Fund Developer).

This is the simplistic way some practitioners evaluate residential property development projects in Australia, which is inconsistent with the desire to incorporate time value of money analysis in property development and investment decision making. For example, the DCF technique which captures time value of money has been used for decades and has become an important tool for financial feasibility evaluation in the property sector. The local independent valuer accepted that there is value associated with flexibility. However, conceded that current evaluation models are unable to determine the value of flexibility. This indicates that using current models that do not consider the potential future values of properties based on stochastic processes and compare with initial cost will likely produce an outcome that is inconsistent with reality.

“Yeah certainly it's valuable because you can use it to create future income. I mean it's valuable, but it is obviously risky as well and I don’t know how the current models will price this” (Local Property Valuer).

The global property valuer suggested that a present value analysis of the potential value of the embedded flexibility at a certain time in future and compared to the cost of embedding the flexibility today would justify the investment.

“This is the future value of the development upside within some time you've got to think it's reasonable. Convert it back to present value and you compare that. Upside, compared to the cost of putting in the amount today and you can make a call whether or not so that's a good investment of constructing it today. Yeah, it depends upon the size of the upside” (Global Property Valuer).

This is in sharp contrast to the view of the local independent valuer. One possible reason for the sharp contrast is that, the global property valuer is probably exposed to best practices internationally and elsewhere around the globe. The indication is that valuers with global exposure to valuation practices in other property markets are more likely to consider flexibility and attempt to ascribe a value to it as compared to local independent valuers who are focused on local practices. Possibly, lack of knowledge may also be a determining factor in the response of the local independent valuer as to how to determine the value of flexibility. Despite the scepticisms, most participants agreed that embedded flexibility has value. This is an important
finding and contributes greatly to the literature on ROA because, the adoption of ROA and the use of ROV for valuation of embedded flexibility could be dependent on the logicality of the theory to practitioners, their level of understanding of the theoretical propositions of ROA and how well it fits into the general valuation methodologies.

### 8.3.1 Determining the value of Flexibility: Practitioners’ perspective

One important consideration regarding flexibility by practitioners was the upside gains or future potential value of flexibility as against initial extra cost. This is essential because most decisions in property development and investment are profit driven using a single numeric value from financial feasibility analysis. As a result, the research sought to determine the means via which the value of embedded flexibility would be determined. This emerged as a probing question during the interviews because investors who have long term (say 3-5 years in the residential sector) investment horizon wanted to know whether the property valuation community would ascribe value to flexibility in practice.

The developers’ method is a simple cost against future potential value at the time of embedding flexibility. The main reason for not projecting into the future is that they believe the Australian residential property market is too dynamic with frequent price fluctuations to enable prediction over a period of 3-5 years. Any prediction over a period of 3-5 years is problematic because conditions can change quickly, changes are constant, and the effects are of different magnitude. This approach is also quite problematic because it does not consider the time value of money and the potential uncertainties that could affect asset values negatively and virtually impact on the values of flexibility as well.

“Developers are very get in get out, get it done, get it solved, they understand the market today, they probably trust predicting 3 years in the future but crystal balling 20 years they probably get a bit nervous” (Local Independent Financial Advisor).

“I find it that I can reasonably predict with some degree of accuracy probably the next 2-3 years, beyond that it becomes more problematic” (Global Property Valuer).

“We have an internal cost plan in the business sales so with a lot of these options, we look at the cost impact and we will then do a cost benefit analysis basically to say look, the cost is 2 million dollars. How is that addressed if it is future proofed? (Large Fund Developer).
The investors on the other hand focused on the cost benefit analysis of flexibility. Thus, a consideration would be given to how much extra profit is likely to accrue from the flexibility as against the extra cost and the reasonable timeframe within which the flexibility may be exercised to realise the profit. One of the investors indicated that

“...from my perspective, it will be the value against cost but the valuers’ interpretation is also important because they provide an independent opinion assessment of property” (Large Investor-REIT).

The valuers who provide independent assessment of residential property values had mixed responses depending on their knowledge and exposure to the practice of valuation. The local independent valuer was fixated on the sales comparison approach as the main method of residential property valuation even if flexibility is embedded. One of them suggested that

“well you have to compare, obviously you need to look at comparable sales of 30 level properties and find out what it's worth, so you can analyse what this property would be worth if it was 30 levels and then obviously take into account the cost. But there certainly is value in future development potential” (Local Property Valuer).

The basis for such analogy is on the development potential of the future opportunity but without the use of present value analysis. This meant a lack of consideration of time value of money and the stochastic nature of property prices, which impacts on profitability and flexibility values. There was no mention of comparing the future value of flexibility to the cost, which might be due to the conservative nature of valuers. This finding is surprising because there is normally conversion of future cash flows into present values to determine potential profitability before the execution of proposed development projects. The effect is that values embedded in flexibility may be determined with the use of inappropriate methodology, leading to inaccurate results.

Similarly, another independent valuer also reiterated the fact that using future value can be problematic because predicting the future is quite difficult and valuers do not normally consider that in valuation of properties. This is quite surprising because DCF technique as a valuation tool projects potential asset values or rental revenue over a 10-year period in determining the values of assets. The independent valuer suggested that, the most important is to highlight the potential savings of embedding flexibility as opposed to redeveloping the whole site within the reasonable period similar to the exercise of the flexibility. This finding is important as it serves as a means of demonstrating the potency of ROV in the valuation of development projects.
because many at times, ROV models show the potential savings that are likely to accrue from investing in flexibility. This has the possibility of convincing practitioners about the benefits of ROV models in decision making as compared to the use of inappropriate current valuation models for evaluating values attached to flexibility. Possibly, a requirement of researchers and academics may be to highlight the savings potential of investing in flexibility. For example,

“You will need to have a discernible and quantifiable indication of what you would have saved for someone to attribute any value to it of being able to develop that additional component” (Independent Property Valuer).

“I think really the question is they are going to pay you something if you can prove that that is more appropriate than the cost of removing the whole lot and starting again” (Independent Property Valuer).

The global property valuer’s response was close to how ROV models account for flexibility values in practice. The participant indicated that the choice of methodology should be the investment valuation method that projects potential future cash flows against the initial cost. A reasonable timeframe within which the flexibility may be exercised could be assumed and the potential value at that specific time based on escalation should be compared to the cost of embedding the flexibility today for a determination to be made as to the viability of the flexible investment.

“Yeah, then that wouldn’t be a very difficult exercise to prove. Because what you are basically saying is this is the opportunity cost of constructing the basement now versus the future value. This is the future value of the development upside within some time you've got to think it's reasonable. Convert it back to present value and you compare that. Upside compared to the cost of putting in the amount today and you can make a call whether or not so that's a good investment of constructing it today” (Global Property Valuer).

A possible reason for this response from the global property valuer is attributable to the exposure to property valuation practice in other matured property markets where real options applications in industry have developed. Later in the interview, the participant indicated that other members of his organisation are using ROV for mining rights valuations. Even though this is a step forward towards convincing practitioners to adopt ROA and ROV models, the participant failed to incorporate probability/possibility analysis in determining the future values of flexibility, which is important in ROA theory. Similarly, the upside gains and downside risks
are all included in the computation of the value of flexibility under RO theory, but the participant did not mention it. Thus, the participant did not mention the range of figures that are possible combined with a weighting towards an outcome, which is the main benefit ROV offers to the valuation community in terms of improving valuation practice. This suggests the need to bring up to speed the knowledge level of local and global property valuers for ROV adoption and application in practice.

Among the practitioners, the developers used the most simplistic method to determine the potential value of flexibility. The view of participants was a basic return on investment potentially possible when investments in flexibility are executed. This finding was surprising because most developers in the Australian residential property industry use Estate Master, which is an industry accepted software for financial feasibility evaluation of development projects. In-built within the Estate Master is a DCF valuation model.

8.4 Receptiveness of Flexibility by Key Stakeholders

In order to integrate ROA and ROV models in practice, practitioners would have to accept it. As a result, practitioners answered questions on the potential of adopting ROA/ROV models in property development decision making. This was to elicit their views on ROV models and ROA analysis as a strategic way of investing in property assets. Secondly, to examine the willingness of practitioners to accept the method for decision-making.

In general, the key stakeholders interviewed indicated that they could envisage the benefits associated with the use of ROA and ROV models in practice. Particularly the thinking around the decision-making process and the probabilistic/possibility weighting given towards the result of potential future values of assets over their entire life cycle. Some scepticism remained, centred on ROA/ROV models because one of the stakeholders indicated that it is possible to end up with a value for an asset outside the range of distribution despite the probability analysis. Secondly, the suggestion by one of the valuers that a ROV model could certainly be of use suggests some level of uncertainty surrounding the response. This is potentially attributable to the newness of ROA/ROV models in the Australian residential property development sector. As evident in the suggestion of the global property valuer who indicated that it is important to develop a solid understanding of the ROV/ROA models for decision-making. The global property advisor was also concerned about how to generate probability estimates for valuation using ROV and reiterated the old saying in financial feasibility modelling, “garbage-in-garbage-out” to support the argument. However, the participant indicated that ROV method
sounds accurate in the manner through which values of assets are derived. Therefore, even though there are benefits in the use of ROV method, stakeholders are generally sceptical about its use. This is an indication that in the future, the method may be adopted in the residential property industry for decision making on the condition that practitioners develop better understanding of ROA theory and the use of ROV models for decision making in property developments. Supporting the discussion above are the following quotes:

“I think this is very interesting in some form of study and I can see the benefits in this but I would need some solid underlying basis for making decision around the probability of the outcome” (Global Property Valuer).

“It sounds like it could be certainly worthwhile, and, yeah it gives you more options to look at different risk factors throughout the period that you're analysing” (Local Property Valuer).

“So really, the benefit that I can see is that you give some weighting towards an outcome” (Independent Property Valuer).

“I like it because it actually gives you your boundaries. What is my worst, what is my best, it is sort of defining it all for you. That is a good thing. Then it's probably coming up with the ability to say, well, what's my probability of being...” (Large Development Company).

“I think in theory it really sounds very good and very accurate; I do wonder a little bit about I mean your output is only ever as good as your input in anything right, so working out the probability for some of these factors, how credible some of those probabilities are and what they are based on. Because your end result is going to be as good as what's going on into it. But I think in theory the model sounds very good” (Global Property Advisor).

### 8.4.1 Acceptance and Adoption of Real Options Theory in Practice

The adoption of ROA in decision-making in property developments is dependent on the acceptance of the method by practitioners. This is in the form of a tacit acceptance of the method as compared to DCF, which was determined through analysing the interviews. The potential of ROA, which allows a decision maker to predict the impact of a decision at a certain time in future and strategize to deal with risks and uncertainties at inception of a project, was important to financial property advisors. Possibly, this is because of the magnitude of capital
committed to projects by financiers and the potential ramifications of failed development projects on their businesses. As a result, their major concern is to mitigate risks as much as possible. Under that circumstance, it is important to highlight the risk enhancement potential of ROA and ROV in feasibility analysis vis-a-vis the cost of achieving such an objective of mitigating risks. Since ROA allows a decision maker to re-evaluate the feasibility of a project mid-way through execution by active management, it allows potentially unviable projects to be discarded thereby enhancing risk management. Moreover, it also enables project developers to capitalise on emerging upside opportunities by embedding flexibility in development projects in order to retain upside opportunities.

Despite the scepticism about ROV models and the possibility of not obtaining funding for initial investments in flexibility, the financiers indicated that it is generally better to have an in-built strategy to deal with risks at some point in time in the life of a development project rather than being helpless in the face of unfavourable market conditions. Thus, financiers favour the use of ROA approach in dealing with risks and uncertainties in property development because of the opportunity to deal with risks better, albeit funding could be problematic. The financial advisors favoured ROA/ROV models for two main reasons: range of values and probability/possibility analysis. One of the large fund developers argued that ROV models improve decision making, especially risk analysis project execution decision-making process as compared to DCF. This is attributable to the range of figures adopted by ROV models in the computation of profitability of Australian residential property development projects which captures all possibilities as far as profitability is concerned. Thus, the use of probability/possibility analysis to represent uncertainties from which potential numeric outcomes (profits) of developments are calculated using ROV is better than the single point estimate using DCF because it weighs the probability of achieving a specific target return or profitability level.

“Oh certainly! No doubt about it; you are much better off assessing them than just looking at one DCF model” (Large Fund Developer).

On the contrary, one of the large developers argued that the DCF is better because it is simple to use as opposed to ROV models, which uses probability analysis. Therefore, it can be argued that property developers would be inclined towards the use of simpler ROV models. Similar to this finding is the work of Vimpari (2014) who argued that property valuation models generally begin from simple models and are later improved. For example, direct capitalisation being
improved and developed into DCF technique. This is supported by a developer who suggested that,

“I think the DCF is better as a straight line from a point of view of simplicity. It comes down to who we are communicating this message to and how close I understand this philosophy. I think it is worth seeing. I think it's worth looking at closely and seeing how it might work and discussing with others within my business, what they think of this?” (Large Development Company).

Thus, among the developers, there is general acceptance of ROV model and they see the worth of adopting it in decision-making. However, they would only do so based on a deeper understanding of ROV models and knowing the assumptions behind the model. In addition, the simplicity or complexity of ROV models would also determine the adoption for applications.

An evaluation of responses from the valuers who responded to the adoption of ROV models in practice is also not unanimous. The local property valuer suggested that it is good to have such a model that can dynamically evaluate the value of flexibility because frequent changes in the property market necessitate flexibility. Again, having such a flexibility affords a developer the opportunity to alter decisions based on future circumstances from the inception of a project. On the contrary, the local independent valuer indicated that the DCF is better under current valuation practice because of client requirements. The indication is that the valuation of flexible investments is executed in a manner consistent with how their clients are evaluating opportunities in the property market. Since there is no demand from clients to adopt or change the current method, the DCF is considered as a better option to ROV models.

“But it certainly sounds like a good option. I mean the property market is always changing so it is good to have a model that allows for flexibility” (Local Property Valuer).

“I actually think that, in the current environment, the DCF will probably be better, because I think that is the way our clients are looking at things” (Independent Property Valuer).

Both valuers did not clearly state that they are willing to adopt ROA and ROV but it was obvious that one was willing and the other was concerned about client’s acceptance of the use of the models.
“I think people are so used to doing what they're doing, it would be difficult to implement and bring it rolled out, and I guess industry wide” (Local Valuer).

“I think that first of all, you've got sales comparison method and income approach which is so important” (Global Property Valuer).

The suggestion that the sales comparison and income methods are very important in valuation is an indication of that practitioners would want to see these methods reflected in ROV models. Because they are familiar with the sales comparison and income approaches, highlighting similarities between ROV and existing valuation models (sales comparison and income approach) could aid practical adoption.

8.4.2 Practical Cases of Flexibility

On ROA, it is vital to note that participants were mostly in favour of flexibility as an important concept in Australian property developments. Particularly, having the managerial flexibility to respond to changes occurring in the property market in future is considered essential. Some of the participants suggested that they were familiar with a number of property development projects that have embedded flexibility in practice. This is an important finding because although flexibility has enormous cost implications for developers and investors as disclosed through the interviews, it was surprising to know of an embedded flexibility in some projects they have participated in the past.

“Yeah we can so an example of this, say I was valuing a big development in South Australia and it was a three stage development, it wasn't one tower like this, it was three individual towers but a hell of a lot of infrastructure that was to be used for all three towers was to be built in the first stage, and so the cost to build the first stage was significantly higher than building the other two stages” (Global Property Advisor).

“Lots of properties that are traditionally retail strips are doing residential above them as well. So, having that flexibility to diversify use is certainly valuable” (Local Property Valuer).

“However, we have just finished this development right here, that project was developed over a car park because the car park has been built such that you could use the existing structure to some extent to build on top of it” (Large Fund Developer).

It is interesting and surprising to know that through flexibility, an office space was redeveloped on top of an existing structure. It would be good to know how the decision to invest in flexibility
was justified before the commencement of the project. Apart from this, local authorities that approve planning permits for developments are also advocating for flexibility in the commercial property market according to one of the participants. This is a significant breakthrough since one of the most important issues raised as a barrier to the execution of flexibility is planning approval. They agreed that flexibility is important in property development. This indicates that the legal barriers to the adoption of flexibility could be overcome if the councils are becoming advocates of flexibility. A large investor-developer who deals with several councils for planning permit suggested that,

“...for example, Melbourne City Council at the moment encourage developers to build car park that in the future can be converted into an office space. As Melbourne City Council achieve its goal of keeping cars out of the city, they are suggesting to developers if you have floor to floor heights that are appropriate in your car park, then you can convert one day back into an office space” (Large Superannuation Fund).

Significant among the findings is also the revelation by the global property advisor that another valuation team in the company uses a ROV model for the valuation of mines and mining rights and had held a discussion on the possibility of adopting it for property valuation. This is an important step towards integration of the method in practice. Since international practices generally trickle down to affect local practitioners, it can be argued that in the long term, ROV models may be introduced to the property industry by some of these international valuation firms and affect the practice of valuation in Australia.

“Yeah, so I know our bigger business valuation team for example uses these techniques and I know it is used in the valuation of mines and mining rights and that sort of things, so we have discussed kind of this methodology, but I do not apply for property valuations. I know others in the firm who do” (Global Property Valuer).

In summary, practical cases suggest an unconscious use of ROA/ROV theory for decision making but, yet to be adopted throughout the industry. It is accepted that there is a bit of work to do to achieve universal practical adoption.

8.5 Requirements for integrating ROV/ROA into Property Decision-Making Process

Currently, a major issue of property academics and researchers regarding ROA/ROV theory is how to achieve widespread adoption in Australian property development and investment
decision making by property practitioners. One of the aims of this dissertation is to determine how to integrate ROA and ROV models into practical decision-making. Therefore, participants were asked questions on the requirements for the adoption of ROA and ROV for decision making in the property industry in Australia. Analysing from the responses provided by participants, the most important factor to consider is developing the knowledge of practitioners on ROA propositions and ROV models. This is in respect of both ROA as a flexible approach to actively managing projects (to capture potential opportunities and cap losses) and the use of ROV models to evaluate and determine the value of flexibility in practice.

8.5.1 Education and Training

It is obvious from the responses of participants that educating and training practitioners on the theoretical propositions of ROA and use of ROV models is the most significant factor in order to achieve adoption in practice in the Australian property industry. Most of the respondents indicated that there is the need to develop a full understanding of the theoretical propositions of ROV models before accepting to use them in practical decision-making. This is augmented by the argument of Uher and Toakley (1999) that among the obstacles to the application of quantitative risk management techniques, which may in this case include ROV models is the lack of a deeper understanding of its potential benefits.

It thus seems researchers have focused on developing numerous ROV models without ensuring that practitioners and stakeholders who are at the forefront of decision-making in the property industry acquire the requisite knowledge for application in practice. It is only when practitioners and stakeholders understand ROA theory, ROV modelling and the underlying propositions that they will have the confidence to use them in property decision-making. There is a need for clarity in the selection of inputs into ROV models and the choice of stochastic processes for the valuation of flexibility.

“Education and then people changing their thinking, I suppose” (Local Property Valuer).

“This FPOM method would require a very powerful in-house analysis team if looking beyond the teams core skills, for example in our team’s case, residual development is our core knowledge base” (Large Development Company).
“I think I understand what you are trying to say about this. If I did have an understanding of how the numbers came about, that would help” (Large Investor-REIT).

“Education around how to use a model like this I think is a big barrier. Yeah, they are probably a bit tough for me; if I do not understand it I am not going to use it” (Global Property Valuer).

8.5.2 Highlight Benefits of ROA and ROV over Existing Valuation Models

While developing the knowledge of practitioners, it is equally significant to emphasise the contribution of ROA/ROV models to valuation outcomes as compared to the conventional valuation methods. Thus, the single numeric information derived from valuations using ROV models must demonstrate superiority to the results derived from the use of existing models. This will ensure that ROA/ROV is seen as a better model for potential adoption. Moreover, there are limitations of using any methodology in arriving at valuation results. Therefore, it would be important to highlight such shortcomings associated with the use of ROV models in order to guide users on the method. This is not surprising because scepticisms are generally associated with the introduction of any new methodology to the industry. The views of participants are captured below as;

“So, what I think will do very, very well is highlight to the use of the valuation and what the risks are which issues are important really going to make a difference in the value of the asset going forward” (Independent Property Valuer).

“You give more weight to the best guess outcome than the other scenarios and so to combine it all, I would want to know how many observations are down in there, within the positive part versus the negative part and if there is a bias, where is the bias?” (Large Investor-REIT).

“Basically, understanding how the market participants are pricing the upside and downside and its risks” (Global Property Valuer).

8.5.3 Involvement of other Stakeholders

A commonality identified among the valuers and developers regarding adoption of ROV models in practice is the role of key stakeholders. On the part of investor-developers, the adoption of ROV models would be dependent on the intended recipient of results from financial
feasibility models that uses ROV. Specific stakeholders may need to understand ROV models for the evaluation of financial feasibility of projects before approving it at the board level. Similarly, the valuers also indicated that until their clients start to demand the use of ROV models, they would stick to the already accepted methods. Thus, acceptance and integration of ROV models in Australian residential property development decision making would require the approval by these stakeholders, at least from the perspective of the investor-developers and valuers.

The developers and investors suggested it is common to find that Australian property development decision-making involves more than a single stakeholder in practice. In many instances, a team of professionals develop financial feasibility models for a specific project that is approved by a higher-level management team or investment board before commencing a project. As a result, the views of the developers suggested that adopting the ROV method in practice would depend on the knowledge of the stakeholders in understanding the ROV technique before accepting it as a basis for decision-making. Since the ultimate decision of approving a project before commencing investment is in the purview of the stakeholders, it is essential they have a very good understanding of the theoretical underpinnings of ROA and ROV models before accepting to use them for property development/investment decision-making.

“I think it is worth looking at closely and seeing how it might work and discussing with others within my business, what they think of this” (Large Development Company).

“I think decision makers need the parameters” (Large Investor-REIT).

“So as part of our submissions to the board...” (Large Fund Developer).

On the part of the valuers, property and financial advisors, the stakeholders are primarily, clients who order valuation reports such as banks, property development and investment companies and institutional investors. Their understanding of the whole valuation and advisory report after expression of opinion of value by a valuer is equally important because if clients do not understand ROV models, there is no basis to make a decision grounded on results from ROV models. In integrating ROV models in practice, it is essential to consider not just the main actors in property development. Several other stakeholders who are involved in decision-making must all understand the underlying theory of RO before practitioners may decide to use these models.
“As I said you going to have to figure out and find out, how the market feels about that because that’s going to impact value” (Local Independent Financial advisor).

“I am conscious that until the market starts looking at this or demand this, why would we offer up something?” (Independent Property Valuer).

“Yeah, it's because we are guided by regulations and our clients at the end of the day” (Local Property Advisor).

A major finding is that the developers and investors based their views regarding practical usage of ROV models on internal stakeholders (board), but the valuers and financial property advisors centred their arguments on external stakeholders (market). A major inference from this is that in the property industry, stakeholder objectives are different for different groups. It is therefore important to consider the intended recipient of a valuation or development feasibility report that uses ROV models in decision making in order to be able to receive the needed support for the adoption of RO in practical Australian residential property development decision-making.

This new finding shows that stakeholder support is important in order to achieve adoption of ROV models in Australian residential property development practice. Vimpari and Seppo (2015) argued that top management support is vital for achieving ROV practical adoption. This finding is a step forward as due consideration to other stakeholders when given is likely to ensure the needed support for ROV models in practice. Similarly, this finding is corroborated by de Neufville and Scholtes (2011) who suggest that top management buy in is important to ensure the adoption of ROA/ROV in practice.

8.6 Barriers to Adoption of Flexibility and ROV Models in Residential Development Decision-Making in Australia

In assessing the potential adoption of RO in practice, participants provided responses to questions relating to embedding flexibility in Australian residential property developments sector. The responses to the questions were related to area of specialization of the participant in the residential property sector. For example, property advisors had to respond to questions related to advising clients to adopt flexibility and use ROV models for the valuation of flexibility to justify initial investments, but valuers were asked to answer questions on the valuation of flexibility in practice using ROV methods and their views on adopting them in practice. Similarly, property developers answered questions related to embedding flexibility in their investments and potential use of ROV models to evaluate flexibility. Through the analysis of the responses provided by participants during the interviews, it was discovered that there are
several issues that could pose as potential barriers to the adoption of flexibility and hence the use of ROV models in practice.

### 8.6.1 A Vicious Cycle of Blame?

During the interviews and from the transcripts, it is evident that the stakeholders are willing to embed flexibility, albeit they have several concerns. These concerns mainly relate to the reactions of major stakeholders including the financiers, investor-developers, valuers and property advisors. The financiers indicated their willingness to offer financing for flexible investments. In their view, lending is fundamentally dependent on the profitability of flexible investments in property developments. Since costs associated with flexibility occur at the initial stage of development, it comparatively leads to higher initial costs for projects embedded with flexibility. The indication given was that, banks would not provide funding for the extra costs associated with flexibility unless developers take on these costs as part of their equity contribution to the specific project (this is dependent on the financing/capital structure for the development). In doing so, banks exonerate themselves from investments that seem unprofitable at the initial stage because the value of flexibility is contingent upon uncertainty in the market. The lack of acceptance of escalations in development valuations for debt funding by financial institutions further aggravates this issue. Thus, in essence, developers need to structure the financing arrangement in such a way that they bear the cost of flexibility because bank financing may be extremely difficult to obtain. Without bank financing, developers are handicapped because most developers borrow significantly to undertake and complete development projects. Thus, financiers are pushing the responsibility of embedding flexibility to developers.

“So, you’ve got money out of the door as sunk cost, you won’t get bank funding for it, unless you structure it someway that your equity becomes the sunk cost” (Local Independent Financial Advisor).

In practice, external valuers usually determine values of investment properties held by property investment/development companies. The investor-developers suggested that it is the opinion of value expressed by independent valuers on flexibility that is fundamental, because when disposing of the property, valuers usually advise clients on the potential value to pay/accept for a property. As a result, the investor-developers suggested that if there is value associated with flexibility, it is the responsibility of independent valuers to determine. The argument is that if values were ascribed to flexibility by independent valuers in practice, then embedding
flexibility in residential property developments would not be a difficult decision for investors. Thus, once value would be ascribed to flexibility during sale, it would be worthwhile executing it to recoup profits in future. Secondly, the investor-developers indicated that flexibility as a concept has not become a market requirement that will drive investments, but accepted as an in-house risk management strategy, flexibility may be valuable, though costly. One major inference to draw is that if independent valuers do not place value on flexibility, investor-developers will not bother embedding it in projects because they would not be able to recoup their investments in flexibility during sale of the asset. Thus, the investor-developers have shifted the responsibility to valuers. As far as developers are concerned,

“Valuers interpretation is also important because they provide an independent opinion assessment of property” (Large Fund Developer).

The valuers answered questions on how to determine the value of flexible investments during sale of assets. Valuers generally determine values of assets based on market data. As a result, valuers are generally interpreting the market using their technical knowledge rather than on their own assumptions. It is therefore not surprising the valuers suggested they would only consider the value of flexibility if the market accepts it. To this end, valuers are similarly shifting responsibility of determining value of flexibility (based on their knowledge of value drivers to reflect flexibility investments in assets) to market forces as the main determining factor.

“The question is, will the market? And if the market does, we would and if the market does not we would not” (Independent Property Valuer).

“The role of the valuer is to interpret the market” (Global Property Valuer).

Regarding the views of property advisors, the suggestion was that they could see the plausibility of the idea. However, the challenge is that investor-developers who are engaged in property developments and hold assets on long-term basis must be able to produce a feasibility report on the project that delivers superior return given consideration to the riskiness of a project in addition to cost of flexibility. Based on the superior return envisaged, the financiers may provide the capital required for flexible investments. They argued that flexibility certainly has value and they can give such an advice, but the ultimate decision to embed it is in the domain of investor-developers.

“They are not gonna want to see that and they are not going to recognise that” (Independent Local Property Valuer).
“The only thing with that development is that it's at a huge expense and typically even institutions need to get in a lot of finance and it’s just a matter of whether the feasibility are that because at the end of the day, that's what someone is going to lend on; because would somebody be able to produce enough revenue out of this to make the deal stuck up” (Local Property Advisor).

“I think a bit of theoretical exercise, it sounds fantastic, but when you consider the cost in terms of today’s value and the fact that buildings that are built today won’t be re-adapted until 30+ years, and an ownership of that change every 10 odd years so, you are asking someone to make a commitment who may not realise the benefit because the ownership of that asset may change 2-3 times before it becomes functionally obsolete” (Large Fund Developer).

Figure 8-2 illustrates the cycle of blame developed from the interviews. Starting from financiers to the property advisors, there is a blame game of pushing responsibility of embedding flexibility to a specific stakeholder by another. This leads to lack of action on the part of practitioners and affects the adoption of ROA/ROV models in practice.

**Figure 8-2 The Cycle of Blame in the Adoption of Flexibility/ROV in Practice**

Source: Author, 2017
In essence, this becomes a cycle where key practitioners are avoiding responsibility and passing on the blame to each other. This is similar to a vicious cycle of blame where the key practitioners are unwilling to take responsibility for initiating action on embedding flexibility in residential property developments. This could primarily be due to their differing objectives and non-aligned interests regarding their participation in the Australian residential property development market. This leads to unwillingness to initiate action on flexibility contributing to slow adoption of ROA/ROV models in practice. It thus suffices to say that such a cycle of blame also accounts for the inaction on flexibility in Australian residential property developments by practitioners leading to slow adoption of ROV models that are required for the valuation of flexibility. Since the major issue of researchers and academics regarding RO is the slow pace of adoption, the determination of this cycle of blame would unravel some of the hidden issues constraining the adoption of flexibility in practice, and hence the use of ROV models in the residential sector. The vicious cycle of blame derived from the interviews is summarised in the words of one of the investor-developers below in a quote;

8.6.2 Financing

Financing is a major issue that can negatively affect the adoption of flexibility in practice and hence, the use of ROA/ROV models. Property developments generally require a substantial amount of capital. As a result, most residential property developers seek funding from financial institutions for property developments. In providing funding, banks have requirements and conditions that Australian residential property development companies are required to meet before securing development loans. Thus, the banks exert considerable influence on the ability of property developers to execute projects and particularly when substantial funding is involved. The financial advisor indicated that the banks normally give funding based on the potential revenue from a development scheme. Since they expect to recoup their investments after completion of a project especially in the residential market, the lending will be based on achievable revenue from a project at completion without accounting for escalations. This could be a huge challenge that will pose a threat to the adoption of flexibility in practice. For example, a financial advisor suggested that,

“The only thing with that development is that it's at a huge expense and typically even institutions need to get in a lot of finance and it’s just a matter of whether the feasibility are that because at the end of the day, that's what someone is going to lend on; because
would somebody be able to produce enough revenue out of this to make the deal stuck up?” (Local Independent Financial Advisor).

The property advisors who are at the forefront of advising residential property developers on the viability of development proposals and doing feasibility analysis were also sceptical about the potential of achieving the projected revenues from flexibility because staging projects vertically over a period may not be feasible in the residential sector. This is compounded by the finding that banks do not accept escalations in financial models developed by practitioners as suggested by the local property advisor.

“So, it's still definite advice that we could give: doing development in stages is always more costly anyway, I wonder how often it would happen like this. Imagine buildings that get built specifically in stages because of the funding point of view; but they always not going to get there in the end” (Local Property Advisor).

No escalation in projected revenues in financial feasibility models means that flexibility may not have value because the value is tied to uncertainty in the market and the associated changes in property values over time. This view is corroborated by the developers and valuers who suggested that escalations have been discarded and variables in financial models use actual figures obtained from market information at the time of preparing financial feasibility models. Despite the escalation, the developers indicated that during the course of development, there is the likelihood of growth in property values and they re-visit estimates quite often to incorporate changes and alter decisions during project execution.

“So, one thing about that is that, for mortgage security purposes such as the banks they don't want us to escalate- they don't want any escalation in anything. They don't want any growth in construction cost and they don't want any growth in house apartment prices or whatever you are doing” (Financial Advisor-Bank).

“We're not putting escalation into models at the moment. The view's been taken by the business right now when we do models that we don't build any escalation of cost or revenues into it” (Large Development Company).

“For some reason and I don't necessarily agree with it but for some reasons when the industry is looking at development cash flows, it tends not to inflate future revenues as the land gets developed. I don't know why, it's just the practice that has become common in valuation work” (Global Property Valuer).
8.6.3 Planning Issues and Disturbance to Existing Tenants

In demonstrating flexibility in residential development, a tower that could be constructed in phases was used as a visual aid, for example as shown in Appendix E, participants provided feedback on the potential of embedding flexibility in the sub-structure of a residential tower. Exercise of the flexibility may occur in future when the timing is right depending on market conditions. Participants raised concerns about potential disturbance to occupants at the time of construction when the flexibility is exercised in future. As to whether it is possible to continue the construction while the existing tenants peacefully enjoy their stay is an issue that poses a challenge to flexibility in practice. This is important due to the regimented nature of the planning system in Australia. Two key things can be deduced from the responses from participants; that the planning authorities may not give consent to such a development and even if they do, there is the possibility of the market rejecting such an idea due to disturbance of tenants’ quiet enjoyment. Even though planners are encouraging flexibility in the commercial market space as indicated earlier, it seems tricky in the residential sector.

“There will be a lot of concern about this. The concern will be disturbing the existing tenants when it comes to time to do that” (Large Superannuation Fund).

“So, design flexibility, is still depending on planning” (Local Independent Financial advisor).

“It would be more around the planning controls and the practicalities to come and build a 21st through 30th floor on top of a completed structure. I think that is where the big issue would lie is in that” (Large Development Company).

8.6.4 Design Obsolescence

It is widely accepted that consumer tastes and preferences change over time. Similarly, specific type of housing designs varies with changes in consumer tastes and preferences over time. Designing the delivery of housing using horizontal staging is already practically possible. However, vertical phasing delivery in the housing market may experience issues such as changing trends in consumer tastes and preferences where some designs can become obsolete with time. Flexibility embedded in property developments has a long-term perspective. As a result, any design that considers flexibility using current designs may experience design obsolescence. Since building shells change and premium designs become obsolete with time, it is important to determine a way to design a high-rise building that incorporates flexibility in
such a way that it can respond to changes in tastes and preferences. Otherwise, at the exercise of a flexibility, there is the possibility of a project suffering from functional obsolescence. Participants including the local independent financial advisor, representative from large development company and local property advisor agreed that design obsolescence can hinder the adoption of flexibility.

“What is the likelihood of my product that I designed based on feasibility doesn’t become obsolete? (Local Independent Financial Advisor).

“Then another issue is that this opportunity might be relevant for a time period: the design obsolescence for the balance of the building, whether the rises are adequate for new technology and changes and the bits and pieces. So, there are considerations that are related to the building design specifically” (Large Development Company).

“What is feasible and what is acceptable to the market” (Local Property Advisor).

8.7 Summary

Chapter eight of the dissertation generally focused on determining the requirements necessary for the adoption of ROA and ROV for the valuation of flexibility in practice. Beyond this broad aim was the assessment of required rate of return (discount rate) as the main rate for representing risks in Australian residential property development. Further, this part was also to explore how ROA can provide justification for investments in flexibility in practice. Another objective of this qualitative part was to assess the receptiveness, acceptance and determine the requirements necessary for integrating ROA and ROV into practical financial feasibility analysis of Australian residential property investments and developments. There may be some theoretical and practical barriers hindering the adoption of ROA and ROV by practitioners.

Using an interview guide, the face to face semi-structured interviews allowed the researcher to ask probing questions to deepen understanding of issues in the Australian property industry regarding the adoption of ROA and ROV for financial feasibility analysis of residential property development/investment projects in Australia. It also led to unravelling of important issues that needs consideration to drive the adoption of ROA and ROV by practitioners.

The data from the transcripts reveals that contrary to the general theoretical position that required rate of return (discount rates) are used to compensate for risks and uncertainties in residential property developments, contingency is rather adopted by investor-developers to
deal with risks by assigning specific amounts from the contingency to line items in construction budgets. Emerging opportunities after commencement of a project are deemed as an inevitable part of residential property developments. Thus, while delaying project sales or lease can be profitable, investor-developers are better off with pre-sale/pre-leased contractual agreements. On the issue of justifying initial investments in flexibility, most of the participants agreed that there is value associated with flexibility. However, the process of and methodology for determining the value of flexibility was inconclusive. Different professional groups of participants had different suggestions as to the process of determining the values associated with flexibility. Even among the same professional group of participants, the results were not uniform.

Participants had a positive view about ROA and ROV’s adoption in the property sector albeit some reservations and scepticism. On the acceptance of ROA and ROV for decision making in the property industry, participants appreciated the benefits of ROA and ROV for decision making but required some solid theoretical understanding of the methodology. Acceptance also hinges on the views of stakeholders (investment committee, clients, board of directors etc) who are decision makers based on numeric outcomes of applying financial feasibility models for evaluation. The practical adoption of ROA and ROV would require overcoming barriers including vicious cycle of blame, financing of initial investments in flexibility, planning, and design obsolescence.
Chapter 9 Practical Implications and Application of Real Options to Australian Residential Property Development Market

9.1 Introduction

This Chapter focuses on a discussion of results of the entire dissertation and its implications for practice, particularly for the Australian residential property sector. It begins with an introduction to give readers a background to the Chapter. Subsequently, the results are presented sequentially using the order of the various Chapters beginning from Chapter Four (4) because these Chapters capture the outcomes of the dissertation. Figure 9-1 demonstrates a summary of the Chapter coverage using a flow chart.

Figure 9-1 A Flow Chart of Chapter Coverage

Source: Author, 2018
As shown in Figure 9-1, the result is grouped under three main headings; the conceptual framework, quantitative modelling of case studies using ROV models and qualitative section to capture the views of leading property practitioners. Figure 9-1 also shows a breakdown of the conceptual framework into two. The first which is a categorisation of real options based on the property development process and a flow network as a risk management tool for managing property development projects under conditions of uncertainty. The second part of the results which deal with quantitative ROV application to selected case studies is divided into three main areas for the discussion including staging option modelling, delay option evaluation and switching output option. The qualitative section is similarly divided into three parts; requirements for integration into practice, receptiveness and acceptance of ROA and barriers and challenges to the adoption of ROA and ROV in practice. Subsequent to the presentation is a discussion of overall implications of the results for practice in the Australian residential property sector. The Chapter ends with a summary of key points from the discussion.

In Chapter Four, a conceptual framework for categorising different types of flexibilities in residential property development in Australia was developed to enhance the understanding of Australian property practitioners on embedded flexibilities in the property development process. All flexibilities naturally embedded and those that can be deliberately created by practitioners and stakeholders through strategic flexibility analysis were grouped and categorised based on a generally accepted property development process in a flow network approach using investor-developers as the unit of analysis. The categorisation covered flexibilities beginning with the initiation stage of property development until the leasing or disposal phase after completion. The widely accepted staged property development process (Reed & Sims, 2015) was adopted for the categorisation in order to make the results generalizable.

In this dissertation, the financial feasibility of selected medium to high rise residential apartment developments have been examined as case studies. These case studies were used to test the application of ROV models for the valuation of flexibility and determine values attached to flexibility as a way of strategically managing Australian residential property developments under conditions of uncertainty. Three case studies were used to demonstrate strategic ways of managing Australian residential property development projects through flexibility and determined values attached to flexibility in practice. The first case study was about staging flexibility of 242 dwellings spread in units of medium and high-rise apartments and houses developed on a greenfield site. The other two case studies were a waiting to invest
or delay flexibility and a switching output flexibility, both in high rise brownfield apartment developments.

In residential property development in general, a decision by a property developer (except certain public entities and charitable organisations) to initiate and execute a project is primarily based on the outcome of financial feasibility. As a result, the application was extended to cover the financial feasibility evaluation of flexibilities embedded within each of the selected case studies. Since evaluation of financial feasibility of flexibilities required the use of ROV models, three different ROV models were adopted to evaluate the value associated with selected embedded flexibilities in the different case studies. ROV models including FPOM, CE-BOPM and Samuelson-McKean Equation were used for evaluating the flexibility to stage, delay and switch output respectively. Results from the financial feasibility evaluation were used as the basis to argue that ROV models are applicable to property development projects in practical settings. Thus, evidence needed to inform practitioners in the Australian residential property development sector on the application of ROV models is delivered in these three cases studies.

Financial feasibility evaluation of similar case studies with embedded flexibilities have been studied in countries such as USA (Greden et al., 2005, Greden & Glicksman, 2005), UK (de Neufville et al., 2006), Italy (Baldi, 2013), China (Leung & Hui, 2002) and Finland (Vimpari et al., 2014), yet practical adoption of ROV models for decision making in the property sector is still limited. Within the Australian property market, informal discussions held with practitioners indicated that some of them have heard about the method but have not adopted it in practical decision making. Therefore, the practical application of ROV models for the valuation of flexibility has demonstrated the models’ applicability to cases in practice.

It was further argued that case studies alone may not be enough to achieve adoption of ROV models in practical decision making. As a result, this dissertation sought further insights into the requirements to achieve practical adoption of ROV models for decision making in Australian residential property development. This aim was achieved using semi-structured face-face interviews to elicit responses from practitioners. The responses from twelve (12) practitioners composed of valuers, investor-developers, property advisors and property financial advisors have been analysed and major inferences drawn from the responses to suggest recommendations and reach conclusions. In subsequent sub-sections of this Chapter, the results and discussion of the practical significance of the conceptual framework, case studies and the major inferences drawn from the face to face semi-structured interviews of the dissertation are presented. Furthermore, requirements for integrating ROV models into
mainstream property financial feasibility evaluation are also discussed in addition to the practical implications of the dissertation. Finally, a summary of the findings and discussion is presented.

9.2 Conceptual Framework

It was evident from the conceptual framework that there are different types of flexibilities embedded at different stages of the Australian residential property development process. Whether the flexibility is a put or call land development option in nature for the purposes of ROV modelling, it was argued that is dependent on how a specific flexible strategy is adopted to deal with potential future risks and uncertainties in development. The property development process was divided into four and flexibilities embedded at different stages were categorised into their respective calls and puts and linked to the development process stages. It was also argued that the conceptual framework can serve as a strategic tool for risk management in property development. The framework captures all the flexible strategies available to Australian residential investor-developers from inception of a development project until completion. This corroborates the conceptual framework developed earlier (Baldi, 2013) as a practical aid for summarising the most common flexibilities available to developers. It further justifies the development of an alternative framework that captures other options embedded in property development projects upon completion for achieving long term property performance. The difference is the staged-like conceptualisation in a flow network approach of the newly developed framework as opposed to Baldi (2013)’s matrix classification developed earlier.

9.3 Results of DCF Financial Evaluation of Case Studies

Initially, DCF technique was used to examine the financial feasibility of the three residential development projects without flexibility. Subsequently, ROV models were used to evaluate the financial feasibility of the three case studies embedded with flexibility. The NPV and IRR for the first case study project was calculated as $-2,069,925 and 18.65% respectively. Similarly, the financial feasibility evaluation of the second case study development project resulted in NPV of $-4,717,168 and IRR of 9.1%. The negative values are as a result of the high IRR that was expected by the respective developers of the projects. These two projects would have been rejected initially by the respective developers as postulated by DCF technique’s rules of decision making. In practice, it is possible that similar proposed residential developments with negative NPVs are being rejected without examining the future potential of
such projects under different market conditions (upside and downside potentials). Even if developers might hold them for a while, it will be based on intuition and experience without a rigorous scientifically proven approach.

In the third case study development project however, financial feasibility evaluation was conducted for two proposals; the original idea of residential apartment and a switching proposal without flexibility using DCF technique. The results from DCF modelling indicated that the original plan was financially viable with profitability potential of about $1,189,411 and IRR of 11.5%. The switching proposal without flexibility resulted in NPV of $2,468,479 and IRR of 12.95%. The two proposals were financially profitable albeit the switching proposal with higher profitability. Thus, the switching proposal would have been accepted by the developer and executed based on the DCF rules of decision making.

The initial potential rejection of the two case studies with negative NPV means the developers would not consider the future potential of the projects and the flexibility/optionality embedded in those developments. Therefore, developers that rely on results of DCF technique alone for decision making are most likely rejecting several residential development projects that may become financially feasible under favourable market conditions due to uncertainties and volatility in the Australian residential property development market. The NPV computed in the third case study was positive, but it did not account for the value of options/flexibility that existed in the project. Thus, despite the results demonstrating profitability potential, practitioners are missing out on the higher profits resulting from strategic flexibility/options analysis as opposed to using DCF without considering the value of flexibility.

9.4 Results of ROV Financial Evaluation of Case Studies

9.4.1 Staging Option

The first case study focused on embedding staging flexibility in land development through the payment of an extra $344,288 as land holding costs to retain the rights to develop other parts of the project in future. A percentage increase of 5%, 10% and 15% was assumed for three different scenarios (minimum, most likely and maximum) and were used in the FPOM for escalating the initial expenditure needed to embed the staging flexibility into the development. Profitability associated with investing in the staging flexibility using ROV model was calculated to be $13,949,148 representing 11.40% on the undiscounted cost of the residential project resulting in an option premium of about 2.7%. The real option value represents the
potential of the residential property development project to be profitable, which is primarily due to the value associated with the management flexibility of staging the project over a period. Through staging, developers are expected to develop only profitable phases of a project and abandon parts that are unprofitable. Within the process of ROV modelling, phases that are unprofitable are not added to the evaluation because they are assumed to be abandoned by the developer. This is the strength of ROV modelling and weakness of DCF because it is unable to model the realistic expected decision of developers through management flexibility. The FPOM realistically modelled this flexibility and incorporated it in the valuation to determine the financial feasibility rather than assuming a static approach to the management of such a large scale residential development project. Geltner and de Neufville (2012) evaluated a similar large scale urban development project in Seoul, South Korea and derived similar results, suggesting that ROV models can complement existing valuation models to deliver better results. The use of the FPOM and Australian case study differentiates the current application. Furthermore, this is the initial application of the FPOM to a horizontal staging option embedded in practical residential property development project in Australia, making it an original contribution to knowledge/literature on real option theory.

9.4.2 Delay/Deferral Option

The aim of this application was to determine the optimal time for the developer to begin construction to maximise the residual value of the land. This case study was used to demonstrate the value attached to the flexibility of waiting to invest in a residential apartment tower with about 143 units in the apartment building. Results from the use of the two different techniques (DCF and ROV) for the financial feasibility evaluation of the residential development was compared. Initially, results from DCF modelling indicated that the project was financially not feasible. The CE-BOPM was the ROV model used to evaluate this case study. The flexibility to delay evaluated in this case study was likened to an American call option on the project and was determined to be $290,000. The value determined using the ROV model was positive as opposed to the negative value derived from using the DCF. A negative NPV under DCF suggests that the project should have been rejected initially. However, the real option value associated with flexibility was positive suggesting that the project has the potential to be financially feasible in future. This demonstrates the ability of ROV models to realistically evaluate development projects with embedded strategic flexibilities. It was also argued that
ROV of $290,000 was not high enough to compensate for giving up the option to delay and commence development. Thus, at ROV of $290,000, it was not optimal for the developer to exercise the flexibility or option. The optimal point for the developer to start construction was also determined in this case study for developers to know exactly when to capitalise on the upside potential associated with the project. In the literature on flexibility or real options in property development, Guthrie (2013) evaluated a deferral strategy in a dynamic two staged approach using a greenfield case study. Similarly, Baldi (2013) used a greenfield case study in Italy to demonstrate the value attached to the flexibility of deferring the commencement of a mixed use project. The findings in this dissertation are similar that of those earlier studies where some property development projects deemed unprofitable turned profitable after they were re-evaluated using ROV. This is an initial application in Australia that uses a brownfield site as a practical case study.

9.4.3 Switching Output Option

The aim of the third case study was to test the application of ROV model to the evaluation of switching output flexibility purposefully designed to deal with future uncertainties associated with a residential project. In recent years, Melbourne has witnessed widespread development of high-rise apartments both in and around the city fringes to supply the housing needs of a growing population. The growth in population is partly due to the emergence of Australia as an attractive destination for tertiary education leading to the influx of international students. Despite this growth in population and demand for housing, there is quite considerable uncertainty surrounding the future population growth and possible over-supply of residential apartments. As a result, there is the need for investor-developers who instigate and hold developments as part of portfolios to develop strategic initiatives to deal with future uncertainty.

A strategy proposed was the switching output from residential apartment to student accommodation in the future should demand decline in the apartment market because there is huge shortage of student accommodation in Melbourne and Australia in general. This is achieved by embedding flexibility in the residential development from inception of the project by spending extra on the sub-structure to retain the flexibility to switch use as a future opportunity. Justification of an extra expenditure in the development was not straightforward in the DCF technique as the value is hidden in uncertainty. As a result, a ROV model (Samuel-McKean equation) was used to justify the extra initial expenditure in embedding the switching
output flexibility in the residential development. The results indicated that ROV of the switching flexibility was valued at $11,481,445.

Comparatively, the value derived from the ROV is higher than the DCF even though they are both positive. This is despite the extra initial expenditure to be incurred to retain the flexibility. Therefore, should the investor-developer embed the switching output flexibility, the projected benefit associated with the flexibility would outweigh the initial extra investment. Similar results were derived by different leading researchers (Leung & Hui, 2002, Paxson, 2005, Trigeorgis, 1993a) thereby confirming that flexibility to switch use embedded in property development is valuable and must be accounted for in project financial feasibility analysis. The current case study proposed a switching output flexibility in an Australian residential property development case study at the initial application stage. As already indicated, the practical applications of ROV models to selected case studies from Australia is in response to the recommendation for further research by some leading authors on real options in property development (Geltner & de Neufville, 2012, Vimpani, 2014). Therefore, these applications extend the literature on flexibility/options and provides a rationale and justification for practitioners to invest in flexibility and use the right tools for valuation of flexibility.

9.5 Requirements for Integration

Besides testing the application of ROA and ROV models in determining values attached to flexibility embedded in Australian residential property development projects, practitioners were interviewed on the requirements for integrating ROA and ROV models into mainstream property development valuations and practical decision making. On the integration of ROA and ROV models in Australian residential property development decision making, one of the most important factors is the justification of extra initial expenditure in flexibility to retain upside opportunities. The views of different practitioners on how to justify expenditure in flexibility was purely based on cost-benefit analysis which is line with ROA because the theory postulates a comparison between costs of embedding flexibility with potential future upside benefits to determine future profitability for decision making. This presupposes that should practitioners have a better understanding of ROV models based on similar cost-benefit analysis, practical adoption could possibly be achieved. The challenge is the possibility of expending money on flexibility without immediately realising the profits, thereby committing expensive equity capital to projects over a long period.
Secondly, the determination of value that would be ascribed to flexibility is a major concern for investor-developers. This is not surprising as in practice most of these decisions are approved based on valuations. It is the process of and techniques for determining the value associated with flexibility that was unclear to most of the practitioners. The valuers suggested that values associated with flexibility would be determined based on the opportunity cost of spending extra amount against the value of flexibility. A view from one of the valuers was that it would be how much can be saved by expending on flexibility at inception stage of a project as against potential future cost of redevelopment. Another valuer indicated that the valuation of flexibility could be determined via calculating the potential future value of an embedded flexibility in an upside state of the respective property market within a reasonable time frame, convert it to present value and compare it with the cost of flexibility at the inception stage. These differences in responses regarding the process of and techniques for evaluating flexibility could also hinder adoption of ROA and ROV in practice as there is uncertainty surrounding the valuation of flexibility among practitioners.

As part of investigation to determine potential adoption of ROA and ROV in practice, the receptiveness and acceptance of RO theory was evaluated among practitioners. Practitioners received ROA concepts and ROV models by revealing the benefits of the distributional and probabilistic approaches adopted, over current valuation models such as DCF which uses a single number estimate without incorporating uncertainty analysis. Practitioners indicated that the assignment of probability towards an outcome and knowing the boundaries of potential profitability in ROV models improved both uncertainty assessments and profitability analysis. Furthermore, some practitioners indicated that they are familiar with selected case studies that have embedded flexibility in practice though unaware of the process of and techniques for their valuations. These practical case studies are encouraging signs that ROA theory could be adopted in property development decision making. The acceptance of ROA and ROV was not unanimous because some of the practitioners had reservations about how some inputs in ROV models are derived for computation. Moreover, the computation of probabilities was also deemed to add a level of complexity to financial feasibility evaluation of property development projects. As a result, practitioners who had reservations indicated that the DCF technique is good for its simplicity in the current decision-making environment. Therefore, it can be inferred that simpler ROV models may be preferred to those deemed complex.

Practitioners suggested that to achieve adoption of ROV models in practice, it would require the involvement of stakeholders who are part of decision making in property investments and
development. The responses revealed that the valuers, property and financial advisors are generally concerned about their clients’ ability to understand theoretical propositions of ROA and ROV models. The developers and investors on the other hand indicated that stakeholders such as people on their investment committee and development analysts must understand RO theory and ROV modelling before adopting them in practice. As a result, it is important to educate property practitioners and stakeholders on the theoretical underpinnings of ROA and use of ROV models in practice due to limited knowledge. This can be achieved through continuous professional training and development.

It was determined that there is a cycle of blame among practitioners regarding investments in flexibility. Financiers are willing to provide funding for flexibility if proven to be profitable. Investor-developers are ready to invest in flexibility if value can be ascribed to flexibility by independent valuers. Similarly, independent valuers suggested that their job is mainly to interpret the market and would price flexibility in valuations depending on the market reaction towards it. The property advisors indicated that giving advice on flexibility is not a difficult exercise but there is the need for it be financially feasible. Thus, integration of ROA and ROV in property decision making would require breaking the cycle of blame recurring among practitioners by analysing the valuation of flexibility from the different practitioner perspectives just as prevailing in the industry currently where the purpose of valuation impacts on final value of property.

9.6 Implications for Practice

The use of DCF in practice is possibly resulting in the potential rejection of several projects that might be financially viable in future due to the positive upside associated with uncertainties. Again, the use of DCF for financial evaluation of projects naturally embedded with flexibility results in developers missing out on several potential future opportunities. Since DCF is unable to properly account for the stochastic changes in asset values over time, the resulting numeric NPV figure biases the results and leads to sub-optimal decisions by rejecting some strategic projects. The first case study has demonstrated the potential of a large scale urban residential development project becoming financially feasible using the staging flexibility approach. It also demonstrated the risk mitigation approach of RO theory through management flexibility rather than the use of required rate of return (discount rate). In practice, phases of projects that are unprofitable can be abandoned. The different phases of the project determined to be profitable were indicated to the developer for execution. On the other hand,
unprofitable phases were deemed to be abandoned by the developer to mitigate overall risks through the ROA framework. This is contrary to the DCF evaluation which would have evaluated the entire project as a complete unit without considering flexibility/optionality analysis under different property market conditions. These are not reflected in current financial modelling using the existing valuation techniques, leading to potentially serious errors and inability to account for stochastic nature of property values. Since Australian residential property developers would likely abandon phases of residential development projects that are unprofitable in practice, it is argued that strategic ROA coupled with ROV modelling should be adopted for financial feasibility evaluation of Australian residential property developments that have embedded flexibility. ROV models adopt strategic thinking combined with market analysis to produce a single numeric information relevant for decision making by Australian residential property developers.

The second case study similarly, considered the flexibility to delay the commencement of a residential project which was deemed to be unprofitable under the DCF technique of evaluation. Using the DCF rules of decision making, such a strategic project with future profitability potential would have been rejected. However, a favourable (rising property prices) change in market conditions which is observed quite frequently in the Australian residential apartment development market would change the profitability potential of the project. ROV modelling was able to consider these potential property price changes, both in rising and declining property markets for financial feasibility evaluation. Property practitioners therefore need to consider all future possibilities of future values of property projects before discarding a potentially profitable project.

The consideration given to potential upside and downside property values in the ROV modelling results in an unbiased estimate of the profitability potential of development projects. Strategic flexibilities embedded in projects are also capable of improving risk assessments. In particular, the demonstration of the project to become profitable at a specific time in future based on market dynamics enabled the developer who participated in the project to appreciate the significance of the waiting to invest flexibility/option. In practice, within the Australian residential apartment development market, it is suggested that since developers normally engage in presales before construction begins, such strategic initiatives could be adopted to capture upside potential during the presales period. This must be factored into the financial feasibility evaluation from inception of a project to ensure that risks of both upside and downside are all incorporated into a profitability analysis.
The potential of switching the current use of a building to an alternative one through embedding flexibility from inception was proven to be valuable using the ROV framework. A justification was also provided in this case study for an extra expenditure on flexibility through flexibility/options analysis to deal with future risks. Switching a residential apartment building to a student accommodation though has not been tried, was proposed as a hedge against potential decline in demand in the residential apartment market. This flexibility was embedded to serve as risk mitigation strategy to deepen uncertainty assessments. In this case study, risk assessment was not concentrated on tweaking required rates of return (discount rates) in tandem with the level of perceived risks associated with a project but through both quantitative and qualitative analysis/strategic flexibility. Justification of initial expenditure in flexibility was important for practitioners who were interviewed during the face to face semi-structured interviews. They argued that stakeholders who approved property developments and investments would require such a justification through profitability analysis. Since justification for initial extra investments in flexibility has been provided in this case study, it extends the breadth of enquiry of ROA and ROV and delivers another evidence of the practical application of ROA and ROV models in the Australian residential property development market. It is envisaged that with these evidences, practitioners would embrace RO theory in decision making in residential property developments. In practice, such a switch may be difficult to do from the perspective of developers who are trader-developers. However, for investor-developers who are holding assets for a considerable period in their portfolios, these decisions can be very critical to risk management strategies. These applications therefore serve as important demonstrations of the use of option pricing techniques in the real estate and construction sector in the Australian residential property development market needed to support the adoption of ROA and ROV techniques in practice as suggested (de Neufville & Scholtes, 2011, Geltner & de Neufville, 2012, Vimpari, 2014).

The different flexible strategies that can be adopted by property practitioners in the Australian residential property development market have been discussed and captured in a conceptual framework based on property development process. In practice, the conceptual framework enhances the understanding of practitioners of flexibilities embedded at respective stages in the development process. Since practitioners have indicated that a good understanding of RO theory and its associated valuation is a prerequisite to adoption, the framework becomes an essential development towards enhancing and deepening practitioners understanding for practical adoption in property development decision making in Australia. It demonstrates
where and what flexible strategies can be adopted during the process of property development from the perspective of investor-developers. The need for a framework that deepens the understanding of practitioners cannot be over emphasised as RO theory is still at the early stages of development in the property and construction sector. The framework corroborates the findings of Baldi (2013) but differs in respect of the staged-like conceptualisation and the use of the entire property development process in a flow network for improving risk analysis.

To enhance the potential adoption of ROA and ROV in practice, practitioners must be educated on the theoretical propositions of ROA and be trained on the use of ROV models through continuing professional development, seminars and conferences. During the training, it is important to highlight the benefits and weaknesses of ROA and ROV to inform practitioners on the merits of ROA and ROV models over existing valuation methods to entice them to consider applications for decision making in practice. Without discussing the benefits of ROV models over current models, practitioners would probably not appreciate the need to learn a new valuation approach when the existing techniques can serve their valuation needs. For example, ROV models give a weighting towards an outcome which is better than DCF from risk management perspective. Similarly, there is the need to discuss the weaknesses of ROV models for practitioners and stakeholders to determine ways of overcoming the limitations through qualitative and other subjective means.

The training should also include stakeholders; both internal and external such as executives who are part of investment and development committees as well as other market participants who employ the services of valuers and property advisors. This is important because most of these executives and clients would only accept results of ROV application for decision making if they understand it. Clients who employ the services of valuers and property advisors expect practitioners to use existing models, especially the DCF technique, because that is what the market accepts. In this regard, should stakeholders accept to use ROV models in property development decision making, practitioners would be required to use same techniques. The reason is that property valuers and advisors are reliant on clients for contracts whereas developers and investors need executives’ approval before project acceptance and execution. Therefore, stakeholders’ involvement is crucial to the adoption of ROA and ROV in practice.

Since some of the practitioners thought that ROV models introduce extra level of complexity which corroborates an earlier argument (Oppenheimer, 2002) through probability analysis, the models must be centred on simplicity in order to achieve adoption. In this sense, the simple, yet novel FPOM must be emphasised because of its use of triangular distribution, which
practitioners and stakeholders are already using in practice in scenario and sensitivity analysis. It is possible that their familiarity with the triangular distribution would generate interest in and acceptance of ROA and ROV in practice. Besides, the FPOM does not require knowledge of probability theory to calibrate and construct value evolution of property asset for ROV computation. As a result, FPOM is simpler for practitioners to be able to use for decision making.

In general, property development decision making is profit driven and hence, practitioners and stakeholders are normally influenced by the profitability potential of residential projects before execution. As a result, ROV modelling has also focused on determining the profit potential of projects in line with industry requirements. However, responses from participants indicate that ROV modelling should also focus on potential savings that can be generated from investments in flexibility in future. Focus should be on those flexibilities that are able to reduce the overall costs of development projects in future through extra initial investments. This has been demonstrated in a project in China (Leung & Hui, 2002) where though the project was not bound to make significant profits, there was potential savings from investing in flexibility. Since these applications are an initial introduction of ROA and ROV to the property and construction sector in Australia, it is argued that subsequent case studies should explore this area.

Investor-developers are at the forefront of property development and investments in the Australian residential property development market, hence, would potentially be the first group of practitioners to accept and begin investments in flexibility to drive ROA and ROV in practice. However, there is the need for the valuation profession to give a level of certainty to the property investment and development community regarding values associated with flexibility. For example, staging flexibility in vertical expansion should have values ascribed to the undeveloped space above, before investors and developers would consider extra investments in substructure to retain the rights to develop the airspace in future. Since banks rely on valuation reports to determine the profitability of investments before providing debt funding for Australian residential development projects, the role of valuers is critical to the adoption of flexibility in practice. Similarly, property advisors also depend on valuation outcomes to provide client advisory services to the property development community. It can be argued that the adoption of flexibility in practice would be greatly dependent on the valuation community recognising values attached to flexibility. If valuers recognise the values
attached to flexibility, this will trigger investments which would also require the use of ROV models to evaluate, resulting in breaking the cycle of blame, leading to adoption in practice.

9.7 Summary

A framework developed for categorising flexibilities based on theoretical review and practitioner’s validation in the Australian residential property development market using property development process is a step towards deepening practitioners understanding. The categorisation captured the entire property development process in a flow network and grouped the different types of flexibilities as either call or put options for ease of valuation. Three case studies have been used to prove that ROV is applicable to selected case studies in the Australian residential property development market. Justification for high initial expenditures for retaining flexibility has also been achieved. Furthermore, ROV models have proven to deliver superior results than DCF technique by incorporating uncertainty analysis and considering several possibilities. However, ROV models are an extension and not a replacement for DCF technique because initial values used in developing the distribution of figures based on which flexibility values were calculated which were derived from DCF output. To this end, ROV can complement DCF in financial feasibility analysis of residential property development projects for better outcomes.

The evidence suggests that the main tool for financial feasibility evaluation of Australian residential property developments (DCF) is unable to capture the value of flexibility embedded in active management of property development projects. As a result, developers are potentially rejecting financially viable projects. Flexibilities such as a deferral strategy until uncertainty is resolved cannot be evaluated in the DCF framework. Similarly, in the staging flexibility where specific phases of Australian residential property development projects can be valued separately through stochastic evolution of property prices, the DCF evaluation method was determined to be inappropriate for the valuation. In the switching application however, DCF valuation resulted in profitability but lower than the values derived from ROV modelling. Evidently, the profitability levels derived from ROV valuations are better than DCF method due to the stochastic processes which accounts for possible future changes in property values and the flexibility to capture emerging opportunities and deal with downside risks.

ROA and ROV have provided a rationale needed to account for the value of strategic flexibility in Australian residential property developments and valuing them as part of financial feasibility analysis. Such strategic planning using management flexibility in residential property
developments/investments enables developers and other practitioners to determine their potential future actions as uncertainties resolve and information becomes available. As a result, property practitioners in the Australian residential property development market needs to reconsider their development financial feasibility evaluation approach and decision making in the face of uncertainties.

Several factors have been identified as the potential issues to resolve before ROV adoption could be achieved in practice in the Australian residential development market. These include educating and training practitioners and more importantly, stakeholders on RO theory and ROV modelling because they are at the helm of decision making in property investments and developments. The valuation community has been identified as having the responsibility of recognising values attached to flexibility to ensure certainty among practitioners towards driving investments in flexibility. Moreover, ROV modelling needs to be simplified to meet the expectation of practitioners as well as highlight the potential benefits of ROV models against existing valuation technique (DCF).

Table 9-1 shows three main divisions for this Chapter. Since the Chapter is basically a triangulation of the two main parts of the dissertation, Table 9-1 basically captures the different sections, their outcomes and practical implications as a summary of Chapter 9. There are three main sections: conceptualising real options through the framework and risk management tool; a quantitative section, which captures empirical applications of ROV to selected case studies; and qualitative section, which encompasses requirements for integrating real options in practical property development and valuation decision-making. There are various sub-sections captured under these broad sections with their specific outcomes and practical implications demonstrated in Table 9-1. For example, the risk management tool provides a new visual tool for risk management of property developments through real options framework. It demonstrates the superiority of real options theory over DCF in terms of property development risk and uncertainty analysis for better decision-making. Similarly, in the quantitative section, ROV results show profitability greater than results of DCF valuation, implying that ROV is applicable to case studies in empirical settings.
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<td>Conceptual framework</td>
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<td>Risk management tool</td>
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<td>Shows the superior risk management attribute of ROA theory as opposed to DCF and demonstrates the type(s) of options for risk management at different stages of property development process</td>
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<td><strong>Quantitative Section-Empirical Application of ROV to Case Studies</strong></td>
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<td>Deferral option</td>
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<td>Justification of flexibility investment</td>
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<td>Flexibility valuation</td>
<td>No consensus on appropriate methodology but valuation community is expected to ascribe value to flexibility</td>
<td>• Current valuation approaches are not capable  • The valuation community is responsible for valuing flexibility</td>
</tr>
<tr>
<td>Receptiveness and acceptance of ROA &amp; ROV</td>
<td>Positive but scepticism prevails</td>
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<td>Requirements for practical integration of ROA and ROV in practice</td>
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<td>• Key stakeholders must accept ROA/ROV  • Practitioners are yet to fully understand ROA/ROV  • Further case studies are needed for evidence  • Highlight ROA’s superior results over existing models</td>
</tr>
<tr>
<td>Potential barriers to adoption of ROA and ROV in practice</td>
<td>• Cycle of blame  • Financing  • Planning regulations  • Obsolescence</td>
<td>• Action is required  • Developers/investors would have to finance flexibility  • Planning approval is crucial in the residential sector  • Designers must focus on flexibility to accommodate design changes</td>
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Source: Author, 2018
Chapter 10 Conclusions

10.1 Introduction

This Chapter presents outcomes which are responses to the objectives of the dissertation. It embraces the findings from the literature review which revealed the gaps in knowledge and substantiated the need for this dissertation in respect of the application of ROV models to empirical case studies of Australian high rise residential property developments and the face to face semi-structured interviews to investigate factors required for possible integration of ROA and ROV models into decision making. The conclusion links the research findings to the research questions and positions it within the extant literature on RO theory and property development.

The dissertation critically evaluates the financial feasibility of selected residential property development case studies using ROV models with the aim of expanding the breadth of enquiry of RO theory in property development and improving the method because it is still at the early stages of development. These applications were important to determine areas where ROV models were applicable in practice and vice versa. Since ROV models are yet to be adopted for decision making in practice, factors that could enhance practical adoption were critically investigated because it is believed that the views of practitioners who are ultimate users of ROA and ROV models in practice are pertinent. The remainder of this Chapter has been divided into six sections. It comprises of a summary of the research, conclusions, contribution to knowledge, validity of the research, recommendations and areas for further research.

10.2 Summary of Research

High rise residential property developments in Australia are vital to support the growing population and the economy. The process of developing such high rise residential property is fraught with uncertainties and risks. There are several ways of dealing with uncertainties and risks in property development. Through financial feasibility evaluation of property development projects, the use of required rate of return to match perceived risks and uncertainties is prevalent among practitioners. This is despite several criticisms levelled against the DCF technique which adopts required rate of return as a discount rate as a means of matching perceived risks with profitability. For example, it has been argued by leading property researchers that the use of required rates of return in the form of discount rates embedded in
financial feasibility models in dealing with risks and uncertainties in property development is myopic and leads to imprudent decisions (Vimpari et al., 2014). Current property market dynamics taking into consideration the life span of property assets necessitate the need for a different approach to dealing with risks and uncertainties. It’s been realised that uncertainties might not pose only negative effects but harbours the possibility of positive upside gains for property developers.

Flexibility in both design delivery process and structure of buildings (options “on projects” and options “in” projects respectively) through the options framework have been proposed as better ways of dealing with uncertainties and risks in property development. It has been argued that flexibility enables property developers to prepare for an uncertain future from the inception of a property development project and opens the possibility of capitalising on emerging opportunities. Flexibility requires initial capital investments in high-rise Australian residential property projects to retain the right to capitalise on future opportunities or limit possible downside losses emanating from uncertainties. It has been argued that estimating the cost of flexibility may be straightforward but long-term investors and developers need to have certainty as to the values attached to flexibility. Determining the values attached to flexibility is not straightforward and can only be determined through the options framework. However, evidence of the practical application and demonstration of ROA and ROV is limited, and particularly in the Australian property market, this is an initial application on case studies.

Accordingly, an extensive literature review was conducted to determine the extent to which ROA and ROV models have been applied to practical decision making in the Australian residential property development sector. In the Australian context, the literature review revealed a very limited body of research on RO theory and lack of empirical applications. Therefore, there is the paucity of research on real options in the Australian property sector. Thus, important areas of application in property development including “options on projects” and “options in projects” have not been explored within the Australian property market. Leading authors on ROA and ROV in property development suggested that there is the need for more applications using empirical data.

The review also revealed that the theoretical framework of ROA and ROV is still at the early stages of development in the Australian property market context. It is therefore important to empirically test ROA and ROV models to determine whether they are applicable to case studies in empirical settings using case studies from the Australian property market. The aim was to
deliver evidence needed for practical acceptance and potential adoption for decision making in property development. As the published work on ROA and ROV in property developments were mainly theoretical and by academics, face to face semi-structured interviews with selected practitioners in the Australian property development provided insights into the relevance of how contemporary property developers account for risks in property development profitability analysis and factors required for integrating ROA and ROV into mainstream property development decision making. It is believed that acceptance is not dependent on only practical applications but input from practitioners regarding acceptance for decision making in practice.

In summary, the aim of the dissertation was to examine the practical application of ROA and ROV models in the Australian residential property development sector with the purpose of delivering evidence needed to support the adoption of RO theory in decision making. The dissertation further aimed to determine factors required for integrating ROA and ROV in practical decision making in the Australian residential property development sector. As a result, the research questions for the dissertation captured three main areas.

Firstly, the question of whether case studies of proposed high rise Australian residential property development projects support ROA and ROV applications as opposed to standard project evaluation methods was explored through quantitative ROV evaluation methods with embedded selected development projects. Case studies have proven to be an important research method for conducting in-depth studies (Yin, 2014) into pertinent issues such as uncertainty and risk management of Australian residential property developments. The case studies for the dissertation were selected through theoretical sampling (Glaser & Strauss, 1967) which is important in case study research to ensure that they are related to the research questions in order to draw major inferences for conclusions and improve research validity. The empirical applications sought to establish values attached to different types of flexibilities embedded in different projects to provide evidence of the value of flexibility. These applications cut across flexibility in design delivery process and building flexibility in terms of structure to adjust to changing use. The capability of ROA to enhance uncertainty assessment in residential property developments was examined through the case study evaluations and use of conceptual frameworks validated through face to face semi-structured interviews. Emphasis was given to comparative analysis between the use of required rate of return (discount rate) as a metric for dealing with risks and uncertainty in standard valuation models as opposed to the use of flexibility. Through the conceptual framework and results from case study applications, a
qualitative analysis and discussion have been presented to support improvement in risk analysis and management using options framework.

The second phase of the dissertation examined the factors or requirements needed for integrating ROA and ROV into mainstream financial feasibility evaluation of projects in Australian residential property developments. This was explored through qualitative face to face semi-structured interviews with selected property practitioners in Australia. It is believed that certain factors could either hinder or expedite the potential adoption of ROA and ROV for practical decision making in the Australian property development sector.

10.3 Conclusions

The conclusion of the dissertation provides a summary answer to each objective set for the dissertation in section 1.4 in Chapter One. Subsequent sub-sections have been organised to provide responses to each of the objectives of the dissertation.

10.3.1 Objective I-To review and establish the nexus between real option theory, valuation and property development

Through the critical review of literature, it has been established in this dissertation that property development is inherently uncertain and therefore, risky. These uncertainties and risks are generally categorised into three by residential property developers:

- Planning risk;
- Construction risk;
- Settlement risk.

Unfortunately, conventional property development evaluation models do not incorporate enough information to deal with risks and uncertainties. Real option theory incorporates both quantitative and qualitative information to broadly capture uncertainties and risks through strategic flexibilities embedded in property development. Despite its slow adoption in practical decision making, existing research and the current dissertation has shown evidence in support of its practical application to property development feasibility evaluation. It has been established that real option theory has been applied to different areas in property development which are categorised as:

- Land valuation;
- Property lease contracts;
• Building flexibility;
• Technology investment;
• Real estate markets.

Other applications fall into two categories:

• Real options “in” projects;
• Real option “on” projects.

Although the theory of real option is still growing, majority of the existing literature provides evidence in support of the theory as a decision-making tool in property development. The current dissertation has added applications in these two main categories of real options “in” and “on” projects. Similarly, the quantitative case studies, that is case studies 1, 2 and 3 can be grouped under real estate markets, land valuation and building flexibility respectively. Furthermore, a conceptual framework has been developed to further categorise real options into stages of the property development process. The qualitative section has unearthed factors that could expedite the adoption of real option theory in practice.

10.3.2 Objective II- To develop real option conceptual model for categorising flexibilities embedded in the property development process to enhance risk management

The conceptual framework developed is connected to the entire property development process capturing all flexibilities into a single tool. The tool can aid practitioners in identifying both the exact stages in a property development process where specific flexibilities are embedded. Based on the conceptual framework, a second tool that uses a process or flow network was developed as a risk management tool for property projects from inception to completion. It was argued that property developers and investors can adopt this framework for risk mitigation and to also capture upside opportunities in different property market situations. Both the conceptual framework and risk management tool have been shared with the academic community at the 22nd Annual Pacific-Rim Real Estate Society Conference, Sunshine Coast, Queensland, Australia, 17-20th January 2016 and the 1st Real Estate & Land Planning International Conference, Mykonos, Greece, 04-08th September 2018 respectively as attached in Appendix G. The conference papers have been published in the conference proceedings for knowledge dissemination in the property sector.
Figure 10-1 Real Options as Risk Management Tool for Property

- Gathering information
- Waiting option
- Staging
  - Success (proceed)
  - Failure (Hold)
- Uncertainty
  - Favourable market
  - Unfavourable market
- Design Flexibility
- Switch
- Expand
- Switch input
- Temporary shutdown
- Contraction
- Abandon
- Dynamic sales strategy
- Flexible leases

Source: Author, 2018

Initiation stage

Design and Construction stages stage

Marketing stage

Source: Author, 2016
Figure 10-1 illustrates the different flexibilities embedded at different stages of the property development process. It captures both reduction and growth flexibilities embedded in the property development process for easy identification by practitioners. The framework is also linked to the state of a property market at a specific time because depending on the performance of the property market, developers have a choice with respect to either reduction or growth flexibilities to capture either upside gains or mitigate downside risks respectively.

**Figure 10-2 Conceptual Framework**

Figure 10-2 shows the conceptual framework that captures real options embedded in property development from inception of a project until completion and beyond. It also captures compound options which is a combination of put and call options present at different stages of the property development process. It is argued that the combination of the different types of options with property development stages would make it likely that practitioners become familiar with the concept of options for potential acceptance and adoption in practice.
10.3.3 Objective III- To examine how Australian residential property developers currently deal with uncertainty and risks in feasibility analysis

Assessing if the discount rate or “all risks yield” can capture all risks in Australian residential property developments and investments. This question was important because DCF technique which uses a discount rate has been criticised as being incapable of dealing with risks, yet, it is still the predominant financial feasibility evaluation model in practice. Changes in key variables such as sale revenue, cost, discount rate, delay in completion etc. can have serious financial implications for any residential property development project.

Through meticulous analysis of the qualitative data taking into consideration suggestions from majority of participants, it was concluded that the required rate of return (discount rate) is not able to capture all risks associated with Australian high rise residential property development projects. Rather, high rise residential property developers are using contingency as the main tool for dealing with uncertainties and risks in Australia. A contingency amount is specified against each uncertain line item in the development budget. These amounts are summed up to derive the total contingency budget and added to the total cost of development.

As a result, the contingency sum becomes the extra amount for dealing with any uncertainty that arises during project execution. The effect is that developer’s profit is unaffected by uncertainty and risks during project execution to the level that the contingency sum can cover.

10.3.4 Objective IV- To apply real option models to feasibility evaluation of selected practical case studies using empirical data and to compare the results with conventional property development evaluation technique

Horizontal Phasing Using FPOM

In order to deliver the evidence needed to convince practitioners of the benefits of using ROA and ROV models for financial feasibility evaluation, selected case studies in the Australian high rise residential development market were used to answer research question one. A discussion around the strategic flexibilities were partly used to answer research question two. The first case study was a staging flexibility (which is an example of options “on” projects) embedded in large scale residential urban development in Australia. The level of this case study application is in the process of development which is vital to the success of any development project and it broadly focused on both investor-developers and trader-developers as the unit of analysis. In practice, horizontal phasing of such large-scale projects during the process of residential development is expected. However, current valuation models for financial feasibility evaluation of property developments cannot evaluate the value attached to the flexibility to horizontally phase a project.
It was indicated and argued that treating the entire residential property development project as a complete whole and evaluating the financial feasibility as such does not represent reality in practice. The reason is that developers are likely to halt or abandon some stages of a development project during implementation when there is an unfavourable market. When the evaluation considered the value attached to flexibility of staging and compared with results from standard evaluation techniques, it was determined that ROV models delivered superior results. As a result, it can be inferred that ROA is practically applicable and can determine values of flexibility embedded in property development projects using empirical data. Besides, the use of the staging flexibility as a qualitative approach to dealing with risks and uncertainties offered property developers a better way to prepare for unforeseen future eventualities with possible courses of action rather than through the use of discount rates. This case study has been published in the International Journal of Housing Markets and Analysis as shown in Appendix G.

*Waiting to Invest Using CE-BOPM*

The second case study is a deferral flexibility embedded in a high rise mixed use development which is another options “on” projects. Thus, the commencement of construction of a property development project was deferred pending resolution of uncertainties. The level of application is in land valuation where the deferral over a specified period result in increased property values to ensure that upside gains in the residual value of the land is captured. This case study demonstrated to the developer who participated in this case study the need to hold onto projects that may benefit from future uncertainty. Therefore, projects that are not financially viable today may be profitable in the future.

Developers who discard financially unviable projects today may miss future upside opportunities emanating from uncertainty. This is an indication that ROA and ROV are applicable to case studies using empirical data. Therefore, ROA models can be applied to the evaluation of other residential property development projects using empirical data from other property markets. Moreover, the embedded deferral strategy enhanced risk analysis through waiting until uncertainties are resolved to have better information for decision making. The results derived were compared to DCF and was superior in terms of profitability. The result of the case study has been shared with the academic community at the 23rd Annual Pacific-Rim Real Estate Society Conference, held in Sydney, New South Wales, Australia, from 15-18th January 2017 and published in the conference proceedings as attached in Appendix G.


Building Flexibility Valuation Using Samuel-McKean Equation

Switching flexibility application adopted in case study three was options “in” projects which is flexibility embedded in a building to make it adaptable to suit changing market conditions for long term performance and functionality of a property asset. The level of application of this case study in the property industry is in building flexibility in property portfolio management because it was argued that investor-developers who are long term property investors must have such flexible strategies embedded in properties in their portfolios to ensure uncertainty and risk mitigation during decline in demand for a specific property asset class. Flexibility to switch the use of the building from the proliferated mixed use of residential and retail to student accommodation and co-working space was proven to have added more value than the originally proposed idea, should demand for the residential use decline. This application has also demonstrated the practical application of ROA and ROV models using empirical data. The switching output was embedded as a strategic flexibility for hedging against uncertainty in demand, hence, enhancing risk analysis by preparing for unforeseen future eventualities. The result of this case study has been published in the Journal of Financial Management of Property and Construction as shown in Appendix G.

These applications have proven that ROA and ROV models are applicable to case studies in practical settings using empirical data, thereby answering the first research question. The use of data from actual case studies also challenges the notion that ROV models are complex and lacks adaptation to practice. It has been argued that ROA and ROV deliver superior results as compared to standard property valuation techniques. However, it is recommended that ROV models should be complementary to DCF because several inputs into ROV models are derived from DCF. For example, in the FPOM, the three different NPV scenarios are derived from DCF. Similarly, the use of the Samuel-McKean Equation demands the determination of value of a development, before applying ROV models to determine the potential future value. These case studies broadly focused on developers but considered the issues from different levels of applications thereby ensuring that the results can be generalised to a large spectrum of property practitioners including developers and investors. Thus, using evidence to elucidate the benefits of adopting ROA and ROV models over standard valuation techniques would entice practitioners to consider its adoption for decision making.

10.3.5 Objective V – To suggest ways of justifying investment in building flexibility in Australian residential property development

Beyond the limited case study applications of financial feasibility evaluation using ROV models in the Australian high rise residential sector, factors required before developers can
justify investment in building flexibility to other stakeholders were also investigated. Determining how ROA and ROV can provide justification for investments in flexibility for risk mitigation in practice involved asking practitioners questions related to possible valuation of flexibility in practice. Flexibility requires extra initial investment in addition to the actual project cost without flexibility. Practitioners argued that it was important to determine values that would be ascribed to flexibility and compare to the cost of embedding it during project inception. Therefore, the majority of practitioners indicated a cost-benefit approach to justification of flexibility investments.

An independent valuer suggested that potential cost savings from flexibility investment as compared to demolition and starting construction anew could provide justification, particularly in the case of vertical phasing and switching flexibilities. It was the global property valuer whose response was closer to the ROV approach in the sense of projecting the value of flexibility over a reasonable period and discounting to present value. The present value is then compared to the cost of flexibility to justify such an investment. As a result, practical acceptance and adoption should focus on case studies that demonstrate cost savings and shows profitability.

10.3.6 Objective VI- To evaluate the requirements for integrating real option techniques into Australian residential property development decision-making

The second phase of the dissertation used a qualitative approach to investigate the factors or requirements for integrating ROA and ROV models into mainstream practical property decision making. Selected case studies have been applied in some countries but, yet to achieve practical acceptance and adoption of RO theory. Therefore, it was argued that it is possible certain factors may be required before practitioners may accept and adopt RO theory for decision making in practice.

The face to face semi-structured interviews covered areas including:

i. Considering the receptiveness and acceptance of ROA/ROV models among property practitioners. Practitioners’ responses towards ROA and ROV models for decision making were positive, suggesting a good reception. On acceptance however, most practitioners were not explicit in their answers but suggested that some benefits of ROA and ROV are important. On the other hand, practitioners also indicated that the simplicity of DCF makes it attractive for decision making in practice as opposed to ROV models. Therefore, an ROV model that is simple to use such as FPOM is proposed as the tool to adopt to further test practical
application in different contexts for demonstration to practitioners. It was argued that the non-acceptance is because most practitioners are yet to develop a full understanding of ROA and ROV modelling. As a result, further empirical tests are needed to ensure that practitioners develop a full understanding of RO theory. The findings on receptiveness and acceptance of ROA and ROV for decision making has been shared with the academic community at the 1st Real Estate & Land Planning International Conference, Mykonos, Greece, 04-08th September 2018 attached in Appendix G;

ii. Examining the requirements for integrating ROV models into practical financial feasibility analysis of flexibility in Australian high rise residential property developments. Key requirements for integrating ROA and ROV models in mainstream financial feasibility evaluation of property development projects are:

a. Education and training of practitioners on RO theory;

b. Highlighting benefits of RO theory over existing valuation tools;

c. Clarity with respect to the process and tools for determining values attached to building flexibility investments by the valuation community;

d. Involvement of key stakeholders such as investment committee members, development committee members, clients and property market participants.

10.3.7 Objective VII- To determine any potential barrier(s) to adoption of real option theory in practical decision making in Australian residential property development

The cycle of blame where participants were unwilling to initiate action on flexibility investment was found to be an impediment to flexibility investments. For example, investors argued that they were willing to invest in flexibility if valuers could clarify whether values would be ascribed to flexibility. Developers suggested readiness to invest in flexibility if long term investors are willing to pay for flexibility during property acquisitions. Property advisors and financial advisors were ready to advise clients on the need for flexibility even though they suggested that financing was a major issue. As a result, there is the need to break the cycle to ensure that investments are directed into flexibility, which will require ROV models for valuation, hence achieving practical adoption. Once the valuation community can bring clarity to the value associated with flexibility, it is argued that this can trigger investments in flexibility.
Financing of flexibility was deemed as a potential barrier to the adoption RO theory in practice. Interviewees argued that banks provide financing for projects based on the potential revenue. As a result, values attached to flexibility which may be realised later in the life of a project may not be considered by lenders. If funding is not provided by lenders, developers may not be able to invest in building flexibility.

Planning permission was raised as a major impediment to the adoption of RO theory in practice. In the words of one of the interviewees, “Australia’s planning regime is very strict”. Interviewees argued that in the residential property market, developers may not be allowed to execute vertical staging because certificate of occupancy is issued only after the entire project is completed. As a result, developers may not be able to secure planning permit for vertical staging in the residential development sector. However, in the commercial property development space, an interviewee indicated that planning officers are currently encouraging flexibility in the building of car parks for future conversions into offices. This finding is important in encouraging practitioners to consider building flexibility as an alternative way to deal with uncertainty and risk in property development.

Obsolescence was among the potential barriers to the adoption of building flexibility in practice, hence RO theory. Interviewees argued that consumer tastes and preferences change with respect to time. As a result, specific designs embedded in property development projects may be obsolete when the need arises in future.

10.4 Contribution to Knowledge

The relevance of any research is examined on its theoretical contribution and practical significance. The contribution of this dissertation to both theory and practice is examined from two perspectives; single case studies and in its entirety.

a) The conceptual framework developed for categorising flexibilities in property development based on flow network approach using investor-developers as the unit of analysis is the initial grouping which connects the entire property development process found in the literature. It differs from an already developed conceptual framework (Baldi, 2013) from two main perspectives; the flow network approach and the combination with the entire property development process, as such capturing flexibilities embedded in projects even after completion. For example, flexible lease agreements were captured in this framework which were not found in the framework developed earlier. This serves
as practical tool for practitioners in deepening their understanding on ROA concepts. Furthermore, the conceptual framework serves as a manual for practitioners to use to determine flexibilities existing at specific phases of a project and the ROV model capable of evaluating specific options. This is a step forward towards enhancing practical identification of flexibilities and application of ROV models for valuation.

b) The horizontal staging flexibility in the large scale residential urban development case study is the first known application using FPOM in practice and also in the Australian residential property development sector. The evaluation of the entire case study in phases enhanced risk and profitability analysis and demonstrated the need for developers to focus on flexibility embedded on projects to enhance profitability and risk analysis. As a result, the developer was able to determine the specific phases of the development that were viable and unprofitable for possible courses of action.

It can be observed from Figure 10-2 that the first two phases in both most likely and maximum scenarios of the residential development project are viable developments for stages 1 and 2, but the most likely scenario changes to negative in stages 3 and 4. The minimum scenario is negative for all stages of the residential development project, suggesting that the project is bound to make losses in an unfavourable market. In a stable market, which is the most likely scenario, the project has the potential to slightly break even during the first two phases but could potentially result in losses at the third phase. These are shown as downward and upward arrows respectively in Figure 10-2. This is an important observation because the developer has the flexibility to develop the first two phases which are economically viable and either postpone or abandon the last phase which is not viable. This has the potential to reduce the total cost of the development, hence bringing down the overall potential losses and increase the ROV value. In this case study, should the developer have adopted the abandonment of the last phase, the developer would have saved an amount of about $17million in construction costs from the development in addition to salvaging the value of the remaining land at the prevailing market value. The cost of abandonment would have been the land option paid to the vendor to hold onto the land for the developer.
c) The second case study focused on evaluating the future potential of a project that was facing enormous uncertainty and was about to be discarded by the developer due to the use of NPV decision rules which suggests that a negative NPV project should be rejected. Through real options analysis and valuation, it was demonstrated that the project had future potential to become profitable if delayed for one year through the payment of holding costs. The potential profit after 1 year was estimated to be $230,000 which is a significant improvement over the negative profitability delivered via the use of DCF technique. This is an initial application of a deferral strategy to an empirical case study using data from Australia. Thus, it is another application that fulfils the request from leading researchers on the need for more case study applications of ROV modelling.

d) The third case study is an initial study to use ROV modelling to evaluate the flexibility to switch output of a residential building to a student accommodation using Australian case study as a way of managing potential future risks associated with a property portfolio. It was argued that the numerous housing development projects ongoing in Sydney and Melbourne could potentially lead to oversupply,
which can have serious financial implications for developers. As a result, embedding a flexibility to switch the use could be a hedge against potential future uncertainties in demand. This provided the developers with important insights into flexibility and how it can enhance long term performance of buildings in different market situations. The results indicated that even though the original idea of apartment and retail in a mixed-use building was profitable, the profitability from the switching option would be higher comparatively. As an embedded strategy for risk mitigation, the switching flexibility was deemed as a waiting option to invest. This was also examined from a portfolio investor’s perspective thereby broadening the spectrum of ROA application.

e) The semi-structured interviews with selected practitioners in the Australian residential property development market is the first known study to explore the potential for adoption of ROA and ROV methods within the property industry in Australia. Through this research, the requirements necessary for adoption have been identified for further action in conformity with current research direction on ROA. Moreover, it was suggested that education and training of practitioners, clarity with respect to values attached to flexibility, highlighting benefits of ROV modelling as compared to DCF modelling and involvement of stakeholders are critical for the adoption of ROA and ROV in practice. The dissertation revealed that there is general lack of appreciation of values attached to flexibility. Long term investors are primarily concerned with values attached to flexibility investments before committing to invest in it. Regulatory requirements dictate that valuation of investment portfolios are performed by independent valuers. As a result, it can be concluded that the adoption of ROA and ROV is highly dependent on valuers. Other studies have focused on evaluating the adoption rate of ROA by corporate organisations in practice without focusing on the needs of practitioners in order to achieve practical adoption of the theory. This dissertation has fulfilled this gap and given indications of factors to focus on to achieve a rapid adoption of ROA and ROV models in the Australian property industry.

f) In its entirety, the dissertation has focused on flexibilities and application to Australian high rise residential property development which is topical in the literature in recent times. This dissertation used the Australian residential property
development market as a context for the case studies. The unit of analysis has broadly been on developers; both short and long-term developers. A conceptual framework for categorising flexibilities in a flow network approach serves as a practical aid developed with the aim of enhancing the potential adoption of ROA in practice. It is argued that the framework deepens the understanding of practitioners to better appreciate and determine the exact phases of a project where flexibility can be embedded for dealing with uncertainty and risk mitigation.

Subsequent to the development of the conceptual framework, some of these flexibilities including delay, staging and switching output, that are embedded in residential property development projects were evaluated to further demonstrate the practical usability of ROA and ROV models. The combination of the framework and evaluation of the value of flexibility using empirical data leads to a comprehensive application of ROA and elucidates the theory’s potential in the property development sector, especially, for residential property developments in Australia. These applications using Australian case studies and empirical data have extended the frontiers of RO theory, the use of ROV models for financial feasibility evaluation and expanded the breadth of enquiry of real options theory in practice.

Through the applications, areas where ROA enhances uncertainty and risk assessments were discussed. For example, it was argued in case study one that instead of a developer assuming the entire project will be completed irrespective of changes in market conditions, the staging flexibility offers the opportunity to wait at specific stages until uncertainties are resolved before beginning construction. In view of this, developers are encouraged to examine financial feasibility of phased projects as separate components within a whole rather than all phases together as a unit. By doing so, phases that are unprofitable are discarded and phases that are financially feasible executed. This was demonstrated to the developer at a workshop organised at the developer’s place of business to demonstrate and highlight some of the benefits of ROA and use of ROV for financial feasibility modelling.

This also demonstrates the realistic modelling approach of ROV as opposed to DCF. In the DCF technique, the different phases of a project are combined and
evaluated as a single project. As a result, phases that are unprofitable are added to the entire project, thereby affecting other viable phases especially when the losses from an unviable phase are substantial. This is demonstrated in the dissertation using the horizontal phasing approach in the first case study. Similarly, Geltner and de Neufville (2012) demonstrated the value of flexibility in a staging development but used a different ROV model as opposed to the use of FPOM in this dissertation. Evidence from these two case studies demonstrate that ROV models perform realistic valuations and deliver better results as opposed to DCF.

The findings from the dissertation have also demonstrated that long term performance and functionality of residential buildings can be achieved through flexibility of switching use, which is important for dealing with uncertainties arising from technological changes that are leading to faster functional obsolescence in buildings. All the applications have opened up important issues on uncertainty and risk management practices that can be adopted by practitioners. Throughout the discussion of findings on the case studies, uncertainty and risk assessment enhancement capability of ROA has been explored. For example, case study three focused on embedding flexibility to switch a mixed use of residential and retail to student housing and co-working space due to impending uncertainty which had the potential to result in functional obsolescence because of change in demand for a specific type of use. The embedded flexibility which was a waiting option to invest can extend the life span of the asset in future because whenever there is low demand in residential apartments, a switch to student accommodation would ensure that the investors are able to capitalise on opportunities in that sector.

Furthermore, in this dissertation the applications have challenged earlier notions of the complexities associated with different ROV models’ applicability in practice and opened opportunities for further uses in other areas of the property and construction sector. For example, all the models (FPOM, CE-BOPM and Samuel McKean Equation) used in evaluating flexibilities are compatible with spreadsheet application which is a dominant software in the property industry for financial evaluation. Probably the simplest and easiest to understand, which also evokes some level of familiarity among practitioners is the FPOM due to its use of NPV and scenario analysis. It is encouraged that the results and applications in this
dissertation should serve as a basis upon which further applications may emerge from the broader Australian property market context to deepen the understanding of practitioners and enhance ROA adoption in practice.

10.5 Validity of the Research

This section provides a brief overview of the reliability and validity of the dissertation and its outcomes. All the case study applications have been double blind peer-reviewed and published in scientific academic journals and conferences. In view of this, limitations associated with each application have been discussed in the articles and in the case study discussion sections in this dissertation.

10.5.1 Choice of Methodology

In terms of methodological choice, the dissertation used a mixed method approach with embedded case studies. The use of mixed methods in terms of multiple types and sources of data, methods of data collection and analysis is generally accompanied by triangulation. Robson (2002) argues that triangulation enhances the reliability and validity of research and this is applicable to methods, data and interpretation of results. In this dissertation, triangulation was applied to all facets including methods, data, analysis and interpretation of results where findings from both the case studies with numeric applications and interviews were discussed as a coherent whole. Since the dissertation has embedded case studies using quantitative data, it is important to examine research validity and reliability of the cases. The quality of case study research is generally evaluated using four main proposed tests; reliability, external validity, construct validity and internal validity (Yin, 2003).

10.5.2 Reliability

Reliability as a measure of research quality deals with the potential repeatability of the dissertation to arrive at the same findings and conclusions (Yin, 2014). Yin (2014) proposes that to increase the reliability of a research and minimise the errors and biases in a case study, researchers need to have clear documentation of the research process ensuring that there are as many steps as possible to guide a later researcher during a repeatability test. In this dissertation, all the steps in the process of data collection, sources and temporal nature of specific data, the exact data collected, discussion on the embedded flexibility in all case studies, choice of methodology, qualitative analysis, quantitative evaluation, results
presentation, analysis, discussion of findings and comparative analysis with DCF in all cases are well documented. Therefore, the processes involved in evaluating the case studies are well enumerated to guide later researchers to repeat this study without obstacles. Moreover, ROA is a well proven theory for the quantitative evaluation of flexibility. Results from the use of ROA were compared to the DCF technique of evaluation which is also a well-documented theory. To this end, the reliability of this dissertation is very high due to use of accurate data and documentation of the process. Therefore, repeating the study using same data, case studies and models should result in same findings and conclusions. The test of reliability is also enhanced via the research outputs from the dissertation published in reputable academic property journals that are attached in Appendix G, because these publications were rigorously peer reviewed by experts in the field before being accepted for publication.

10.5.3 External Validity

A proposal by Yin (2014) in evaluating case study research is the test of external validity. External validity is the generalizability of research outcomes and it focuses on sample size and quality (Robson, 2002). Analytically, the findings of this dissertation are generalizable to the extent that, similar data and ROA models can be used to test and verify the outcomes of the research. Since the case studies are practical in nature and were sourced from industry including the data, similar studies can be replicated under similar conditions to determine outcomes and compare with the results of the dissertation. In terms of sample quality of case studies, they were sourced from reputable property development companies operating in Australia. Since this dissertation does not follow statistical analysis, sample size for the case studies is considered irrelevant and therefore the findings are analytically generalized to suit other similar case studies under similar contexts. However, the case studies are from multiple sources using theoretical sampling. The qualitative phase uses a sample size of twelve participants who were purposively selected based on specific criteria to ensure that views from the participants were highly relevant to the research. Even though this could result in bias, it rather strengthened the findings because the result was that participants were spread across small independent property companies/consultants, mid-size and large companies ensuring a balance in the responses of participants. In qualitative research, sample size is generally irrelevant as well (O'Leary, 2014).
10.5.4 Internal Validity

Internal validity as explained by (Yin, 2014) evaluates the relationship between causal and explanatory research. Thus, there should be a relationship between the starting point and the outcomes except in exploratory case study research. This dissertation falls into exploratory case study research, as such causality tests are irrelevant to establish internal validity. The main concern is the major inferences that are drawn based on results from case studies to determine conclusions. The use of ROV models require quantitative inputs which then produces a numerical output for interpretation and comparison to DCF to draw conclusions. As a result, there is an objective criterion to assess the findings, make inferences and draw conclusions which is devoid of researcher bias. Moreover, the link between the data inputs in the model and outputs for interpretation enhances the internal validity as there is consistency. Besides, the input data is accurate and verified from the data providers. In this dissertation, the developers supplied data used for financial feasibility evaluation on the case study projects and the researcher extracted the pertinent information for ROV modelling. Other sources of information were all credible such as ABS and RBA databases. The results of the applications rival the long-held notions that ROA and ROV models are not practically applicable. All these account for better internal validity of the dissertation.

10.5.5 Construct Validity

Construct validity is a measure of outcomes compared with the aims and objectives of research (Yin, 2003). In other words, did the research answer the questions it sought to? It also evaluates whether correct operational measures were used for the concepts studied (Yin, 1994). Since the dissertation uses multiple sources of evidence, the results from the different case studies form a chain of evidence. The results and findings of the dissertation were also reviewed and discussed with key informants, thereby enhancing construct validity as proposed (Yin, 2003). The case studies and related data in this dissertation are from different property development companies and relate to different projects meeting the requirement for multiple sources of evidence. The quantitative data was used for the modelling in order to answer the research questions of whether ROV models support practical applications.

The results from the various applications were used to draw conclusions because there was a chain of evidence built-up from the research questions to the conclusions in each of the case studies. In most cases, findings from new research are compared to previous studies to either confirm or disprove a theory. In this dissertation, the results have been compared with
previous research conducted by leading authors in the fields of ROA and property development. In all cases, the results were also discussed with industry practitioners and their views were solicited during the face-face semi structured interviews to validate the findings. Thus, all these results and outcomes from multiple sources of case study applications have built up a chain of evidence coupled with industry validation has enhanced the construct validity of the dissertation.

10.6 Recommendations

Currently, the difficulty in achieving adoption or ROA in practice emanates from several issues including no practical knowledge, lack of empirical evidence, regulatory requirements on valuers on how to conduct valuations and use of appropriate valuation methods, planning issues around acceptance of flexibility and general understanding of ROA theory by practitioners. This section focuses on providing recommendations that can enhance the acceptance and possible adoption ROA and ROV in practical decision making.

10.6.1 Education and Training of Practitioners

The low level of theoretical understanding of ROA and ROV models by most practitioners requires educating and training them on the propositions and use of ROA. It is therefore recommended that, practitioners should be trained and educated on ROA and ROV modelling for decision making through conferences, workshops, seminars, webinars, YouTube videos, and continuing professional development. Currently, DCF is the main tool embedded in the most widely used industry software for financial feasibility evaluation; Estate Master. It is recommended that ROV models are embedded in such a software as a way of promoting its acceptance and possible adoption. It is also important to involve internal and external stakeholders in these education and training workshops to ensure that they understand ROA and ROV because these stakeholders make final decisions regarding either accepting or rejecting development proposals.

In countries where RO theory has been accepted by academia, concerted efforts have resulted in the development of courses as part of property and construction programs. Similar initiatives can be embarked upon in Australia to train the next generation of property practitioners on the use of ROA and ROV in practical decision making. This should happen alongside industrial training for senior practitioners who normally mentor young graduates during the early stages of their career. Otherwise, when ROA and ROV are introduced by
young graduates to senior practitioners, there will be difficulty in accepting it for decision making.

10.6.2 Harmonisation of ROV Models

There is the need to harmonise the various ROV methods of evaluating flexibility and propagate a single model that captures the value attached to flexibility. Currently, there are several models including BOPM, FPOM, Data-Matthews method, Samuel McKean Equation, Monte Carlo Simulation and Black-Scholes models without guidelines as to which method to use for the valuation of a specific flexibility. Besides these models, there other partial differential equations derived using specific case studies, thereby rendering such models inappropriate for evaluating other case studies because they are derived under specific contexts. The result is a lack of appreciation of ROA concepts by practitioners and unwillingness to accept and adopt in practical decision making because there is uncertainty surrounding the use of the models. In view of this, ROV models that are transparent, simple and familiar to practitioners should be emphasised. For example, the FPOM model which uses NPV, scenario analysis and does not require the computation of probabilities or volatility could be highlighted and used in demonstrating the simplicity, transparency and benefits of ROV models in practical settings to property developers.

10.6.3 Support from Regulatory Institutions

Valuation of flexibility is highly dependent on valuers as realised from the interviews. Since the practice of valuation is regulated by the International Valuation Standards Council (IVSC), it is imperative to seek the support of such professional bodies and councils on the use of ROA and ROV models in practice. Valuers follow guidelines issued by these groups to determine the values of property assets. It is therefore recommended that, the IVSC, Royal Institution of Chartered Surveyors (RICS) and Australian Property Institute (API) are consulted on issues relating to the use of ROV models in practice. It is argued that should these regulatory bodies accept to value flexibility, the use of ROV would be inevitable because it is the appropriate method. This will also trigger investments in flexibility by developers and investors because values would be ascribed to flexibility during transactions.
10.7 Areas for Further Research

10.7.1 Further Applications from Different Parts of the World for More Evidence

Research on ROA and ROV applications in property development is still at the early stages of development. Even though this dissertation has focused on evaluating the practical application of ROA and ROV models using empirical data from the Australian residential property development market, further applications are needed to develop evidence to convince practitioners of the benefits of the theory. Within Australia, values attached to flexibility in commercial properties are yet to be determined through ROV modelling. ROA and ROV are yet to be applied to other areas of within the property sector. The initial case study applications in this dissertation have opened an opportunity for further tests in other areas within the property sector and beyond, particularly in Australia. New case studies should be explored from countries that are yet to embrace ROA and ROV to drive practical acceptance and potential adoption for property decision making.

10.7.2 Datasets from New Projects

Unarguably, the case studies and findings of this dissertation can serve as a reference point for interested researchers to develop new ideas for further research. The conceptualisation of flexibility in an entire development process opens the opportunity to adopt any of the flexibilities and collaborate with practitioners to quantitatively determine the values attached to a specific flexibility in different contexts using new data to arrive at new findings to expand ROA theory. For example, the case study on student accommodation has opened an opportunity for further research into flexibility in leases in the student accommodation sector. When student accommodation is developed in Australia, legal requirements restrict the occupants to be students only. Developers and long-term investors can opt for flexibility through a dual permit application where during school holidays, student accommodation can be used for short term residential accommodation such as serviced apartments.

Furthermore, the case studies must also demonstrate potential savings from embedding flexibility and capitalising on it in future as opposed to waiting and redeveloping an entirely new structure when it’s appropriate to execute. This particular demonstration was proposed by one of the practitioners who participated during the validation stage of the results. During the face to face semi-structured interviews, a participant indicated that councils have begun asking car parking developers to design for flexibility to be able to convert to office in future. For example, if office developers are encouraged to have increased ceiling to floor heights to
be able to convert offices into car parks and vice versa. Even though this has happened in practice, the participant argued that the decision was only a “gut feeling” and not based on any rigorous quantitative analysis. As a result, ROV models can be used to justify investments in such a flexibility that is already accepted in the market to deepen the understanding of practitioners on ROA and enhance practical adoption.

10.7.3 Unit of Analysis Using “Developer-Traders”

Case studies may include consideration of “options in projects” from the perspective of developer-traders who are generally selling residential developments off-the-plan even before construction begins. It will be interesting to know the perspectives of such residential developers and the conflict between short term development goals and long-term nature of flexibility investments. The potential effect is the value attached to flexibility from the perspective of a developer whose aim is not to hold assets for a long period contrary to the proposition of RO theory.

10.7.4 Practical Valuation of Building Flexibility by Valuers and Investors

Another application could be an evaluation of flexibility from the perspective of valuers and other practitioners using existing valuation methods and subsequent demonstration of the weakness in the use of the prevailing models. This will open discussion on the need for improving valuations using new and appropriate methods, paving the way for ROA and ROV models to be adopted for the valuation of flexibility in practice. Such a demonstration can be organised through focus group discussions after selected valuers have performed individual valuations of flexibility using existing methods.

10.7.5 Latent Value of NatHERS Rating Tool in Residential Sector in Australia

It was identified in the literature that a leading researcher has valued energy efficiency certificates in commercial buildings using ROA. In the Australian residential property development market, Nationwide House Energy Rating Scheme (NatHERS) has also been developed to encourage energy efficiency investments. There is no consensus among practitioners on the value attached to a specific level of energy efficiency rating in the housing sector according to a participant during the interviews. ROA can be applied to selected case studies to determine the hidden values associated with energy efficiency investments in the housing sector.
10.7.6 Receptiveness and Acceptance of Flexibility by Local Councils

Further research can focus on the reaction of planning officers and council members who ultimately approve development permits within specific local authorities regarding building and design delivery process flexibility. Throughout the face to face semi-structured interviews, practitioners, especially the developer-traders were worried about vertical expansion flexibility in the housing sector. In practice, most of the units in residential apartments are sold off-the-plan before construction begins. Therefore, the possibility of a developer getting a permit from the council to develop further floors on top of an existing building after certificate of occupancy is issued was deemed to be a challenge. This area could be explored further to determine ways of achieving vertical expansion flexibility in the residential sector in practice.

10.7.7 The Value of Flexibility in Fixed Term Leases in Australian Residential Sector

Leasing of residential properties by investor-developers who are managing residential property portfolios is another area for further research. In the residential sector in Australia, even though the minimum leasing period for a fixed contract is six months, landlords and portfolio managers prefer to lease properties for one year. The main argument is that it offers stability of rental income. Flexibility in the lease agreements can offer possible upside opportunities because rent reviews are allowed every six months. The values attached to such flexibilities can be explored in further research through ROA to improve decision making in residential portfolio management.

10.7.8 Property Portfolio Acquisitions

ROA and ROV can also be applied to the valuation of property portfolios during acquisitions in the Australian property market. The use of ROV models for the valuation of property portfolios is yet to be demonstrated in the literature. On the backdrop of uncertainties affecting valuations of property portfolios and hence decision-making, it would be important to consider an application of ROV models that captures uncertainty as part of valuation for better decision making in property portfolio management.
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Appendix A: Ethics Approval

Notice of Approval

Date: 26 November 2015

Project number: CHEAN A&B 0000019763-11/15

Project title: Is there value in waiting? An empirical study of real options application to property developments

Risk classification: Low risk

Chief investigator: A/Professor David Higgins

Status: Approved

Approval period: From: 26 November 2015 To: 31 March 2019

The following documents have been reviewed and approved:

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<tr>
<th>Title</th>
<th>Version</th>
<th>Date</th>
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<td>26.11.2015</td>
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<tr>
<td>Participant Information and Consent Form</td>
<td>2</td>
<td>26.11.2015</td>
</tr>
<tr>
<td>Research Questions</td>
<td>1</td>
<td>26.11.2015</td>
</tr>
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</table>

The above application has been approved by the RMIT University CHEAN as it meets the requirements of the National statement on ethical conduct in human research (NH&MRC, 2007).

Terms of approval:

1. **Responsibilities of chief investigator**
   It is the responsibility of the above chief investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by CHEAN. Approval is valid only whilst the chief investigator holds a position at RMIT University.

2. **Amendments**
   Approval must be sought from CHEAN to amend any aspect of a project. To apply for an amendment use the request for amendment form, which is available on the HREC website and submitted to the CHEAN secretary. Amendments must not be implemented without first gaining approval from CHEAN.

3. **Adverse events**
   You should notify the CHEAN immediately (within 24 hours) of any serious or unanticipated adverse effects of their research on participants, and unforeseen events that might affect the ethical acceptability of the project.

4. **Annual reports**
   Continued approval of this project is dependent on the submission of an annual report.
Annual reports must be submitted by the anniversary of approval of the project for each full year of the project. If the project is of less than 12 months duration then a final report only is required.

5. Final report
A final report must be provided within six months of the end of the project. CHEAN must be notified if the project is discontinued before the expected date of completion.

6. Monitoring
Projects may be subject to an audit or any other form of monitoring by the CHEAN at any time.

7. Retention and storage of data
The investigator is responsible for the storage and retention of original data according to the requirements of the Australian code for the responsible conduct of research (section 2) and relevant RMIT policies.

8. Special conditions of approval
Nil.

In any future correspondence please quote the project number and project title above.

Professor Joseph Siracusa
Deputy Chairperson
RMIT DSC CHEAN A

cc: Ms Suzana Kovacevic (Ethics Officer/CHEAN secretary), Kwabena Mintah.
Appendix B: Interview question guide

Title

Is there Value in Waiting? An Empirical Study of Real Options Valuation (ROV) Application to Property Developments

Interview Questions for the semi-structured interviews

Information about participant

1) Can you briefly introduce yourself?
2) What is your role within your organisation and how long have you been in this role?
3) What type of development/investment project do you frequently analyse in your organisation?
4) Do you carry out the analysis alone or with other professionals? If not alone, what is your role in the team?

Current financial evaluation methods for property development and investment

5) What method(s) of valuation is/are frequently employed in your evaluation analysis within the specific market your organisation operates (retail, apartments, office)?
6) How are uncertainties and variability related to rents, demand, supply, interest rates, property values, and costs of development treated during feasibility evaluation of projects?
7) How about changing lease lengths, technological changes, flexibility and adaptability of buildings, long term performance of assets, value appreciation opportunities, technical variations etc.?
8) Is the discount rate a suitable measure of all risks and uncertainties?

**Real options analysis/methods and potential integration into mainstream valuation techniques**

9) Does your organisation consciously seek flexibility and adaptability of use of floor plans in real estate projects to better prepare for future uncertainties? If yes, how? If no, why not?

10) Do you make a conscious effort to determine embedded real options (flexibility and future opportunities) in your projects? If yes, how? If no, please explain?

11) Real option values are realized later in the life of a project/investment. However, they need to be considered at early stages of developments/investments. Do you think this approach to risk management is feasible and persuasive in practice within your specific market?

12) Have you encountered any risks/opportunities that were not examined at the inception of a project but occurred later during the implementation phase due to uncertainties?

13) Can you mention some of the opportunities and risks encountered and how were you able to deal with them?

14) How can new and emerging opportunities be justified to management for investments in flexibility, for example expanding a building later when uncertainties are resolved by investing into it initially?

15) Do you think ROA and ROV provide enough justification for strategic property investments that can be profitable in the future but may be deemed unprofitable today? Please explain?

16) Do you think uncertainties are resolved by the ROA/ ROV methods better, as compared to standard evaluation methods (DCF)?

17) Would it be valuable to incorporate real options models into standard evaluation models in practice? If yes, why? How can it be done and what could be the likely barriers? If no, please explain?

18) Which of the ROV method(s) do you think has the potential to be adopted by practitioners and why?

**Thank you**

**CRITERIA FOR SELECTING PARTICIPANTS**
1) Must be a developer, investor, financier or a valuer involved in property developments/investments or performing financial feasibility evaluation of property developments

2) Must be involved in the development/investment decision making process

3) Must have considerable experience in the field of real estate development and investments (would be desirable to have participants with between 5-15 years of experience in order to have a blend of knowledge from old and new generation)

4) Selected from major players (companies) in the industry
Appendix E: Visual Aid 3

- **LEVEL 21-30**: STAGING/ABANDON/TEMPORARY SHUT DOWN
- **LEVEL 11-20**: STAGING
- **LEVEL 1-10**: STAGING
- **BASEMENT**: REQUIRED STRENGTH, EXCESS STRENGTH

**EXPANSION**
# Appendix F: Participant’s Matrix-Interviewed Property Professionals

<table>
<thead>
<tr>
<th>Role in organization</th>
<th>Type of organization</th>
<th>Location/Coverage</th>
<th>Code for data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director/Owner</td>
<td>Small private financial advisory services</td>
<td>Melbourne and inner suburbs</td>
<td>Local independent financial advisor</td>
</tr>
<tr>
<td>Senior advisor</td>
<td>Large projects financing company</td>
<td>Melbourne and Nationally</td>
<td>Financial advisor</td>
</tr>
<tr>
<td>Managing partner</td>
<td>Large private property advisory services company</td>
<td>Nationally and globally</td>
<td>Global property advisor</td>
</tr>
<tr>
<td>Senior property advisor</td>
<td>Large property advisory services firm</td>
<td>Melbourne and nationally</td>
<td>Local property advisor</td>
</tr>
<tr>
<td>Senior investment analyst</td>
<td>Real estate investment trust-residential developments</td>
<td>Melbourne and nationally-Medium to high rise residential apartments</td>
<td>REIT</td>
</tr>
<tr>
<td>Investment director</td>
<td>Large listed property investment company</td>
<td>Melbourne and nationally-High rise residential apartments</td>
<td>Large super fund</td>
</tr>
<tr>
<td>Development director</td>
<td>Global property development company with offices in Melbourne</td>
<td>Melbourne and nationally-land banking, Medium and high-rise apartments</td>
<td>Large development company</td>
</tr>
<tr>
<td>Investment director</td>
<td>Large private company-invests pension funds-Melbourne and nationally</td>
<td>Melbourne and nationally</td>
<td>Large fund developer</td>
</tr>
<tr>
<td>Director/Owner</td>
<td>Private independent company-Small residential developments</td>
<td>Melbourne and inner suburbs</td>
<td>Small independent developer</td>
</tr>
<tr>
<td>Senior valuer</td>
<td>Large property valuation company</td>
<td>Melbourne and nationally</td>
<td>Local property valuer</td>
</tr>
<tr>
<td>Director</td>
<td>Small valuation company</td>
<td>Focusing on Melbourne market</td>
<td>Independent property valuer</td>
</tr>
<tr>
<td>Managing partner</td>
<td>Large valuation company specializing in valuing different assets including property, businesses, machinery</td>
<td>Globally with offices in Melbourne</td>
<td>Global property valuer</td>
</tr>
</tbody>
</table>

Source: Author
Appendix G: Publications and Conference Papers


Citations for doctoral colloquium presentations include:


Appendix H: Awards

RMIT University International Postgraduate Research Scholarship-PhD Scholarship