DEVELOPMENT OF HEDONIC-BASED PRICE INDEXES FOR KUALA LUMPUR OFFICE SECTOR

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DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (ESTATE MANAGEMENT)

FACULTY OF BUILT ENVIRONMENT
UNIVERSITY OF MALAYA
KUALA LUMPUR

2015

UNIVERSITY OF MALAYA

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Registration/ Matric No: BGD110001

Name of Degree: Master of Science (Estate Management)

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ABSTRACT

The recognition by the IMF on the importance of commercial property price index motivates this study, which attempts to develop the first commercial property price index in the country, in specific the Kuala Lumpur Office Price Index (KL-OPI). The transactions data used in the study are sourced from the National Property Information Centre (NAPIC), spanning from 2006 to 2011, comprising office lots in purpose-built office buildings in Kuala Lumpur. At the initial point of the study, more than 6,000 transactions data are utilised. Having gone through the cleansing and validation process, the final data set comprises 3,247 transactions. The transaction-based methodology, namely the Hedonic technique is employed based on the review carried out on literature as well as in practice. Furthermore, the familiarity of the industry with Hedonic technique as employed in Malaysian House Price Index and Purpose-Built Office Rental Index provides another platform justifying the employment of the technique for KL-OPI. Three hedonic price models are examined, which are the Conventional Hedonic Price Model, the Laspeyres Time-Varying Parameter Hedonic Price Model and the Chained Time-Varying Parameter Hedonic Price Model. The study reveals that all the three Hedonic Price Models are plausible to be employed in modelling KL-OPI. In order to determine the degree of precision of the models, Signal-to-Noise Ratio is used. The results show that though the three Hedonic Price Models have quite similar predictive power, the Conventional Hedonic Price Model records the best precision performance. This indicates that the Conventional is deemed as the most suitable model for KL-OPI.

ABSTRAK

Pengiktirafan badan dunia IMF ke atas kepentingan indeks harga harta tanah komersil merupakan pendorong kepada kajian ini, yang merupakan kajian perintis dalam negara, secara khusus Indeks Harga Pejabat Kuala Lumpur Office Price Index (KL-OPI). Data transaksi yang digunakan untuk kajian ini diperolehi daripada Pusat Maklumat Harta Tanah Negara (NAPIC), dari tahun 2006 to 2011, terdiri daripada lot pejabat di dalam pejabat binaan khas di Kuala Lumpur. Pada permulaan kajian, lebih daripada 6,000 data transaksi digunakan. Setelah data tersebut melalui proses pembersihan dan validasi, set data akhir terdiri daripada 3,247 data transaksi. Metodologi berasaskan transaksi, iaitu teknik Hedonik digunakan berdasarkan penemuan daripada kajian literature dan kajian praktis. Tambahan pula, kebiasaan industri terhadap teknik Hedonik sepertimana yang digunakan dalam Indeks Harga Rumah Malaysia dan Indeks Sewa Pejabat Binaan Khas memberi alasan yang lebih kukuh dalam penggunaan teknik ini bagi KL-OPI. Tiga model harga hedonik dikaji, iaitu Model Harga Hedonik Konvensional, Model Harga Hedonik Parameter Ubahan Masa *Laspeyres* dan Model Harga Hedonik Parameter Ubahan Masa *Chained*. Hasil penemuan mendapati bahawa ketiga-tiga Model Harga Hedonik mempunyai tahap keupayaan yang munasabah untuk membangunkan KL-OPI. Bagi menentukan tahap ketepatan model tersebut, nisbah *Signal-to-Noise* digunakan. Hasil penemuan mendapati walaupun ketiga-tiga Model Harga Hedonik mempunyai keupayaan ramalan yang hampir sama, nisbah *Signal-to-Noise* bagi Model Harga Hedonik Konvensional memberikan prestasi ketepatan yang tertinggi. Ini menunjukkan bahawa Konvensional merupakan model paling sesuai untuk membangunkan KL-OPI.

ACKNOWLEDGEMENTS

First and foremost, Alhamdulillah to the Most Gracious and Benevolent, for only with His blessings I am able to complete this task.

To Associate Professor Dr. Md Nasir Daud, I am grateful for your continuous support, positive encouragements and most assuring of all your calmness in handling the difficult times in the course of completing this research.

To Encik Zulkifli Esha, your assistance is much appreciated.

To Associate Professor Dr. Rasimah Aripin, thank you for all your time, effort and guidance in ensuring that I'm on the correct analytic path.

To NAPIC, thank you for providing the invaluable data; without which, the research would not materialise.

To my husband, Azrul Thani Sa'adun and children, 'Atiqah Najwa and Adam Haikal, your sacrifice, love, support and prayers have eased the path to completion.

To my parents, the very reason I pursue this study, your love, support and endless prayers are the pillars of my strength.

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LIST OF ABBREVIATIONS AND ACRONYMS

BNM	Bank Negara Malaysia
GDP	Gross Domestic Product
IMF	International Monetary Fund
IRB	Inland Revenue Board
IPD	Investment Property Databank
KLIFD	Kuala Lumpur International Financial District
KL-OPI	Kuala Lumpur Office Price Index
MHPI	Malaysian House Price Index
MIER	Malaysian Institute of Economic Research
MIT-CRE	Massachusetts Institute of Technology – Centre of Real Estate
MNC	Multinational Corporation
MOF	Ministry of Finance
NAPIC	National Property Information Centre
NCREIF	National Council of Real Estate Investment Fiduciaries
NPI	NCREIF Property Index
PBO-RI	Purpose-Built Office Rental Index
PDPA	Personal Data Protection Act
PRISM	Property Information System Malaysia
TRX	Tun Razak Exchange
VPSD	Valuation and Property Services Department

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

Indices are regarded as important benchmarking and decision-making tools in financial and capital markets, and also in the real estate market. In mature economy, its importance has led to the development of the internationally renowned NCREIF Property Index (NPI), the Moody's/REAL Commercial Property Index, MIT-CRE Transaction-Based Index, among others in the United States and those published by the Investment Property Databank (IPD) in the United Kingdom. These indices provide indicators on the performance of commercial properties that are within the holding of the investment institutions. This would allow investors to manage, strategise and decide informatively on their investment portfolio.

The International Monetary Fund (IMF) reiterated the importance of real estate market, as evident from the indicators included in its Financial Soundness Indicators Compilation Guide 2006. In the guide, IMF incorporated four real estate market indicators, comprising Residential Real Estate Prices, Commercial Real Estate Prices, Residential Real Estate Loans to Total Loans and Commercial Real Estate Loans to Total Loans. Bank for International Settlements, which initially mooted the idea in 2003, also concurs with the fact that real estate prices are a critical factor in the financial sector and in measuring a country's wealth.

On the local front, property plays a pivotal role in driving the overall economy. In 2011, a total of 430,403 property transactions was recorded worth RM137.83 billion. Of these, residential sub-sector accounted for 62.7% of the total market activity whilst commercial sub-sector held another 10.1% of the total volume. In the financial segment, broad property sector took up more than 46.8% of bank lending as at the end of December 2011. Therefore, constant and close monitoring of property price movements and its performance are important as nearly half of banking exposure was on property.

All these point to the importance of having indicators that enables market players gauge the health of the property market. In Malaysia, the Malaysian House Price Index (MHPI) was the first real estate index developed in the country in 1997. MHPI indices are constructed using the hedonic approach, whereby the price of an "average" house is determined based on a set of characteristics attached to the property whilst the indices are calculated using Laspeyres weighted formula. MHPI is the only index that relates directly to property.

At its initial stage, the reception of the industry towards MHPI was merely a new product for the industry. After more than a decade since its inception, MHPI is regarded as one of the important macroeconomic indicators by Bank Negara Malaysia (BNM) and the Ministry of Finance (MOF). On this end, the National Property Information Centre (NAPIC), the federal agency that is responsible to collect, collate and disseminate property data, provides MHPI data on quarterly and annually basis to BNM and MOF for them to incorporate these data in their quarterly statistical updates and annual reports.

Moving forward, as Malaysia is on its path to transform the economy and in particular to transform Greater Kuala Lumpur/Klang Valley into the top-20 most liveable city in the world and top-20 in terms of economic growth by year 2020, innovations of new property market indicators such as Kuala Lumpur Office Price Index (KL – OPI) to complement the financial and economic indicators would prove to be beneficial.

The KL - OPI would enable occupiers/investors to benchmark the performance of commercial property market in Malaysia, particularly the performance of office buildings, against those in other major cities across the globe. The research on developing commercial property index is in a class of its own and is still rare in the country. This provides a motivational drive to pursue research on this topic.

1.2 Research Aim and Objectives

The research aim is 'To establish a commercial property price index, in specific Kuala Lumpur Office Price Index (KL-OPI)' that could be utilised by the industry for investment decision-making and benchmarking of office sector's performance among others.

Based on the issues discussed in earlier section and to fulfil the aim, four objectives are defined for this research:

i) To identify the existing approaches in use for commercial property index construction.

ii) To establish a protocol appropriate for the construction of KL- OPI.

iii) To determine the hedonic functional form most suitable to use for KL-OPI.

iv) To derive a decision model for index computation.

1.3 Scope of Research

The research focuses on private purpose-built office buildings in Kuala Lumpur as these are the buildings where investment potential is vested. Government office buildings though have investment potential are excluded from this research as these buildings are for own occupancy. The rationale to scope the research in Kuala Lumpur is because it is the capital city of Malaysia and the main choice of international real estate investors (Boon, 2003). This is evident from the fact that the city has managed to attract outstanding multi-national companies to set up their operations here; some of which have been established for more than 50 years.

In relation to the property market, Kuala Lumpur has 341 private office buildings as at the fourth quarter of 2011, accounting for 51.6% of the country's total private office space (6.49 million square meters). By market activity, Kuala Lumpur recorded 733 office lot transactions worth RM456.58 million in 2011, which formed 33.2% of the country's total office transactions.

Based on the facts stated above and in view of Kuala Lumpur transforming into a top-20 city in terms of economic growth by the year 2020, it would only do justice to focus the research in this city.

1.4 Importance of Research

The absence of commercial property price index in the country provides a valid merit to pursue this research. In achieving the aim and the objectives, the development of the index would be the first commercial property price index that is representative of office

buildings' performance in the country. The research will offer a significant endeavour in promoting the development of other commercial property indices and subsequently in developing a commercial property composite index that could represent the entire commercial property population in the country.

The research also provides another financial soundness indicator for the financial sector as the commercial property price indicators i.e. price index are considered as one of the important elements by BNM, in consonant with the IMF.

1.5 Organisation of Chapters

The organisation of chapters in this research is as follows:

Chapter 1, in which this section resides, provides the holistic framework of this research encompassing the research aim, objectives, scope of study and the significance of the research to the development of property price-related indicators for the benefit of the industry at large.

Chapter 2 reviews the literature of past works which is similar in nature to the research undertaken. The strengths and challenges of property index construction methodology are reviewed and analysed in two aspects. Firstly, a methodological review based on research undertaken by various quarters is conducted. These studies are mainly in the US with few others in the UK, Singapore, Hong Kong and Japan. Secondly, the actual development of the commercial property price indices in practice is reviewed. By reviewing both the literature and the practice, including those indices available in Malaysia and presenting the main findings of the review in a matrix tabulation form,

the justification of employing the hedonic price model in developing KL-OPI could be made firm.

Having reviewed the literature and the practice in Chapter 2, the subsequent Chapter 3 discusses on the methodology of this research. This provides the explanation on the overall "behind the scene" procedures in arriving at the research aim. The step-by-step flow starts by understanding the source of data and the method of data collection. As the study only utilises secondary data, the complexity of acquiring the data is minimised. Although these data come from a reliable source, which is from the National Property Information Centre (NAPIC), the data cleansing and data validation procedures need to be undertaken as a precautionary measure to ensure data quality. The tools employed for this purpose is also explained in the chapter. The following sub-section discusses on the method to determine the functional form of the KL-OPI model, which entails identifying the appropriate form of dependent variable, the independent variables chosen as the explanatory variables as well as the measurement of precision of the model.

Chapter 4 provides the findings of data validation and analysis of the data. This chapter explains how the original dataset, which stands with more than 6,000 transactions data, is trimmed down to slightly more than 3,200 transactions data. Further, the descriptive statistics of the dataset are also discussed and explained. The transformation of data i.e. data recode and data compute of relevant variables to make it workable in the SPSS environment is discussed as well as the regression outputs of each hedonic price model .

Chapter 5 focuses on the decision model for KL-OPI, having considered all the findings in the previous chapter. A comparison is made between the three hedonic price models

i.e. Conventional, Laspeyres and Chained. In addition, the evaluation of model precision is also undertaken so as to determine the model that is the best to be adopted. Subsequently, the computation of index for each model is presented in graphical format and entails a discussion on the similarities and differences of the index movements. As a form of checking, these indices are plotted against the GDP growths so as to see should there be any form of correlation between the two.

Chapter 6 provides a summary of the whole research i.e. in relation to the achievement of the research aim, objectives as well as the limitations faced in undertaking the research. The significance of the research as well as the future path of related research is discussed.

Figure 1.1 shows the diagrammatic presentation of the research structure.

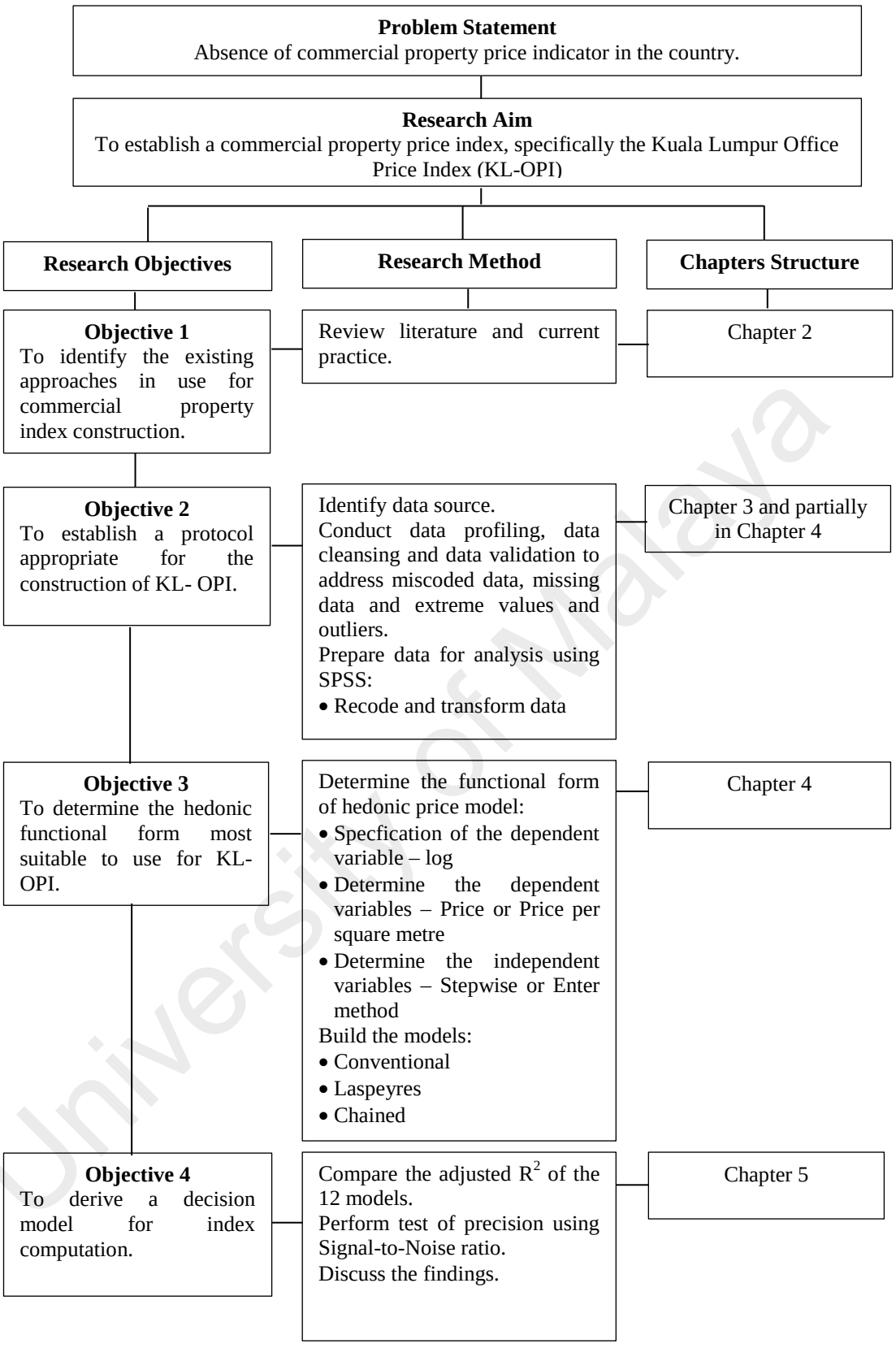

Figure 1.1: A Summary of the Research Structure

CHAPTER 2

LITERATURE REVIEW

2.1 Internationalisation of Real Estate Market

Real estate formed the largest component of wealth in the US (DiPasquale and Wheaton 1992). Similarly, in Malaysia, capital investment in terms of loans by commercial banks and merchant banks to broad property sector stood at RM469.91 billion as at the end of 2011, which accounted for 46.8% of the total loans. Hoesli and Lizieri (2007) hold the opinion that property performance indices are important as a prerequisite for international real estate investment.

The importance of real estate sector to the economy has raised the concern on the scarce availability of commercial real estate market information (Keiler, 2012). The inclusion of both residential and commercial property prices in the IMF 2006 Financial Soundness Indicators reiterated the importance of establishing price-based indicators. The increase in awareness and interests in cross-border real estate investment makes it more pertinent to have reliable yardsticks to measure property prices.

As real estate investment is becoming a global investment asset class, more investors are acquiring assets in foreign countries (World Investment Report, 2012). On a similar trend, the number of REITs in Malaysia has expanded to 16 as at September 2012 with a market capitalisation of RM24.55 billion. This shows the rapid evolution of the real estate landscape in Malaysia, in line with the country's economic transformation towards a developed nation in 2020.

2.2 Overview of the Malaysia Commercial Property Market

The commercial property sub-sector recorded 43,674 transactions in 2011, the third largest contributor to the overall property market in the country (Property Market Report 2011, VPSD, MOF). This figure represented 10.1% of the total market activity, after residential (62.7%) and agricultural sub-sectors (19.7%) (Figure 2. 1). In terms of value, the commercial sub-sector remained dominant with RM27.64 billion, accounting for 20.0% of the total value (Figure 2.2).

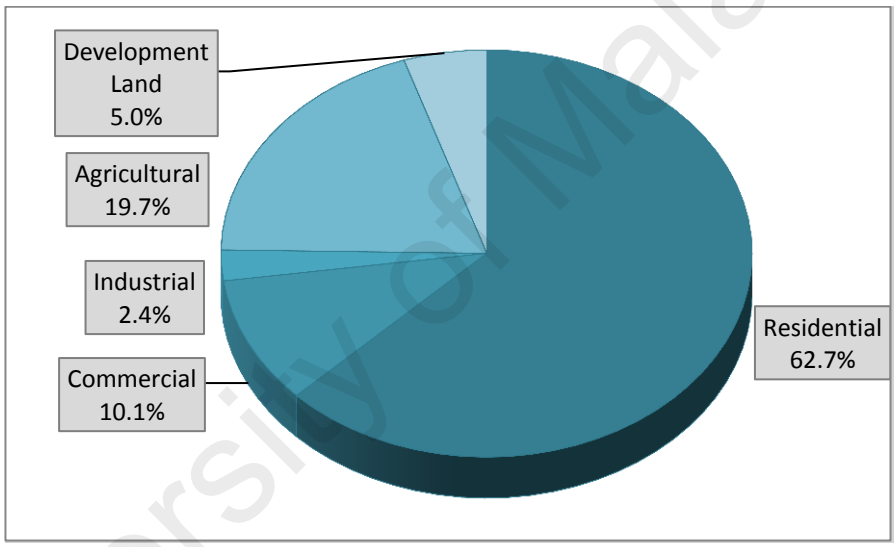

Figure 2.1: Breakdown of Volume of Transaction by Property Sector 2011
Source: National Property Information Centre (NAPIC)

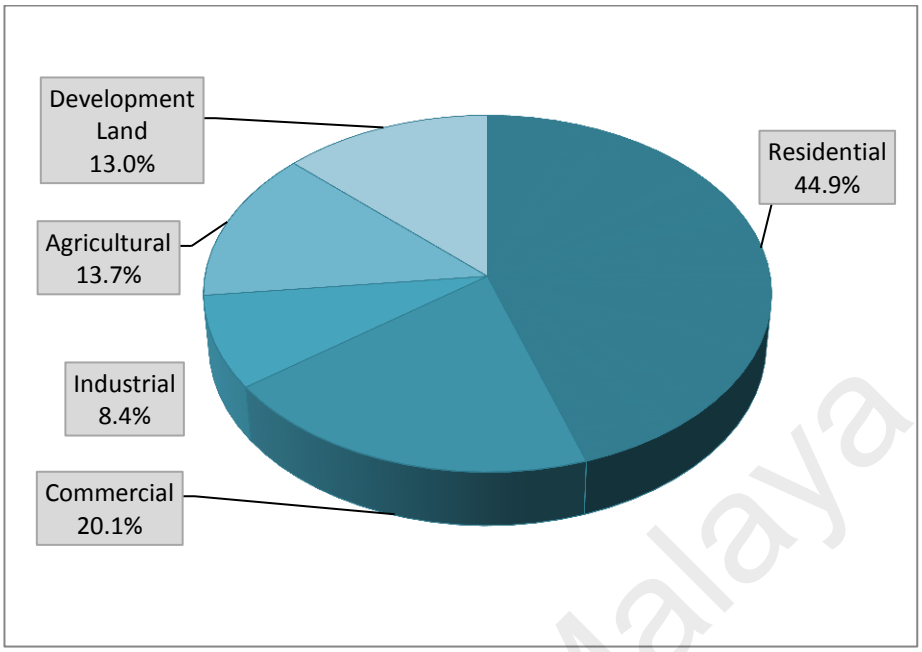

Figure 2.2: Breakdown of Value of Transaction by Property Sector 2011
Source: National Property Information Centre (NAPIC)

The prominence of commercial property sector was more evident as both the volume and value of transactions showed an uptrend in the last few years (Figure 2.3 and Figure 2.4, respectively). The sector is seen to capture larger portion of the overall property market over the years. In 2011, market volume in the commercial sector increased by 9.7% (year-on-year), after recording a double-digit growth of 19.4% in 2010. In terms of value, the growth was more significant at 15.9% in 2011 (2010: 45.5%).

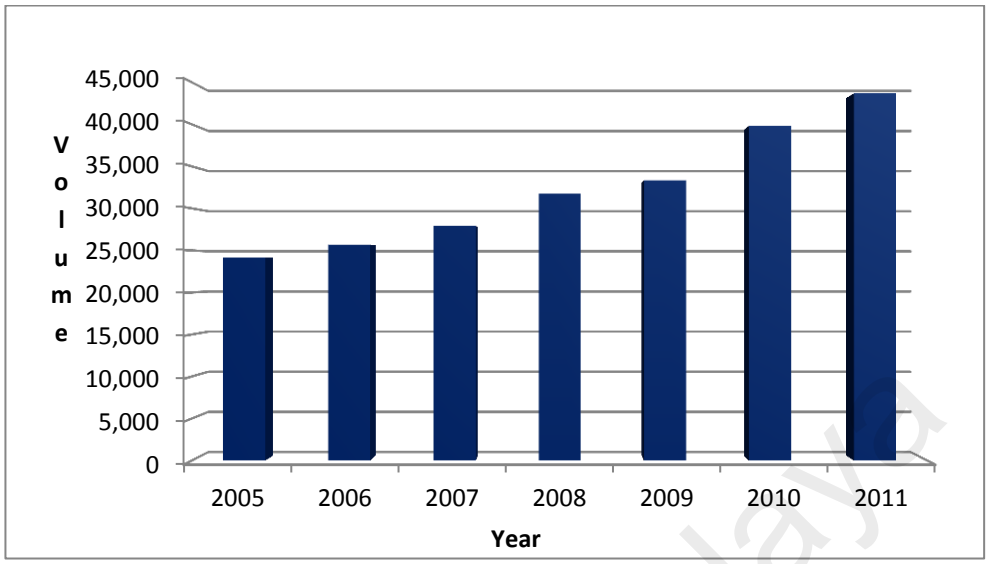

Figure 2.3: Annual Volume of Commercial Property Transactions, 2005 to 2011
Source: Property Market Report 2006 to 2011,
National Property Information Centre (NAPIC)

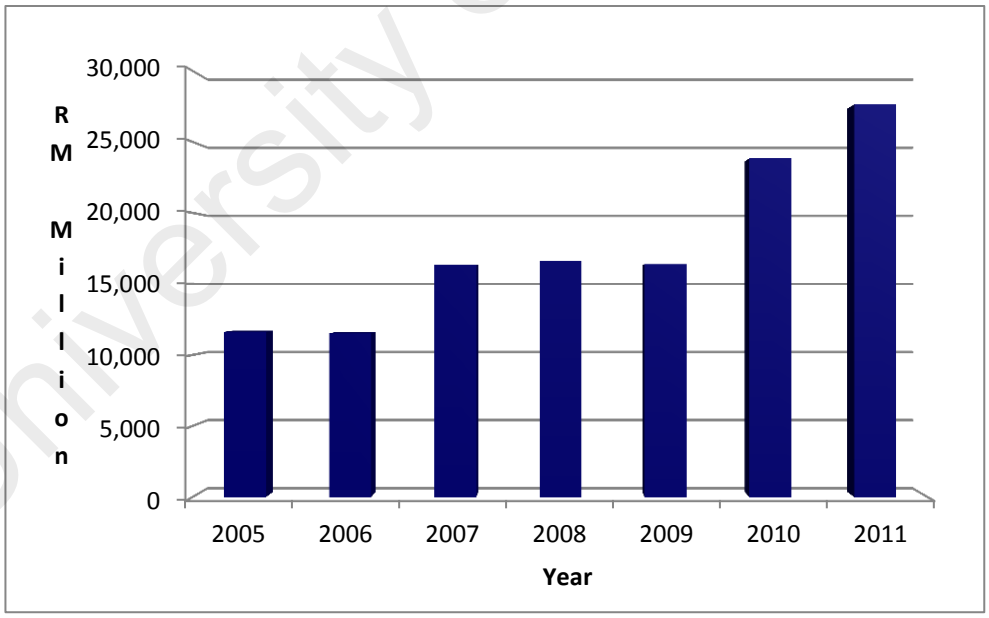

Figure 2.4: Annual Value of Commercial Property Transactions, 2005 to 2011
Source: Property Market Report 2006 to 2011,
National Property Information Centre (NAPIC)

Comparison by state in Figure 2.5 shows that in 2011 Kuala Lumpur was ranked second in terms of commercial market activity with 14.8% market share (6,478 transactions) but was the leader in terms of value at RM7.72 billion, accounting for 27.9% of the total volume of commercial transactions for that year (Figure 2.6). Selangor was the leader in terms of transactions but was second behind Kuala Lumpur for volume. Hence, these two states made up the bulk of property transactions in terms of number as well as volume.

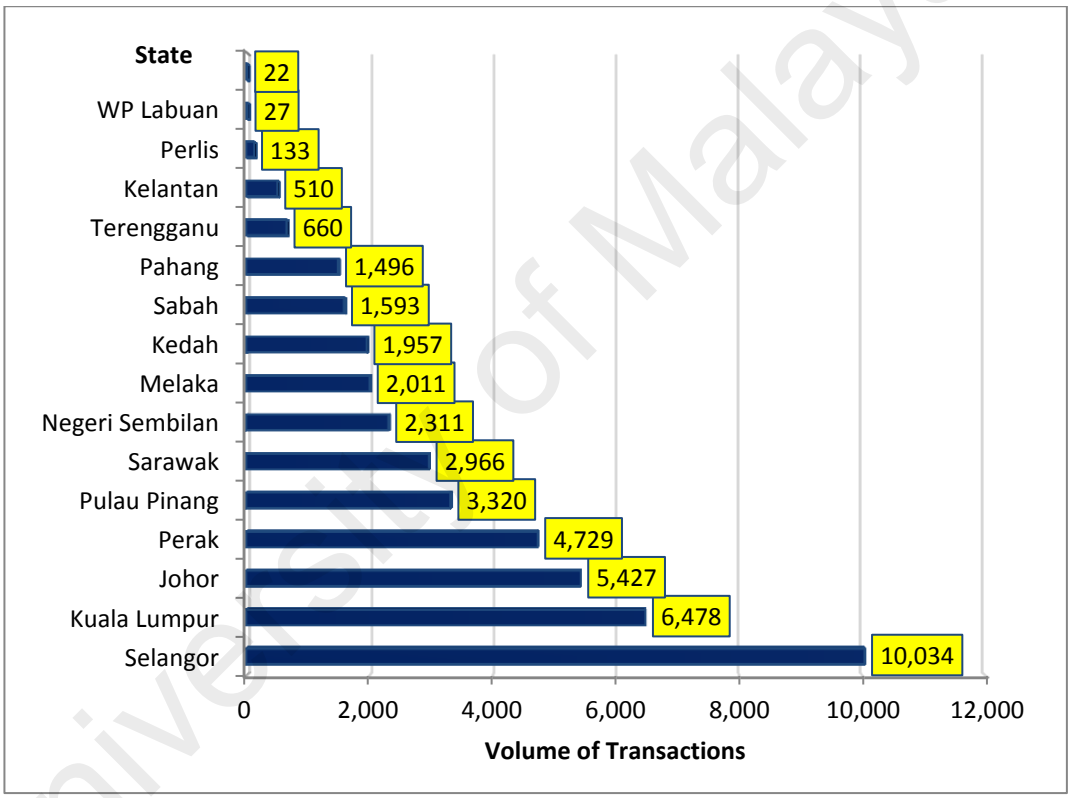

Figure 2.5: Breakdown of Volume of Commercial Property Transactions by State 2011
Source: Property Market Report 2011, National Property Information Centre (NAPIC)

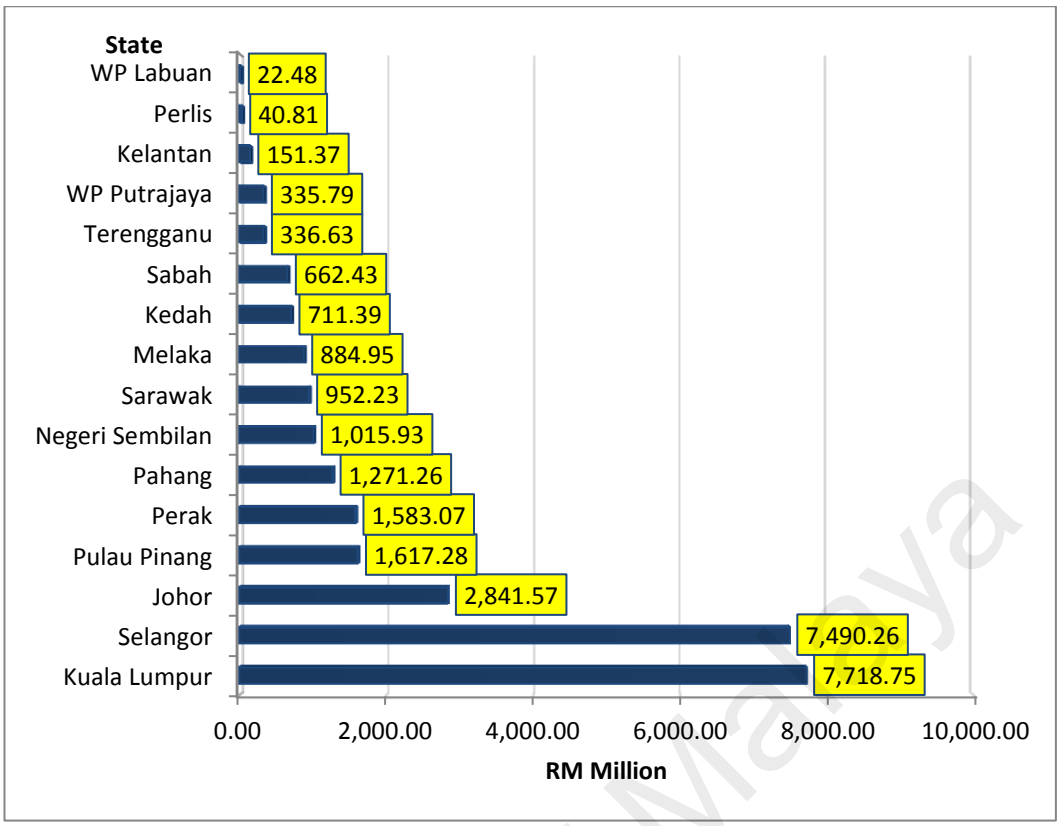

Figure 2.6: Breakdown of Value of Commercial Property Transactions by State 2011
Source: Property Market Report 2011, National Property Information Centre (NAPIC)

2.3 Kuala Lumpur Office Market

The office property market has experienced rapid growth since the turn of the millennium. In year 2000, there were 1,789 office buildings as compared to 2,282 buildings in 2011. Figure 2.7 depicts the supply of space in Malaysia grew from 12.07 million square metres in year 2000 to 17.38 million square metres in 2011, which recorded an increase of 44.0%

Kuala Lumpur is the major provider of office space in the country, taking up almost 40.0% of the country's total existing office supply with 387 buildings offering 6.96 million square meters of space as shown in Figure 2.8. Of these, private office buildings comprised 341 buildings with a total space of 3.49 million square meters.

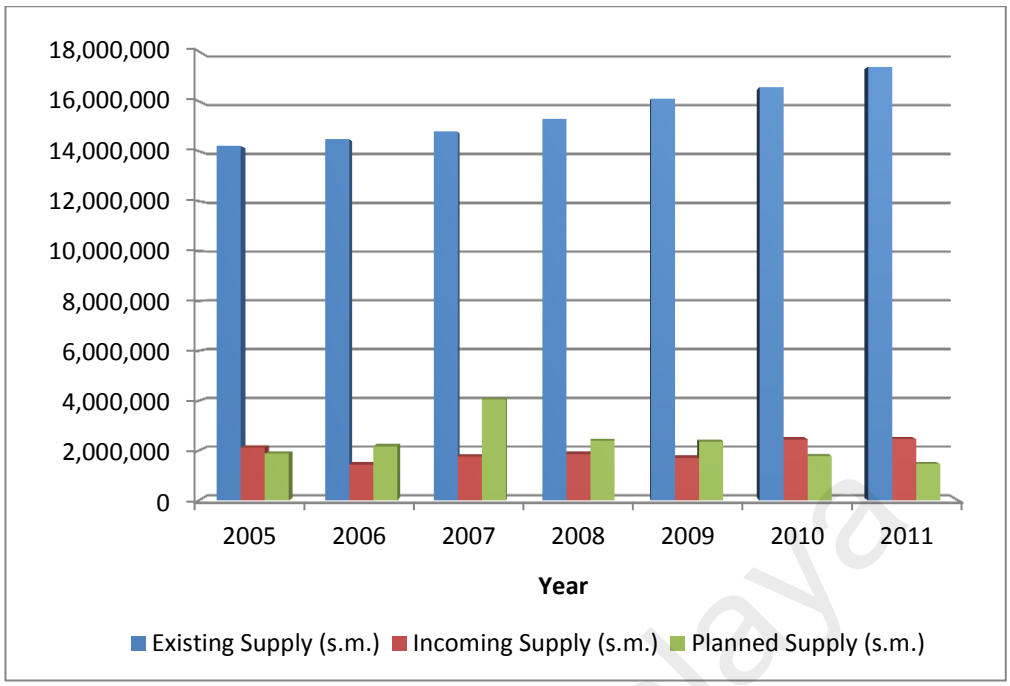

Figure 2.7: Supply of Office Space in Malaysia
Source: Property Market Report 2006 to 2011, National Property Information Centre (NAPIC)

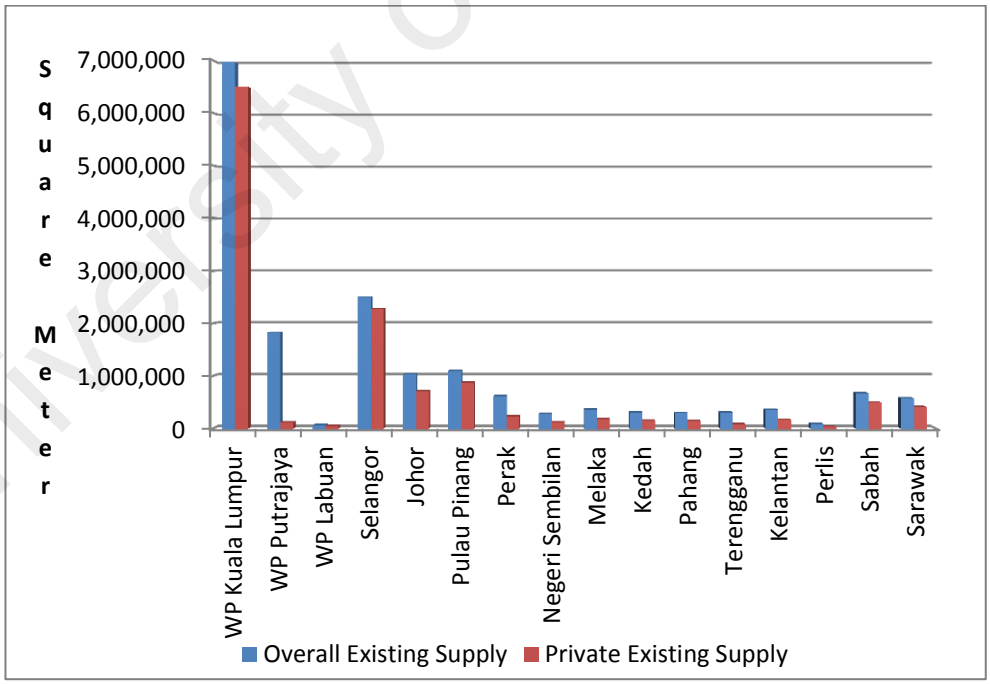

Figure 2.8: Breakdown of Existing Office Space by State, 2011
Source: Property Market Report 2006 to 2011, National Property Information Centre (NAPIC)

The capital city's position as the country's major office market is expected to be more prominent in the coming years with the launching of Tun Razak Exchange (TRX), formerly known as the Kuala Lumpur International Financial District (KLIFD). This would give a competitive edge to the office market as the TRX is expected to attract 250 of the world's leading companies to locate their operations. This in turn would translate into higher office take-up rate in years to come. On this note, the importance of having commercial price indicators to enable benchmarking by investors and occupiers is evident.

According to Price Waterhouse Coopers (InvestKL 2011), real estate makes up the largest component in services sector for approved domestic and foreign investments, accounting for 26.0% of the total share. As of the end of December 2011, a total of 217 operational headquarters were approved amounting to RM758 millions of investment worth. The office market in particular has the potential for better growth as seen in the escalating numbers of MNCs setting up their regional and global operations in recent years.

Malaysia's 3rd ranking in the A.T. Kearney's Global Services Location Index 2011 has placed Malaysia in a better investment position. This was further affirmed by the World Bank's Ease of Doing Business Survey 2013 that saw Malaysia in the 12th position from a total of 185 economies surveyed. All the positive indicators signify that the Kuala Lumpur property market, particularly the commercial sector, has the competitive edge against other capital cities in the region.

2.4 Real Estate Indicators

The financial crisis in 2008 – 2009 has illustrated that the value of real estate has a direct impact on national wealth and investments (Chegut et al., 2013). Close to home, the Asian Financial Crisis in 1998 – 1999 was the impetus to NAPIC establishment in September 1999. When the crisis hit Malaysia then, there was no centralised information on the property market status. The number of unsold property and the vacancy in the commercial property sub-sector could not be concretely established. The unavailability of these data prolonged the time taken to nurse the property sector to the pre-crisis level.

When the economy was again hurled into another financial crisis in 2008 – 2009, the property market though was affected, managed to regain its position within a shorter period. With the real estate information readily available, regulators and policy makers were able to make timely informed decisions.

Since its establishment, NAPIC has produced several commercial property indicators namely the supply-side and demand-side indicators. Pertaining to office sub-sector, the supply-side indicators include the supply of space according to stages of development i.e. existing, incoming and planned as well as buildings completed, started and approved for construction at a particular time period. On the demand-side, NAPIC produces data on occupancy, vacancy, rental and price.

In order to place the Malaysia property market at par with other advanced countries, it is imperative that more property indicators are developed to further enhance the level of information on commercial property market in Malaysia (Ting, 2002).

2.5 Development of Real Estate Index

The development of property indices dates back to 1997, the time when MHPI was first published by VPSD. The quarterly report contains the "average" house price representing the whole housing market aggregated by districts and types. The MPHI is a transaction-based index constructed using the hedonic approach, whereby the price of an "average" is determined based on the characteristics attached to the property. The indices are calculated using Laspeyres weighted formula.

Another property index is the 'Residential Property Index', which was first published by the Malaysian Institute of Economic Research (MIER) in 2003. A different approach is employed in constructing the index in that it is based on responses to seven key questions on supply, sales, bookings, investment, total unsold units, prices and employment. The respondents comprise 780 housing developers throughout the country.

Bursa Malaysia also develops its own Property Index Series but the index portrays the performance of property companies instead of the performance of properties owned by these companies.

In recent development, VPSD unveiled its new property index, the WPKL Purpose-Built Office Rental Index (PBO-RI). The first of its series was launched in July 2012. The purpose of the index is to provide an overview of the office rental index for Kuala Lumpur, with its main focus on investment grade buildings. The PBO-RI employs hedonic method and calculated based on Laspeyres weighted formula.

At international level, various commercial property price indices have been produced and disseminated across the globe. The methodology employed in arriving at the index, the property sectors involved and the purpose of the index are shown in Appendix A.

According to Ting (2002), despite industry's recognition of the importance of property price indicators the following three contributory factors have militated against research into property indices:

i. a limited extent of property investment by institutional investors;
ii. a lack of adequate and reliable property information databases;
iii. an absence of pressures on property consultants to provide performance measures.

2.6 Methodology for Real Estate Index Construction

The main discussion theme of previous studies was on the methodology of developing property indices, which are either appraisal-based or transaction-based. The following sections review the strengths and weaknesses of each of these methodologies.

2.6.1 Appraisal-Based Methodology

The traditional method of valuing commercial properties has been appraisal/valuation-based due to the nature of the property and its infrequent sales (Fisher, 2003). The NCREIF Property Index (NPI) was the pioneer commercial property index developed to measure the performance of income producing real estate. Since its inception in 1978, NPI has been recognised as the primary index that institutional investors use to benchmark the performance of real estate (Fisher, 2003).

Notwithstanding this, the appraisal-based index tends to be less volatile to market movements and the application of appraisal-based approach comes with a number of technical difficulties in using the approach, namely the appraisal-smoothing (Geltner et al., 2003).

In appraisal-based approach, the reliance on historical data leads to its disadvantage. This is because as appraisal is historical in nature, it tends to suffer from the lag in reflecting the actual market conditions at that point of time. Therefore, in a situation where the market is booming, the index tends to be lower than the actual price and vice-versa. Apart from that, Fisher (2003) also identifies that the appraisal-based approach has two errors namely the comparable sample error and the comparable lag error. Nevertheless, the NPI, which has since developed using the appraisal-based approach is received well by the industry and academics alike.

Appraisal on its own entity is synonym to subjectivity in the measurement of value. The issue of index smoothing can surface from the appraisal update either on quarterly or monthly basis. Chau et al. (2005) in their study reveals that new information, which is scarce and more often unlikely to be captured at frequent interval leads to temporal aggregation effects on the index generation.

In London commercial property market, real estate indices are mainly appraisal-based due to the absence of robust aggregate transaction data (Chegut et. al, 2013). Even with sufficient transactions data, they may not be the best tool for identifying market volatility.

2.6.2 Transaction-Based Methodology – Repeat-Sales Technique

Another methodology is the transaction-based approach, which is feasible when property transactions data are sufficiently large and comprehensive. Although the transaction-based approach is unencumbered with the issues of smoothing and lagging, property transactions particularly commercial buildings are usually infrequent and heterogeneous, making the statistical control of quality variation difficult. Vigorous methods have been devised with transaction evidence as input decades ago by several scholars (Bailey et al., 1963; Rosen, 1974; Quigley, 1995). This approach can be subdivided into repeat-sales model, hedonic pricing model and the hybrid model.

The repeat-sales model is an econometric technique developed by Bailey et al. (1963), where transaction prices of the same property are observed from two periods based on the assumption that the quality of the property stays constant over the period of time. Bailey et al. (1963) and Case and Shiller (1987) were the pioneers to employ the repeat-sales methodology in the residential sector. This model often applies to residential sector as transactions are many and frequent, unlike the commercial property.

In recent years, the employment of this methodology is more feasible in the latter sector due to availability of extensive transactions database. Gatzlaff and Haurin (1998) conducted a study on Florida commercial market and found that repeat-sales index recorded more price movements than the appraisal-based NCREIF index. Due to the advancement of the financial capital in the US market, Geltner and Pollakowski (2006) have taken the effort to develop derivatives to allow trading of commercial real estate future prices. The goal is to provide indices that are practical in nature and useful in the derivatives market. Geltner and Pollakowski (2006) and Bokhari and Geltner (2010)

accomplished a national index for the US and 15 sub-regions spanning from 2001 to the present.

Similar to appraisal-based, the repeat-sales technique also has its drawbacks. The assumption of quality of a property remains constant across time may not necessarily hold. The quality of property tends to change over time due to age, depreciation and also appreciation resulting from renovation works. Another case in point is that the repeat-sales model only takes into account properties that are repeatedly sold across time. This arguably led to the issue of "representativeness" and selectivity bias as only the active properties are taken into account, which could overstate the actual performance of the general property market.

2.6.3 Transaction-Based Methodology – Hedonic Technique

Perhaps, the earliest work employing hedonic technique in Kuala Lumpur office market was undertaken by Yusof (1999). However, this study focused on determining depreciation of office buildings in Kuala Lumpur using hedonic technique, which revealed that property-specific factors have more influential impact on depreciation in comparison to economic factors. Although there seems to be a similarity in terms of technique and scope of study, the current research is conducted based on secondary data available from NAPIC's database and focused on identifying the variables to model the Kuala Lumpur office market.

The hedonic technique is a transaction-based approach, which has been in use for more than 70 years. In hedonic, transaction prices are used as a function of characteristics of the property such as age, location, land area, built-up area, condition of building, etc. As

opposed to the former model discussed earlier, the hedonic model does not require repeat sales of the same property. However, the model requires the characteristics of the property to be captured extensively along with its spatial features (Haurin, 2003). Fisher et al. (2003) developed an extension version of the hedonic pricing model that incorporates controlling for selectivity bias and adjusting for liquidity variations over the property cycle.

In principle, the technique can be feasibly employed if all of the attributes that affect property value are captured so as to control the differences in the transacting properties' quality across time (Fisher et al., 2007). The employment of this methodology is possible if high-quality catch-all hedonic variables of the properties transacted are readily available. Hedonic technique offers an alternative pricing mechanism that can enhance index generated at a metro-level.

Hedonic approach has a strong theoretical grounding (Griliches 1971; Rosen 1974) and use regression techniques to control for compositional and quality change. The key advantage of the general hedonic formulation is that it provides direct estimates of pure price change and can, in principle, control for changes in the composition and quality of properties sold.

There are several studies on the application of hedonic technique to model the price or rent of office property. Colwell et al. (1998) apply the hedonic technique to evaluate the office price trend in Chicago between 1987 and 1993. Their study reveals that prices trended upwards after 1986 and declines in the latter time period, which differs from the prevailing view of the market.

Munneke and Slade (2001) applies variation to the hedonic technique in their study by using three time-varying parameter techniques namely the chained hedonic, Laspeyres hedonic and Paasche hedonic. The aim of this study is to evaluate the most reliable hedonic technique to model the office market by applying the Signal-to-Noise ratio as the deterministic tool.

A more recent study by Nappi-Choulet et al. (2007), a pioneer on Paris office market reveals the spatial attributes and inter temporal effects on the price index. This study also examines the functional form of the dependent variable (Price) and the implication on the explanatory power of the model. Their study recommends that dependent variable takes the functional form of Log Price over the Log Price per square meter as the former demonstrates higher explanatory power. As suggested by them, the relative price index change is of essence, and not the change in actual price.

Caduff (2013) attempts an advance application of spatial hedonic regression model in identifying price determinants of office, retail and industrial space in Singapore market. The study suggests that the main determinants office space price are the access, location and the tenure conditions.

Nevertheless, the hedonic method is not without limitations. The use of regression techniques implies that hedonic models are only as good as the specifications used to derive them, which often depend on the quality of the data available. If hedonic regressions omit variables that have a significant impact on property prices, this can result in biased estimates of pure price changes. Nevertheless, there are statistical procedures available that can assist the identification of appropriate model specification.

2.6.4 Transaction-Based Methodology – Hybrid Technique

The third transaction-based approach is the hybrid technique, which basically combines and modifies attributes of repeat-sales and hedonic pricing models. This technique developed by Quigley (1995), essentially involves "stacking" repeat-sales and hedonic models, whilst imposing a constraint that the estimated price change is equal in both models. Even so, Quigley (1995) do not see any clear efficiency gains in using the hybrid model over the hedonic technique.

The summary of several renowned existing commercial property price indices is as shown in Appendix A.

2.7 Justification on Index Construction Methodology

Based on the literature and the existing real estate indices available across the globe, the development of commercial property price indices is seen to focus on and limited to properties that are within the portfolio of the participating institutional investors. As with the case of NPI and CPPI, sales are obtained from those in the investment portfolio; thus, making it feasible to employ the repeat-sales approach in arriving at the price index. The rationale is that the index is able to portray the actual price change of the same property as transactions are based on those sold within the portfolio.

Appraisal-based is the first approach employed by NCREIF as transactions were fewer in the earlier years of its establishment. With appraisal, valuations of property are carried out based on historical transactions, which bring about the issue of time lag and not actually portraying the current market situation.

In Malaysia, attempts to develop property index have been undertaken by various quarters, namely, VPSD, MIER and Bursa Malaysia. Presently, the MHPI is the only property price index that is directly related to physical property and has been accepted and referred to nationally and internationally. On this end, due to the non-existence of similar indicator in the commercial property sub-sector, this research attempts to bridge the gap by initially developing an office price index that could represent the overall office market performance in Kuala Lumpur.

Given the availability of extensive and comprehensive data in NAPIC's database, hedonic pricing model is seen as the most appropriate methodology to employ for the office price index development. Arguably, due to the comprehensiveness of the data available, repeat-sales approach could also be considered. However, given the fact that Kuala Lumpur office market only recorded less than 15 sales of purpose-built office buildings in a year, the repeat-sales approach is not feasible. Even when repeat-sales could be found within the period of 2006 to 2011, they did not occur in numbers that were sufficiently large for any statistically meaningful construction of the index.

As a property index is as good as its data, the best possible methodology to employ in arriving at the index is the hedonic pricing method. This is because it is relatively straightforward to apply, is based on actual market prices and fairly easily measured data. Data on sales and characteristics are readily available and data preparation can be carried out within realistic time frame.

2.8 Conclusion

In conclusion, having reviewed the strengths and weaknesses of both methodologies and judging from the application of hedonic technique in modelling office price index in earlier studies, it is justifiable to explore the possibility of developing KL-OPI using hedonic technique. Based on Malaysia's experience, the MHPI and the PBO-RI have been developed on similar premise i.e. using the Laspeyres Time-Varying Hedonic Model. The research progresses on similar standing with an extension of employing two other hedonic models namely the Conventional and Chained, adapting from the earlier work of Munneke and Slade (2001). While it is recognised that several studies have attempted to incorporate the application of hedonic and spatial techniques in property index studies, mostly are focused on housing sector. The application of hedonic and spatial techniques is not feasible to be undertaken at this point of time in view of data limitation.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is the underlying foundation that provides the holistic process involved in solving the research problems and arriving at the research objectives. Research methodology encompasses a wide scope from data collection and analysis to the logical reason behind the research. This chapter explains the research design adopts for this research and the procedures to be undertaken in order to achieve the objectives of the research.

3.2 Research Design

As the aim of the research is to develop KL-OPI, the research takes in the form of quantitative design. Having established the aim, the research objectives as outlined in Chapter 1are addressed accordingly.

3.3 Sources of Data

The transactions data utilised in this study are obtained from the National Property Information Centre (NAPIC), an arm under the Valuation and Property Services Department (VPSD). VPSD is a department under the Ministry of Finance, Malaysia. The transactions recorded in NAPIC database are by far the most comprehensive and extensive database in the country.

These data are quite similar to those utilised for the Moody's Commercial Property Price Index, which are sourced from Real Capital Analytics Inc. While the latter only captures transfers priced more than USD2.50 million, NAPIC database is a catch-all pool of transactions. This data source has been and is still utilised in the construction of MHPI, which provides the rationale ground for this study to do the same.

The flow of transactions data from the source to the VIS data mart is summarised in Figure 3.1. The Inland Revenue Board (IRB) submits property transfer records to the respective VPSD branch offices online as VPSD is the department responsible for conducting statutory valuation for Stamp Duty assessment.

The property transfer records received are entered into VPSD internal database known as the Valuation Information System (VIS). The VIS captures data on sale price as well as the characteristics of the property in terms of location and physical features. After undergoing the valuation process and re-submission to IRB, these transactions data are then submitted online to NAPIC's property database known as the Property Information System Malaysia (PRISM) every week. These data undergo a series of data cleansing process before finally channelled to VIS Data Mart in PRISM database.

The variables available in VIS transactions comprise among others sales details, buildings details, scheme and neighbourhood details. To augment the information available in VIS' transactions with additional neighbourhood and locational variables, additional data are sourced from NAPIC's PRISM database.

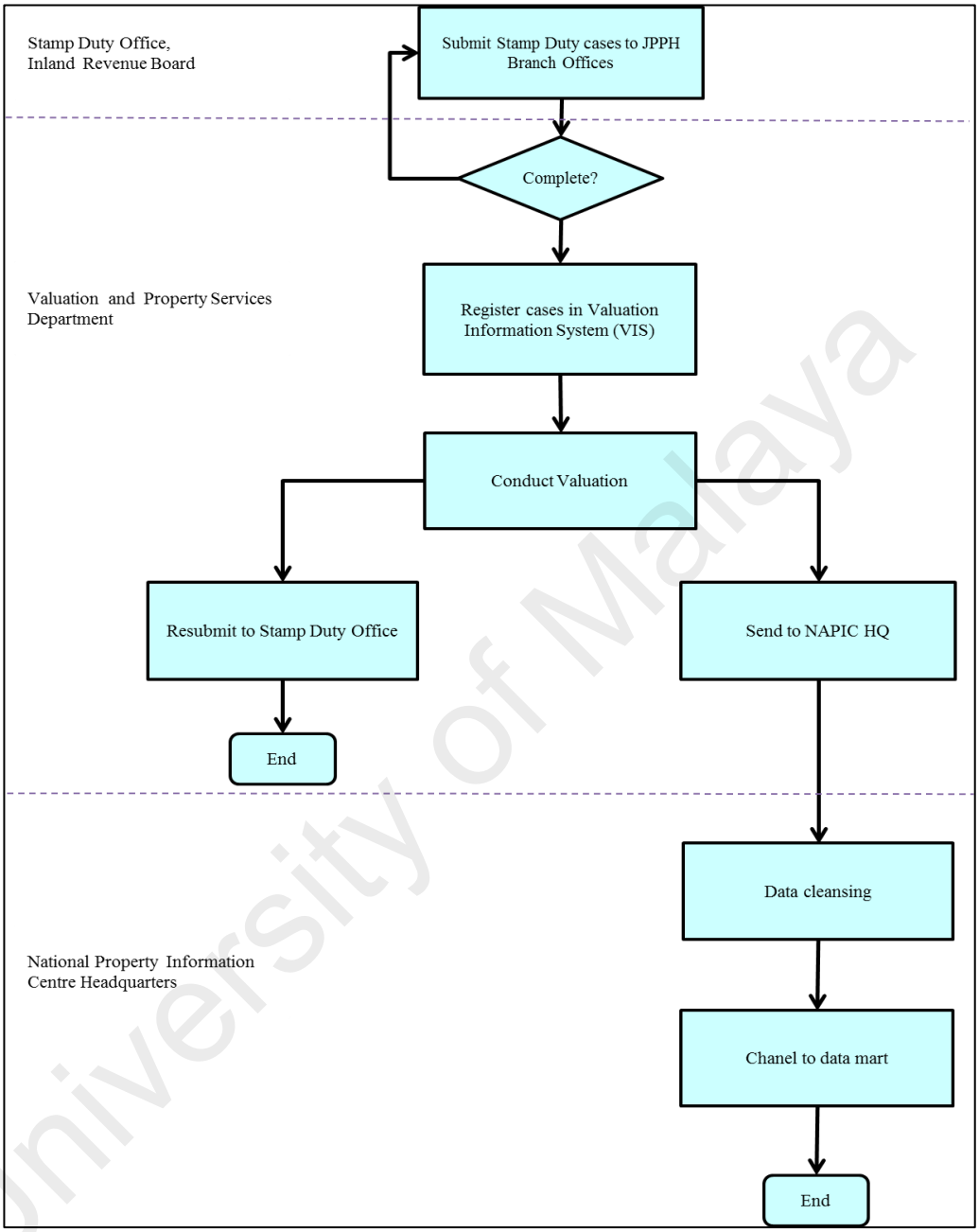

Figure 3.1: Process Flow of Transactions Data Captured by VPSD

3.4 Data Collection

The transactions data for this study is sourced from NAPIC's database, which comes in the form of time series data. The data are requested from NAPIC via written application as these data are classified as private and confidential. Although these data do not fall under the ambit of Personal Data Protection Act (PDPA) 2010, the secrecy in terms of names of purchasers and sellers need to be adhered to. Moreover, it is not the intention of this study to conduct profiling of the purchasers but sufficient to identify the status of transferor and transferee.

3.5 Preliminary Data Validation

The development of transaction based indices has been limited mainly by a lack of data on commercial property transactions (Miles et al., 1991), a ubiquitous problem in commercial real estate. Even if the data are deemed sufficient, the problem with data quality is another impediment to the development of commercial real estate price index. Hills (2011) concurs that the development of reliable price indices is hampered by lack of suitable data sets and the heterogeneous nature of real estate, both residential and commercial properties.

In relation to the transactions data utilised in the study, pertinent data issues most probable to arise during the data preparation stage include miscoded data, missing data and extreme values and outliers. Data quality is examined by means of data triangulation and employing statistical tools deemed appropriate.

Figure 3.2 provides a summary of data validation process to ensure data utilised in the study are reliable. The details are as explained in subsequent paragraphs.

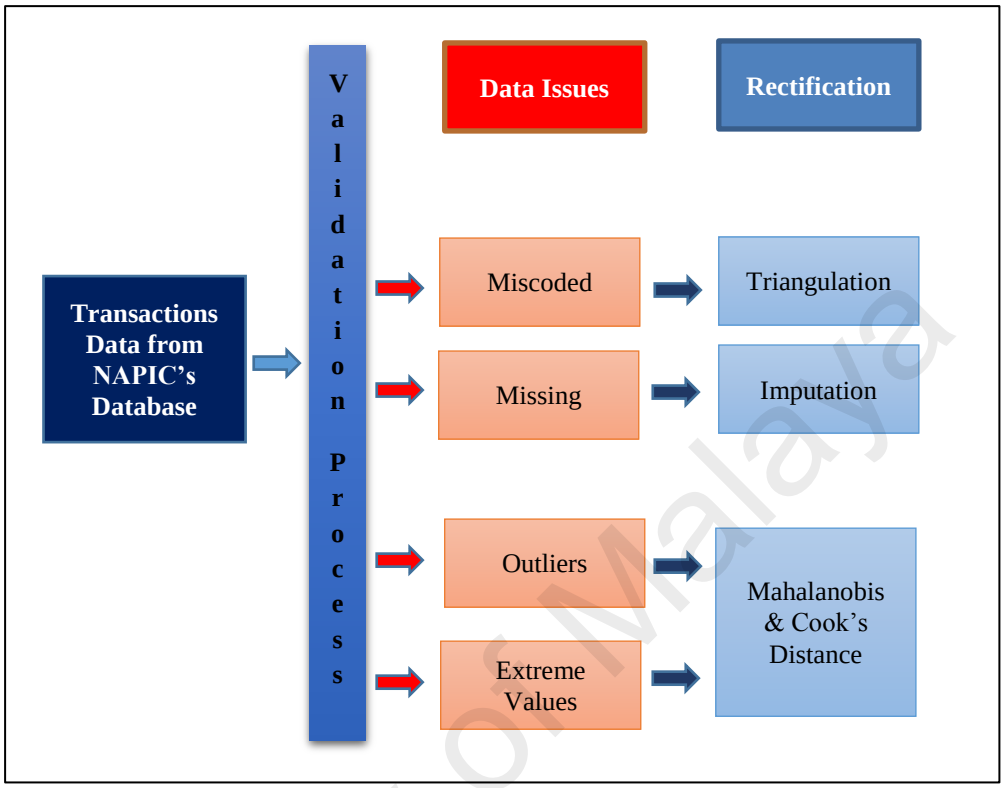

Figure 3.2 Summary of Data Validation Process

3.6 Handling Miscoded Data and Missing Data

The triangulation technique is employed in the process of rectifying both the miscoded and missing data. Triangulation as defined by (Campbell & Fiske, 1959) involves "multiple operationism towards validating the research results." Kimchi et al. (1991) define triangulation as applying more than two methods of validation to the same set of data. In relation to the transactions data in this study, the triangulation technique is applied on a minor scale in the sense that it may only apply to a small portion of the dataset.

3.7 Handling Outliers and Extreme Values

Outliers are observations that appear to deviate distinctly from other observations in the sample. Statistical method for outlier detection often indicates that these observations are located relatively far from the centre of the data distribution. Hawkins (1980) defines outlier as "an observation which deviates so much from other observations so as to arouse suspicions that it was generated by a different mechanism".

In the study, the Mahalanobis distance and Cook's distance are used to detect outliers. These are well-known criteria which depend on the estimated parameters of the distribution. Observations with large Mahalanobis distance are indicated as outliers. Both outliers' criteria are run repeatedly on the transactions with those with Z-residuals score beyond $\pm$ 3.0 omitted from the analysis. The exclusion of these outliers is important as it could provide inaccurate results to the analysis.

In order to graphically display the dispersion of the transactions data, the box-and-whisker- plot is used as it is a useful tool to display outliers and extreme values (Tukey, 1977).

3.8 Exploratory Data Analysis

This section presents the analytical process designed to explore the transactions data in identifying consistent patterns and/or systematic relationships between variables and to validate these findings.

Exploratory Data Analysis (EDA) is a critical step in analysing the transactions data for:

- identifying data errors
- checking of assumptions

- preliminary selection of appropriate models
- determining relationships among the explanatory variables
- assessing the direction and quantum of relationships between explanatory and outcome variables.

The EDA employs non-graphical and graphical methods. For the non-graphical method, analysis is presented in the form of summary statistics and frequency tables while the graphical method involves presenting the analysis in a diagrammatic format, namely, box plots generated using Microsoft Excel and Statistical Package for Social Science (SPSS).

3.9 Constructing the KL-OPI Model

3.9.1 Identifying the Appropriate Functional Form of Hedonic Price Model

The specification for regression comes in various forms and more often than not, the regression is best fit rather than a perfect fit (Baum, 2009). In determining the appropriate functional form for the KL-OPI model, the initial option is to identify the specification of the dependent variable i.e. 'Price' as the dependent or to transform 'Price' into log.

Log transformation is useful when the data displays right skewness (positively skewed) (Cornell, 2012). Another reason is to make the relationship more distinct and visibly clear for interpretation. In the realm of real estate, where market is imperfect, for the 'Price' to be normally distributed could prove to be a challenge. Therefore, it is deemed as necessary to apply the log transformation for the very reason that it could normalise the data (increase the normality of the data) (Baum, 2009).

Notwithstanding this, the study will initially attempt to display 'Price' in a histogram presentation so as to see the "normality" of the data. As this study utilises the same source of transactions data and employs hedonic price model, it only seems appropriate to adopt the same log transformation specification. Nevertheless, in spite of the fact that log transformation for 'Price' and 'Rent' is respectively employed in the construction of MHPI and also the PBO-RI, it would give an added mileage in the rationale for employing the determined specification.

3.9.2 Determining the Dependent Variable

In its basic form, the hedonic price model is estimated using regression analysis with one dependent variable and a set of predictor (independent) variables. After the determining the functional form, the unit of measurement for the dependent variable needs to be established.

Pursuant to the existing literature which uses different units of measurement for price as the dependent variable, the study sees the necessity to establish which of these two dependent variables is best explained by the predictors. The first functional form uses the natural logarithm of transaction price as the dependent variable whilst the second functional form uses the natural logarithm of price per square meter.

3.9.3 Determining the Independent Variable

In arriving at the appropriate model, it is equally necessary to identify the significant variables that best estimate the price function. There are several methods to control the

way variables are included into the regression namely ‘Enter’, ‘Stepwise’, ‘Backward’ and ‘Forward’ methods.

For this study, ‘Enter’ and ‘Stepwise’ methods are chosen as the control mechanism in the inclusion of variables into the model. The ‘Enter’ method is the most straight forward method, where all independent variables are entered into the equation all at once, or termed as “forced entry”. On the other hand, ‘Stepwise’ is a method of identifying the best regression model by either adding variables to or deleting variables from the present regression model.

Essentially, stepwise regression repeatedly runs the regression, each time removing the weakest correlated variable. Eventually, the variables that can best explain the price function remain in the model. The advantage of using ‘Stepwise’ is that it eliminates the presence of multicollinearity in the model.

Multicollinearity may arise in a situation where two or more of the explanatory variables are linearly related. In other words, two or more independent variables are strongly correlated and would post a problem in interpreting the regression coefficients (Evans and Olson, 2003). In order to further support the option chosen and in ensuring that multicollinearities among the variables are within acceptable range, collinearity diagnostic test is run.

When two or more of the independent variables are correlated, the condition index for each will be above one. If the condition index is one, the variable is independent, whilst values greater than 15 indicate there may be a problem and values above 30 are highly questionable.

However, it is worth noting that multicollinearity does not reduce the predictive power or reliability of the model as a whole, at least within the observations used in the study; it only affects calculations regarding individual predictors.

3.9.4 Building the Model

In this study, three hedonic price models are considered, namely the conventional, chained varying parameter and Laspeyres varying parameter hedonic price models. Hedonic approach is employed in the research as it is the most feasible approach in developing commercial property price index (Haurin, 2003), after taking into account the availability of transactions data and relevant variables available in the transactions database.

The **conventional hedonic price model** is built upon the core hedonic model which uses a core model of explanatory variables unrelated to time along with a series of time dummy variables. The model is written as follows:

$$\ln P = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n + \delta_1 T_1 + ... + \delta_m T_m + \varepsilon \qquad (3.1)$$

Where P represents the sales price of the property;

X_1 …… X_n represent a vector of *n* explanatory variables such as land tenure, land area, floor area, area classification, date of completion, etc;

T_1 ……. T_m represent a vector of dichotomous time variables for *m+1*periods

$\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ …… represent vectors of parameters to be estimated

ε ……..... represents a vector of random error terms

The time vector contains one variable for each year for the period 2006 through 2011. With this approach, it is assumed that the parameters estimates are not time-dependent and are constant over the period.

The **Laspeyres time-varying parameter hedonic model** uses only the core model of explanatory variables and omits the time dummy variables. This technique allows parameter estimates to vary for each year and requires a model for each study period. The formula is written as follows:

$$\ln P = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n + \varepsilon_0 \quad (3.2)$$

With this method, the time vector is omitted from the equation as parameter estimates are obtained by estimating separate regressions for each year. At the same time, it is also necessary to determine the weights for the base year i.e. the mean of the quantitative variables included in the model as well as the percentage proportions of the qualitative variables.

The **chained time-varying parameter hedonic model** uses the core hedonic model, similar to the conventional hedonic model and added a single time dummy variable. As the study time period runs from 2006 to 2011, there are six chained years that are pooled together. In a case where year 2006 and 2007 are pooled into a sub-sample, the dichotomous variable takes the value of 1 if the observation falls in year 2007 and zero if otherwise. This technique allows the parameter estimates to vary over the study period, which would capture the changes in the market. The formula is written as:

$$\ln P = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n + \delta_1 T_1 + \varepsilon_0 \quad (3.3)$$

The subsequent sections present the explanation on each of the three models and the empirical results.

3.10 Computation of Index

3.10.1 KL-OPI by Conventional Hedonic Price Model

The computation of index from the conventional hedonic price model follows the procedure that the index is computed by taking the exponential of the time dummy coefficients.

3.10.2 KL-OPI by Laspeyres Time-Varying Parameter Hedonic Price Model

For Laspeyres technique, the time dummy variable is omitted from the equation and data are regressed according to each study period. The index derived from this technique is also known as a "base-weighted" or "fixed-weighted" index because the price changes are weighted by the quantities in the base period. In this instance, the base year is 2006. The formula to compute Laspeyres index is as follows

$$PI_t = 100\left(\frac{e^{\beta_t X_0}}{e^{\beta_0 X_0}}\right) \tag{3.4}$$

where

PI_t…… represents the price index for a particular year

β_0 …… represents the hedonic model regression coefficient of the base year 2006

β_t …… represents the hedonic model regression coefficient of the current year

X_0 ……represents the mean of the variables of office lots in purpose-built office sold in the base year 2006

3.10.3 KL-OPI by Chained Time-Varying Parameter Hedonic Price Model

The chained model combines two-year adjacent period into a pool and regression is run based on each individual pool. The time dummy coefficients in the model explain the price change from a previous time period. In other words, the price change from period zero to period T can be cumulatively written as,

$$\alpha_{0,T} = \sum_{t=0}^{T-1} \delta 1$$

where δ^{1} is a parameter of time dummy variable at period t and $\delta^{0} = 0$. For the base year of 2006, the index level is assumed as 100; therefore, the index level at period T, PI_T is calculated by $PI_T = 100 \exp(\alpha_{0,T})$.

3.11 Measurement of Precision

The signal-to-noise ratio is applied as the measure of the precision as adapted from the study undertaken by Munneke and Slade (2001). This signal-to-noise is initially suggested by Case and Shiller (1987) and later applied by Gatzlaff and Ling (1994) and Gatzlaff and Haurin (1998) in their studies on housing market. This ratio that measures index precision is obtained by dividing the standard deviation of the price changes with the average standard error of the estimates. The larger the ratios i.e. signal has larger numerator value that that of noise indicates a higher degree of index precision.

3.12 Conclusion

The methodology employs in the research as explained in earlier paragraphs, provides a detailed process from data identification, data preparation, model specification to the final stage of measuring precision of each model.

CHAPTER 4

DATA VALIDATION AND ANALYSIS

4.1 Description of Variables

The transactions data obtained from NAPIC's PRISM database contain information on physical, location and sale of the transfers. For the purpose of this study, information containing variables that are deemed as essential in developing the index model are extracted from the database. These variables are a combination of ratio, ordinal and nominal data. The description of the information or the variables extracted from the database is presented in Table 4.1.

Table 4.1: Description of the Variables

Variable		Description of Variable	Level of Measurement
Physical	Name of Building	The name of the office building	-
	Land Area	The size of land area where the office building resides	Ratio - measured in square meter
	Floor Area	The size of the floor space	Ratio - measured in square meter
	Building Completion Date	The date of Certificate of Fitness (CF) or Certificate of Completion and Compliance (CCC) issuance on the building	Ratio - measured in day/month/year
	Floor Level	The floor level where the office unit resides	Ratio - measured in number
	Condition of Building	The state of building condition rating	Ordinal - rating scale of i. New ii. Very Good iii. Good iv. Moderate v. Poor
	Land Tenure	The tenure of land	Categorical - 'Freehold' or 'Leasehold'

Table 4.1: Continued

Variable		Description of Variable	Level of Measurement
Location	Address	The address of the office unit of office block	-
	Distance from town	Straight line distance of the office building from Kuala Lumpur city centre. City centre is taken as the point where Petronas Twin Tower resides.	Ratio - measured in kilometer
	Classification of Area	Segmentation of Kuala Lumpur into four regions	Categorical - i. Kuala Lumpur City Centre-Golden Triangle (KLCC-GT) ii. Central Business District (CBD) iii. Within City Centre (WCC) iv. Suburban (SUB)
Sale	Date of Transaction	Date of Sale and Purchase Agreement	Ratio - measured in day/month/year
	Consideration	The price stated in the agreement for the purchase of the office unit or office block	Ratio - measured in Ringgit Malaysia
	Reported Value	The value of the office unit or office block reported to IRB, which may be similar to the 'Consideration'. In a case where valuation of the property by VPSD is higher by 10 percent than the 'Consideration', value reported to IRB is based on valuation.	Ratio - measured in Ringgit Malaysia
	Status of Transferor	Status of citizenship of the transferor (seller)	Categorical - i. Local ii. Foreigner iii. Local Company iv. Foreign Company
	Status of Transferee	Status of citizenship of the transferee (purchase)	Categorical - i. Local ii. Foreigner iii. Local Company iv. Foreign Company
	Share Transfer	Share portion of transfer	Ratio - measured in ratio

The delineation of Kuala Lumpur into four sub-market regions is as shown in Figure 4.1 and the specific KLCC-GT region is as shown in Figure 4.2.

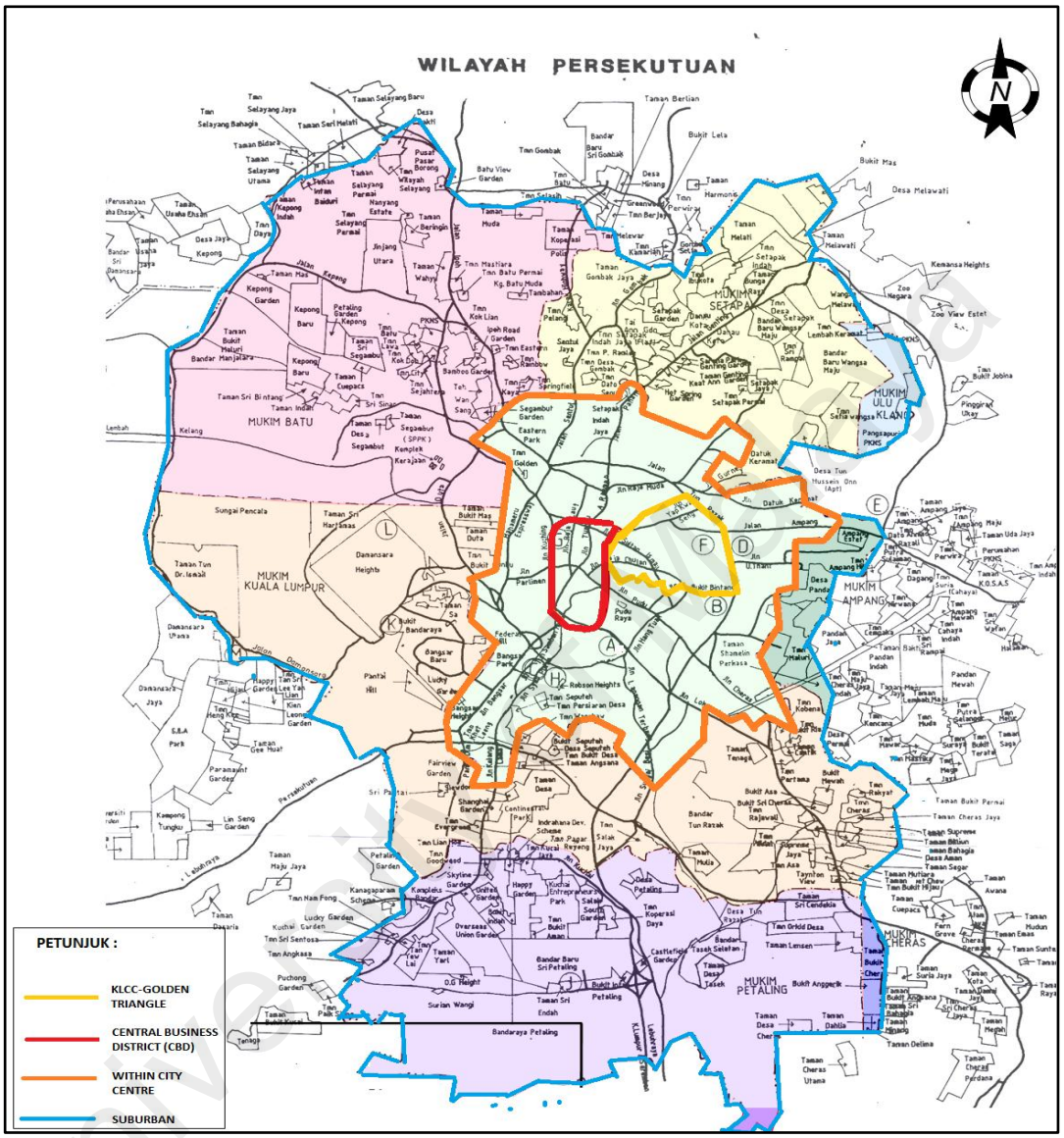

Figure 4.1: Boundary of Kuala Lumpur Four Sub-market Regions
Source: National Property Information Centre (NAPIC)

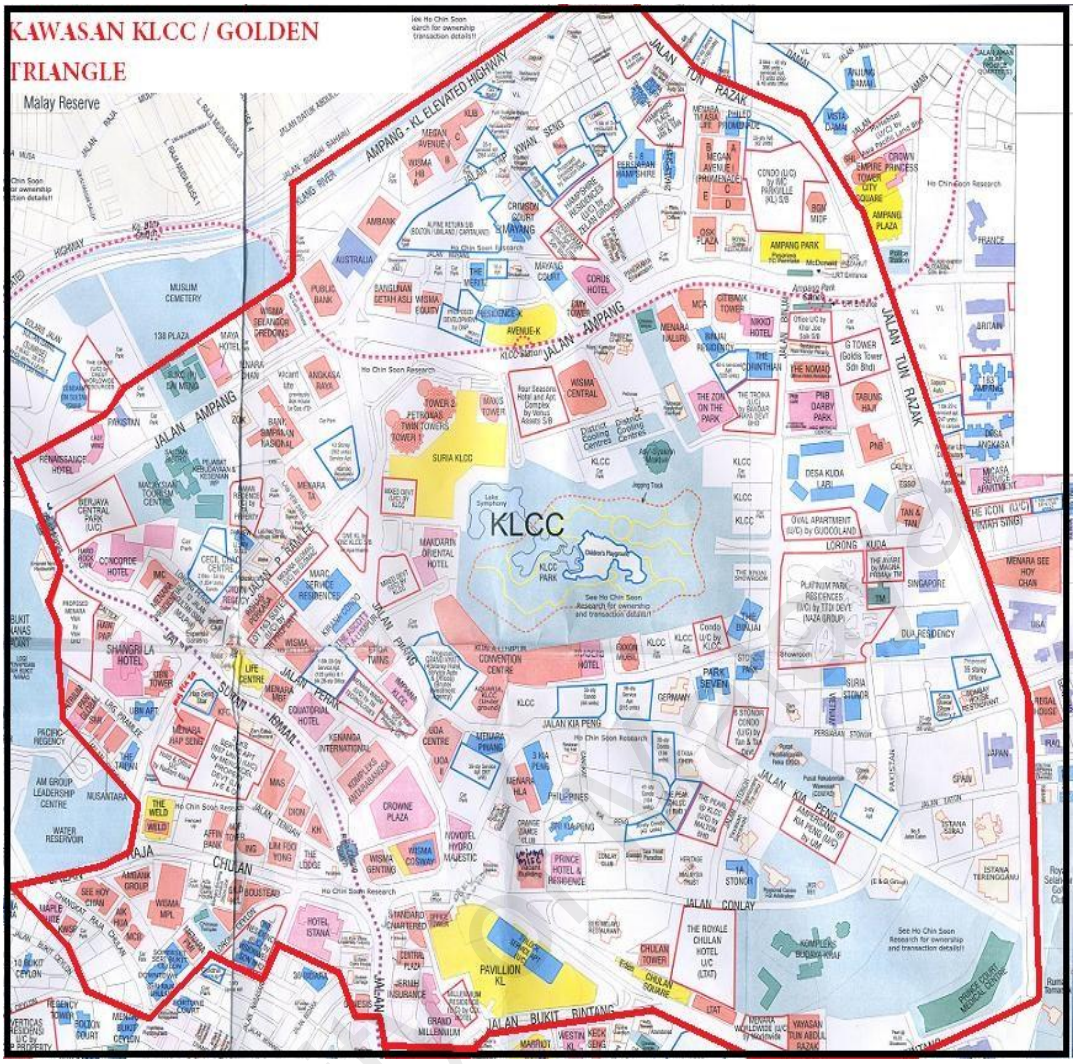

Figure 4.2: Boundary of KLCC-GT Region
Source: National Property Information Centre (NAPIC)

The boundary of these four sub-market regions as defined by NAPIC is stated below:

i. KLCC-GT Region:

- Jalan Sultan Ismail/ Jalan Ampang intersection to the Jalan Ampang/ Jalan Yap Kwan Seng/ Jalan Pinang intersection.
- Along Jalan Yap Kwan Seng that trails from Ampang Selatan - KL Elevated Highway to the Jalan Yap Kwan Seng/Jalan Tun Razak intersection.
- West side of Jalan Yap Kwan Seng /Jalan Tun Razak intersection to Jalan Tun Razak/ Jalan Bukit Bintang intersection.
- North side of Jalan Bukit Bintang to the Jalan Bukit Bintang / Jalan Sultan Ismail intersection.

- North side of Jalan Bukit Bintang/ Changkat Bukit Bintang/ Changkat Raja Chulan.
- Along Jalan Changkat Raja Chulan/ Jalan Raja Chulan.
- North side of Jalan Raja Chulan/ Jalan Puncak to Jalan Sultan Ismail/ Jalan Ampang intersection.

ii. CBD Region

- Jalan Sultan Ismail, starting from the west side of Jalan Ampang intersection to Jalan Kuching including Jalan Tuanku Abdul Rahman and Jalan Raja Laut.
- North side of Jalan Kinabalu to Jalan Stadium including Jalan H.S. Lee, Jalan Tun Tan Cheng Lock and Jalan Tun Perak.
- To the east, it encroaches Jalan Pudu and part of Jalan Bukit Bintang, Jalan Raja Chulan and Jalan Ampang.

iii. Within City Centre (WCC)

- City centre area encompasses Section 1 – 100 excluding the areas covered by KLCC-GT and CBD.

iv. Suburban

All mukims outside the Section 1 – 100 area:

- Mukim Kuala Lumpur encompasses Jalan Pantai Baru, Bangsar, Bukit Kiara, Damansara Heights, Jalan Damansara, Taman Tun Dr. Ismail and Jalan Duta.
- Mukim Batu encompasses Jalan Ipoh and Jalan Kepong.
- Mukim Setapak encompasses Wangsa Maju and Jalan Setiawangsa.
- Mukim Ulu Klang.
- Mukim Ampang encompasses Jalan Ampang within the mukim.
- Mukim Cheras encompasses Jalan Cheras.
- Mukim Petaling encompasses Jalan Kelang Lama.

4.2 Data Description

The initial target of the study is to build the KL-OPI index based on transactions data from 2000 to 2011 (Figure 4.3). However, as the transactions data captured for the 2000 to 2005 period have substantial missing values, the study is constrained to the 2006 to 2011 time frame. In addition, the number of transactions for the first period is relatively small compared with the latter time frame (even before data cleansing is carried out).

As the aim of this study is to develop KL-OPI, it is important to capture the price movements of office space in purpose-built office buildings. According to NAPIC, 'Purpose-Built Office Building' is defined as buildings that are intentionally built with at least 75.0% of the net lettable area used for offices. Based on Figure 4.3, it can be seen that the number of en-bloc purpose-built office buildings transactions recorded for the 12-year time span is 99 buildings. This number is relatively too small to represent the entire office market of Kuala Lumpur and, as such could prejudice the true interpretation of the market.

In order to ensure a sufficient number of cases for building the regression models, 'Office Lot in Purpose-Built Office' transactions for the period 2006-2011 are used. As shown in Figure 4.4, the annual distribution of transactions is not even. The number of transactions dropped slightly (11.9%) from 639 transactions in 2005 to 563 transactions in 2006, but increased steadily, reaching its peak in 2009. However, there was a tremendous drop of more than forty percent (42.4%) in the number of transactions recorded in 2011 (467) compared with that of 2010 (826).

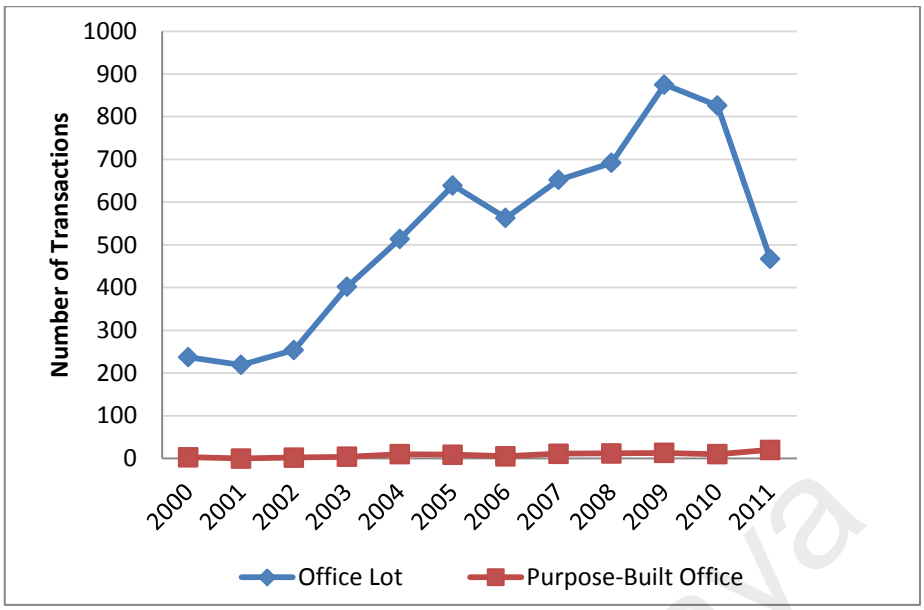

Figure 4.3: Number of 'Office Lot' and 'Purpose-Built Office' Transactions, Kuala Lumpur, 2000 to 2011

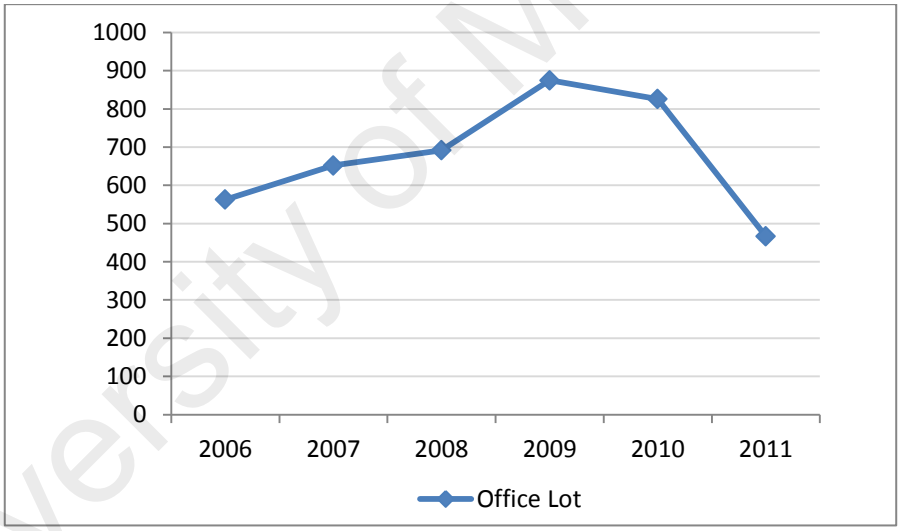

Figure 4.4: Number of Office Lot Transactions, Kuala Lumpur, 2006 to 2011

Several data issues found during data preparation are discussed in the next section. Among them are miscoded, missing and extreme data values.

4.2.1 Miscoded Data

Although the study is to focus on 'Office Lot', further examination of en-bloc 'Purpose-Built Office' transactions is carried out. This is because there is a tendency that 'Office Lot' is miscoded as 'Purpose-Built Office' and vice-versa. These miscoded data are identified by checking against the corresponding floor area. Transactions coded as 'Purpose-Built Office' but having small floor areas are recoded as 'Office Lot'. The recoding is confirmed by triangulation with the 'Address' and 'Title Number' fields.

Having corrected the miscoded transactions, the number of 'Office Lot' transactions increased slightly for year 2009, 2010 and 2011. The number of transactions increase from 875 (2009), 826 (2010) and 467 (2011) to 876, 828 and 482 respectively as shown in Figure 4.5.

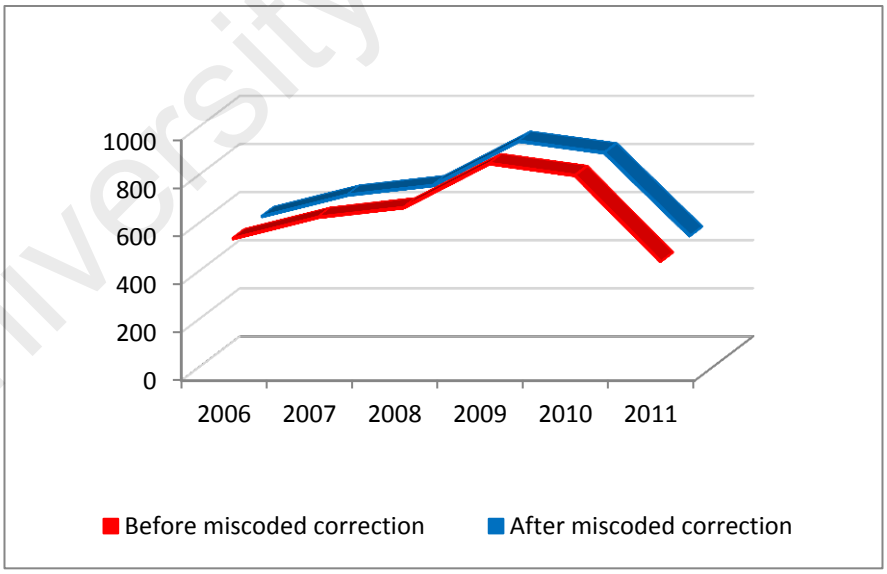

Figure 4.5: Number of Office Lot Transactions, Kuala Lumpur, 2006 to 2011 (Before and After Miscoded Correction)

4.2.2 Missing Data

The use of regression analysis requires complete information for all variables in the data. Any case with one or more missing values will be dropped from the model building, hence reducing the sample size for analysis. As presented in Table 4.2, date of the building completion has the most number of missing values (35.8%), while the rest of the variables have very small proportions of missing values, between two percent to less than one percent. Since the age of building as indicated by the date of building completion is an important explanatory variable, further examination is required to identify the root of the problem and subsequently its solution.

Table 4.2: Missing Value Analysis

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
Land Area	4,732	133	256	0	.0
Floor Area	4,732	148	195	0	.0
Distance from Town	4,732	4	3	0	.0
Address	4,446	.	.	286	.1
Classification of Area	4,438	.	.	294	.1
Name of Building	4,432	.	.	300	.1
Condition of Building	3,740	.	.	992	.2
Date of Building Completion	3,039	1998	8	1,693	35.8

The transactions data with missing values in 'Address' have to be omitted as there are no means of identifying the location of the property. It is also observed that whenever the 'Address' field is missing, the 'Name of Building' field is also missing. In certain cases, even when the 'Address' field is complete, the 'Name of Building' field is missing. This explains the higher number of missing values in the latter as compared to the former. Of these, 11 transaction data with missing values in 'Name of Building' are rectified by making reference to the address.

The missing values in the 'Classification of Area' field are determined by the 'Address' field. As for the missing values in 'Condition of Building' and 'Date of Building Completion', data are sourced from NAPIC's PRISM database, specifically the Property Inventory Survey data mart so as to complete the missing values.

4.2.3 Data Screening

Having rectified the miscoded and missing data, the number of transactions left for further data exploration is 4,446. The first stage of the data screening involves selecting 'Office Lot' transactions. These transactions can be further divided into 'Office Lots in Shops' and 'Office Lots in Purpose-Built Office'. As the study focuses on 'Office Lots in Purpose-Built Office', only the latter transactions are selected, leaving a total of 3,320 transactions.

4.2.4 Outliers and Extreme Values

The distribution of the transactions before and after the omission of the outliers and extreme values are presented in Figures 4.6 and 4.7, respectively. It is observed that the distribution and spread of data is almost similar but Figure 4.7 did not indicate the presence of any extreme values. A total of 3,247 transactions are available for subsequent data exploration.

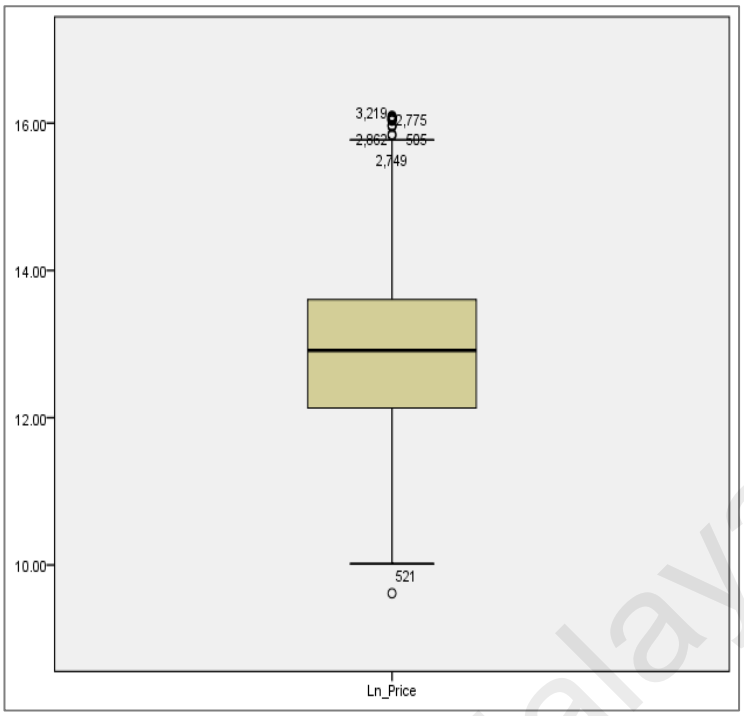

Figure 4.6: Distribution of initial z-scores (3,320 values)

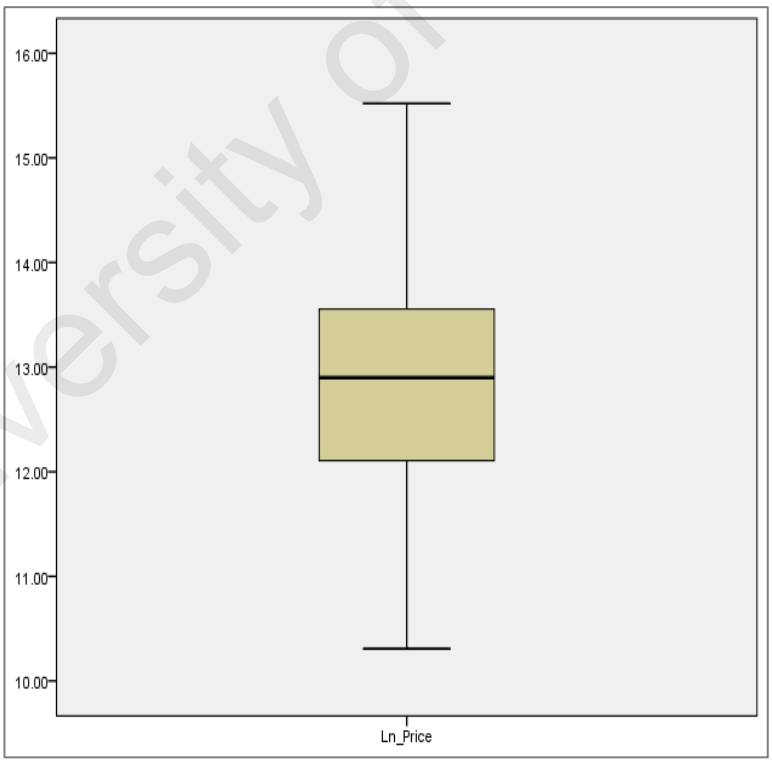

Figure 4.7: Distribution of z-scores after outliers and extreme values omission (3,247values)

4.3 Data Exploratory

This section discusses on the data exploratory findings of the final data set.

4.3.1 Profile of Transaction Data

The final data used in the study consist of 3,247 office lot transactions and the descriptive statistics of all variables are presented in Table 4.3. The building sampled are relatively new with an average age of 13 years old (median = 13.0; mean = 13.06 years). As for the proximity to the Kuala Lumpur city centre, the mean 'Distance from town centre' indicates that the buildings are within reasonable distance from the focus point of Kuala Lumpur.

The location variable, which segments the Kuala Lumpur office market into four sub-markets, reveals that most of the transactions focus on Suburban market. As shown in Table 4.4, more than 57.2% of these transactions are held by the Suburban market.

The upkeep and maintenance of these properties are generally good as indicated by the 89.9% representation of the 'Condition of Building' variable. In terms of 'Tenure', more than 85.6% of these properties are 'Freehold', indicating buyers' inclination towards freehold units.

The summary of the findings on data exploratory analysis are presented in Table 4.3 and Table 4.4 as shown below.

Table 4.3: Descriptive Statistics of Office Lot Transactions, 2006 to 2011

Variables	Minimum	Maximum	Standard Deviation	Median	Mean
Transaction Price (Ringgit Malaysia)	30,000.00	5,500,000.00	541,685.50	406,620.00	576,530.84
Floor Area (square meter)	8.00	932.00	89.60	114.00	128.55
Floor Level	0.00	58.00	5.63	5.00	6.67
Age of building (Years)	1.00	38.00	8.43	13.00	13.06
Distance from town (kilometer)	0.20	15.00	2.90	4.00	4.32

Table 4.4: Frequency of Dichotomous Variables of Office Lot Transactions, 2006 to 2011

Variables	2006 - 2011	2006	2007	2008	2009	2010	2011
Number of Transactions	3,247	433	514	526	692	672	410
Percentage (%)	100.0	13.3	15.8	16.2	21.3	20.7	12.6
Tenure							
Freehold	2,780	377	441	463	551	564	384
Percentage (%)	100.0	13.6	15.9	16.7	19.8	20.3	13.8
Leasehold	467	56	73	63	141	108	26
Percentage (%)	100.0	12.0	15.6	13.5	30.2	23.1	5.6
Condition of building							
Good	2,920	379	456	472	617	634	362
Percentage (%)	100.0	13.0	15.6	16.2	21.1	21.7	12.4
Moderate	327	54	58	54	75	38	48
Percentage (%)	100.0	16.5	17.7	16.5	22.9	11.6	14.7
Sub-market							
KLCC-GT	706	112	159	133	159	93	50
Percentage (%)	100.0	15.9	22.5	18.8	22.5	13.2	7.1
CBD	81	8	8	8	16	8	33
Percentage (%)	100.0	9.9	9.9	9.9	19.8	9.9	40.7
WCC	602	77	101	96	172	120	36
Percentage (%)	100.0	12.8	16.8	15.9	28.6	19.9	6.0
SUBURBAN	1,858	236	246	289	345	451	291
Percentage (%)	100.0	12.7	13.2	15.6	18.6	24.3	15.7

4.4 Determination of the Functional Form of Dependent Variable and Independent Variables of the Model

4.4.1 The Dependent Variable

In the effort to determine the appropriate form of dependent variable, the distribution of 'Price', denoted as 'Value reported to LHDN' is displayed by means of histogram. Based on Figure 4.8, it is evident that 'Price' is positively skewed and does not conform to the requirement of normality for regression analysis.

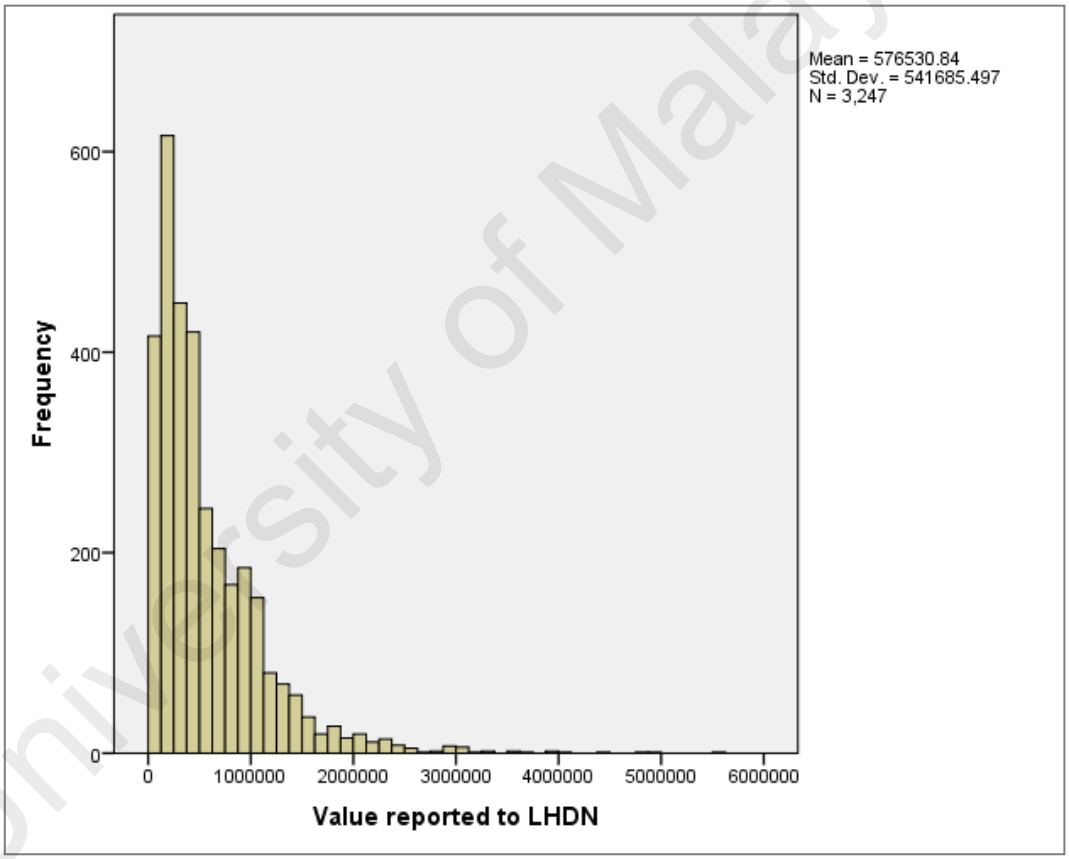

Figure 4.8: Histogram with 'Price' Distribution

Figure 4.9 depicts the distribution of log transformed 'Price', as denoted by 'Ln_Price'. As compared with the histogram in Figure 4.8, there is a distinct difference between the two. The transformation has improved the data distribution markedly. It can be seen that with log transformation, 'Ln_Price' is nearly normally distributed.

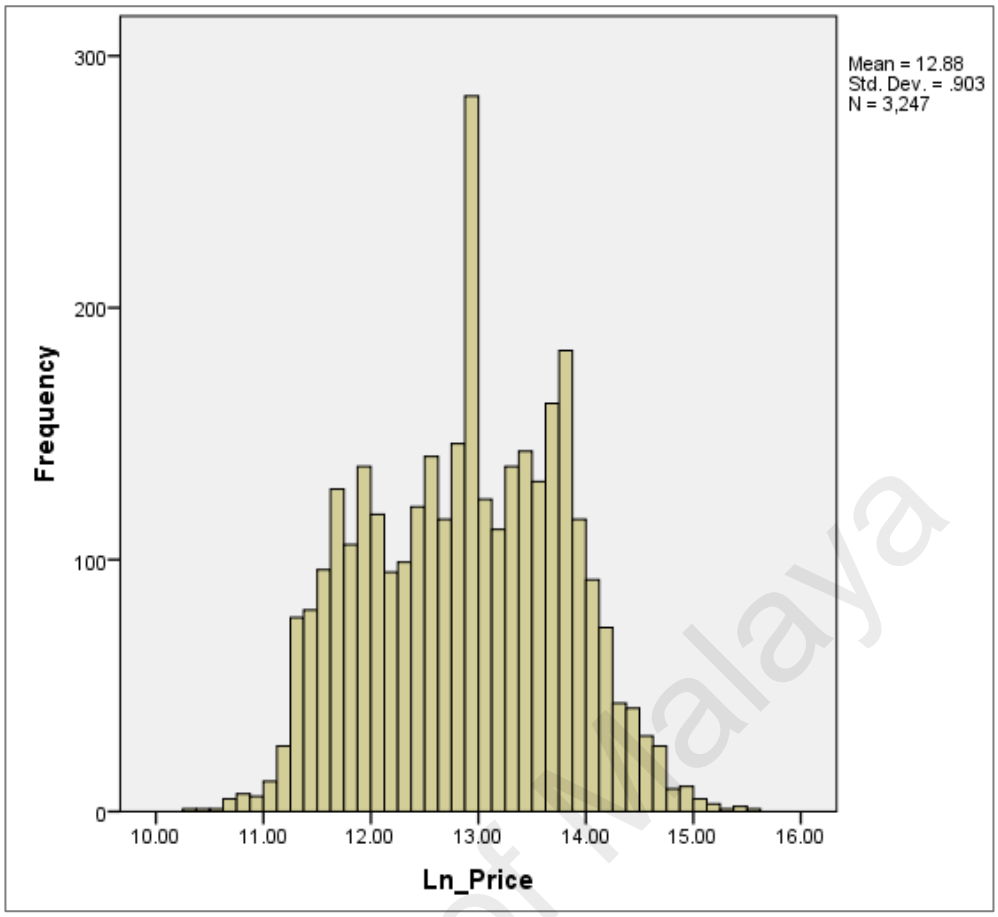

Figure 4.9: Histogram with 'Ln_Price' Distribution

This clearly indicates that the dependent variable be in form of Ln_Price. The model adopts a linear regression which is run on a log-level functional form. This means the price is transformed into natural logarithm (Ln) while its independent variables stand at level form.

4.4.2 The Independent Variables

The probable independent variables are those defined in Table 4.5 and several are dichotomous variables expressed as dummy variables. The details of these variables are as discussed below:

- Floor area relates to the nett space of the office lot.
- Floor level defines the level on which the office lot is located.

- Distance to town is a location attribute, which defines the straight line distance of the office building (in which the office lot resides) to the Kuala Lumpur city centre.
- Age is computed based on 'Building Completion Date' which states the age of the building at the time the study is undertaken.
- Tenure is categorised as 'Freehold' or 'Leasehold, a qualitative variable that is expressed as dummy variables. Transactions assume the code of '1' if it has 'Freehold' tenure and '0' if otherwise.
- Condition of building, which initially has five rating scale is recoded into two category namely 'Good' and 'Moderate'. This is also a qualitative variable that is expressed as dummy variables. Transactions assume the code of '1' if it has 'Good' condition and '0' if otherwise.
- Classification of Area classifies the area into four sub-markets. This is also a qualitative variable that is expressed as dummy variables. Transactions assume the code of '1' if it is within 'KLCC-GT' sub-market. Similar applies to 'CBD' and 'WCC' sub-markets. 'Suburban' sub-market assumes code '0'and is taken as the base comparison.

The summary of the independent variables specification is as set out in Table 4.5.

Table 4.5: Independent Variables Specifications

Variables	Variable Code	Measure
Price	Report_Value	Number
Floor area	Floor_area	Number
Floor level	Floor_level	Number
Age	Age	Number
Distance from town	Distance_from_town	Number
Tenure - Freehold	Freehold	-
Tenure - Leasehold	Leasehold	Dummy
Condition - Good	Good	-
Condition - Moderate	Moderate	Dummy
Submarket - KLCC-GT	KLCC-GT	-
Submarket - CBD	CBD	Dummy
Submarket - WCC	WCC	Dummy
Submarket - SUBURBAN	SUB	Dummy

4.4.3 Regression Model Estimates

4.4.3.1 Ln_Price and Ln_Price per square meter?

The next procedure towards building the regression model is to determine the unit of measurement i.e. Ln_Price (L_P) or Ln_Price per square meter (L_PSM). Table 4.6 shows the model summary of the two regression specifications, estimated with Ln Price (L_P) and Ln Price per square meter (L_PSM) as the dependent variable, respectively.

Based on the results, it is evident that the variability in (L_P) is better explained by the set of independent variables set out in Table 4.5 in comparison to (L_PSM). This is indicated by the higher Adjusted R Square, R^2, at 69.0% obtained by the (L_P) dependent variable as compared to 48.5% explanatory power when (L_PSM) is used as the dependent variable.

Table 4.6: Model Summary of Ln Price and Ln Price Per Square Meter as Dependent Variable

Dependent Variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
Ln Price	.831[a]	.690	.690	.50311
Ln Price per square meter	.698[a]	.487	.485	.43138

The above results concur with several other studies. Nappi-Choulet et al. (2007) in their study on Paris' office price index observed that higher R^2 is obtained with Ln Price as the dependent variable. Similarly, earlier works of Colwell et al. (1998) on Chicago's office market suggests similar findings. The explanatory power of their models records a high R^2 at 84.0% when using price as the dependent variable as opposed to an R^2 of approximately 40.0% when price per square foot is used as the dependent variable.

Based on the findings above, this study employs (L_P) as the dependent variable from this section henceforth.

4.4.3.2 'Enter' or 'Stepwise' Procedure?

The results of the 'Enter' and 'Stepwise' regression are as stated in Table 4.7 and Table 4.8. It can be seen that the explanatory power of regression models that included variables using 'Enter' method and 'Stepwise' method is similar at 69.0%. This indicates that there is no significant difference on the explanatory power of both models.

Another notable finding is that variables that are significant in 'Enter' method model are equally significant in 'Stepwise' method. On the other hand, the two dummy variables that are insignificant in 'Enter' procedure, namely 'Condition – Moderate' and 'CBD',

have been excluded from the 'Stepwise' procedure. However, as 'CBD' is part of the four categories of location (Sub-markets), it is erroneous to exclude it from the regression model.

Table 4.7: Comparison of Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Enter Method	0.831	.690	.690	.50311
Stepwise Method	0.831	.690	.690	.50306

Table 4.8 – Comparison of Regression Result Using 'Enter' and 'Stepwise' Method

Variables	Enter Method			Stepwise Method		
	B	t	Sig.	B	t	Sig.
Intercept	13.253	317.062	0.000	13.255	317.251	0.000
Floor Area	.006	56.735	0.000	.006	58.256	0.000
Floor Level	.012	7.036	.000	.013	7.142	.000
Distance from town (Kuala Lumpur city centre)	-.086	-19.153	.000	-.090	-19.575	.000
Age	-.050	-30.975	.000	-.049	-38.416	.000
Leasehold	-.272	-9.840	.000	-.272	-9.859	.000
Cond_Moderate	.029	.649	.517	Excluded		
CBD	.055	.916	.360	Excluded		
WCC	-.174	-5.410	.000	-.181	-5.742	.000
SUB	-.240	-7.078	.000	-.247	-7.403	.000
Adjusted R Square	0.690			0.690		

4.4.3.3 Diagnostics Checking

As shown in earlier section, there is a similarity of explanatory powers in both models. Given the simplicity of 'Enter' procedure, the study opts for this method in building the hedonic price model. To further justify the option of 'Enter' procedure, a diagnostic checking is carried out.

Table 4.9 shows that the Condition Index of the variables ranges between 1 and 12.257, which indicate acceptable reading. This has been explained in paragraph 3.9.3., which states that there is a problem if the index exceeds 15. In view of that, even when 'Enter' procedure or forced entry is used to build the model, multicollinearity is not a pertinent issue that would compromise the reliability of the model.

4.5 Conclusion

Data validation and analysis forms the crucial part in ensuring conformity of data in terms of quality and reliability. This is important as these data are to be used in data modelling. In conclusion, having analysed the data and the procedures to be adopted, the study holds the opinion of adopting the 'Enter' procedure in the construction of KL-OPI model.

Table 4.9: Collinearity Diagnostics for Model

CollinearityDiagnostics[a]													
Model		Eigenvalue	Condition Index	Variance Proportions									
				(Constant)	Floor Area	Floor Level	Distance from town (Kuala Lumpur city centre)	Age	Leasehold	Cond_Moderate	CBD	WCC	SUB
Enter	1	4.890	1.000	.00	.01	.01	.00	.00	.01	.00	.00	.00	.00
	2	1.491	1.811	.00	.00	.00	.01	.01	.03	.10	.14	.00	.01
	3	1.201	2.018	.00	.00	.01	.01	.00	.10	.00	.01	.18	.02
	4	.809	2.459	.00	.00	.00	.00	.00	.10	.06	.76	.00	.00
	5	.705	2.633	.00	.05	.06	.00	.00	.47	.11	.02	.02	.00
	6	.372	3.626	.00	.08	.26	.04	.00	.23	.00	.03	.36	.01
	7	.276	4.206	.00	.56	.44	.00	.01	.01	.00	.00	.00	.02
	8	.132	6.091	.00	.19	.00	.00	.54	.00	.69	.02	.06	.07
	9	.091	7.327	.04	.01	.05	.94	.01	.04	.02	.02	.05	.37
	10	.033	12.257	.96	.12	.17	.00	.42	.00	.00	.00	.32	.50

a. Dependent Variable: Ln_Price

CHAPTER 5

SELECTION OF A DECISION MODEL FOR THE CONSTRUCTION OF KL-OPI

5.1 The Conventional Hedonic Price Model

In the construction of KL-OPI using the conventional hedonic price model, the vector of time related variables in Equation (3.1), T_1 ……. T_m represent a vector of dichotomous time variables for *5* periods, one variable for each year of the study period, 2007 through 2011, with 2006 as the base period.

With this approach, all the transactions data from 2006 to 2011 are combined into one pool for the analysis and the parameters of non-time related variables are held constant throughout the study period. This allows the parameter of each time dummy variable to capture the pure price change.

In other words, the parameter estimates of the dichotomous time variables are regarded as the basis for the construction of KL-OPI. Table 5.1 provides the model summary of conventional hedonic price model and the results of the model estimates.

Based on the model summary in Table 5.1, it can be seen that the explanatory power of the conventional hedonic model is slightly better than that of the core hedonic model (Table 4.6) at 69.5%. All but three variables are significant predictors of the model at the 5% significance level. The exceptions are dummy variables of 'Condition – Moderate', 'CBD' and 'Year 2007'.

Overall, the signs of the coefficients are consistent with expectations. Both 'Floor Area' and 'Floor Level' are statistically significant. The positive coefficients for 'Floor Area' and 'Floor Level' suggest that both variables have positive impact on the values of office.

Table 5.1: Model Summary of Conventional Hedonic Price Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Conventional	.835[a]	.697	.695	.498
Variables		**B**	**t**	**Sig.**
Intercept		13.087	271.607	0.000
Floor Area		.006	57.515	0.000
Floor Level		.013	7.192	0.000
Distance from town		-.081	-17.989	0.000
Age		-.049	-30.515	0.000
Leasehold		-.282	-10.251	0.000
Cond_Moderate		.030	.684	.494
CBD		.021	.352	.725
WCC		-.186	-5.814	0.000
SUB		-.270	-7.885	0.000
Year2007		.078	2.386	.017
Year2008		.167	5.142	0.000
Year2009		.197	6.397	0.000
Year2010		.211	6.772	0.000
Year2011		.182	5.195	0.000

a. Dependent Variable: Ln_Price

The negative coefficient of 'Distance from town' indicates that office property values decline with distance from the city centre. On similar note, value declines as the property aged over the years as indicated by the negative coefficient of 'Age' variable. However, this is debatable in an instance where a building undergoes refurbishment works at its later life cycle. The age factor as examined by Colwell et al. (1998) found that the age effect on office values diminishes as the buildings grow progressively older due to renovation work that older buildings usually undergo.

The negative coefficient for 'Leasehold' tenure also shows a negative impact on values, as buyers' preference, more often than not is slated towards freehold property. The indicated coefficient could also be interpreted as on average, the value of leasehold office property is lesser than the freehold ones.

In relation to location variable, in particular the office sub-markets, two locations namely 'WCC' and 'Suburban', reflect negative coefficients. These results suggest that office property in these two sub-markets have lower values in comparison to those in 'KLCC-GT'. This can be explained by the fact that KLCC-GT area has better advantage in terms of location and accessibility as compared to the former two sub-markets. In contrast, the 'CBD' has positive coefficient sign but is statistically insignificant, suggesting that the value of office property in 'CBD' is not statistically different from the ones in 'KLCC-GT'.

The 'Cond_moderate' variable depicts positive sign on value. However, given the fact that the variable is not significant indicates that the value of office property in moderate condition is not statistically different from the ones in good condition.

The time dummy variables are statistically significant in the model, with the exception of year 2007. Its significance indicates that there is a substantial change in office value for the period 2008 to 2011. The time dummy coefficients indicate gradual increases in office values from 2007 through 2010, followed by a decline in 2011.

As explained earlier, the conventional hedonic price model pools the transactions into one, resulting in aggregation effects on the parameters. Although the drawback is related to the constant-parameters, the conventional index sets a benchmark for comparison with the time-varying parameter techniques.

5.2 The Laspeyres Time-Varying Parameter Hedonic Model

The application of Laspeyres method in the construction of KL-OPI is similar to the hedonic methodology employed in the construction of Malaysian House Price Index (MHPI). The difference is on the base year, whereby the MHPI employs 2000 as its base year whilst in this study, 2006 is the base year.

The regression results in Table 5.2 reveal that the explanatory power of the models varies from 63.6% to 81.5%. For most years, the adjusted R^2 are higher than that of the conventional hedonic. This indicates that the models fit the data satisfactorily for the six-year period.

Table 5.2: Model Summary of Laspeyres Time-Varying Parameter Hedonic Price Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
2006	.905[a]	.819	.815	.38426
2007	.850[a]	.722	.717	.50623
2008	.824[a]	.679	.674	.54724
2009	.800[a]	.640	.636	.59103
2010	.842[a]	.708	.704	.45369
2011	.857[a]	.735	.729	.38307

a. Dependent Variable: Ln_Price

Based on Table 5.3, it can be seen that the coefficient signs for most variables conform to expectation. Variables namely 'Distance from town' and 'Age' indicate negative coefficients and are statistically significant for all the years; the explanation for such results is similar to that provided in paragraph 5.1. On the other hand, 'Floor Area' and 'Floor Level' has positive signs and are significant for most years.

The 'Leasehold' variable carries negative coefficients, which has also been explained in earlier section. It is significant for years 2006, 2008 and 2009 only. For the three other years, the insignificance of the variable suggests that there is no price difference between freehold and leasehold office property.

For 'Cond_moderate' variable, negative signs are seen for the four consecutive years from 2006 to 2009 but it turns to positive signs for the following two years. In terms of significance, the variable is significant for years 2007, 2008 and 2011. The sub-market dummy variable of 'Suburban' is statistically significant and shows negative coefficient for all the years. This suggests that office property is Suburban locality has lower value than the ones in KLCC-GT and there is statistically difference in value between those

two sub-markets. Mixed coefficient signs are seen for 'WCC' dummy variable. For the years that the variable is significant, the coefficient signs are negative i.e. year 2008 through 2011. The 'CBD' dummy variable also has negative coefficient for most years and remain insignificant for all the years.

The year-by-year analysis process is quite tedious as compared to the conventional hedonic analysis, where estimates are obtained by running the data at one go. On a positive note, the Laspeyres allows the parameter to vary according to the study period; thus, the aggregation effect is eliminated.

Table 5.3: Results of the Model Estimates

Year	2006			2007			2008			2009			2010			2011		
Variables	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**	**B**	**t**	**Sig.**
Intercept	12.867	124.388	0.000	13.277	127.589	0.000	13.756	26.106	0.000	13.753	131.478	0.000	13.486	133.075	0.000	13.281	135.791	0.000
Floor Area	0.006	25.859	0.000	0.004	23.667	0.000	0.004	1.452	0.147	0.003	20.575	0.000	0.006	24.050	0.000	0.008	21.902	0.000
Floor Level	0.000	0.019	0.985	0.007	1.500	0.134	0.009	0.590	0.556	0.028	5.685	0.000	0.014	3.797	0.000	0.006	2.534	0.012
Distance from town	-0.076	-7.238	0.000	-0.054	-4.960	0.000	-0.138	-13.309	0.000	-0.091	-8.262	0.000	-0.070	-6.570	0.000	-0.085	-6.501	0.000
Age	-0.042	-11.206	0.000	-0.041	-8.782	0.000	-0.048	-10.836	0.000	-0.053	-13.305	0.000	-0.057	-17.311	0.000	-0.059	-13.701	0.000
Leasehold	-0.296	-5.035	0.000	-0.105	-1.457	0.146	-0.327	-5.089	0.000	-0.350	-5.169	0.000	-0.094	-1.609	0.108	-0.148	-1.744	0.082
Cond_moderate	-0.019	-0.194	0.847	-0.322	-2.781	0.006	-0.347	0.452	0.651	-0.177	-1.765	0.078	0.065	0.601	0.548	0.457	3.170	0.002
CBD	-0.101	-0.708	0.479	0.174	0.862	0.389	-0.134	0.517	0.605	-0.281	-1.805	0.072	-0.237	-1.375	0.170	0.202	1.886	0.060
WCC	0.112	1.702	0.090	0.010	0.146	0.884	-0.382	-3.929	0.000	-0.683	-8.187	0.000	-0.349	-4.243	0.000	-0.337	-3.394	0.001
SUB	-0.142	-1.922	0.055	-0.462	-5.677	0.000	-0.202	-1.893	0.059	-0.336	-3.910	0.000	-0.574	-6.489	0.000	-0.346	-3.910	0.000

5.3 The Chained Time-Varying Parameter Hedonic Model

Another time varying parameter technique employed is the chained technique. In this procedure, the estimation of the price model requires the two adjacent years' transactions data to be pooled into one. In this instance, data for year 2006 and 2007 are pooled into one, 2007 and 2008 into another pool, and so on and so forth. Eventually, there are five adjacent year pools or five chains.

In comparison to the Laspeyres hedonic price model, a slight twist is given to the chained model. With this model, a single dichotomous time variable which represents the latter year in each of the pool is included. The antilogarithm of the time dummy estimates represents the price change from one year to another.

As presented in Table 5.4, the adjusted R^2 for the chained models ranges from 0.62 to 0.74, indicating that the models fit the data quite well. 'Floor area' is significant in all the five chained models and carries positive signs, similar to that in the conventional and Laspeyres models. On the same note, 'Floor level' is also a significant predictor with the exception of 2006 – 2007 chain.

The 'Distance from town' and 'Age' variables are significant for all the models and both have negative impact on value. The negative coefficient for 'Leasehold' indicates that on the average leasehold properties fetch lower values than freehold properties. Likewise, the 'Cond_moderate' variable also depicts similar coefficient sign and is significant for all the chained years. This suggests that on the average, the value of office property in moderate condition is lower from the ones in good condition.

Table 5.4: Results of Regression for Chained Hedonic Price Model

Year	Chain 06 - 07	Chain 07 - 08	Chain 08 - 09	Chain 09 - 10	Chain 10 - 11
Predictors	**Coefficients**				
Constant	13.161	13.403	13.734	13.626	13.478
Floor_Area	.005	.004	.004	.004	.006
Floor_Level	.005	.011	.019	.023	.011
Distance_from_town	-.059	-.091	-.112	-.076	-.072
Age	-.042	-.044	-.050	-.050	-.056
Leasehold	-.197	-.200	-.368	-.259	-.125
Condition_moderate	-.202	-.270	-.264	-.166	.176
CBD	-.001	-.016	-.241	-.297	.099
WCC	.044	-.171	-.488	-.514	-.324
SUB	-.375	-.287	-.267	-.520	-.521
Year 2007	.048				
Year 2008		.069			
Year 2009			.023		
Year 2010				.029	
Year 2011					-.018
Adjusted R Square	.744	.675	.644	.621	.689

Dependent Variable: Ln_Price

The dichotomous time variable is statistically insignificant for all the chained models except for the 2007- 2008 chain, suggesting that for most of the chained years, there is a statistical difference in value between each of the two chained years. The positive signs for the coefficient of this time variable in each model show positive impact on value, with the exception for 2011.

For the location variable, the 'Suburban' sub-market dummy variable is significant in all the models and has negative coefficients, similar to the ones in the Conventional and Laspeyres models. This indicates that on the average, the office property in 'Suburban' fetches lower value that those in 'KLCC-GT'. For 'WCC' sub-market dummy variable, in the chain models where the variable is significant, the coefficient carries negative sign and vice-versa. This suggests that value in 'WCC' is lower than 'KLCC-GT' on the

average and the value is statistically difference between the two sub-markets. On the contrary, the 'CBD' sub-market dummy variable portrays the contrast. The variable is not significant in all of the chained models except for 2009 – 2010 chain and has negative coefficients for most years except for 2010 – 2011 chain. This means that there is no statistically difference in value between 'CBD' and 'KLCC-GT' though it fetches lower value than 'KLCC-GT' with isolated exceptions.

5.4 Computation of KL-OPI

The following sub-sections presents the results of the KL-OPI based on the estimation results of each model discussed above.

5.4.1 Conventional Hedonic Price Index

Table 5.5 presents the KL-OPI derived from the Conventional Hedonic Price Model whilst Figure 5.1 depicts the index movements for the six-year period. There is a gradual increase in the indices from 2007 to 2010 but the rate of increase diminishes in 2009 and 2010. This is followed by an eventual fall in the index in 2011, recording a negative contraction of 2.9%.

Table 5.5: KL-OPI from Conventional Hedonic Price Model

Year	Time Dummy Coefficients	Exponential	KL-OPI	Index Change (%)
2006	-	1.00	100.0	0.0
2007	.078	1.08	108.1	8.1
2008	.167	1.18	118.1	9.3
2009	.197	1.22	121.8	3.1
2010	.211	1.23	123.5	1.4
2011	.182	1.20	119.9	-2.9

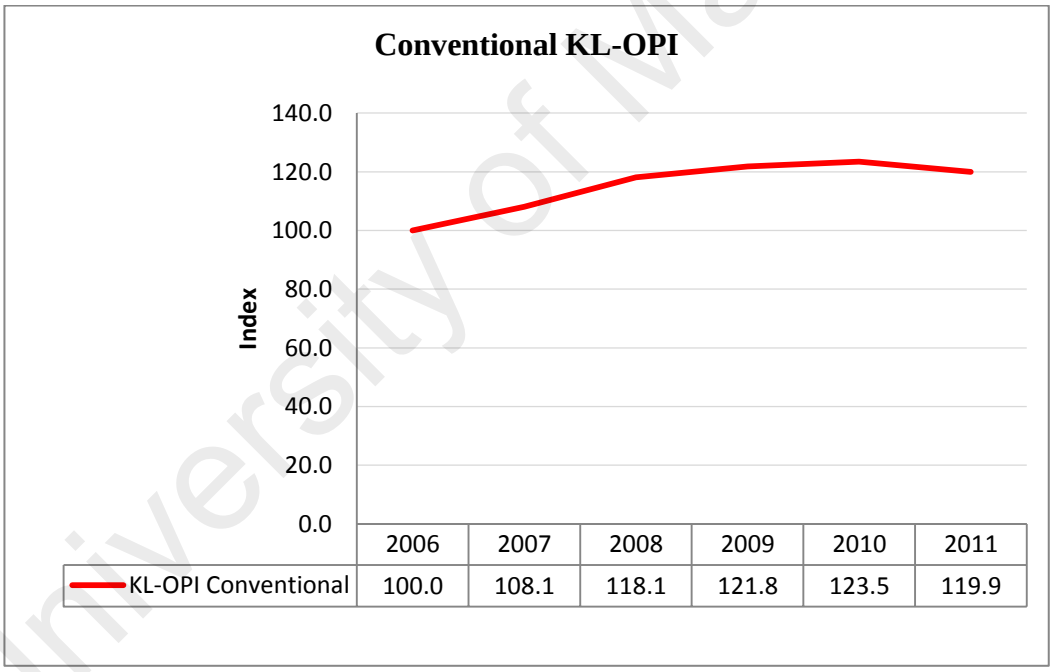

Figure 5.1: Conventional Hedonic Price Index

5.4.2 Laspeyres Hedonic Price Index

Table 5.6 provides the results of KL-OPI derived from Laspeyres Hedonic Price Model. The trend is quite similar to that of Conventional KL-OPI, recording an increasing trend from 2007 through 2010. Compared with the rate of increase of Conventional KL-OPI, the Lapeyres KL-OPI's scales upwards in 2008 (7.1%), down slightly in 2009 (5.2%) but takes an upturn in 2010 (5.8%) before finally plunged by negative 1.5%.

Table 5.6: Results of the KL-OPI from Laspeyres Hedonic Price Model

Year	2006	2007	2008	2009	2010	2011	Weights 2006
Variables	Coefficients						
Intercept	12.867	13.277	13.756	13.753	13.486	13.281	
Floor Area	.006	.004	.004	.003	.006	.008	134.584
Floor Level	7.642E-05	.007	.009	.028	.014	.006	7.129
Distance from town	-.076	-.054	-.138	-.091	-.070	-.085	4.505
Age	-.042	-.041	-.048	-.053	-.057	-.059	14.025
Leasehold	-.296	-.105	-.327	-.350	-.094	-.148	0.129
Condition moderate	-.019	-.322	-.347	-.177	.065	.457	0.125
CBD	-.101	.174	-.134	-.281	-.237	.202	0.018
WCC	.112	.010	-.382	-.683	-.349	-.337	0.178
SUB	-.142	-.462	-.202	-.336	-.574	-.346	0.545
Product	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	1.3E+01	
KL-OPI	100.0	105.6	113.1	119.0	125.9	124.0	
Index Change (%)	0	5.6	7.1	5.2	5.8	-1.5	

Figure 5.2 displays the Laspeyres KL-OPI movements over the six-year period.

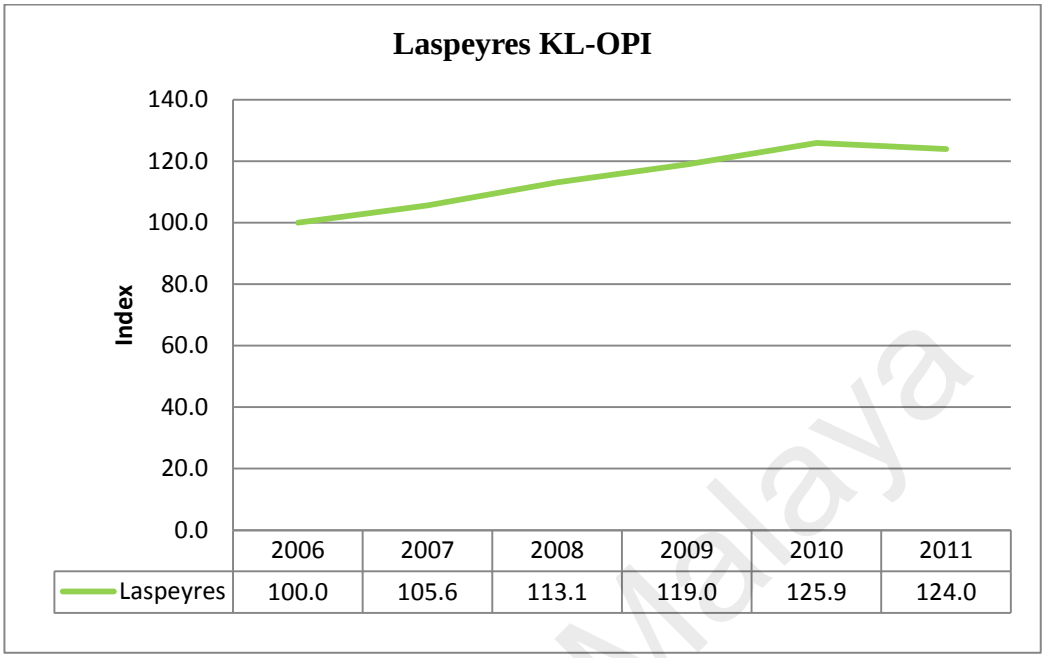

Figure 5.2: Laspeyres Price Index

5.4.3 Chained Hedonic Price Index

Table 5.7 shows the KL-OPI computed based on Chained Hedonic Price Model. The trend records an increase in 2007 and 2008, followed by a negative growth in 2009. The index improves slightly in 2010 at 0.6% increase. However, the index fell by 4.6% in 2011. Figure 5.3 charts the index pattern for the study period, which portrays a slightly different trend line as compared to Figure 5.1 and Figure 5.2.

Table 5.7: KL-OPI from Chained Price Model

Year	Time Dummy Coefficients	Exponential	KL-OPI	Index Change (%)
2006	-	1.00	100.0	0.0
2007	.048	1.05	104.9	4.9
2008	.069	1.07	107.2	2.2
2009	.023	1.02	102.3	-4.6
2010	.029	1.03	102.9	0.6
2011	-.018	0.98	98.3	-4.6

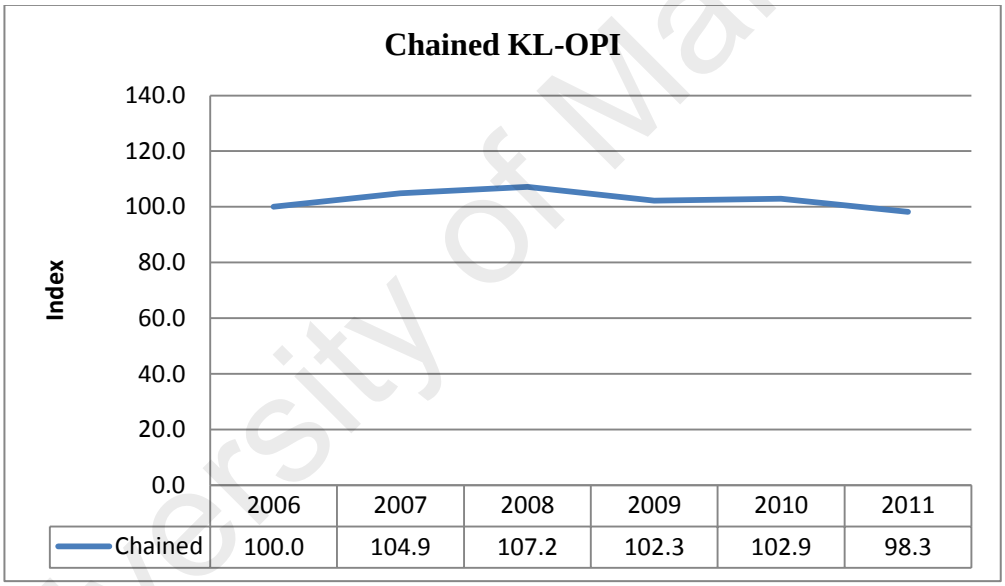

Figure 5.3: Chained Price Index

5.4.4 Comparison of the Hedonic Indices

Figure 5.4 compares the KL-OPI computed based on Conventional, Laspeyres and Chained Hedonic Price Models. It can be seen that the price index trend for Conventional and Laspeyres hedonic models are almost similar. The trends and changes exhibited by the Conventional and Laspeyres' indices are very similar. However, the chained indices are lower and exhibit a much lower growth.

Table 5.8: KL-OPI by the Three Hedonic Price Models

Year	Conventional	Percentage Change (%)	Laspeyres	Percentage Change (%)	Chained	Percentage Change (%)
2006	100.0	-	100.0	-	100.0	-
2007	108.1	8.1	105.6	5.6	104.9	4.9
2008	118.1	9.3	113.1	7.1	107.2	2.2
2009	121.8	3.1	119.0	5.2	102.3	-4.6
2010	123.5	1.4	125.9	5.8	102.9	0.6
2011	119.9	-2.9	124.0	-1.5	98.3	-4.6

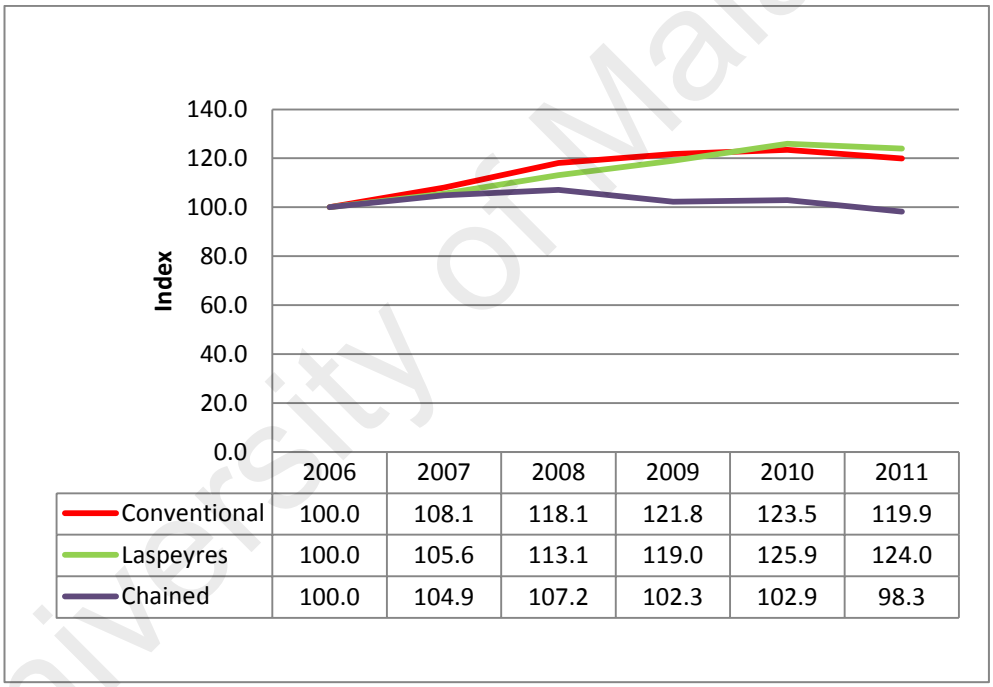

Figure 5.4: Plotting KL-OPI of the Three Models

Both models record positive growth in price index from 2007 to 2009 as stated in Table 5.8, with the highest growth seen in 2008. This is followed by a lower growth rate in 2009 and 2010. The movement is of particular interest as 2008 was the year when the US economy was hit by the subprime meltdown. The impact of the US economic recession slowly crept to other parts of the world and in Malaysia the pinch on our

economy was felt in 2009. This could have explained the lower growth rate in the price index recorded for 2009 and subsequently in 2010.

For the Chained index, lower index points are recorded from 2007 to 2011 as compared to those of Conventional and Laspeyres indices. Whilst the Chained index shows diminishing growths in 2007 and 2008, the Conventional and Laspeyres index show a reverse trend. This could be explained by the "pooling" effect of the transactions data in the Chained model.

In 2010, all three indices see an increase in price index but vary in terms of magnitude. The Laspeyres index records the highest growth rate, whilst the Conventional and Chained indices record low growths. All the three indices portray contractions in growth in 2011.

Figure 5.5 depicts the annual percentage change of the Conventional, Laspeyres and Chained indices from 2007 to 2011 together with GDP growths. Chained index growth and GDP growth are in tandem in terms of growth. Another distinct feature is the downfall in indices in 2009, which is similar to GDP series. Based on Figure 5.5, it is fair to conclude that the economic factor does have an impact on the price index changes. However, the magnitude of the impact is not within the ambit of this study.

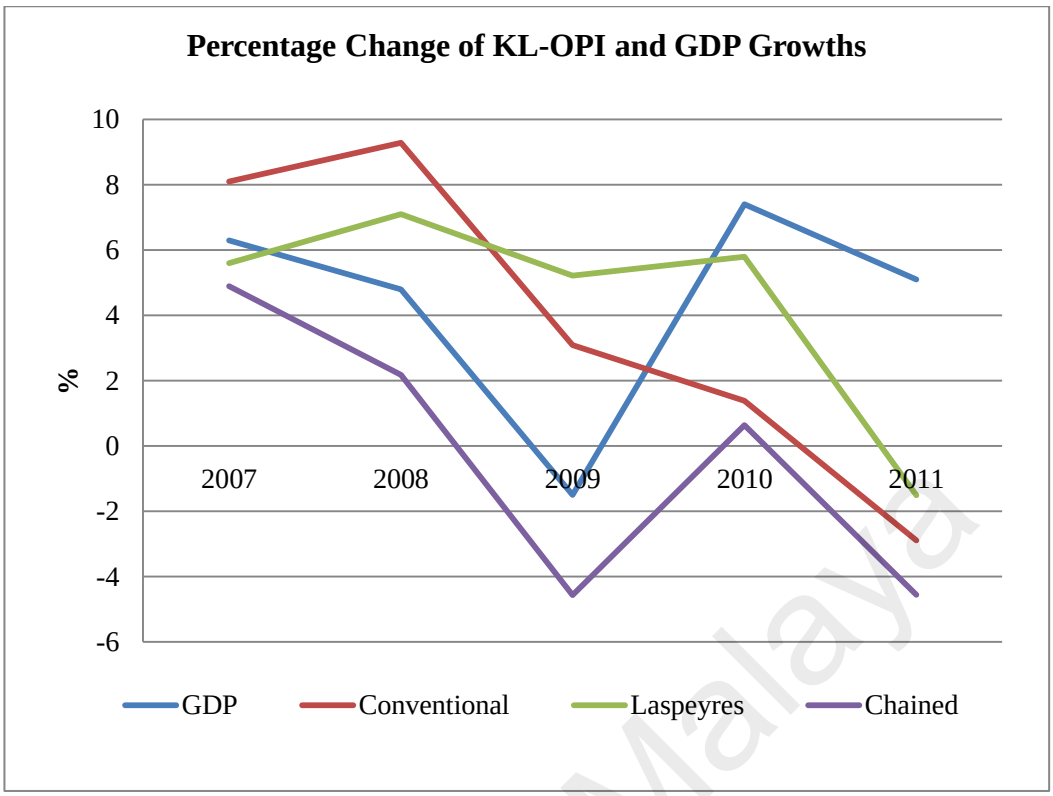

Figure 5.5: Plotting KL-OPI Changes and GDP Growths

5.5 Measurement of Precision

The signal-to-noise ratios in the study range from 0.53 to 1.54 as shown in Table 5.9. The Conventional indices exhibit the highest signal-to-noise ratio of 1.54 as compared to Chained indices at a ratio of 1.297 and Laspeyres at an even lower ratio of 0.53. This indicates that the Conventional indices have a higher degree of precision as compared to the other two.

Table 5.9: Comparison of Signal-to-Noise Ratios

Year	Conventional	Laspeyres	Chained
	Annual Growth Rate		
2007	0.081	0.056	0.049
2008	0.093	0.071	0.022
2009	0.031	0.052	-0.046
2010	0.014	0.058	0.006
2011	-0.029	-0.015	-0.046

Standard deviation of the annual growth rate		
0.050	0.034	0.042

Mean of standard error of time dummy parameter	Mean of standard error of the coefficients	Mean of standard error of time dummy parameter
0.032	0.064	0.032

Signal-to-noise ratio		
1.541	0.532	1.297

If comparison is made to the Adjusted R^2 as provided in Table 5.10, Laspeyres indices record the highest predictive power at 0.712, whilst Conventional comes second with 0.695 and Chained third with 0.674. On the whole, the predictive power of these models is not far off from one another.

Table 5.10 – Comparison of Adjusted R Square and Signal-to-Noise Ratio

Study Undertaken by	Conventional	Laspeyres	Chained
	Signal-to-noise ratio		
Author	1.541	0.532	1.297
Munneke and Slade	2.227	1.679	2.754
Adjusted R Square			
Author	0.695	0.712	0.674
Munneke and Slade	0.840	0.837	0.838

5.8 Conclusion

In conclusion, it is imperative to conclude that though a model has high predictive power, it is not necessarily deemed as the model with the highest degree of precision. The deterministic tool applied in determining the best model for KL-OPI, which is the Signal-to-Noise ratio, indicates that Conventional model has the highest precision compared to the other two. Therefore, it is best to model KL-OPI using the Hedonic Conventional Price Model.

CHAPTER 6

CONCLUSION & RECOMMENDATIONS

6.1 Introduction

This chapter provides a holistic summary of the research which attempts to develop the first commercial property price index in the country and among the few in the region, known as KL-OPI. This KL-OPI is hoped to add value to the series of property indicators currently published and disseminated by NAPIC, in assisting the industry players and also policy makers arrive at informed decisions.

The move by the IMF to include property price indicators for residential and commercial segments proves the significance of property sector. In fact, our Bank Negara Malaysia recognises MHPI as one of the important macroeconomic indicators. Although KL-OPI has yet to be made known and obtained endorsement from the industry, it is believed that KL-OPI has the potential to be a leading indicator in a class of its own.

The subsequent sections review the findings of the research based on the objectives outlined in Chapter 1. This is followed with a discussion on the significance of the research, limitations of the research and the future research on similar subject.

6.2 Summary of the Research

The availability of property price indicators in the region and Malaysia, in particular, is limited. In spite of the various property indicators published and disseminated by

NAPIC for the reference of the industry, more new property market indicators i.e. price-related indicators could be established in view of ample data within the custodian of NAPIC.

In essence, the aim of this research is to establish KL-OPI. The KL-OPI will not only strengthen the functions of NAPIC but will also put this country on equal standing with the developed economies in terms of the provision of property indicators. Thus this research acts as a pilot initiative in laying the foundation upon which more property price indices can develop.

The three objectives set forth in the initial Chapter 1 are achieved along the way of conducting the research. The following paragraphs explain how the research objectives are achieved.

6.2.1 Objective 1 – To identify the existing approaches in use for commercial property index construction

In compliance with this objective, a review on literature and practice is undertaken in Chapter 2 in order to evaluate the methodologies employed in constructing commercial property indices mainly in the US i.e. the appraisal-based methodology and transaction-based methodology. An overall theoretical understanding of the subject matter is established by this objective.

Although the property industry is familiar with transaction-based hedonic price model (which is applied in MHPI and PBO-RI), the research remains impartial in deciding the best possible methodology to adopt, which is based on the review conducted. It can be

seen that there has been a move from appraisal-based to transaction-based as years moved on i.e. NPI, most probably due to the availability of accumulated transactions data over the years that permits the application of repeat-sales and hedonic technique.

Having discounted the appraisal-based and considered the three techniques of transaction-based methodology, it was decided that this research is to pursue the development of KL-OPI by means of hedonic technique, the rationale being the familiarity with the technique and, more importantly, the ready availability of transactions data.

6.2.2 Objective 2 – To establish a protocol appropriate for the construction of KL- OPI

This objective is addressed in length in Chapter 3 and partially in Chapter 4 respectively. By establishing the protocol, the how, what, where, when and why of the research are answered. The transactions data are the essence of this research, which are specifically the office lots in purpose-built office buildings in Kuala Lumpur. These data are sourced from NAPIC and of considerable quality. Nonetheless, data preparation and validation procedures need to be adhered to ensure reliability and credibility of the data.

On the whole, the data quality is not an impediment to this study as only less than 3.0% of the transactions have incomplete data. One variable that was particularly prone to missing values was ‘Age’. However, the problem was circumvented by recovering the missing data from PRISM database maintained at NAPIC. After completing the data

preparation process, the final data set for this study stood at 3,247 transactions, which are of acceptable numbers when compared with earlier works.

Data exploration is another pertinent procedure to understand the profiling of the data by means of descriptive statistics. Within the six-year period, year 2009 and 2010 recorded higher number of transactions. The main features of these data are follows:

- Majority are of freehold tenure
- Majority are in good building condition
- Suburban recorded the highest number of transactions throughout the years, followed by KLCC-GT and WCC whilst only a handful for CBD.

The next procedure involves determining the functional form of the dependent and independent variables. The normality distribution of dependent variable, 'Price', reveals right-side skewness, which requires for log transformation of the variable. The independent variables i.e. those of ratio measurement remain at its level form.

6.2.3 Objective 3 – To determine the hedonic functional form most suitable to use for Kuala Lumpur Office Price Index (KL – OPI)

The objective 3 is dealt with and explained in Chapter 4. It is noted that log-level functional form is the basis of the hedonic formula. Subsequently, this study attempts to further examine in a two-step procedure.

The first step is to determine which 'Price' log transformation should be applied in the formula, either log 'Price' (Ln_P) or log 'Price per square meter' (Ln_P SM). This is necessary as the application of each has impact on the explanatory power of the model,

the former with higher R^2 whilst the latter has lower R^2. Based on the model estimates, it is decided for the study to employ 'Ln_P' as the dependent.

The second step in determining the estimation procedure either 'Enter' method or 'Stepwise' method. After much deliberation, 'Enter' method is chosen over 'Stepwise' given the almost similar explanatory power of both methods. In support of 'Enter' method, diagnostic checking to rule out multicollinearity among the variables is carried out. The diagnostic reveals that the multicollinearity level is within acceptable range so as not to interfere with the validity of the models.

6.2.4 Objective 4 – To derive a decision model for index computation

The objective 4, which relates to determining which of the three hedonic price models, is the most appropriate to employ, is discussed in Chapter 5. The study opted for three types of hedonic price models namely Conventional Hedonic Price Model, Laspeyres Time-Varying Paramater Hedonic Price Model and Chained Time-Varying Paramater Hedonic Price Model. Since the common type of hedonic employed in MHPI and PBO-RI is Laspeyres, this study explores the possibility of constructing indices using two other hedonic techniques.

Having reviewed and analysed the results of the models, the Conventional Hedonic Price Model estimates 69.5% variability of price, Laspeyres Hedonic Price Model year-by-year estimates on average 71.2% whilst Chained Hedonic Price Model records a lower 67.4%.

Judging from the explanatory power of the three models, Laspeyres has the highest and should be the model to best adopt for KL-OPI. This study improves on model selection by means of measure of precision test known as 'Signal-to-Noise' ratio. The results of this test show that Conventional Hedonic Price Model records the highest 'Signal-to-Noise' ratio, signifying that the Conventional model has the highest degree of precision over the other two models. In conclusion, it can be deduced that a price model with a high explanatory power is not necessarily the one with the highest degree of precision.

6.3 Significance of the Research

This research pioneers the study on the construction of commercial property price index, specifically on the office price index in Kuala Lumpur. This makes it not only the first such research to be undertaken in the country but also among the first few in the region. At present, there is only one property price-related index in the country, which is the MHPI and another is rental-related index, the PBO-RI.

In the course of developing KL-OPI, three variations of hedonic techniques are explored. Although this is a replication of earlier works in the US, its application has yet to be examined in Malaysian context. Furthermore, the results from the examination of the three models would help improve or value-add the existing methodology of MHPI or PBO-RI. The study goes further to measure degree of precision of the models, which would help increase the reliability of the models and index generated.

By having KL-OPI, the nonexistence of commercial property price indicator is no longer an issue of concern. KL-OPI bridges the gap in property market, which at present, only has residential property price indicator.

This study also highlights the strength of the property market database i.e. transactions data, which should be capitalised for the benefit of the industry. Without these transactions data and its state of quality, the outcome of this research would have painted a different picture altogether.

6.4 Limitation of Research

Several pertinent limitations arise in the course of completing this research. Firstly, there is a time lag for transactions data transmission to NAPIC's PRISM database. The process flow for transactions to be captured from its inception (cases submitted by IRB to VIS) to the final storage in PRISM database could take a bit of time. Therefore, should one requires real time data, there is a possibility that not all transactions transpired within that particular time period are available in PRISM database. As experienced in the course of this study, transactions data for year 2011 are fewer than the earlier time period due to lag factor.

As hedonic model is built upon a set of independent variables, which comprise physical and location characteristics, variables such as availability of light rail transits, view of the building (i.e. what would occupiers be overlooking from the building) and environmental features among others could improve on the predictive power of the model. With regards to the condition of the building, the study has relied fully on what has been determined at that point of time the transaction was recorded. It is assumed that the condition remains 'As-Is' at the time the study is conducted as it would have been a laborious task to inspect each of the 3,247 office lots.

6.5 Future Research

This study opens up more avenues for future research in developing commercial property price index and a composite property price index for the country. As to the methodology to be chosen is subjected to the comprehensiveness of data, quality of data, expertise of prospective researchers and application of the latest computer software.

In years to come, there is little possibility for repeat-sales to be applied in developing commercial property index in the country. Nevertheless, the prospects of employing other sophisticated hedonic technique such as spatial hedonic technique seem more promising. This is in view of the current on-going development of NAPIC's PRISM Geographical Information System, which is expected to be completed in the next couple of years. In addition, other deterministic tools to measure precision of models can also be explored namely the Root Mean Square Error (RMSE).

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