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Aims and Scope

The Journal of Valuation and Property Services is a publication specially intended for real estate professionals to keep abreast with development in the real estate industry as well as the real estate profession.

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REFEREE PANEL

Towards Developing A Facility Space-Time Management Method

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Abstract

A major problem area in the management of facility space in the office sector is maintaining an appropriate balance between the supply and demand for space as organisations and their nature of work change. The changing circumstances affecting the supply and demand for space naturally require new methods and techniques for the management of space over time. This establishes the proposition that time must be included in the planning and management techniques. Through the undertaking of three case studies and a review of recent literature, a sequence of comparative analyses between traditional and space-time methods is made. It is argued that an explicit inclusion of the time factor within management procedures does enhance decisions about the management of space, although it will not completely eliminate traditional practices. In discussing the advantages and limitations of space-time management, suggestions are also offered as a basis to further develop a general method of space management of facilities in rapidly changing circumstances.

Keywords: change, space-time management, allocation, utilisation, management responses

Introduction

Towards the last decade of the twentieth century, there has been serious concern over the impact of information technology (IT) on business operations, particularly in providing facility space in organisations. Many organisations were facing recurrent problems in balancing the supply of and the demand for space during the initial use, re-use and 'change of use' phases. These have been documented either as impact studies concerning organisational change on their space provisions (College of Estate Management, 1983; Becker et al, 1991; Duffy, 1983; Davis et al, 1985; BOMA, 1995), or as new facility prototypes creation (Stone & Luchetti, 1985; DEGW & Teknibank, 1992).

A high level of mismatch has been reported between what is really required and what is being provided in terms of spatial support. The limitations to the traditional methods of space management in changing situations arise from the space per person measure which makes quantitative estimates superfluous (BOMA, 1995) and occupancy costs increasing (Apgar, 1993), or from the allocation procedure which prevails in single location, which effectively reduces the variety of provisions (BOMA, 1995) when there is changing preference and expectations in working practices (The Eclipse Group, 1995; Sproull & Kiesler, 1991).

As a result, industry has developed some radical approaches in the management of facility space – through the use of time factor considerations instead of using an assumed total presence; utilisation levels instead of headcounts; allocation by actual use instead of rank and status; and management responses by levels of predictability of changes instead of pre-determined and rigid solutions (Harrison, 1996; FM DATA Monthly, 1999b). A trend where time dimension and time frames were seriously considered in the space management process was beginning to develop.

In the past, the space-time approach has been studied extensively as a basis for policy formulation, particularly in relation to university buildings (Bullock et al, 1968; 1974; Doidge, 1972; Rawlinson, 1973; 1982), library facilities (UCERG, 1970a), refectory facilities (UCERG, 1970b) and within the context of urban planning (Chapin Jr., 1974; Abercombie, et al, 1974; Cullen & Phelps, 1975; Cullen & Godson, 1974). These policies focused on major functions of facility space management namely estimating requirements, allocation and utilisation of spaces. For example, Bullock's (1974) study on teaching space has found advantages of applying a probabilistic approach over the time-tabling technique in estimating requirements. Doidge's (1972) study on allocation has produced a dynamic allocation model in solving space shortage problems through space sharing, time-tabling and central allocation. Rawlinson's (1973) study has introduced a procedure for activity-space management by allocating activities using time-tabling and classifying spaces as room types. This system was later developed commercially, for use in tertiary institutions of education (Rawlinson, 1982). Additionally, the Unit of Architectural Studies (UAS), University College London, has published a series of papers between 1967 and 1971, focusing on studies on the availability, distribution and patterns of use of space in the college. Another research series (Bullock, 1970), published by the Land Use and Built Form Studies (LUBFS), Cambridge University, between 1970 and 1972, has focused on the development of a comprehensive model of activities appreciating the effect on increasing the provision of space in one facility as related to the resultant use of another.

The common feature of these studies referred to a major proportion of space users who were using space for a limited period of time. Besides, those organisations were experiencing financial cutbacks for new building projects while at the same time having to absorb the growing needs and pressures of demand (Rawlinson, 1984). This background is comparable to the contemporary business organisational climate. Some preliminary researches and application in this area are already in progress in several major organisations across North America and Europe (Becker et al, 1991).

Aims and Objectives of the Paper

The purpose of the investigation is to develop the basis from which to plan the tools needed to rationalise and support tactical, operational and strategic decisions concerning the management of facility space under rapidly changing circumstances of use. The study has two main objectives: first, to develop the theoretical basis for estimating the demand for and allocation of space and second, to propose practical techniques for the space-time management of facilities which could enhance the planning and management measures already in existence. The targeted areas are: estimating the total space required, new forms of procurement to meet these requirements, allocation of space, utilisation, adoption of measures to face the problems of subsequent changes and to the eventual disposal phase should surplus space no longer be required.

Structure of the Paper

The paper has five main parts (Figure 1). Part A, introduces the broad context of the problem. An extensive literature survey together with published case studies on the general concepts of space management over the past thirty years including the changing circumstances and their implications on management is summarised. A review on the literature on space-time methods and techniques across all types of facilities was also undertaken. After assimilating these reviews a method was devised as to how to research the topic based on the aims and objectives of the investigation.

Part B sets out to establish the conceptual framework of the space-time management approach while Part C explains the research approach detailing the hypotheses and the key issues for potential testing through the case study method. The overall findings of the research investigation conducted around the three case studies are reported in Part D. The basic support materials of the case study investigation are presented in the form of an Appendix in Part F. Both parts, D and F, are not presented explicitly in this paper. Finally, Part E reports on the comparative analysis of the case findings with the existing literature and some potential areas of application are suggested. The results of the analysis are summarised and the conclusions offer some important points for further researches. It also highlights the contribution the research has made to theoretical development of the space-time management approach.

The Conceptual Framework of Space-Time Management Method

Given the present and likely future circumstances, the management of facility space establishes a real concern for time in its process. The mechanics of the system has been discussed in detail elsewhere (Haron, 1997). Figures 2 and 3 describe the main parameters of the space-time management technique.

Figure 2 shows the stages of a decision making process over a one-year period. The

process iterates through five main stages: starting with the measurement and diagnosis (through pre-survey activity analysis), planning and control (through allocation and re-allocation activities), organising (through prototype arrangements), re-measurement (through monitoring use), and finally implementation (through communication activities).

Figure 3 captures the dynamic relationships between supply and demand. It conceptually illustrates the variation of management responses adopted according to the problem situations, expressing the changes in use over time. The crucial task in this model lies in identifying the recurrent problem situations and their expected time frames of occurrence.

To date, documentations of the approach (Figures 1 & 2) in facility planning, design and management are readily available (FM DATA Monthly, 1997) and are steadily increasing.

The Research Approach

The effects of the changing circumstances lead to several questions for those involved in the management of facility space, as shown below. Six key questions which need to be addressed are as follows:

1. Which spatial factors significantly affect the activities, operations and management of an organisation in contemporary conditions?
2. How may the relative suitability of facility space be assessed and reviewed over time?
3. How may the relative severity of the spatial constraint imposed by a facility on the occupying organisation be measured?
4. To what extent are traditional space standards and space allocation procedures relevant and applicable in an era of rapid change?
5. How should an organisation calculate its total demand for space over the short, medium and long term period?
6. What methods and techniques might be developed to assist in the management of space through time?

Three hypotheses were generated: first, given the dynamic space requirements affected by time factor, the traditional methods for estimating space requirements will become increasingly inadequate. Applied research in the 1980s and 1990s has identified the major limitations to traditional approaches to space management in contemporary conditions, particularly the over-estimation of spaces required, uneven distribution of spaces, insufficient provision of space types, inefficient space demarcation and extreme levels of utilisation occurring at all levels of the organisation. Although each has different and multiple causes, the most significant cause of these inadequacies has been traced to the simple 'space per person' criterion.

Second, the explicit inclusion of time within space management procedures is likely to result in a more reliable method for estimating space requirements, allocating space and providing the balance of supply and demand over time. This is supported by the development of the conceptual framework of space-time management. On the management of the demand-side, the quantitative measure is based on full-time equivalent (FTE) people hours load incorporating a forecast of possible future needs, so as to ensure that a real demand for space is estimated at each level of the organisation. On the supply side, the quantitative measure is in space hours availability. Its relationship to the level of availability will ensure that a real supply of space is attained at each level of the facility. On the demand and supply

interface, the utilisation is based on the level of satisfaction in the duration of use and occupancy which ensures that a reasonable utilisation is targeted. The balance between supply and demand will depend on the acceptable level of tolerance of space utilisation across the different levels of the organisation.

Third, the space-time management methods will provide a more viable and efficient basis for the planning and management of space than the traditional methods. Firstly, it will provide a better forecasting method for estimating the quantitative and qualitative space requirements. It will provide better estimates of the 'real' demand/supply for space (actual/effective) and a richer view of the variety of spaces required over time. Secondly, an improved allocation and use procedure will allow flexibility in spatial adjustments for minimising wastage. Finally, it will provide an expert basis for a comprehensive management response system, incorporating the basic time frames and relating these to the management problems and appropriate management options.

The expected advantages of applying the method were considered in a selection of key issues; the demand side focused on arriving at a better estimate of the aggregate spatial support requirements and their varieties, while the supply side focused on improved allocation/ reallocation procedures. The management side focused on control measures through improved utilisation and expert management responses to changing problem situations. These issues were analysed through three case studies, as a basis for exploratory investigation.

The aim of the case study strategy was to support the potential relevance in the application of the new space-time method alongside the traditional approach by using data from the original case studies. The sample for the study comprised commercial business organisations occupying headquarters and other building facilities. These organisations were from the high change rate category in terms of people and space. In this investigation, the measure was changes per period (Birchall & Lyons, 1995), in the previous 24 months. This period was considered a rapid pace at the time the study was undertaken.

The data on the demand, supply, utilisation and time frames aspects were collected using structured interview questionnaire with key personnel who are responsible for policy formulation and implementation of space use in their respective organisations. They included the director, the facility manager, the property manager or the human resource manager. The interview data is supported with materials from documentary sources such as building plans and space policies. A comparative analytical technique was applied following closely to these steps: within-case, cross-case and paired case comparisons (Eisenhardt, 1989; Yin, 1994), incorporating similarities and differences (Tversky, 1977) to draw out the key findings. These are then compared with existing conflicting or similar literature (Eisenhardt, 1989:544). Eisenhardt's work is instrumental to the development of this analytical framework because previous writings tend not to provide the framework for theory building from cases as developed in her analysis.

Testing the Study's Hypotheses

Initial results from the case studies showed that the three organisations were at different levels of acceptance of the full capability of the space-time method as a management tool. At their lowest level of acceptance organisations display a reluctance of implementing space-time method unless prodded by top management. At their highest level, organisations will

fully implement the space-time method across the full spectrum of change. The details of these findings will now be compared against those of recent literature.

Hypothesis 1: *Given the contemporary and likely future work conditions, the traditional methods for estimating space requirements will become increasingly inadequate.*

The findings of the case studies initially gave mixed results. On one hand, all the case organisations have asserted that traditional space standards were still applicable. On the other hand, in-depth analysis confirmed that the effects of inadequacies were present.

Where the traditional space standards remains relevant, work organisation is conducted around the presence of staff within the facility. This suggests *full occupancy* - an essential requirement for assigning space in the traditional method. Where the standards do not remain relevant, work organisation is conducted according to their actual duration of performing the activities. This could be much less than the required amount of contractual hours per week. As a result, assigned workspace was under-utilised over the total available organisational time (Figure 4) as indicative from the difference in space hours and people hours utilisation graphs. Therefore the 'space per person' allocation is considered inadequate when space-time budget records of the actual use of the workspace were applied.

Furthermore, there is a weak relationship between the number of employees and the amount of space provided. The difference between theoretical space per person ratios and the actual use ratios of each organisation was inconsistent (Table 1) particularly in two of the three cases, which indicates substantial positive and negative differences. Should management rely on this indicator, future estimates for space provision could be grossly misleading.

The case studies evidence also showed that individuals and groups have a tendency to ask for a wider range of primary workspace types to be provided within the central facility (Table 2), indicative from the levels of acceptance. Should management apply the current perceived indicators for increase in dedicated workspaces particularly, then there will be a serious mismatch between the demand and supply in the future.

Recent research and reviews seemed to reconfirm the inadequacy of the "old ways of planning workspace" which tend towards excessiveness and inefficient responses (McGregor, 1999:59) as mentioned previously. McGregor forwarded questions such as, "what if organisations need less space, not more?" or "what if different locations are needed or if not required at all?" Such claims have been substantiated through performing comparative analyses on annual occupancy costs (Apgar, 1998). It was found that these costs were highest in traditional space office types, gradually decreasing in shared spaces or virtual arrangements of the new working environment organisation (Apgar, 1998:129). Some claimed upwards of 25 per cent in cost savings from a square-foot reduction (US General Services Administration, 1999). These are brought about by applying fewer differentiating categories, removing or reducing the number of status based standards which have significant influence towards over estimation of usable area requirements (USGSA, 1999).

We conclude from the literature and case studies that the traditional methods of estimating space requirements are becoming increasingly inadequate when applied to changes that involve changing work organisation, but may remain relevant in the traditional working arrangement types.

Hypothesis 2: *The explicit inclusion of time within the space management procedures is likely to result in more reliable methods for estimating space requirements, allocating space and adjusting the balance of supply and demand.*

The space-time analysis carried out on the case studies data has produced estimates of the total space requirement that are some 17 per cent to 33 per cent lower than those resulting from traditional methods (Table 3) and releasing 27 per cent to 35 per cent of usable area for diversification.

This was effectively achieved through a reallocation technique, commonly practised in industry such as in these companies: IBM UK Ltd. (IBM, 1991), Digital (Digital, 1993) and Andersen Consulting (Chadwick, 1993; 1996). Space allocation procedures now depend on the average duration of activities or time spent at the workspace. The higher the average time spent at the workspace, the more eligible for space assignment. Conversely, a shorter duration would lead to a degree of space sharing (Table 4). As a result, primary usable areas have lesser allocation for dedicated workspaces, creating a balance which could be diversified into other space types (Figure 5).

When estimating capacity requirements, organisations need first to adopt reasonable targets for utilisation of space. The case studies simulation showed that the actual reported facilities utilisation was between 36 per cent and 41 per cent compared to the theoretical levels of 75 percent (Table 5) giving a difference of 33 per cent - 39 per cent as gross misrepresentation on utilisation.

Should the current utilisation be required to be improved, to say, 50 per cent, assuming full occupancy at 70 per cent, then the frequency factor should theoretically be increased to 71 per cent. This will allow the facilities to accommodate higher numbers of full-time equivalent (FTE) users, possibly up to 38 per cent more (Table 6) when the additional numbers are contracted at lower working hours - implying a potential increase in part-timers. Should spaces be available to a capacity of 24 hours maximum per day, their implication on the facility demand capacity would be overwhelming. There is a potential to increase the total number of FTE to a maximum of 167 per cent if their contractual hours were at 39 hours work week or up to 366 per cent at 18 hours work week (Table 7).

If, on the other hand, the level of utilisation and contractual hours are unchanged, the capacity could be augmented from the occupancy levels. Some form of sharing arrangement operates. The fixed availability of supply of each space type could be effectively occupied by more than one FTE so that each workstation could accommodate more changes in number of users (Table 8).

However, these kind of adjustments which target on utilisation levels were feasible in short-term arrangements. In long-term arrangements, when business plans and strategies were considered, the spatial flexibility of existing spaces is simultaneously considered.

The analysis on spatial features has found three categories of facility space types: the least constrained facility, moderately constrained and the most constrained facility. A facility space was considered to be least constrained by their dispersed cores and uninterrupted floorplate, such as in Case 1 (Figure 6) which facilitates sub-divisioning arrangements. In contrast, the most considered facility has fragmented floorplates of less than 500m, semi-dispersed cores and awkward column positions, such as in Case 2, which allows

poor subdivisioning. By combining management responses and spatial analysis, the case findings showed that it is not necessary for the most constrained building to have the most significant impact on management when organisations have gone through changes; neither will the least constrained facility require the least effort (Figure 7). The implications on management are usually supported by the endorsement of space-time policies at the top management level and the eventual acceptance at the end user level; individual, working group, business units.

Recent literature again tends to confirm the reliability of applying the 'space-time' notion in terms of estimating capacity requirement and for planning through different time frames. Thus organisational people hours demand measure could be theoretically deployed into space, place and time (Nutt, 1999:29), regardless of change factors. The emphasis is placed on the FTE in demand forecasting allowing variation in duration of use. Elsewhere, when there is a constant target on duration of use, variation occurs at occupancy levels (FM DATA Monthly, 1998). The method could also enlarge the requirement for a variety of work settings to suit changing needs and new work processes (Varcoe, 1998; USGSA, 1999). The overall space availability is optimised if spatial flexibility (FM DATA Monthly, 2000) becomes an important issue in space utilisation or reutilisation over different time frames.

Combining recent literature with the case findings, it is concluded that explicit consideration of time within the space management procedures is likely to result in more reliable methods for estimating space requirements, allocating space and adjusting the balance of supply and demand. The space-time measures in people hours, space hours, and utilisation levels, are seen as the common denominators in future changes and could be accommodated and managed with reasonable flexibility.

Hypothesis 3: *A space-time management method will provide a more viable and efficient basis for the planning and management of space than traditional methods.*

The case studies support the well-known fact that management responses to changing conditions are related to their problem situations and potential future plans. Decisions tended to vary across specific time frames of change expectation: a time frame of less than eight weeks (immediate-short term); up to six months ahead (short-medium term); and five or ten years ahead (medium-long term). The anecdotal evidence showed that most change expectations tend not to involve move or relocation decisions; rather, typical responses were modifications to space use, space adaptation, review of space standards and flexible work arrangements (Table 9).

In a situation of unexpected demand, the case findings showed that short-term tactical measures by offering space sharing typical operational measures through furniture arrangement, activity settings or an innovative strategy by space charging were adopted. However the activity, some kind of control measures were used; by decreasing the amount of space per person or by adopting fewer space standards. This has created some management problems particularly when Headquarters sites were preferred over other locations, to the point of being detrimental to health and safety of the workers. Alternatively, an adaptation strategy was applied as a mean to defer direct property investments in new buildings as the decision process suggests that a 'space-time management method' is already in practice at different levels of implementation in the case studies (Table 10) although at different levels of impact and acceptance.

The space-time budgeting technique complements the new management method to derive the required utilisation levels of the different organisational operations. The space-time analysis from case studies indicated this as feasible (as discussed earlier). Those who actually used their space for less than 20 per cent of the time for which it was available found themselves targeted by management to improve the utilisation of the workspaces.

Recent papers lend explicit support to space-time management. The current key objective of workspace management is to match requirements of the tasks to be performed to the most effective time-space relationship (McGregor, 1999: 61). The initiatives combined the organisational needs from short-term to long-term demand to achieve the balance between supply and demand (FM DATA Monthly, 1999a) at facilities portfolio level. Its development in the offices sector is supported when "key trends of IT convergence and performance offer greater time and space options to end users" (Watts, 1999:105) and this goes beyond mere allocation. The end users have now "choice in the selection of work setting - as they look for more freedom, fluidity and excitement" (Watts, 1999:107). A recent contribution supports this initiative under the development of Integrated Workplace (USGSA, 1999) while another has represented it as purely business strategy (Centre for Digital Culture, 2000).

Both the case studies and the literature indicate that space-time management is viable in view of its ability to produce real estimates for future requirements in amount and diversity of space types, although there is already an indication that the method may not be fully facility related; it also presents potential disadvantages in its implementation at the individual, group and business units' levels of operation.

Application Areas

A major concern of highly variable use pattern is to develop a management system that permits a versatile and flexible response in the provision of spatial support. Space-time management necessarily treats the three time frames – short, medium and long-term - as equally important, although Facility Management authors tend to stress on the strategic nature (Lawson, 1996; Reeves, 1999), relating particularly to critical decision making requirements in holding properties and real estate.

There are four broad areas of potential application for this method (Figure 8): strategic planning and forecasting of space requirement; strategic positioning through estimating capacity requirement; strategic management for the management of change and strategic design for future management of space.

- *strategic planning and forecasting of space requirement*, when the management decides on a fundamental organisational change through new working practices, innovative contract of employment, different business priorities or technological advancement. The changing nature of work will demand more effective control and allocation of net usable areas (NUA) and net internal areas (NIA); Figure 8 (a) conceptually indicates the demand-led initiatives;

- *strategic positioning through estimating capacity requirement*, where the opportunities for spatial support in the market supply may have changed with the introduction of new types of space, new uses, mixed uses, new types of venue and location, and/ or new types of leasing arrangements. Opportunities for support of fully serviced office space on a 'provide as and when needed basis' may now exist.

If the nature of supply is measured in space hours, a more precise matching to the facility resource may help determine a new workforce structure through new contracts and employment. This allows the dynamic changes in demand to occur continuously and enables the organisation to better position itself in the market as supply dictates. Figure 8 (b) conceptually indicates the supply-led initiatives;

- *strategic management for the management of change,* where the use of space fluctuates throughout different time periods, with peaks and troughs. The method can better balance supply and demand by improvements in utilisation through reallocation procedures. This is targeted at two sources, the duration of use or the occupancy levels in their respective time frames of short, medium and long term. Hence, during peak times, the duration of use may be reduced, and occupancies increased, and vice versa for the troughs. This results in a uniform distribution in the long term. Figure 8 (c) shows the utilisation-led initiative;

- *strategic design for future management of space*, where the spatial design needs to be appraised to determine the extent of flexibility, adaptability, capacity and suitability of buildings and facility spaces, using building plans and post-occupancy evaluation tools; Figure 8 (d) conceptually shows the management-led initiative.

Table 11 shows examples of these practical management techniques across the different levels of management and utilisation.

Result of the Analysis

Whilst recognising that many traditional methods of management remain relevant to traditional working organisations, especially where work is organised in one location, our case studies showed that factoring in measurement of demand by people hours load rather than mere occupancy resulted in a significant reduction in the net usable area estimates. On the supply side, the measurement of workspace by space hours availability also gave a more reliable estimate of the facility capacity, although the influence of the relative severity of spatial constraints needs to be noted as placing varying degrees of limitations on the activity, operations and management of an organisation.

The method was seen to have immediate application in all forms of work practices over space and time. A typology of space-time management has been developed in tandem (Figure 9), which shows the interaction of the two dimensions: predictability and utilisation. Very predictable events of high utilisation require the application of the traditional method in space assignment. In the other extreme situation, very unpredictable events with low utilisation require the application of space-time method with ready availability of flexible spaces and locations. If displayed in a continuum, the nature of allocation will transmute correspondingly with variations in facility locations and the group of users.

The challenge remains to ensure data collection and analysis which is as accurate as possible. Estimates based on selective memory, or diary self-reports or subjective observation may either be unavailable due to personal or time constraints, or may produce over-estimates of important activities or under-estimates of personal time (Hartley, 1975). Similarly, at the facility level, the initial assumption treats

its data as considerably reliable when these are bound to change through adaptation or renovation activities. Thus, this would require regular observation. Adding in further checks to data collection, and ensuring proper monitoring and review stages are crucial in highlighting problems and remedies. This should also be done where new space management initiatives have been implemented. Measures of efficiency on the part of the time which the facility space is actually being used should be monitored. This area, if already researched has been under-reported.

Conclusions and Recommendations

As a conclusion, a number of points need to be borne in mind:

- the calibration of the allocation guidelines relating to sharing, at the individual and group levels, has significant influence on the real demand estimates of the organisation;
- the determination of the extent of control over allocated spaces at all levels of operation tends to influence the basis for adjustments of supply and demand for space over time;
- the targeted utilisation levels which could be manipulated separately from either the duration of use or the size of groups tend to influence the employment structure directly rather than presented as an option to improve space use;
- the integrity of the data derived from space-time budget technique establishes the options for management responses offered by the expert system;
- the organisational and facility policies are essential elements which initiate the management of space over time.

Further research could focus on these areas. Resulting improvement in quantitative data, measures of efficiency and understanding of strategic and design problems and possibilities would enhance management's capacity to make allocation decisions which are more accurate and precise.

If the above findings were to be offered to the case studies organisations, they would perhaps see why things were as they were. Obviously present developments are spurred by the shift to virtual spaces or satellite centres, which are state-of-the-art in the current world of business organisations. But it is also clear that, the approach will not completely eliminate the traditional method, rather it will enhance and support management in making secure decisions about use and management of space.

Some day the limits to change will be reached. Prudent space-time management may not ward off that day but, hopefully, it will delay it for a while. This is the special outcome from the present research. As results of further empirical investigation are available, a general method of space resource management of facilities can be developed.

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Table 1: Comparing Theoretical Against Actual Space Per Person Indicators From Traditional Method

		Case 1	Case 2	Case 3
Theoretical Estimates	FTE NUA1 (1) NUA1 per person sq.m. per person	1323 12896 9.7	236 3436 14.6	891 16678 18.7
Actual Estimates	FTE NUA2 (2) NUA2 per person sq.m. per person	1323 12896 13.8	236 3317 14.1	891 11274 12.7
Difference	NUA per person sq.m. per person	+ 4.1	- 0.5	- 6.0

Source: Haron (2000)
(1) Appendix 2; Table 2.5 (Case 1), Table 2.23 (Case 2), Table 2.42 (Case 3)
(2) Appendix 2; Table 2.6 (Case 1), Table 2.24 (Case 2), Table 2.43 (Case 3)

Note: FTE = Full time equivalent, NUA = Net usable area

Table 2: Comparison of Space Classification in Three Studies

	Case 1	Case 2	Case 3
Space classification			
Dedicated workspace/office	unacceptable (-)	just tolerable (-)	just tolerable (-)
Shared workspace	just tolerable (-)	na (-)	acceptable (+)
Group space (Ancillary)	just tolerable (-)	just tolerable (-)	just tolerable (-)
Amenity space	acceptable (+)	unacceptable (-)	just tolerable (-)
Special space	acceptable-just tolerable (+-)	just tolerable (-)	acceptable (+)
Indicate:			
Diversity of space type	just tolerable	unacceptable	just tolerable

Source: Haron (2000)
Appendix 2; Table 2.8 & 2.11 (Case 1), Figures 2.22 & 2.29 (Case 2), Figure 2.41 & 2.44 (Case 3) Appendix 3, Table 2.64

Note: Unacceptable refers to complaints received and management having to take remedial steps
Just tolerable refers to complaints received and management not having to take remedial steps
Acceptable refers to no complaints received and therefore no action is necessary

Table 3: Comparing Demand Estimates Between the Traditional and Space-Time Approaches, in Net Usable Area (sq. m.)

	Demand estimates		
	Case 1	**Case 2**	**Case 3**
Traditional method theoretical NUA (sq. m.) (1)	12896	3436	16678
Space-time method (adjusted) NUA (sq. m.) (2)	10677	2297	13575
Percentage difference	-17%	-33%	-19%

Source: Haron (2000)
(1) Appendix 2; Table 2.5 (Case 1), Table 2.23 (Case 2), Table 2.42 (Case 3)
(2) Appendix 2; Table 2.12 (Case 1), Table 2.29 (Case 2), Table 2.48 (Case 3)

Note: (1) estimated from space per person standard on total number of FTE
(2) estimated from effective working hours, i.e. space-time budgets on total number of FTE

Table 4: Reclassification and Reallocation of Work Activities by Time Budget

Categories	**Occupation type**	**Average time spent at desk**	**Suggested sharing ratios**
Group A	Directors	< 20%	1 : 10*
Group B	Managers, professional, Marketing, Sales	21% - 40%	1 : 3
Group C	Technical	41% - 70%	43 : 100
Group D	Support (Administration, Personnel, Clearical and Secretarial)	> 70%	1 : 0.75**

Note:
1. Suggested sharing ratios (desk to person) are based on the average duration of time spent at the workspace. These could be as low as 1:2 (shared assign) or as high as *1:10 (free address). It is unsual for Directors to share space. Group D represent assignment of space**
2. According to the field studies and applied research literature, ratios are derived from evaluation surveys on the level of satisfaction of the users involved.

Table 5: Levels of Utilisation of Workspaces Across the Three Case Studies

		Case 1	Case 2	Case 3
Traditional 100% Space-time budget - Theoretical	FTE (1)	1323	236	891
	FTE hours (1)	49613	8850	33396
	Space unit hours (2)	66510	11800	44528
	Utilisation	75%	75%	75%
Actual reported Space-time budget - Adjusted	FTE (1)	1323	236	891
	FTE hours (1)	25061	4289	18193
	Space unit hours (2)	66510	11800	44528
	Utilisation	38%	36%	41%
% difference	Utilisation	- 33%	- 39%	- 34%

Source: Haron (2000)
(1) Appendix 2; Table 2.7 (Case 1), Table 2.25 (Case 2), Table 2.44 (Case 3)
(2) Appendix 2; Table 2.8 (Case 1), Table 2.26 (Case 2), Table 2.45 (Case 3)

Note: (1) estimated from traditional contractual arrangements of 37.5 hours per week
(2) estimated from space-time budgets reported as actual working hours per week

Table 6: Summary Table For Estimating Demand Capacity at Different Contractual Policies at Current Space Hours Availability

	Case 1		Case 2		Case 3	
Space hours	66150	66150	11800	11800	44528	44528
Utilisation factor *(b)*	50%	50%	50%	50%	50%	50%
Projected FTE loads *(c)*	33075	33075	5900	5900	22264	22264
Current FTE load *(d)*	25061	25061	4289	4289	18193	18193
Difference FTE loads *(e = c-d)*	8014	8014	1611	1611	4071	4071
Hrs per week *(f)*	39	19	39	18	41	20
Additional FTE *(g = e/f)*	205	422	41	90	99	204
Actual FTE *(h)*	1323	1323	236	236	891	891
Total FTE *(i = g+h)*	**1528**	**1745**	**277**	**326**	**990**	**1094**
Actual Full time *(j)*	1288	1288	236	236	876	876

Source: Haron (2000)
(1) Appendix 2; Table 2.7 (Case 1), Table 2.25 (Case 2), Table 2.44 (Case 3)
(2) Appendix 2; Table 2.8 (Case 1), Table 2.26 (Case 2), Table 2.45 (Case 3)
(3) Appendix 2; Table 2.13 (Case 1), Table 2.31 (Case 2), Table 2.50 (Case 3)
(4) Appendix 2; Table 2.14 (Case 1), Table 2.32 (Case 2), Table 2.51 (Case 3)

Note:
(a) Assume a constant space availability in space hours per week at current operating hours.
(b) 50% utilisation is decided by the management as the describe level
(c) Projected FTE load in people hours estimated from multiplying spacehours by utilisation factor
(d) Current FTE load in people hours estimated from space-time budget analysis
(e) Difference in FTE load between projected and current
(f) Full time contractual hours have two option here;
1) at 39 - 41 hrs per week, 2) at 18 - 20 hours per week
(g) Additional FTE numbers are estimated by dividing the difference from (e) by contractual hours (f)
(h) Actual FTE numbers taken from the original case data
(i) Total FTE numbers sums up the additional (g) and the actual (h)
(j) Actual Full time numbers are taken from the original case data
(k) We take each part time employee as 0.5 - 0.6 the equivalent of full time staff
(l) The total percentage increase in FTE numbers can be estimated to give the FTE capacity estimates for the facility

Table 7: Summary Table for Estimating Demand Capacity at 24 Hours Maximum Space Availability

	Case 1		Case 2		Case 3	
Space hours	222264	222264	39648	39648	149614	149614
Utilisation factor *(b)*	50%	50%	50%	50%	50%	50%
Projected FTE loads *(c)*	111132	111132	19824	19824	74807	74807
Current FTE load *(d)*	25061	25061	4289	4289	18193	18193
Difference FTE loads *(e = c-d)*	86071	86071	15535	15535	56613	56613
Hrs per week *(f)*	39	190	39	18	41	20
Additional FTE *(g = e/f)*	2207	4539	395	863	1381	2831
Actual FTE *(h)*	1323	1323	236	236	891	891
Total FTE *(i = g+h)*	**3530**	**5853**	**631**	**1099**	**2271**	**3721**
Actual Full time *(j)*	1288	1288	236	236	876	876
Part time *[k = (i-j) x 2]*	4484	9130	-	-	2791	5690
Total % increase in FTE *[l (g/h) x 100%]*	**167%**	**342%**	**167%**	**366%**	**155%**	**318%**

Source: Haron (2000)
(1) Appendix 2; Table 2.8 (Case 1), Table 2.26 (Case 2), Table 2.45 (Case 3)
(2) Appendix 2; Table 2.15 (Case 1), Table 2.33 (Case 2), Table 2.52 (Case 3)
(3) Appendix 2; Table 2.16 (Case 1), Table 2.34 (Case 2), Table 2.53 (Case 3)

Note:
(a) Assume that space hours are available at maximum capacity, 24 hours daily, within the week.
(b) 50% utilisation is decided by the management as the describe level
(c) Projected FTE load in people hours estimated from multiplying space hours by utilisation factor
(d) Current FTE load in people hours estimated from space-time budget analysis
(e) Difference in FTEload between projected and current
(f) Full time contractual hours have two option here;
1) at 39 - 41 hrs per week, 2) at 18 - 20 hours per week
(g) Additional FTE numbers are estimated by dividing the difference from (e) by contractual hours (f)
(h) Actual FTE numbers taken from the original case data
(i) Total FTE numbers sums up the additional (g) and the actual (h)
(j) Actual Full time numbers are taken from the original case data
(k) We take each part time employee as 0.5 - 0.6 the equivalent of full time staff
(l) The total percentage increase in FTE numbers can be estimated to give the FTE capacity estimates for the facility

Table 8: Improving Utilisation Through Changes in Occupancy Factor Workspaces

	Case 1	Case 2	Case 3
Enumerated # of workstation *(a)*	1655	278	905
No of user *(b)*	1358	236	905
Actual # of workstation *(c)*	1323	236	891
No of user *(d)*	1323	236	891
Recalibrated # of workstation *(e)*	991	198	662
No of user *(f)*	1323	236	891
Seat used *(1) = b/a*	0.82	0.85	1.00
Seat used *(2) = d/a*	0.80	0.85	0.98
Seat used *(3) = f/e*	1.34	1.10	1.35

Note: (1) derived from layout plan analysis
(2) derived from 1 : 1 allocation procedure
(3) derived from space-time method.

Table 9: Problem Situation and Prevailing Management Responses in Current Situation to Future State

Level of management	Case 1	Case 2	Case 3
Individual level: Current	inadequate	adequate	adequate
Future	Desk on demand		
less requirement		Sharing of PCs	do nothing
Working Group level: Current	inadequate	adequate	adequate
Future	Sharing group space	Increase in use of IT	Move functions around
changing requirements	Increase commons area		
Business units level: Current	adequate	adequate	adequate
Future	Activity settings	Space standards	Move functions around
changing requirements	And space charging		
Organisational level: Current	more than adequate	adequate	adequate
Future	Consolidation	Design strategies;	Move functions around
changing requirements	and teleworking	adaptation	

Note: Haron (2000) Appendix 2, Section B of A1, A2, A3

Table 10: Time Frame of Predictability of Each Level of Management Across Three Case Studies

Level of management	Time frame of predictability		
	Case 1	Case 2	Case 3
Individual	na	na	na
Group	2-8 weeks	na	na
Departmental/Business units	3 months	1 year	1 year
Organisational	6 months	1 year	1 year
Indications to 'real' demand	Fully aware	Not fully aware	Not fully aware

Source: Haron (2000) Appendix 2, A1, & A3, Section A

Table 11: Some Example of Space-Time Management Measures to Accommodate Changes in Use Over Time

variability in use	individual Workstation	Group space	Business units/Divisional spaces	Property portfolio spaces
short term tactical measures	•free address •kit of parts •clear desk policy	•time-tabling •shared facilities •group address	•chargeback system	•hotelling
medium term operational measures	•JIT/hotelling •electronic home office •first come first served	•booking system •team office •shared office	•system furniture •non-territoral office •universal plan	•conversion •refurbishment •universal plan
long term strategic and innovative measures	•flexible working •shared office •non-territorial office	•touchdown •mobile net working	•satellite office •telecentres	•virtual office •telecentres •24 hours office

Figure 1: Structure of the Paper

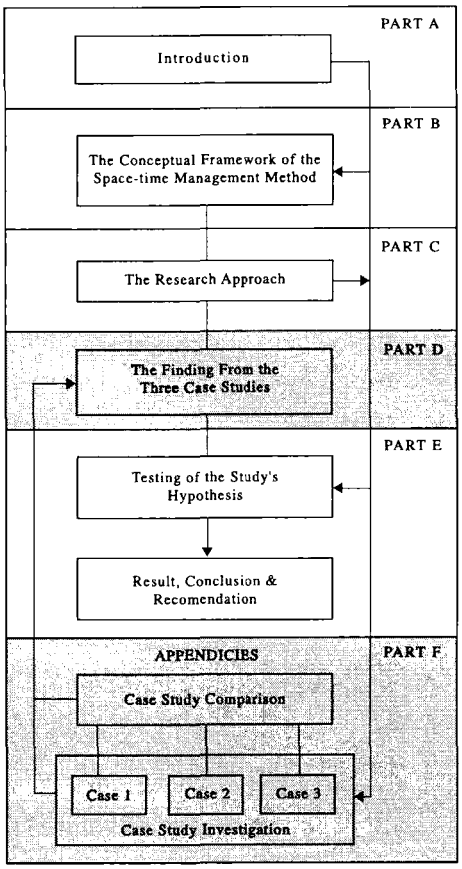


Figure 2: The Space-Time Management Process

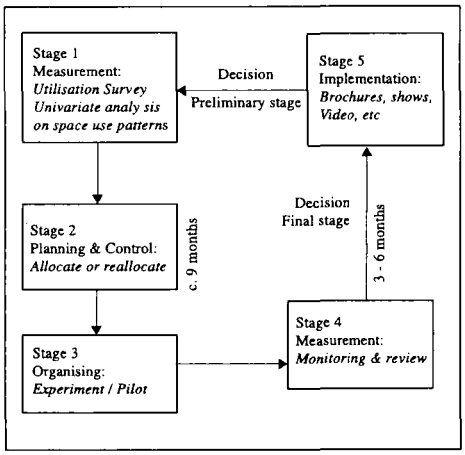


Figure 3: The Space-Time Management System

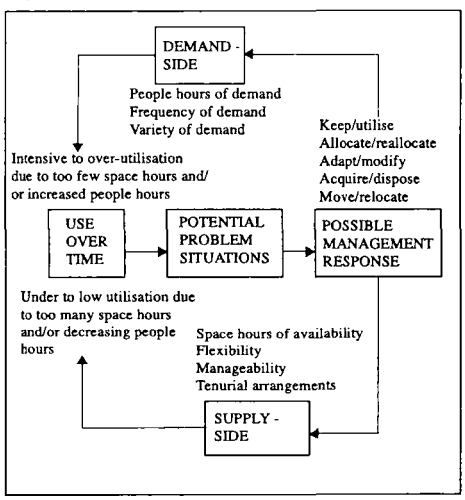


Figure 4: Matching People Hours and Space Hours to Show the Level of Utilisation by Actual Time in Use Across Three Case Studies

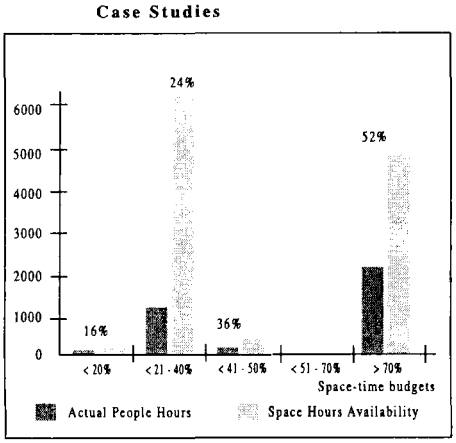
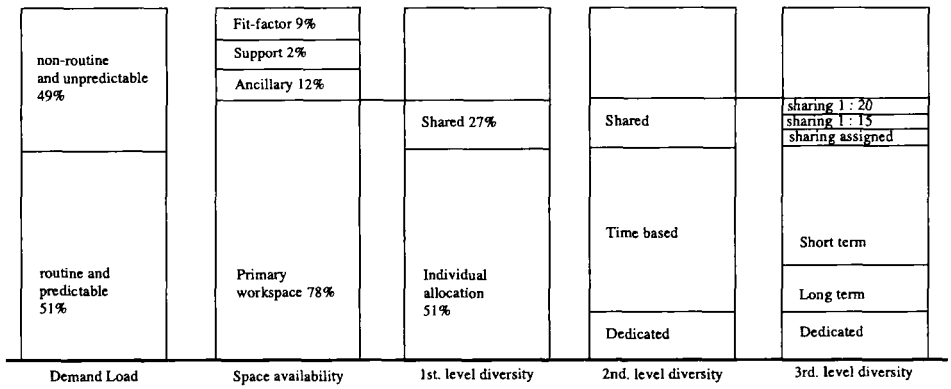
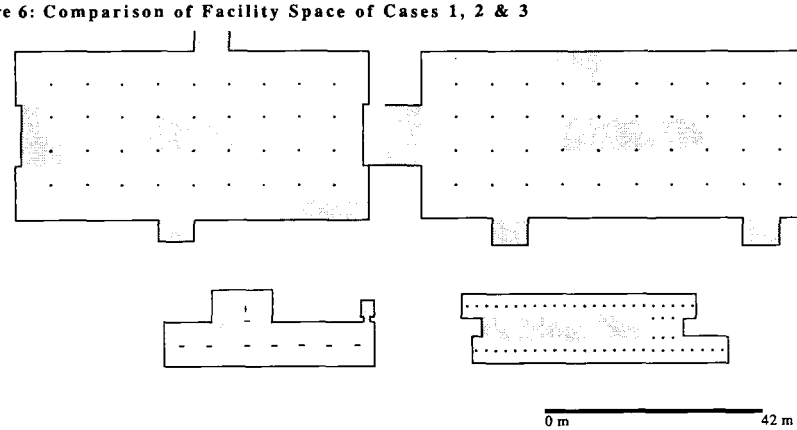


Figure 5: National Space Diversity from the Original Allocation of Primary Workspaces, Simulated from Case Study 1



Source: Haron (2000) Appendix 2, Figure 2.5 (Demand load), Figure 2.10 (Space availability)

Figure 6: Comparison of Facility Space of Cases 1, 2 & 3



Note: Anti-clockwise, first two building plans are from Case 1, next from Case 2, and finally Case 3

Figure 7: The Extent of Impact from Change Againts Facility Profits by Space-Time Management Intervention Profiles

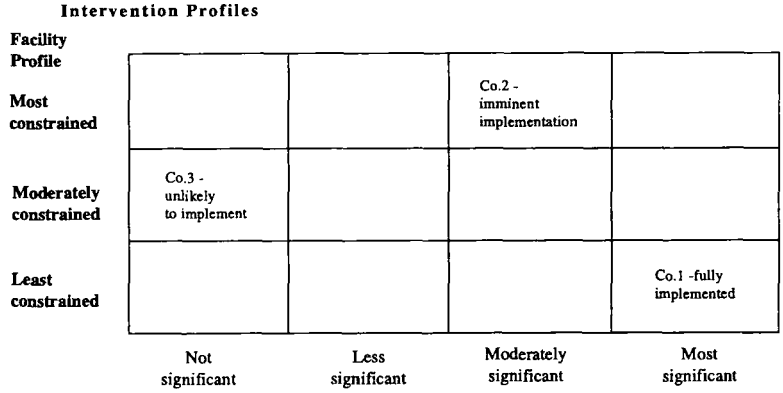


Figure 8: Application Areas of the Space-Time Management Methodology

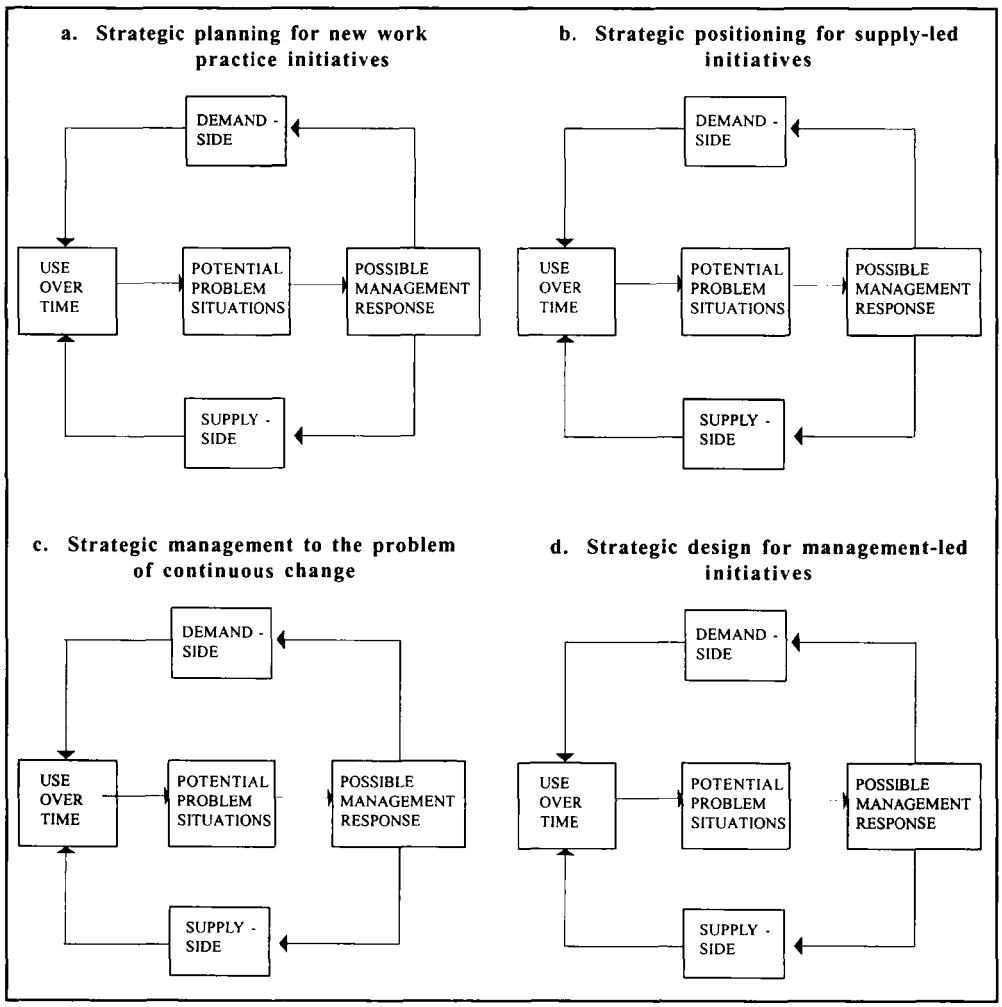
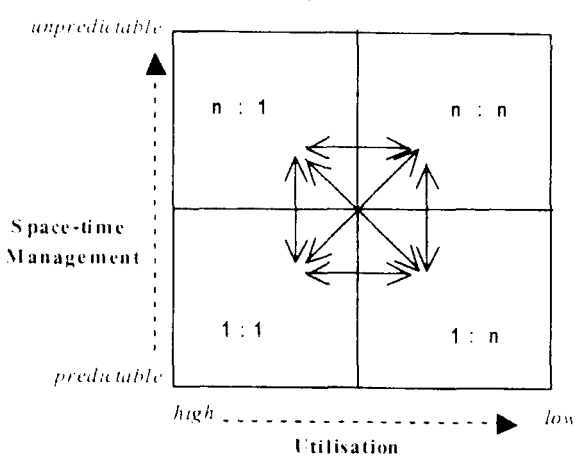


Figure 9: Practical Concept of Space-Time Management



An Analysis of Office Investment Depreciation - Hedonic Modelling of Its Sources

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Abstract:

This paper attempts to develop a systematic statistical method for the analysis of office depreciation. An appropriate functional form, which avoids potential bias as well as links depreciation to physical deterioration, building and site obsolescence, is selected. A hedonic model for the city of Kuala Lumpur office rental depreciation aims to explain rather than to predict the phenomenon as the cross-section analysis of rental market in 1996 was undertaken. The perceived importance of variables in causing depreciation is identified and explained in detail. The result indicates that depreciation of offices in the city of Kuala Lumpur is largely dominated by physical deterioration and building obsolescence compared to site obsolescence.

Keywords: impact of depreciation, physical deterioration, obsolescence and hedonic modelling

Introduction

Depreciation and its impact on property investment has been the focus of many studies in the early 1980s. In the United Kingdom, the analysis of property depreciation concerns the growing awareness of property mispricing as a result of implicit analysis of its impact. This issue has raised the need for a better approach to quantify its impact as well as its capability to consider other depreciation variables apart from 'age'. The approaches to estimate depreciation have developed significantly since the last decade especially in economic (Hulten and Wykoff, 1996) and accounting. The methods progressed from a simple measurement to more complicated methods (bivariate to multiple depreciation causal) as well as the improvement of the methods with statistical tools aimed to appropriately quantify and explain property investment depreciation.

This paper aims to construct a hedonic model for office depreciation considering all possible causes of depreciation. This empirical model expands upon the previous studies (Md Yusof, 1999 and 1999a) relating the relationship between rental depreciation and three major causes of depreciation namely physical deterioration, building obsolescence and site obsolescence using the hedonic price technique. Within the context of a hedonic price model, various included variables explain the impact of depreciation, which is an alternative to the version whereby 'age' was used as a depreciation variable (Sykes, 1984; Salway, 1986; Barras and Clark, 1996 and Clapp and Giacotto, 1998). In this paper, depreciation factors, which are represented by original and an orthogonal combination of depreciation variables, are used. The original variables refer to variables collected from literature review and survey whilst orthogonal factors are variables extracted via the Principal Component Analysis (Md Yusof, 1999a). The hedonic

price for each factor is calculated and used to explain the perceived importance of each factor in office investment depreciation.

The development of the model begins with a review of related literature in the next section of this paper. This literature review is followed by the specification of the model. Data used in developing the model is presented next. Data efficiency and bias associated with the construction of the hedonic model is discussed. The empirical results are reported and the research is summarised in the final section.

Literature Review

In property investment, depreciation rate (especially for residential property) is commonly estimated by examining price data on units of various ages (for example, Barras and Clark, 1996 and Clapp and Giacotto, 1998). The rate of change of observed property prices with respect to 'age' is interpreted as a depreciation rate. Works such as Sykes (1984), Salway (1986) and Barras and Clark (1996) also quantified the property ages as the rate of depreciation. The age-life method of estimating depreciation is one method that incorporates the above information and is often used by practising appraisers (Cannaday and Sunderman, 1984). The difficulty of determining the efficient or economic life of a property has been a major inadequacy highlighted in Baum (1989) and Md Yusof (1999). 'Age' is strongly correlated to other variables (see for example, Epley, 1990); therefore the effect of other depreciation variables, such as design cannot be separated.

Md Yusof (1999 and 1999a) proposed three main sources of depreciation: physical deterioration, building obsolescence and site obsolescence (further discussion on sources of depreciation can be found in Md Yusof, 1999 and 1999a). Physical deterioration indicates the situation of utility declining due to physical usage and the passage of time. Physical deterioration emanates from 'use' and 'action of elements', which require the passage of time, as both 'use and action of elements' occur progressively through time. Obsolescence is a decline in property utility or usefulness (Salway, 1986 and Baum, 1989), which is not directly related to physical deterioration. The property becomes obsolete as it falls in comparative status due to factors such as technology or design of a new property. Obsolescence can be classified as building obsolescence and site obsolescence

Building obsolescence refers to a degree of mismatch between a building and its use. Building obsolescence may arise from deficiency in design, building systems, services and other factors. Site obsolescence indicates a decline in the usefulness of a site (Md Yusof, 1999 and 1999a). Factors which may cause obsolescence of a particular site or location include accessibility, site-specific, planning and environmental factors.

The attempt to incorporate different sources into the analysis of depreciation has resulted in the application of statistical tools. In Baum (1989), Hulten and Wykoff (1996), Khalid (1992) and Md Yusof (1999), a multiple regression analysis and its extension hedonic price model has been used to explain rather that predict the impact of depreciation on property investment especially when the data is analysed cross-sectionally. The main concern here is to review the causes of depreciation using the hedonic price technique. The technique has been used as a better alternative to explain different sectors in property investment analysis. The application of hedonic price technique to determine rental and house prices and the impact of the countryside characteristics on values of residential can be seen in some

cases, for example, Garrod and Willis, 1991 and 1993. In addressing the impact of depreciation, numerous studies have measured house depreciation by the coefficient on age in the hedonic regression, for example, Palmquist (1979), Linneman (1980) and Chinloy (1980). The most recent is a rational expectation framework for interpreting the coefficient on age in a standard hedonic model developed by Clapp and Giacotto (1998) for the residential sector.

In office investment, the models used to measure office performance can be linked to the analysis of depreciation as it is largely related to property performance. Hough and Kratz (1983) and Vandell and Lane (1989), for example, consider the price of good architecture in the rental determination of offices by hedonic price technique, which can be linked to depreciation in terms of method and variables used. Dunse and Jones (1998), include factors such as physical characteristics, tenure and location as those which determine the value of offices in the United Kingdom, which is also appropriate to the analysis of depreciation.

Hedonic regression is an extension of Multiple Regression Analysis (MRA), which can be applied to a series of property values, together with their associated characteristics to identify and quantify the significant determinants of value and consequently depreciation. Hedonic multivariate regression is a technique for measuring price while controlling for the quality of the heterogeneous commodities. Hedonic price is the implicit price of each attribute possessed by those goods. Each attribute contributes to the values of the good as the model specified that the good per se, does not affect the level of their utility to a consumer, but instead the good possesses attributes that increase or decrease the utility (Rosen, 1974). The interpretation suggests that the price paid for a particular good is the sum of the implicit prices of the associated attributes as the hedonic price equation is a reduced-form equation reflecting both the demand and supply influences (Halvorsen and Pollakowski, cited by Edmond, 1984).

In this study, the hedonic model is based on the assumptions that an office user's utility is a general function of a dimensional vector of characteristics which encompasses locational and physical characteristics, the market price is known for any offices and each user maximises utility, subject to a budget constraint. In the office unit, Z, is composed of n attributes (Dunse and Jones, 1998) where z_1....., z_n is a vector of n attributes for which rent depends upon the quantities of the various attributes associated with Z. The rent function can be expressed as $R(Z) = f(z_1, z_2....z_n)$. The hedonic equation is estimated using regression analysis to obtain a price measure, $R(Z_k)$, the corresponding z_k for the k^{th} property which forms the equation of:

$$R(Z_k) = \beta_o + \sum_{i=1}^{n} \beta_i Z_{ik} + \varepsilon_k$$

The hedonic price function may increase, decrease or be constant depending on the functional form of R(Z). Despite the various advantages of hedonic analysis, some issues require careful consideration. Caution must be taken to ensure that included characteristics must be restricted to those which pertain to the good itself. A proper set of characteristics of demand and supply should be carefully examined. Other issues relate to the underlying factors that cause depreciation to vary and whether the importance of these factors will vary cross-sectionally. This is also the subject of interest that requires accurate measure of prices on a standardised bundle of office services for each locality considered. More importantly, the appropriate functional form for a hedonic price equation cannot in general be specified on theoretical grounds and the lack of a firm basis for the choice of functional form is unfortunate. This, nonetheless, does not prevent the application of hedonic price model in other studies as well as in this study.

Methodology and Research Design

This research is designed to explain the impact of depreciation on rental for offices in the city of Kuala Lumpur. It is aimed to show the perceived importance of each variable in depreciation by regressing dependent variables (rental depreciation) against two sets of independent variables; non-transformed and transformed variables. Non-transformed variables consist of original variables, which are significantly associated with rental depreciation. The transformed variables consist of factors extracted via the Principal Component Analysis. Full discussion on Principal Component Analysis performed on the similar dataset can be found in Md Yusof (1999a).

The stepwise selection is used as the method refines and combines both forward and backward selection. In stepwise method, the variables are reassessed at every stage as opposed to forward and backward where as variables are entered, they remain in the equation. The modelling process involves identifying data for analysis, building a hedonic model, specifying model and assimilating of the whole process to explain the impact of depreciation.

The Specification of the Model

The model specification includes selection of the dependent and independent variables and determining the overall functional form of the model. As mentioned earlier, two forms of hedonic model are developed in this paper. The highest rental achieved in the market is selected as a benchmark. In 1996, the prime rent was RM5.80 per square feet. The rate of depreciation is arrived as follows:

$$\text{RentalDepreciation}(\%) = \frac{[\text{PrimeRent} - \text{OfficeRent}]}{[\text{PrimeRent}]} \times 100$$

Dependent variable is the difference in rental between equivalent new, modern and prime and the subject property, consistent with other studies (Baum, 1989; Khalid, 1992; and Barras and Clark, 1996). Selection of independent variables for the model attempts to incorporate all physical deterioration, building obsolescence and site obsolescence variables that would be required to minimise specification bias. Therefore, the selection of variables is guided by the results of previous studies and the availability of data.

A testable form of equation related to depreciation begins with a standard cross-sectional hedonic model (Rosen, 1974):

$$Y = a + b_1x_1 + b_2x_2 + \ldots\ldots b_nx_n \quad or$$
$$Y_i = a + b_1x_{1i} + \ldots + b_nx_{ni} + e_i$$

$$\text{Dep}R = a + b_1(x_1) + b_2(x_2) + b_3(x_3) + \ldots\ldots + b_n(x_n)^{ii} + e,$$

where the rate of depreciation at any particular time, R is a function of physical deterioration, building obsolescence and site obsolescence for the i^{th} offices. The intercept 'a' represents that portion of rental depreciation for each office that may be attributed to the overall level of depreciation. The coefficients on 'b_1' to 'b_n', are allowed to change over time. Any unexplained variation is captured by the random error e.

i) Model with original variables

In the model, rental depreciation is a function of a set of original variables

$$\text{DepR} = a + b_1(V_1) + b_2(V_2) + b_3(V_3) + b_4(V_4) \ldots + b_n(V_n) + e_i$$

ii) Model with orthogonal factors

$$DepR = Constant + b_1(Fac1) + b_2(Fac2) + b_3(Fac3) + b_4(Fac4) + b_5(Fac6) + b_7(Fac7) + b_8(Fac8)$$

Any violation of the model is observed carefully. Problem of multicollinearity, normality error, linearity or heteroscedasticity is analysed through appropriate statistics. Tolerance level, for example, shows the proportion of variability which cannot be explained by other variables. The smaller the

tolerance, the larger the standard errors of the coefficient. Large standard errors of coefficient cause computational problems and are always associated with multicollinearity. The determination of the importance of the variables in the equation can be difficult if the model is affected by multicollinearity.

Data

Data for this study is derived from information on forty-nine offices in the city of Kuala Lumpur. The average rental for these offices ranged from RM3.10 to RM5.80 per square foot in 1996. The offices are located in three traditional commercial areas: Golden Triangle Area (GTA), Central Business District (CBD) and Decentralised Area (DCA). The GTA is the prime area in the city followed by the Central Business District and Decentralised Area. Rental depreciation as the dependent variable is denoted as the percentage rental difference between subject and prime offices. 'Prime' is used to indicate the highest rental achieved in the market based on the consumer theory; a good is paid the highest price for the highest utility offered (Lancaster, 1966). The selection of property characteristics or attribute is guided by the analysis of sources of depreciation. Variables selected are linked to physical deterioration, building obsolescence and site obsolescence. A total of 51 variables were collected. Nonetheless, only 31 variables, which are significantly associated with rental depreciation, are used for further analysis. The specific information on the broad categories compiled for each property is summarised under the categories of location, age of the offices, physical characteristics, services available in the building, building systems and building design according to the city of Kuala Lumpur, 'Guideline on Office Classification' (DBKL).

In addition to the original variables, eight components are also used to explain the impact of depreciation based on three sources of depreciation: physical deterioration, building obsolescence and site obsolescence. The components, which were extracted via the Principal Component Analysis, represent the underlying constructs of thirty-seven office characteristics collected (Md Yusof, 1999a). Principal Component Analysis is performed on 31 variables, aimed to summarise and reduce the number of independent variables. The use of a large number of independent variables can create a number of problems such as multicollinearity. Principal Component Analysis, however, eliminates mulicollinearity problem, which can be easily observed when variables are strongly linked to each other. The problem of multicollinearity may cause difficulty in determining causal variables in the model, as the independent variables are closely associated among themselves.

Eight orthogonal factors derived in the Principal Component Analysis are:

i. The quality of building (BldQty),
ii. Size and efficiency (SizeEff),
iii. Design and lay-out (DesLay),
iv. Location (Locat),
v. Appearance (Appear),
vi. Complementarity (Compl),
vii. Facilities (Facil),
viii. Parking services (Park).

Empirical Findings

The first stage of the analysis involve performing different methods of selecting variables. Stepwise selection provides extra advantages over forward selection and backward elimination. The included independent variables are reassessed at every step of the model development, ensuring the significant variables remain.

Two models with different sets of independent variables are presented as follows:

Model with original variables

Only variables which are statistically significantly associated with rental depreciation are selected for further analysis. Thirty-seven variables are regressed with rental depreciation. Eight variables included in the model are 'Age', 'Bay_rate', 'Ex_fin', Fl_fin, 'Plratio', 'Schrg', 'Stry' and 'Ty_con'. The model is developed using eight variables, which explain 82.86 per cent of variation in DepR. The adjusted R^2 of the model is 79.25 per cent. The equation can be rewritten as:

DepR = 49.27 + 0.34 (Age) - 2.02 (Bay_rate) - 1.02 (Exfin) - 2.534 (Fl_fin) - 0.557 (Plratio) - 21.491 (Schrg) - 0.161 (Stry) + 2.72 (Ty_con)

There is no site-related factor included in the equation, which means that the aim to consider site obsolescence may not be achieved. Further statistical tests are carried out and relevant statistics are observed. The associated F-test shows that there is a significant relationship between the dependent and the entire set of independent variables. With eight variables, the model explains 82.86 per cent of variation in DepR. Adjusted R^2 is used to compare equation fitted not only to a specific set of data and two or more entirely different sets of data. In this case, adjusted R^2 fall to 79.25 per cent, which indicates the ability of the model as decreasing.

The equation can be read as, for example, one unit of 'age' contributes 0.34 per cent of rental depreciation. The largest variation in rental depreciation is due to 'Schrg', which means that as increases, charges will increase. The main concern here is that 'service charges' neither represents nor indicates any depreciation factors. Furthermore, although most variables indicate correct magnitude of association (the better quality of variables minimise depreciation), 'Ty_con' displays different pattern of association. An error is suspected in the model. There is no variable related to site hence there is no scope to consider the impact of site obsolescence. In addition to this, it is shown that the equation is seriously affected by multicollinearity (see Exhibit 1.0A). Low tolerance level indicates the problem. As a result, the model with original factors/variables is not favoured in the study.

Model with orthogonal factors

The DepR model is developed with seven orthogonal factors.

$$DepR_{96} = 15.61 - 5.202\ (BldgQty) - 3.438\ (SizeEff) - 1.557\ (DesLay) - 3.143\ (Locat) - 1.947\ (Compl) - 1.587(Facil) - 1.515\ (Parking)$$

i. Classification

In Md Yusof (1999 and 1999a), it is suggested that physical deterioration is related to the normal wear and tear of mechanical and electrical systems. The rate of deterioration depends on the level of use and the quality of the materials used. In the analysis, the components 'BldgQty' (Building Quality) and "SizeEff' (Size and Efficiency) can be classified as physical deterioration-related factors. "Design, Facil and Park' can be building obsolescence factors. Nonetheless, it is important to realise that this is not an ultimate classification, as 'SizeEff' and 'BldgQty' may also influence building obsolescence and vice-versa. The only possible difference between them is that physical deterioration is concerned with wear

and tear but obsolescence is more related to qualities which correspond to changes in demand. In the study, site obsolescence is described by "Compl' (Complementarity) and 'Locat' (Location). The factors can be used to show the relative impact of site obsolescence.

ii. Variables inclusion

The model incorporates multiple variables which is different from Sykes (1984), Harker (1985) and Salway, (1986). In these studies, 'Age' is the only explanatory variable. A summary of the model is shown in Exhibit 1.0A.

The first factor entered into the equation is 'Building Quality'. 'BldgQty' explains 32.22 per cent of variation in rental depreciation for the selected offices in the city of Kuala Lumpur in 1996. This further shows that rental depreciation was reduced by 5.2 per cent with an increase in one unit of 'BldgQty', as shown in the DepR model.

An increase of 15.19 per cent of variation in DepR is caused or explained by 'SizeEff'. Here, the size of the space and the level of efficiency offered by the property influence more than 15 per cent of office rental depreciation. In other words, high-rise buildings with efficient services are preferred and, therefore, a higher rental could be expected (hence low rental depreciation). In the model, a unit increase in 'SizeEff' decreases rental depreciation by 3.44 per cent.

Additional variables such as 'Locat' and 'Compl' explained a further variation in rental depreciation. Although the contribution of each component is still considered significant, it is obvious that as more variables enter the equation, the marginal contribution of each decreases steadily. The role of each factor in minimising depreciation becomes less. Exhibit 1.0B summarises the contribution of factors in the model.

The above discussion shows that with seven factors or components, 73.78 per cent (adjusted to 69.07 per cent) of variation in rental depreciation in 1996 is explained. The remaining 26.22 per cent (adjusted to 30.93 per cent) is however due to factors which were collected but are not in the equation or were not collected or observed during the proforma survey. This includes the micro aspect of location, which could explain further variations in rental, and consequently depreciation.

iii. Violations checking

The model is checked for any violations that may result in inconsistent findings. The following have been undertaken:

Heterogeneous Variance: It is always assumed that errors of variance of regression models are homogeneous. The assumption of a homogeneous error of variance, as suggested by Myers (1989), is often violated in practical situations. This occurs because as numbers of either dependent or independent variables increase, the variation around the trend of fitted models becomes larger. To investigate if the error variance is homogeneous, One-Way ANOVA was performed and is discussed. With the one-way test of equality of variance, the hypothesis

is that all residuals from which the random samples are taken must not only be normal but must also have the same variance. Here, if the significance levels are relatively large, the hypothesis that the populations have the same variance cannot be rejected. In case of DepR, the result of the test indicates a significance level of 0.2022. Thus, for the model there is no danger of violation in terms of equality of variance.

Non-normal error: In regression analysis, the error is assumed to be normally distributed. Kolmogorov-Smirnov and Shaphiro-Wilks tests check the normality assumption. Again, although it is possible to test normality using a histogram of standardised residual to visualise the error distribution, it has poor resolution in the tails or wherever data are sparse.

The Kolmogorov-Smirnov test is used to test how well a random sample of data fits a particular distribution (uniform, Normal and Poisson). It is based on the comparison of the sample cumulative distribution function to the hypothesised cumulative distribution function. If the D statistic is significant, then the hypothesis that the respective distribution is normal should be rejected. The result of the test indicates high significance levels, D-statistics for DepR model (0.9379) suggesting that error terms for the models are normally distributed. The normality error distribution is further justified by a high significance value of *Shaphiro-Wilks* as another test of normal distribution. The Wilks statistic is 0.5327 for DepR and the result of the test proves that the error for the model is normally distributed.

Outliers: Outliers are problems of individual data points that do not fit the trend set by the balance of the data. The model violations may produce a suspicious data point on two occasions, (i) there is a breakdown in the model at the *ith* point, producing a location shift, $E(e_i) = D_i \neq 0$, which is known as the mean shift outlier model, and (ii) there is a breakdown in the model at the *i*th point and $Var(e_i)$ exceeds the error variance at the other data locations. In the statistical package, the outlier cases are those with residuals greater than ± 3. However, in this study, a standard deviation of ±2.5 has been used as well as ± 3. There are no outliers for DepR in both, when ±2.5 and ± 3, standard deviations were used.

Appropriate statistical tests have been performed to detect any violation in the model. There is no evidence to suggest that violations exist in the model thus it can explain depreciation based on the information collected.

Conclusions and Recommendation

The analysis of rental depreciation indicates that for the selected Kuala Lumpur offices, the levels of depreciation ranged from 1.2 per cent to 33.6 per cent in 1996. The study shows that the level of risk associated with the city's offices is a function of changes in demand for and supply of better quality offices. The study of decline or loss in value, in terms of rental was undertaken in 1996, aimed to explain the impact of depreciation based on three sources of depreciation: physical deterioration, building obsolescence and site obsolescence. Although the attempt to model each factor separately has not been successfully undertaken, the hedonic price model shows that physical deterioration and

building obsolescence have been the major causes of depreciation for offices in the city of Kuala Lumpur. This, nonetheless, does not negate the importance of site obsolescence in the city's office depreciation. When the offices are considered based on location, the analysis shows less systematic influence of the site factor but there is scope for cancelling the severe impact of building obsolescence and deterioration for offices in the Golden Triangle Area only, as the impact of site obsolescence is low.

The study indicates that Kuala Lumpur office depreciation is greatly influenced by differences in building characteristics. The differences are attributed to variations in construction technology to respond to changes in working styles. The requirements of office occupiers change over the 1980s where demand for modern offices became significant. The finding of this study is similar to some tenant's survey (for example, Valuation and Property Services, 1992) where the building components were rated above location or site-related variables. This indicates that the role of site becomes less dominant as evident from by hedonic pricing for site related factors, which are less significant, compared to those related to building. It was found that good locations might not necessarily lower the level of depreciation. However, the combination of good location and good buildings may decrease the impact of rental depreciation.

Nonetheless, as the study has been undertaken cross-sectionally, the effect of temporal variation has not been considered. The level of the general economy, for example, may change the perceived importance of variables selected in the model discussed earlier. Further research should be undertaken to test the validity of the depreciation model under the current economic scenario.

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EXHIBIT 1.0

1.0A A Summary of Stepwise Selection

DEPENDENT VARIABLE: DepR

Multiple R	0.91026
R Square	0.82858
Adjusted R Square	0.79249
Standard Error	4.08027

Variable	B	SE B	Beta	Tolerance	VIF	T	Sig T
Age	0.3404	0.138	0.245	0.457	2.189	2.465	0.0183
Bay-Rate	-2.0231	0.862	-0.187	0.789	1.267	-2.477	0.0178
Ex_fin	-1.0167	0.587	-0.172	0.457	2.184	-1.732	0.093
Fl_Fin	-2.535	0.571	-0.332	0.855	1.169	-4.437	0.0001
Pl_Rat	-0.557	0.252	-0.171	0.754	1.329	-2.215	0.0328
S_Chrg	-21.492	4.06	-0.452	0.617	1.621	-5.289	0.0000
Stry	-0.161	0.078	-0.184	0.573	1.744	-2.073	0.0450
Ty_con	2.717	1.052	0.260	0.443	2.253	2.582	0.0138
Constant	49.273	5.116				9.631	0.0000

Notes:

1) B is regression coefficient- the relative importance of variables
2) SE B is Standard Error of Coefficient
3) Beta is the standardised regression coefficient
4) Tolerance -Variance of Estimators
5) VIF- Variance Inflation factor
6) T statistic
7) Sig T - observed significance level

1.0B A Summary of Multiple Component Regression Analysis

DEPENDENT VARIABLE: DepR

Multiple R	0.85893
R Square	0.73776
Adjusted R sq.	0.69069
Standard Error	4.98157

Analysis of Variance

	DF	Sum of Squares	Mean Squares
Regression	7	2722.80374	388.97196
Residual	39	967.82435	24.81601
F = 15.67424		Signif *F* = .0000	

Variable	B	SE B	Beta	T	Sig T
(Fac1-BldgQty)	-5.203	0.741	-.576	-7.016	.0000
(Fac2-FffSize)	-3.438	0.729	-.387	-4.718	.0000
(Fac3- DesLay)	-1.557	0.720	-.177	-2.164	.0366
(Fac4-Locat)	-3.143	0.727	-.355	-4.323	.0001
(Fac6- Compl)	-1.947	0.728	-.219	-2.674	.0109
(Fac7- Facil)	-1.587	0.733	-.178	-2.167	.0364
(Fac8- Parking)	-1.515	0.720	-.172	-2.104	.0419
Constant	15.614	0.728		21.452	.0000

1.0C A List of Variables in The Study

Labels	Description
1. Ac_sys	Air-conditioning system in the building. The variable is measured by score with higher values for better and modern systems.
2. Ac_fl	The variable indicates whether the air - conditioning system is equipped with the latest feature of system; Variable Air Volume. The score is indicated by Yes or No.
3. Access	The variable used to describe the accessibility of the property from the main road and public transport
4. Age	Age of the building
5. DepR	Annual Depreciation on Rent
6. Dep Y	Annual depreciation on Yield
7. Bas	Explains the state of the building automation system of the building.Modern or best system denoted by higher scores.
8. Bay	Number of parking spaces provided in the building
9. Bay_rate	Indicates percentage provision of parking spaces based on floor area and space ratio
10. Big_spac	The biggest space occupied by a single tenant in the building
11. Bigs_ten	Number of bigger tenants occupying space of 5,000 square feet and above
12. Ce_high	Measured floor to ceiling height, more or less than 10 feet
13. Comm	Telecommunication system in the building
14. Cm_ref	Shows whether a common refreshment area is available in the building
15. Conf	Conference hall or room in the building
16. Cr fin	The state of architectural flnishes of lift car
17. Dine	Dining facility
18. Ex_fin	External finishes of the building

19. Fn_com	Tenants profile - Finance Companies
20. Fire	Fire prevention system of the building
21. Fl_area	Gross floor area of the building, denoted by several categories
22. Fl_fin	Building floor flnishes
23. Gen_com	Type of the ownership -general commercial
24. Govtagen	Tenants profile -Government agency
25. Gym	Gynmasiumfacility
26. Int car	Car interval movement
27. Lascap	The state of landscape in the building
28. Ld_area	Land area of the property
29. Lif car	Number oflift cars
30. Lif_con	The control system for the lift
31. Locat	Location of the property - Three commercial areas in Kuala Lumpur used
32 Mj_Inst	Type of ownership - Major institution
33. Numten	Number of tenants in the building
34. Occrate	Occupancy rate of the building
35. Owrel	Relationship to owner
36. Plratio	Plot ratio of the property
37. Profser	Tenants proflle - professional service
38. Prox	Proximity to other uses such as retail
39. Rd_fr	Is the property situated on road frontage
40. Re_count	The state of reception counter in the building
41. Refur	Any refurbishment undertaken
42. Rnt_rev	Rent review interval
43. Schrg	Service charge, measured as a fraction of gross rent
44. Security	Security system of the building
45. Sp-utl	The space utilisation (Column free, etc.)
46. Spd_car	The speed of the lift cars
47. Stck_br	Tenants profile -Stock broker
48. Stry	Number of storeys
49. Trdagen	Tenants profile - Trade agent
50. Ty_bay	Type of bay provided in the building
51. Ty_con	Type of construction - modem, transitional or traditional
52. Use_lev	The intensive use, based on type of business and number of tenants
53. Wait_car	The average waiting time during peak hours

Examining the Performance of Kriging in the Estimation of Property Value - A Case Study

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Abstract

Location is paramount to property value. Unfortunately, the conventional methods of valuation are often implicit in their treatment of location as a value determinant. This paper investigates the practicality of a method that provides for the explicit consideration of location in valuation by using a spatial interpolation technique known as the ordinary kriging method. To evaluate the performance of this single-variable location-explicit method, a comparison was made against the results generated with the multi-variable less location explicit Multiple Regression Analysis (MRA).

Keywords: multiple regression analysis, kriging, PRESS sums, trend surface analysis (TSA), variogram

Introduction

Existing methods of valuation range from the conventional techniques such as the comparison method to statistical techniques such as regression analysis. These methods are not always based on the explicit consideration of location in their determination of housing property value; this is despite the all-time recognition that location is a critical factor to property value.

In this paper, we investigate a method that explicitly provides for the consideration of location in valuation. More specifically, the spatial interpolation technique of interest is the ordinary kriging method. This method proceeds by analysing the geographic arrangements of data and using the analysed information to interpolate value on other points of interest. For an evaluation of the method's predictive performance, the value estimates derived by this method are compared against the actual property values. The estimation performance of this method is then compared against that of the multiple regression analysis (MRA) using the *PRESS* sums criterion. This comparison enables conclusions regarding the extent to which a single-variable location-explicit model performs against a multi-variable but location-implicit model of value prediction.

As a tool for spatial analysis, kriging is not exactly new. Its property for handling the prediction of values where points are spatially dependent between one and another is known. In the realm of property valuation, however, the application of this method has remained practically unheard of. What makes this technique interesting to investigate is the fact that it explores the patterns of spatial dependence within local areas and uses the information to interpolate value at points of interest. This

makes it a tool of different and greater precision to other surface interpolation techniques attempted before for property valuation.

To implement this case study, a simulated dataset was in use. We start with a discussion of the motivations for considering surface interpolation technique.

Spatial Interpolation for Housing Property: A Rationalisation

The rationale behind spatial interpolation is the observation that, on average, values at points closer together in space are more likely to be similar than points farther apart (Tobler, 1979). This notion of spatial 'association' is extendable to housing since house units close together tend to have similar values, concordant with the valuer's 'tone of the list' assumption applied in rating valuation (Wyatt, 1994). Further, it is common practice in dealing with the traditional comparison method that, ceteris paribus, nearer houses take precedence over houses farther away in the choice as comparables.

Valuers have for quite some time recognised the potential in exploiting the relationship between spatial autocorrelation and patterns in house values. Indeed, if it can be shown that meaningful associations exist between the positions in space of houses and the way the value of these houses relates to one another, then it is plausible that the former can be used as the basis for the prediction of the latter. The work of Byrne *et al* (1973) represents probably the earliest known attempt at exploring this possibility. In that study conducted in 1973, the investigators had used the trend surface analysis (TSA), a variant of the surface interpolation techniques, to determine housing prices in St. Albans on the basis of their locations.

It is well acknowledged here that interpolated surfaces are continuous while property values are discrete. However, if we can exploit a spatial interpolation method to create continuous surfaces from a sample of discrete points, we can derive the value estimate for each point from the interpolated surface. Indeed, if this interpolation method performs satisfactorily, we have indeed found another approach to mass valuation, which will be potentially useful for rating applications.

Nonetheless, underlying the above approach is the pretense that we can predict a house value solely on the basis of its locational information. It is often the case that property values vary drastically even between neighbouring housing units, such as when a vacant detached residential plot is situated next to a fully built plot. In such a situation, spatial interpolation techniques would be of limited value. Still, means can be found to mitigate such an effect, both through the choice of appropriate interpolation methods and the careful stratification of the data to achieve improved homogeneity.

The Kriging Method of Spatial Interpolation

Kriging has developed from the practice in earth science. For this, it has also been referred to as the geo-statistical method of interpolation. A number of methods are available within the kriging family, such as block kriging, co-kriging and probabilistic kriging, but in this study we utilise the ordinary kriging method.

The method of kriging was developed in the late 1960's by G. Matheron who was inspired by the contributions of D.G. Krige (Christensen, 1991). It was originally developed for use in the mining industry but has become increasingly popular in many fields of science and industry where there is

a need for evaluating data using the consideration of spatial or temporal correlations (Wackernagel, 1995).

The methods developed by Matheron produce optimal results in the sense that the interpolation weights are chosen to optimise the interpolation functions in order to provide a 'best linear unbiased estimate' (BLUE) of the value of a variable at a given point (Burrough *et al*, 1998). It is linear because it bases estimates on linear combinations of available data, unbiased because it aims to make the mean residual error equal to zero, and best because it aims to minimise the variance of the errors (Isaaks *et al*, 1989).

Kriging utilises the theory of regionalised variable which is founded on the notion that spatially distributed data behaves more like random variables and should therefore be treated stochastically (Oliver *et al*, 1990). The theory assumes that the spatial variation in the data can be described as the sum of three components, namely the deterministic structural component corresponding to either a constant mean or a trend, the stochastic spatially correlated component, and the spatially independent residual term (Burrough *et al*, 1998). In its simplest application, the theory assumes a constant local mean and a stationary variance of the differences between places separated by a given distance and direction; this constitutes the intrinsic hypothesis (Lam, 1983).

The variance of the differences, denote λ is the semi-variance. Formally

$$Var[z(x)-z(x+h)]=E[\{z(x)-z(x+h)\}^2]=2\gamma(h) \quad (1)$$

where $z(x)$ is the value of some attribute at position x, and $z(x+h)$ is the value at position $(x+h)$. This semi-variance value depends on the separation distance between the points, h; the actual positions are not relevant.

Kriging is similar to inverse distance weighted averaging in that it uses a linear contribution of weights for calculating value estimates, but differs in that the weights are derived according to the variance minimisation and unbiasedness criteria that it self-provides. Kriging explores the nature of spatial autocorrelation in the data and produces a semi-variogram to reveal the spatial variation underlying the data. The semi-variogram conveys useful information concerning the size, orientation and shape of the neighbourhood from which the sample points are drawn. Kriging also provides a measure of the error or uncertainty of the estimated surface (Lam, 1983).

Kriging analyses the pattern of spatial variation present in the data. The character of this variation is captured in functions such as the autocovariogram and (semi)-variogram, which provide the information for optimising interpolation weights and search radii. Unlike most other interpolation methods, kriging involves an interactive investigation of the spatial behaviour of the phenomenon of interest represented by the z values prior to the selection of the best interpolation strategy for generating output surface.

a. The rationale of Kriging for the current case study

In a sense, this study performs a revisit of the surface interpolation problem in the context of property value prediction. As indicated earlier, Byrne *et al* (1973) attempted the use of trend surface analysis (TSA) to achieve the prediction of property value. In that study, the authors found the method of limited value in investigating local detail such as required by the problem. We argue here that TSA is by nature a global interpolator and is therefore

not the most appropriate tool for dealing with short-range or local influences. Kriging is different in the sense that it investigates local patterns of spatial dependence and uses the analysed information to interpolate the values of interest. Due to this, it is thought that kriging would make for a more appropriate tool on the problem of such nature as the one at hand. This motivates the experimentation with kriging for the current investigation.

Most methods of interpolation neither provide the means for determining the number of sample points, the size, shape and orientation of the sample neighbourhood to use, nor look beyond the simple function of distance for the estimate of interpolation weights; the errors of estimates are not given (uncertainties associated with interpolated values). Kriging provides all of the above.

It has long been recognised that property prices tend to be similar for properties nearer to one another. This is explained in terms of a multitude of factors, but spatial separation has been known to play a significant contribution. This is so when dealing with point observations because units closer together will have similar values, concordant with the valuers' tone of the list assumption applied in rating valuation (Wyatt, 1994). Estimates of the dependent variable are made on the basis of location rather than by reference to independent variables (Shaw *et al,* 1985).

In terms of predictive performance, kriging has emerged superior to most other interpolation methods empirically. Isaaks *et al* (1989), in conducting the comparison using the dataset from geological activity, shows that the ordinary kriging estimates not only lead to lower standard deviation of errors, but also that "the estimates are also very good according to many other criteria" such as the mean absolute error and mean squared error. In another study, by Burrough *et al* (1998), kriging performs favourably against other methods of interpolation. These results, although specific to the context of the individual studies, indicate kriging as capable of improving the quality of prediction.

Kriging is unique compared to other estimation procedures in that it does not limit the weights to between 0 and 1. Rather, it extends the weights' boundaries to include negative values as well as values greater than unity. As a result, it allows the possibility of estimates that are not necessarily constrained to the minimum-maximum range as defined by sample values. This allows estimates that lie beyond the minimum and maximum of sample values, which is useful because in reality, there is also the likehood that the true values being estimated lie beyond the extremes of the available samples. Procedures that restrict the weights to within 0 and 1 can only attain estimates that lie between the minimum and maximum sample values.

The Methodology of Ordinary Kriging

For a more comprehensive treatment of the ordinary kriging methodology, the reader is referred to Isaaks *et al* (1989). The steps involved in ordinary kriging are as follows:

1. Compute the experimental variogram and deduce from the output whether it is feasible to interpolate the data
2. If feasible, use a suitable variogram model to generate value surface on a regular grid
3. Use the surface to interpolate values at unvisited sites

a. Computing the experimental variogram

The experimental variogram is the first step towards a description of the regionalised variation. It provides useful information for interpolation, optimising sampling and determining spatial patterns. The variogram reveals the nature of the variance-covariance structure given by the actual data and provides an insight into the pattern of spatial continuity present in the dataset.

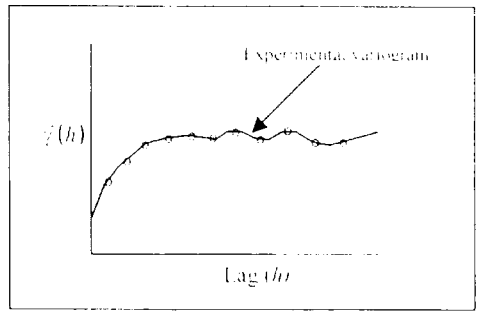
If the conditions specified by the intrinsic hypothesis are fulfilled, the semi-variance $\hat{\gamma}(h)$ can be estimated from sample data:

$$\hat{\gamma}(h) = \frac{1}{2n} \sum_{i=1}^{n} \{z(x_i) - z(x+h)\}^2$$

where n is the number of pairs of sample points of observations of the values of attributes z separated by distance h. A plot of $\hat{\gamma}(h)$ against h is known as the *experimental variogram* (Isaaks *et al*, 1989).

With h representing the lag, a typical experimental variogram takes the appearance of a curve that shows a steep rise from lag 0 but which changes to a more gradual one at larger h to eventually reach some kind of a plateau. The shape is illustrated in Figure 1.

Figure 1: A Typical Shape for Experimental Variogram



Since the experimental variogram is a plot of the variances of difference against lag distances, it provides an indication about the nature of spatial dependence present in the data. The shape derives from the fact that the spatial dependence between data points is greater when two points are at a shorter distance of one another than when they are further apart. The rising part of the curve describes how inter-site differences are spatially dependent: the closer the sites together, the more similar their z values are, as indicated by the low semi-variance values.

b. Modelling the experimental variogram

The next step is to decide on the suitable model to fit the data, taking into account the configuration of the experimental variogram, the sill and the nugget values, which are further explained below. A curve from mathematical models is fitted to experimentally derived semi-variances in order to describe the way in which semi-variance changes with the lag (Burrough, 1986). This curve displays several important features. First, at large lag values, it levels to what is known as a *sill*, implying that at these lag values, no

spatial dependence exists between the data points because all estimates of variances of difference are invariant with distance. Second, the curve rises from a low value to the sill, reaching it at a value h, known as the *range*. This describes the range of spatial distances at which inter-site differences are spatially dependent. Within this range, the closer together the sites, the more similar the values at the sites are. The *range* gives an idea about the size to consider for a search window. If the distance separating an unvisited site from a sampled point is greater than the range, then the latter can make no useful contribution to interpolation – it is too far away.

The *range* of the variogram therefore provides information about the size of the search window to consider. In effect, it defines the radius of distance from the point under investigation within which sample data points should lie to be considered influential to the estimation. These distances can vary as a result of anisotropy, which modifies the shape of the search neighbourhood from a circle to an ellipse.

Another feature of the fitted model is that it does not necessarily pass through the origin but cuts at a positive value of $\hat{\gamma}(h)$ despite the theoretical assertion that the semi-variance should be zero at lag 0. This situation arises because the positive value estimates the residual, spatially uncorrelated noise g^n. Also known as the nugget, g^n represents the variance of measurement errors combined with that from spatial variation at distances much shorter than the sample spacing, which cannot be resolved (Isaaks *et al*, 1989).

A number of variogram models are possible but the more common models in use are the spherical, exponential and gaussian models. Basic variogram models can be divided into two broad groups, known generally as transition and non-transition models. Transition model is 'bounded' in the sense that its variogram reaches towards an upper bound in the sill. Non-transition model, on the other hand, is unbounded since its variogram rises continuously as a function of lag distance h. Some transition models reach their sill asymptotically; for such models, the range is arbitrarily defined to be the distance at which 95% of the sill is reached (Isaaks *et al*, 1989).

Briefly, the spherical model has a linear behaviour at small separation distances near the origin but one that flattens out at larger distances to reach the sill at a. The tangent at the sill crosses the sill at about two-thirds of the range a (Isaaks *et al*, 1989). This model is normally used where there is a clear range and sill (Burrough *et al*, 1998). The exponential model is linear at very short distances near the origin but rises more steeply compared to the spherical model and flattens more gradually. The model is more appropriate where the approach to the range is more gradual. The Gaussian model has a parabolic shape near the origin and is often used to model extremely continuous phenomena. Like the exponential model, the Gaussian model reaches its sill asymptotically and the range is defined as the distance at which the variogram value is 95% of the sill. It is the only transition model whose shape has an inflexion point.

c. Fitting a model

Variogram fitting is an interactive process requiring considerable judgement and skill (Burrough *et al*, 1998). Model fitting is in order to produce the values of the parameters a, c_0 and c_1. These values can be obtained by least-squares or maximum likelihood procedure.

When the nugget variance dominates the local variation and the experimental variogram shows no tendency to diminish as $h \ominus 0$, the interpretation is that the data are so noisy that interpolation is not sensible. In such a situation, the best estimate of $z(x)$ is the overall mean computed from all sample points in the region of interest without taking spatial dependence into consideration.

A noisy variogram, in which the experimentally derived semi-variances are scattered, suggests that too few examples have been used to compute it. As a rule of thumb, at least 50 - 100 data points are necessary to achieve a stable variogram although smooth surfaces require fewer points than those with irregular variation. Smoother variograms can also be obtained by increasing the size of the search window.

The presence of a hole effect in the experimental variogram (a dip in the semi-variances at distances greater than the range) may indicate a pseudo-periodic pattern due to long range variation over a study area that is too small to encompass the total range of variation (Burrough *et al*, 1998). If the range is large, then long-range variation dominates: if it is too small, then the major variation occurs over short distances.

d. Dealing with the directional issues

Anisotropy in the experimental variogram suggests a directional effect in value pattern, but directional differences can also occur if there are insufficient samples to get robust estimates in all directions. In many cases where samples are spaced irregularly, a circular search radius is used to define a zone whose mid-point is h from its centre. All data points falling within the circle are used to estimate the contribution of $(z_i - z_j)^2$ from all pairs. If directional effect is absent, the resulting variogram is isotropic, i.e., it results from averaging over all directions (Burrough *et al*, 1998). However, variograms can also be computed in specific directions β, in which case they are known as anisotropic variograms. If different ranges and sills are obtained for different variograms, they may indicate spatial variation that varies with direction.

Kriging the Property Value: A Case Study

The implementation of this kriging case study was performed with GS+, a commercial geo-statistical package available from Gammadesign. This software provides the functionality necessary for performing the various tasks required in kriging analysis. Further, it generates its output in ASCII files which can be read into other GIS application software such as ArcView.

As a tool for kriging, GS+ is rather versatile (Robertson, 1998). It copes well with interactive needs of the user. Its interactivity allows models to be refined, or the parameters to be adjusted on the fly. This is very useful particularly when the

need is to consider several alternative models instead of just one. Speed is also its plus point. Finally, the 3-d mapping it provides along with the zoom and rotation capabilities allow the user full control over the display.

a. Preparing the Data

The dataset for this case study comes from simulated house prices in Newcastle upon Tyne, UK. It embraces a total of 37,812 housing properties located within the eight sub-areas of Benwell, Byker, Fenham, Gosforth, Heaton, Jesmond, Kenton, Longbenton and Walker. Each house is represented by its seed point in the digital map, and this has been extracted from the Landline data, which provides the original positional information.

The data was then split into two smaller sub-samples in the proportion of 80% to 20%. The larger sub-sample, consisting of 30,250 data points, is to be used in the modelling. The smaller sub-sample consisting of the remaining 7,562 data points is to be retained as an independent 'test' sample for the purposes of tests on the models derived with the first sub-sample.

In undertaking this case study, three effects are of particular interest to investigate in terms of their influences on the performance of kriging models: first, the effect of sample data density; second, the effect of sample stratification by house type; and third, the effect of variable normalisation.

In the real world, house price data are not as abundant as the simulated data suggests since such data does not regularly become available. House price data arises when the property undergoes market transactions, but for any particular property, this does not occur with any regularity. Further, property value is not static and changes over time. Since value has its validity period as dictated by the market to which the property relates, not all price data is relevant for a particular time-period of interest. This introduces a further limitation to the availability of value data. To study the influence of data availability on kriging's predictive performance, tests at three levels of data density corresponding to 5,000, 10,000 and 15,000 house units will be performed.

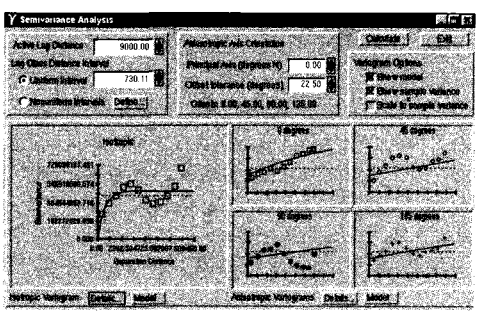
It is commonly observed that different house types have different characteristics and this heterogeneity leads to their different value classes in the market. House type is therefore a significant influence to consider and needs to be accounted for in modelling. Kriging, due to its single-variable nature, has no intrinsic means for dealing with this problem. As such, it would also be of interest to investigate if separate modelling of each property type would lead to better performance with kriging.

So far, the basis of interpolation is the value for the total property (land and building). However, it is also of interest to investigate the effect of value normalisation on kriging's predictive performance. Value normalisation in this study means the 'devaluation' of whole property value in which the value of a house is averaged over its parcel size. Underlying this approach is the supposition that normalising this way will improve homogeneity in the data and hence help improve the modelling with kriging.

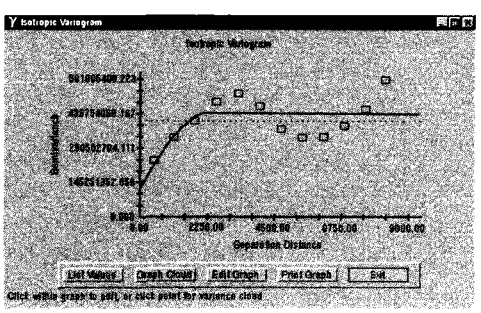
b. Variogram modelling on property value

Figure 2 shows the isotropic variogram produced from 10,000 house values in this study. Plotting at uniform lag distance intervals of 730 metres, the plot shows a typical rising trend, hitting the peak at an approximate lag distance of 3,400 metres followed by a declining trend to the trough at about 5,400 metres and a rising trend again thereafter. The whole shape takes the appearance of a reflected S-curve. The semi-variance analysis for the data taken at lower and higher densities of 5,000 and 15,000 points respectively reveals similar variogram shapes, as shown in Figure 3.

Figure 2: Isotropic Variogram for the 10,000 Data Points

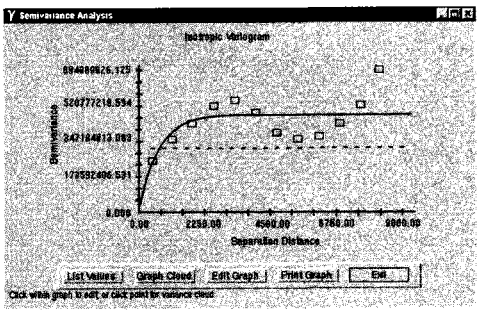


Semi-variance analysis based on 10,000 points

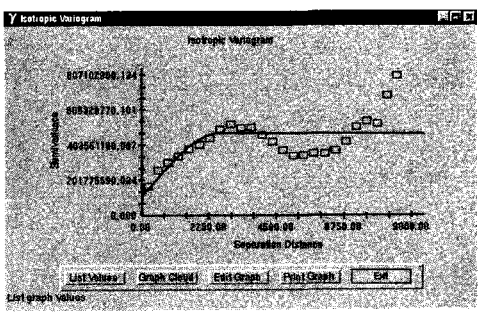


A close-up of the isotropic variogram

Figure 3: Isotropic Variogram for the 5,000 and 15,000 Data Points Respectively



Semi-variance analysis based on 5,000 points

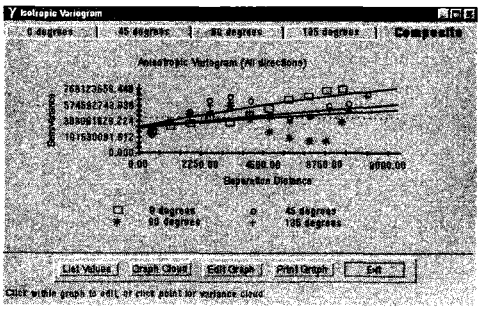


Semi-variance analysis based on 15,000 points

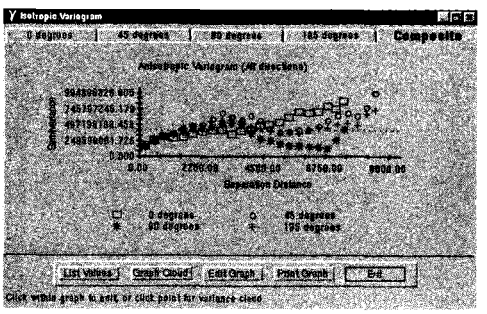
The variogram indicates spatial dependence that weakens as separation distance increases up to around 3,400 metres but this dependence seems to grow thereafter for some larger separation distances before diminishing again finally. This behaviour of spatial dependence is generally typical apart from the temporary dip, which is rather anomalous when the ideal experimental variogram would show a clear and horizontal sill after 3,400 metres. In the circumstances, it seems best to treat the data with one of the transition models, by assuming the presence of a sill that cuts a path roughly midway between the peak and the trough. Indeed the default model fitted by the GS+ is precisely of this nature.

The variogram in Figure 4 shows no clear anisotropy or directional

Figure 4: An Analysis of the Multi-Directional Effect of Spatial Dependence (anisotropy)



Variograms for the multi-directional semi-variance analysis on 5,000 data points



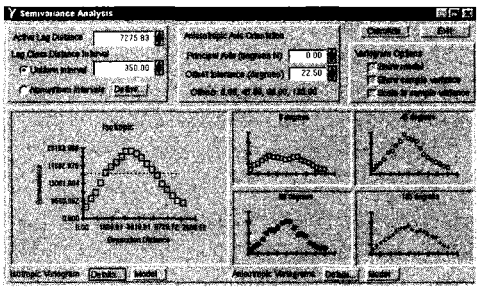
Variograms for the multi-directional semi-variance analysis on 15,000 data points

variation of spatial dependence in the data, and this negates the need to consider models of non-omnidirectional nature.

c. Modelling for property value as normalised by parcel size

Figure 5 shows the experimental variogram produced from the 5,000 data points by the normalised value variable. The semi-variogram pattern seen here defies the textbook description of an ideal variogram shape. Here, the typical rising trend at the beginning is followed by an ever declining trend to give the overall appearance of a peaked hill. This appears to indicate that at separation distances larger than about 3,300 metres, the square metre value of houses tends to become

Figure 5: The Variogram for the Normalised Value Based on the 5,000 Data Points



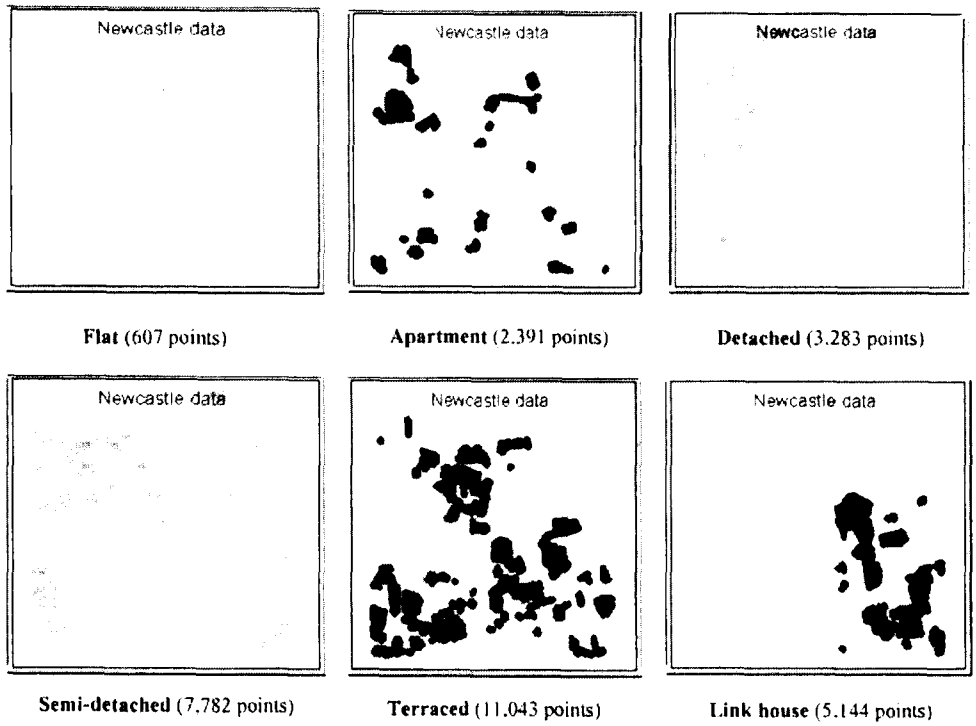
more similar again, in fact more similar the further the houses are apart. This behaviour is neither intuitive nor easy to explain in the present data set. The nature of spatial dependence in the data as described by the experimental variogram appears too anomalous to be treated with kriging. On this basis, the planned extension to this investigation involving the normalised value is abandoned and is not pursued further in this case study.

d. Modelling by property type

Modelling by property type requires separate semi-variance analysis on the data points on different property types. The implications are two-fold here: each property type is a much smaller sample size than the original work dataset, and each property type is an uneven distribution of data points spatially. Figure 6 shows the spatial distribution and sample size for each house type.

It is clear from Figure 7 that the variograms are not as smooth as for the whole work dataset. The combined effects of reduced sample size and the scatteredness of data points could have contributed to this situation. The variogram for flat

Figure 6: The Spatial Distribution of Houses by Type



units, which has the lowest number of points, is particularly jagged. It is also noticed that variogram smoothness in this data generally improves for the larger sample house types although the semi-detached variogram provides an exception; this is certainly true in the case of the link house.

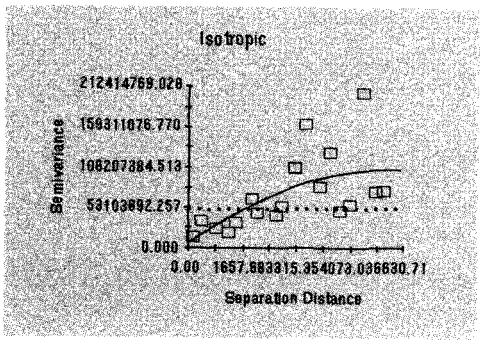
The variogram for the apartment data is devoid of a sill but instead shows a continuous linear rise over the spatial extent considered. For such spatial structure, theory recommends the use of a linear model (Burrough *et al*, 1998).

e. Value interpolation by Kriging

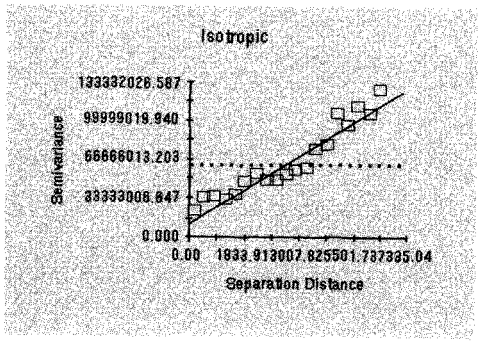
Given the information from their respective variograms, kriging interpolations are performed on the independent 7,562 point test dataset. This allows the house value represented by each point to be estimated by the kriging method. Since the spatial structure in the normalised values does not provide a clear case of spatial dependence for modelling with kriging and also, since the patterns of spatial dependence for individual property types are too erratic, the interpolations based on the individual types are abandoned.

A series of kriging interpolation are performed based on the three levels of sample density used for the weight calculations. The interpolated values are then compared against their corresponding original final values in the dataset and the *PRESS* statistics calculated. Although kriging does produce estimates of errors, these estimates are not looked at because the *PRESS* statistics present a more

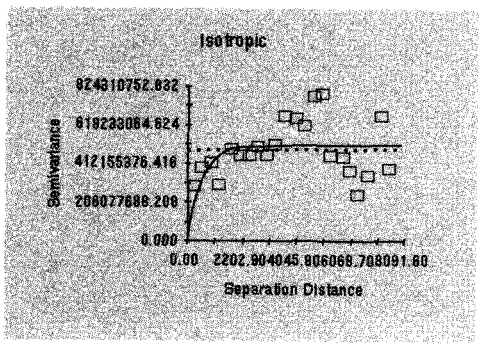
Figure 7: The Isotropic Variograms by House Type



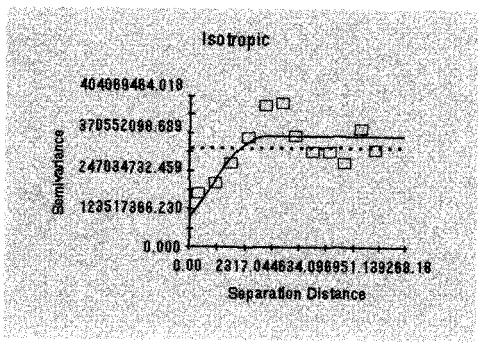
Flat



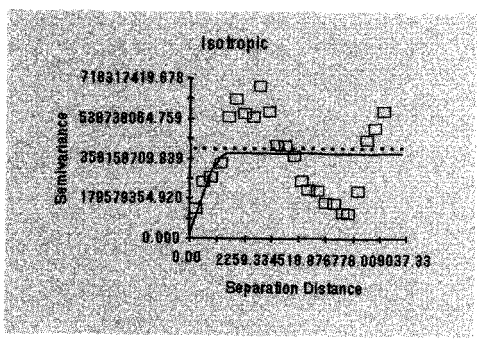
Apartment



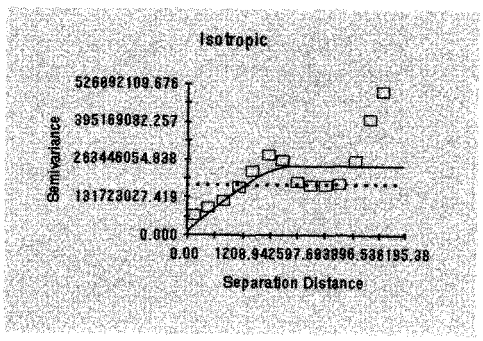
Detached



Semi-detached



Terraced



Link

desirable criterion for the comparison of performance due to their tests on independent samples.

The *PRESS* statistic is defined as: where,

$$PRESS = \sum_{i}^{n} (P_i - A_i)$$

N= the number of observations in the test sample
P_i= predicted house value
A_i=the observed house price

The aim is to achieve minimum value for PRESS. The model with the smallest PRESS statistic prevails as the best model for predictive performance.

The results on four of the interpolation runs are of interest and their *PRESS* sum calculations are presented in Table 1.

Table 1: The PRESS Statistics Obtained for the Different Levels of Data Density Used in the Kriging of Independent Test Data Points

Data density and model fitted	PRESS Sum	PRESS Maximum
Spherical model on 5,000 data points	***915,481,005,731***	25,913,695,301
Exponential model on 5,000 data points	***864,920,477,807***	26,800,453,327
Spherical model on 10,000 data points	***834,042,753,822***	25,876,385,828
Spherical model on 15,000 data points	***793,489,424,232***	26,114,944,609

There is a progressive reduction in the *PRESS* sum with greater number of data points used. Since lower *PRESS* sums are associated with higher predictive performance, the above results suggest that overall, the use of a greater number of sample points has led to improved predictive power of kriging in this investigation. At the individual property level, however, the position is not so clear. The statistics on *PRESS* maximum show that increasing the sample size does not necessarily reduce the gap between the actual and the predicted values in the property with the largest value difference.

Comparing the Predictive Performances of Kriging and MRA

For the comparison of predictive performance between kriging and MRA, *PRESS* statistics are again used. They are computed from the predictions made by both the methods on house values in the common (7,562 points) test dataset. The *PRESS* statistics for the kriging models are already available as a result of the comparison performed on the effect of different sample sizes used on predictive performance. It is now necessary to obtain similar statistics for the MRA models.

For the MRA, two models have emerged as the best in terms of predictive performance in this research. The models are *EnterA* and *StepA* (Appendix A). To arrive at the prediction of these models on the test data, their equation forms are applied on the appropriate variables in the dataset concerned. Once the predicted values for each model have been obtained, *PRESS* statistics are calculated in the same way as before.

Table 2 presents the *PRESS* statistics for both the kriging and MRA models. The *PRESS* sums indicate that the kriging models have not outperformed the MRA models in terms of predictive performance. In fact, the *PRESS* sums of the latter are more than four times lower than that achieved by the best model from kriging. The means and standard deviations of the *PRESS* suggest that the variability in the gap between predicted and actual values is much greater in kriging than in the MRA. Given the fact that the MRA models have been derived with a larger sample of 30,250 data points and bearing in mind the finding that predictive improvements have been achieved with successive increases in sample size used, it is interesting how much further kriging models would have improved if this investigation has had the opportunity of modelling them with the larger sample.

However, kriging results do have their interesting aspects too in this investigation. As Table 3 shows, the minimum predicted values obtained by the kriging models are

Table 2: PRESS Statistics Obtained from Modelling the Independent Test Dataset: Kriging V. MRA

Model	PRESS Sum	PRESS Minimum	PRESS Maximum	PRESS Mean	PRESS Std. Dev
KRIGING					
15000, spherical	**793,489,424,232**	0.29	26,114,944,609	104,931,159	423,214,465
10000, spherical	**834,042,753,822**	0.38	25,876,385,828	110,293,937	430,836,079
5000, exponential	**864,920,477,807**	2.69	26,800,453,327	114,377,212	441,553,144
5000, spherical	**915,481,005,731**	0.10	25,913,695,301	121,063,344	435,826,102
MRA					
Stepwise (StepA)	**181,942,677,523**	0.23	3,714,051,752	24,060,127	82,654,039
EnterA (EnterA)	**181,972,992,980**	1.93	3,719,835,025	24,064,136	82,697,784

much closer to the actual minimum property value in the sample compared to those of the MRA models. Further, the kriging models do not produce negative predictions whereas the MRA models do. If this is taken in isolation, it means that kriging is more realistic than MRA since their estimates are more 'acceptable' in terms of the common perceptions in the real estate community. The krigings' predicted means are in line with the mean of the actual value. So are the standard deviations; in fact the krigings' standard deviations are smaller than that of the actual value. Unfortunately, the ceiling values of prediction in kriging are much lower than the maximum of the actual value. This has meant that very poor predictions have been made on the properties with the very largest actual values.

Table 3: Descriptive Statistics for the Predicted and Actual Values

	Range	Minimum	Maximum	Mean	Std. Dev.
KRIGING					
15000, spherical	134,014.74	9,656.66	143,671.40	43,143.26	17,565.00
10000, spherical	173,495.59	8,361.57	181,857.16	43,209.54	18,506.91
5000, exponential	149,443.39	9,010.08	158,453.47	43,063.52	17,429.49
5000, spherical	131,490.60	9,441.27	140,931.87	43,079.91	16,699.61
MRA					
Stepwise (StepA)	192,053.77	- 7,641.80	184,411.98	43,291.57	19,700.88
EnterA (EnterA)	192,055.74	- 7,691.19	184,364.55	43,291.72	19,701.67
ACTUAL VALUE	**238,271.00**	**7,084.00**	**245,355.00**	**43,346.78**	**20,533.08**

Conclusions

This study shows that kriging is a poorer predictor of property values compared to MRA. However, this has to be set against the fact that a simulated dataset has been worked with and that this dataset has been geared directly towards modelling with MRA. Given that this is the case, the results are perhaps not too surprising. It would be interesting if we can make similar comparisons based on real data where both methods are on the same level of advantage or disadvantage.

Despite its comparatively inferior predictive performance, the potential of kriging for mass appraisal of housing properties is perhaps not to be dismissed altogether. The experimental variograms arrived at in this study show that the patterns of spatial dependence exist in property values, suggesting that the exploitation of spatial correlation for value determination does have its basis. It is just that reliance on this pattern of spatial dependence alone may not be good enough to arrive at estimates that compare favourably with MRA, or perhaps that the kriging models are in need of further refinements. Further investigations are necessary. As the bottom line, kriging should be useful where the concern is with the investigation on locational factor in isolation in valuation as opposed to the investigation on property value in this study, which involves a multiplicity of factors.

The attraction of kriging comes from the fact that it utilises the information about localised spatial variation to estimate values at local positions. To arrive at this information, however, a large number of sample points and their fair distribution over the study area are important. It is this that probably makes the technique rather workable for housing properties, where the volume of data and their spatial omni-presence are relatively more favourable compared to most other types of properties. For properties that do not have such advantages (industrial properties, for example, are clustered around certain locations only), the practicality of a similar exercise remains to be tested and requires a separate study. For the moment we can only presume that the reliability of the estimates will be lower due to the greater presence of regions where no sample data points are available to draw information from for interpolation.

One issue remains particularly outstanding from this study: the lack of intuitive appeal that some of the kriging results provide. It is difficult to reconcile the fact that the variogram is better behaved for the data that combines all the property types than for the data that has been made more homogeneous by dealing with only a particular property type. Probable explanations lie in the reduced sample size and the unevenness of spatial spread that occurs in the individual property dataset, but these are just possibilities. Could there be other more valid explanations?

It is argued that a major issue with kriging lies in the fitting of appropriate models to interpolate. This is because the fitting involves examining the variogram plots and choosing a model that is considered the best fit, a procedure that can entail arbitrary decisions on the part of the user. Collins (1996), for example, remarks that kriging has been criticised due to the subjective nature of variogram fitting – a central component of kriging. Nonetheless, arbitrariness is not something the user can avoid completely in dealing with problems of this nature. For that matter, not even the MRA can claim to be entirely free from arbitrary decisions, particularly in the choice of variables and of equation forms to use. On this score, kriging cannot be said to be any less desirable than the regression technique.

On the basis of the above initial evaluation, this study recommends that kriging should be investigated further before decisions are made about its utility for valuation. This constitutes yet another benefit the consideration of geography contributes towards the practice in valuation.

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Appendix A

Comparison of Regression Coefficent from the Different Regression Models

	NEWC11 DATASET (24,033 records)			
	UNLOGGED		LOGGED	
	FULL VARIABLE			
	EnterA	*StepA*	*EnterB*	*StepB*
(Constant)	- 2,286.615	- 1,454.892	14,923.027	15,188.478
ACCESS	2,484.021	2,361.140	2,377.030	2,338.168
AGE	- 239.279	- 239.322	-	-
BLD_AREA	189.742	189.771	190.577	190.525
C_FIN	455.750	455.487	466.173	465.982
DF_SCH	- 1.097	- 1.087	- 0.545	- 0.567
DISTCITY	- 2.503	- 2.504	- 2.536	- 2.535
DISTROAD	0.750	-	0.220	-
DISTTOWN	- 1.359	- 1.357	- 1.442	- 1.444
DSTMETRO	- 0.302	- 0.307	-	-
GEOG1	-22,623.081	- 22,632.347	- 20,957.772	- 20,967.179
GEOG2	-19,876.360	- 19,874.560	- 19,079.748	- 19,091.350
GEOG3	- 20,161.101	- 20,179.121	- 18,599.337	-18,614.185
GEOG4	2,586.272	2,583.948	3,245.591	3,246.849
GEOG5	24,098.266	24,095.323	24,504.722	24,502.517
GEOG6	10,676.208	10,676.893	10,913.277	10,918.283
GEOG7	-	-	-	-
GEOG8	-13,572.188	- 13,577.371	- 12,851.418	-12,841.671
GEOG9	-16,538.263	- 16,544.409	- 15,696.363	- 15,698.330
LANDAREA	83.290	83.253	83.486	83.542
LEVEL_NO	- 5,909.085	- 5,912.154	- 5,600.600	- 5,594.127
LNDMETRO	-	-	- 1,122.217	- 1,122.864
LNAGE	-	-	- 4,428.472	- 4,429.468
LNNOBATH	-	-	4,821.346	4,820.199
LNROOMNO	-	-	7,629.416	7,626.449
NBOR_QUA	3,144.258	3,147.381	3,212.139	3,212.718
NO_BATH	2,913.904	2,914.328	-	-
NOISE	- 1,324.245	- 1,363.038	- 1,402.315	- 1,413.945
Q_FIN	1,005.874	1,005.625	1,004.582	1,004.176
ROOM_NO	2,431.791	2,431.219	-	-
UNITYPE1	28.357	-	- 785.530	- 781.006
UNITYPE2	3,268.569	3,262.827	3,302.410	3,308.332
UNITYPE3	2,455.196	2,455.183	681.470	682.187
UNITYPE4	-	-	-	-
UNITYPE5	874.841	874.400	- 572.934	- 579.376
UNITYPE6	- 2,990.528	- 2,992.763	- 3,596.005	- 3,615.763
ZONE1	-	-	-	-
ZONE2	6,842.258	6,840.429	6,733.303	6,729.109
ZONE3	- 2,897.712	- 2,897.610	- 2,856.022	- 2,857.522
ZONE4	- 1,479.899	- 1,495.077	- 1,055.444	-
ZONE5	8,296.337	-	7,626.575	-
ZONE6	- 3,460.108	- 3,462.749	- 4,829.184	- 4,818.577

Note: The base reference of the above models is a hypothetical property of the LINK HOUSE type located in RESIDENTIAL zone in HEATON.

Appendix A1

Comparison of Regression Coefficent from the Different Regression Models (contd.)

	NEWC11 DATASET (24,033 records)			
	UNLOGGED		LOGGED	
	DROPPED VARIABLE			
	EnterC	StepC	EnterD	StepD
(Constant)	- 8,907.997	- 8,894.750	6,741.762	6,744.574
ACCESS	2,443.673	2,442.214	2,426.390	2,425.849
AGE	- 229.271	- 229.268	-	-
BLD_AREA	134.132	134.132	136.723	136.719
C_FIN	440.913	440.545	451.437	451.023
DF_SCH	- 1.427	- 1.436	- 0.864	- 0.866
DISTCITY	- 2.772	- 2.771	- 2.787	- 2.786
DISTROAD	-	-	-	-
DISTTOWN	- 1.159	- 1.161	- 1.241	- 1.242
DSTMETRO	- 0.197	- 0.199	-	-
GEOG1	-22,462.486	-22,459.119	- 20,852.729	-20,848.820
GEOG2	-19,587.310	-19,589.577	- 18,810.346	-18,811.732
GEOG3	-19,962.375	-19,963.678	- 18,431.178	-18,431.520
GEOG4	3,115.646	3,115.653	3,712.447	3,712.134
GEOG5	24,209.355	24,209.986	24,587.238	24,588.189
GEOG6	11,387.087	11,387.021	11,579.619	11,579.535
GEOG7	-	-	-	-
GEOG8	-13,018.798	-13,015.500	- 12,375.471	-12,374.898
GEOG9	-16,882.447	-16,880.815	- 16,063.152	-16,063.079
LANDAREA	118.690	118.695	117.635	117.634
LEVEL_NO	-	-	-	-
LNDMETRO	-	-	- 992.465	- 992.343
LNAGE	-	-	- 4,219.521	- 4,219.169
LNNOBATH	-	-	4,298.640	4,298.650
LNROOMNO	-	-	5,989.403	5,988.106
NBOR_QUA	3,152.117	3,152.194	3,217.570	3,217.661
NO_BATH	2,741.783	2,742.075	-	-
NOISE	- 1,252.817	- 1,252.382	- 1,306.638	- 1,305.851
Q_FIN	1,003.710	1,003.366	1,002.005	1,001.738
ROOM_NO	1,828.453	1,827.830	-	-
UNITYPE1	3,703.790	3,703.473	2,671.978	2,671.296
UNITYPE2	7,028.773	7,027.252	6,740.750	6,738.879
UNITYPE3	2,667.579	2,667.199	1,020.444	1,020.749
UNITYPE4	-	-	-	-
UNITYPE5	- 2,079.645	- 2,081.788	- 3,250.310	- 3,250.959
UNITYPE6	- 8,526.287	- 8,531.673	- 8,850.190	- 8,851.125
ZONE1	-	-	-	-
ZONE2	7,333.813	7,331.049	7,221.978	7,221.186
ZONE3	- 2,950.443	- 2,952.494	- 2,927.396	- 2,927.868
ZONE4	- 478.218	-	- 110.863	-
ZONE5	7,747.334	-	7,150.754	-
ZONE6	- 4,821.144	- 4,816.834	- 6,084.707	- 6,082.082

Note: The base reference of the above models is a hypothetical property of the LINK HOUSE type located in RESIDENTIAL zone in HEATON.

The Listed Property Trust Industry in Malaysia: Factors Constraining Its Growth and Development

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Abstract

This paper aims to investigate the factors which constrained the development and growth of the listed property trust industry in Malaysia.

The study includes an opinion survey, an analysis of stock turnover ratio and an analysis of the shareholding of institutional investors in listed property trusts.

An opinion survey of CEOs/managers of listed property trusts wss carried out to find out the factors constraining the development and growth of the industry. Among the major factors hindering the growth of the industry are lengthy capital market requirements in capital raising, restrictive Securities Commission's Guidelines on Property Trust Funds and the lack of demand from the institutional investors.

An analysis of the annual stock turnover ratio is used to measure the level of transactional interests by investors. The analysis shows that the transactional activities are low as there is poor demand from investors.

An analysis of unit holdings in listed property trusts is also carried out to determine the extent of investments by institutional investors. Institutional ownership is found to be low due to the small number of institutional investors interested in indirect property investment.

Keywords : listed property trusts, chief executive officer/property manager survey, annual stock turnover ratio, institutional ownership.

Introduction

It is noted that since the debut of property trusts in 1989 there has been little development and expansion in the Malaysian listed property trust industry. The number of listed property trust funds has remained the same i.e. three funds from 1989 to 1996. The fourth listed property trust fund was listed in 1997. In addition, the property portfolios of existing property trust funds have not expanded in a significant manner. This static situation had occurred within the context of an active property market, a buoyant stock exchange and economy from 1989 to 1997.

Background to Study

Azim (1992, 1993) had commented that the property trust industry is too regulated by the Guidelines on Property Trust Funds 1991. The restrictions imposed by the Guidelines are related to property acquisition, disposal, development and borrowing limit (Ting, 1996 and Ting et al, 1998).

The Guidelines provisions relating to property acquisition had prevented property trust funds from expanding their investment portfolio through new property acquisitions. Subsequently promoters and managers of trust funds had sought major reviews on the Guidelines from the regulatory authorities particularly the Securities Commission.

A revised Guideline on Property Trust Funds was issued by the Securities Commission on 26 June 1995. The new guideline provides a more systematic format outlining the various provisions regulating the property trust funds. The key amendments are related to property acquisition, property disposal, property development and borrowing limits. The revised guidelines are well received by property trust managers (Azim, 1995).

The amendments have enabled property trust funds to acquire property more easily by providing more options and flexibility in property acquisitions. In particular, property trusts can now acquire property interests such as :-

(a) strata properties,
(b) equities of real estate companies,
(c) properties in foreign countries,
(d) properties such as office buildings which are not fully tenanted but have the potential of achieving full occupancy.

The wider property acquisition options are supported by corresponding changes in financing and borrowings regulations.

Despite the relaxation on the Guidelines, property portfolios of property trusts have not expanded significantly. In the case of First Malaysia Property Trust, property acquisitions from 1994 - 1997 are merely reinvestments of the proceeds from the sale of its flagship property investment, Plaza MBf in 1994. The seven property acquisitions by Amanah Hartanah PNB are small properties comprising six shop premises and one office building (refer Appendix I). The property acquired by Mayban Property Trust in 1997 is an acquisition of a property owned by the Maybank Group.

In short, the revised Guidelines 1995 have not made a positive impact on the property trust industry and there are impediments that prevent property trust managers from taking full advantages of the revised provisions under the Guidelines.

Objectives of the Study

To investigate further the problems that had constrained the growth and development of the property trust industry, this study investigated :-

(1) the views of Chief Executive Officers(CEO)/Property Managers of listed property trusts on the development and growth of the listed property trust industry,

(2) the level of interest by investors in listed property trusts,

(3) the extent of institutional shareholdings in listed property trusts.

The first question is answered by carrying out a questionnaire survey on CEO/ Property Managers of listed property trusts. The second question is investigated by analysing the listed property trust stock turnover ratio. The third question is answered by analysing annual reports on the unit holdings by institutional investors in the listed property trusts.

Questionnaire Survey on CEO/Property Managers of Listed Property Trust Funds

A questionnaire survey was carried out to obtain views/opinions of CEO/Property Managers on the development and growth of the listed property trusts in Malaysia. The survey was conducted in May 1998 with intent to cover all the four existing listed property trusts in Malaysia. Only three had responded, of which two of the respondents were property managers and the other is a CEO.

The survey addressed key issues concerning property securitisation including:-

(1) The growth and development of the listed property trust industry;

(2) Factors affecting the performance of listed property trusts;

(3) Suggestions on improvements to the listed property trust industry.

The results of the survey are summarised in the following sections.

The Growth and Development of the Listed Property Trust Industry

(a) *Problems that have constrained the expansion of existing property portfolios*

The problems identified by the respondents were as follows:-

- Lengthy capital market requirements in raising capital for property acquisition.

  The property managers found that the approval process for property acquisitions from the regulatory authorities had been lengthy. Property purchased using equity financing such as rights issue could take up to 12 months from the date of signing of the sales and purchase agreement to the date of purchase settlement due to the need for regulatory approvals and procedures to be observed. Property owners are not keen to sell to property trusts as the sellers would be tied down by their purchase offers.

- Restrictions on bank borrowings by the Securities Commission's *Guidelines on Property Trust Funds 1991 and 1995.*

  The Securities Commission's *Guidelines on Property Trust Funds* restrict borrowings to a maximum of 10% of the gross assets of the fund. Borrowings that

exceed the 10% limit require prior approval from the Securities Commission. Approvals are also required for assets pledged to secure borrowings.

An associated problem is the long waiting period to obtain the necessary acquisition approvals from related capital market regulatory authorities. Property owners are reluctant to be tied down while awaiting the approvals.

- Poor investor perceptions on property trust investments.

  The initial performance of listed property trusts upon its debut in the Malaysian capital market (January 1991 - November 1993) was worse than the stock market and the monthly closing prices were hovering at around RM1.00, the initial issue price (Kok and Khoo, 1995). This performance brought a stigma on the potential of listed property trust as an investment option. Property trust funds are ignored in the stock market as it is not perceived to be a speculative counter that could provide quick capital gains to speculators. The lack of interests by investors is supported by the findings of low annual stock turnover ratios (see Section 5.0).

- The lack of interests from institutional investors.

  The lack of interests from major investors to invest in listed property trusts has been a deterrent for property trusts in their acquisition of property. One of the trust funds had experienced the difficulty of marketing their units upon the creation of new units. Demand from major institutional investors was low on these new units. The fact that there is a lack of interest from institutional investors is evident from the low level of unit holdings by institutional investors (see Section 6.0).

- Properties available for acquisitions are providing low yields.

  The respondents commented that properties available for acquisition are available at a high market price and low yields. Such acquisitions would bring about a dilution in the earnings of the trusts. Unit holders and regulatory authorities may not approve of such property purchase. Also underwriting support may be lacking.

(b) *The reasons why existing property trusts have expanded their portfolios by acquiring non-prime/small properties e.g. shop-offices, shop-houses, secondary office buildings*

The reasons offered by the respondents are as follows:-

- Secondary properties are easier to negotiate and to acquire.
- Prime properties are capital intensive and the lack of demand from institutional investors had deterred trust funds from making major property acquisitions.
- It was difficult to acquire prime properties at a good yield without diluting the high yield of the property trusts.
- Few prime properties are available in the market for sale and properties available are going for high asking prices.

- Prime property owners are not keen to sell to property trusts due to the lengthy approval process.

(c) *Factors that hinder the launching of more property trust funds in Malaysia (ranked in descending order of importance)*

The responses from the survey are:-

- Competing investment alternatives (e.g. initial public offerings (IPOs) and unit trust funds). In the past, IPOs on the KLSE had achieved high premiums upon listing resulting in high capital gains by stags. Property trusts which have a trust structure are not allowed to speculate and are viewed as defensive stocks offering stable returns and prices.
- Poor investor perceptions on property trust investments (see section 4.1a),
- A restrictive Securities Commission's *Guidelines on Property Trust Funds,*
- The lack of demand from institutional investors (see section 5.0).
- Too few institutional investors are interested in property trust investments (see section 6.0).

The Performance of Listed Property Trust Funds

(a) *Factors that drive the performance of listed property trusts*

The factors identified by the respondents ranked in descending order of importance are as follows:-

- The performance of the stock market
- Investment decisions of institutional investors
- Analysis, promotions and recommendations of securities analysts
- Yields of the property trusts
- Interest rates of savings and fixed deposits
- Yield of Government bonds.

(b) *Aspects of listed property trust funds which attract investments from institutional investors*

Feedbacks from the respondents indicate the following:-

- Substitute for direct property investment
- Liquidity of property trusts
- Diversification for investment portfolios
- Access to prime property
- High yields of property trusts.

Suggestions to Improve the Listed Property Trust Industry

The respondents offer the following suggestions:-

- Greater relaxation on the *Guidelines on Property Trust Funds.*
- Allow further property trust funds to declare tax exempt dividends.
- Allow major expenses of the property trust funds to be tax deductible.

- Generate greater interests among the institutional investors.
- Educate the investing public.
- Relax the requirement on the sponsorship of new property trust funds by allowing other institutions/parties to be sponsors e.g. entrepreneurial owner developers/builders apart from financial institutions.

Stock Turnover Ratio

The stock turnover ratio is used to measure the transactional intensity of the listed property trusts. Stock turnover ratio is defined as the number of shares traded in each year divided by the number of shares outstanding at the end of the year. Trading data of the listed property trusts is obtained from the Investors Digest published by the Kuala Lumpur Stock Exchange (KLSE).

The level of trading conveys information. An active trading activity shows interest from both sellers and buyers. The results of the analysis as shown in Table 1 indicate a low level of trading activities in listed property trust funds reflecting poor interests and demand from Malaysian investors. The average ratio of 0.33 over the 8 year period compares poorly against a ratio of higher than 1 for the Property Sector of the KLSE.

Table 1: Annual Stock Turnover Ratios of Listed Property Trusts in Malaysia (1990 - 1997)

Year	Stock Turnover Ratios
1990	0.153
1991	0.164
1992	0.095
1993	0.571
1994	0.994
1995	0.216
1996	0.218
1997	0.221
Mean	**0.33**
Std. Deviation	**0.30**

Institutional Ownership in Listed Property Trusts

The extent of institutional ownership is analysed using information on the twenty largest unit holders disclosed in the annual reports of listed property trusts. Institutional investors are categorised into three major categories i.e. insurance companies, provident/pension funds and unit trusts. Table 2 shows the extent of institutional unit holdings in listed property trusts.

Table 2: Percentage of Listed Property Trust Units (i.e. Amanah Hartanah PNB, Arab Malaysian First Pproperty Trust and First Malaysia Property Trust) held by Institutional Investors (1989 - 1997)

Year	Insurance companies	Unit trusts (%)	Pension funds	Institutions (%)	Total (%)
1989	4.4	0.0	0.0	0.0	4.4
1990	0.3	0.0	0.6	0.0	0.9
1991	1.7	0.3	0.3	0.0	2.3
1992	1.3	0.5	0.3	0.0	2.1
1993	3.7	1.5	0.3	0.0	5.5
1994	2.7	0.2	0.3	0.0	3.2
1995	5.8	0.0	0.3	0.0	6.1
1996	2.7	0.0	0.2	0.0	2.9
1997	3.2	0.0	0.3	1.1	4.5
1998	5.6	0.1	0.2	1.1	7.0
1999	5.6	0.1	0.2	1.1	7.0
Mean	**3.36**	**0.25**	**0.26**	**0.30**	**4.17**
Std. Deviation	**1.86**	**0.45**	**0.14**	**0.51**	**2.07**

The above analysis shows that institutional ownership is low in listed property trust units with an average annual unit holdings of 3.43% for the 1989 - 1997 period. Generally direct property does not constitute a significant asset holding in institutional portfolios. Properties owned by these institutions are basically used as headquarters or for their own operational use. Real estate is rarely purchased for investment purposes and is not perceived

by institutional investors as an alternative investment class comparable to government bonds, shares, etc.

Thus there is little demand from institutional investors on listed property trusts which could offer property securitisation benefits of liquidity, divisibility, diversification, etc.

In fact institutional investors who have invested in listed property trusts have difficulty in exiting the investments due to the low transactional activities in the stock market and the lack of interests and demand from other institutional investors.

Coupled with the poor investment performance of listed property trusts in terms of discount to net tangible assets and market prices trading below IPO subscription prices, listed property trust is not perceived as an ideal investment vehicle.

The lack of institutional investors participation in the Malaysian property investment market is attributable to the following:-

(a) *The state of evolution of the Malaysian property market*

Building construction in Malaysia is predominantly for owner occupation. This is one of the characteristics of the initial stage of the property market evolution. The Malaysian property market has entered into a stage of overbuilding as indicated by the oversupply situation in the major sectors of the property market i.e. office, retail and hotel sectors.

The Malaysian property market is moving towards a maturing property market where institutional investors would constitute the major players in property investment.

(b) *The small number of institutional investors*

Existing public provident and pension funds in Malaysia are limited to Employees Provident Fund (EPF), Social Security Organisation (SOCSO), Armed Forces Fund, Pensions Trust Fund, Teachers Provident Fund and Malaysian Estates Staff Provident Fund. Other significant institutional investors are Permodalan Nasional Berhad and unit trust funds.

Among these institutional investors, those interested in property investment are small and their investment portfolios are limited to cash, money market instruments, government bonds and securities. In fact, the bulk of investments by institutional investors are in government bonds and securities. A change in perception of property investment as an asset class would help to increase demand for property. Once direct property is accepted as an investment class, the listed property trusts will play their role in offering the benefits of liquidity, divisibility, diversification, etc.

(c) *Restrictions on foreign institutional investors*

Restrictive regulations on foreign investors in the past e.g. Foreign Investment Committee (FIC) requirements, unfavourable Real Property Gains Tax and inconsistencies in regulations/ policies on property have reduced the attractiveness and competitiveness of property investment in Malaysia.

This has exacerbated the lack of demand from foreign investors who

could provide the support and stability to the Malaysian property investment market.

(d) *A high percentage of owner occupiers*

A large number of the institutional investors are owner-occupiers as opposed to tenants that could provide occupational demand for office space in the office market.

Limitations of the Study

The weakness on the extent of institutional ownership analysis is that institutional investors may have holdings in listed property trusts through nominee companies. However, beginning 1999, annual reports are required to disclose the names of the beneficiaries to the nominee companies/ accounts.

Another weakness is that the analysis could not take into account changes in institutional ownership within and less than a financial year.

Conclusions and Suggestions

The CEO/Property Manager Survey has revealed regulatory requirements which are not supportive of the investment operations of the trust funds pertaining to property acquisition, property disposal, property development and borrowings.

The annual stock turnover ratio analysis shows that investors interest is very low due to a poor perception of listed property trust as a profitable investment option, and this led to poor demand for the trusts. This perception is not expected to improve in the near future due to the current overhang in the property market which will affect future dividend distributions.

The analysis on institutional ownership shows a low level of unit holdings by institutional investors. The poor level of demand by institutional investors is because property is not perceived as an investment class of its own comparable to bonds and shares.

The potential of the Malaysian property trust industry is yet to be fully realised. It is pertinent that interest in the listed property trust industry is revived and given a new lease of life as property securitisation in the form of listed property trusts provides a key solution to the current oversupply of commercial properties. The large supply overhang needs to be cleared to lessen the drag on the recovery of the Malaysian economy.

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Appendix I : Existing Property Portfolios of Listed Property Trusts in Malaysia (1999)

Property Trusts	Types of property	Acquisition Year	Location
FMPT	4 units of shopoffices	1994	312-318, Jalan Pudu, K. Lumpur
	12-storey office building	1995	Wisma Suria, Butterworth, Penang
	10 1/2-storey office building	1995	The Securities Commission Building, Bukit Damansara, Kuala Lumpur
	Industrial building	1995	Lot 14, Bukit Rajah Industrial Estate, Klang, Selangor
	Resort	1996	Homestead Beach Resort, Kuantan, Pahang
	Warehouse	1997	274, Whitehouse Road, Nunawading, Victoria, Australia
AMFPT	26-storey office building	1989	Bangunan Arab Malaysian, Jalan Raja Chulan, Kuala Lumpur
	14-storey office building	1994	Wisma Kimseah, Jalan Punchak, Kuala Lumpur
AHP	24-storey office building	1989	Plaza IBM, Taman Tun Dr Ismail, Kuala Lumpur
	4-storey shopping complex	1989	Jaya Jusco, Taman Tun Dr Ismail, Kuala Lumpur
	4-storey office building	1996	Sri Impian, Taman Setiawangsa, Kuala Lumpur
	1 unit of shop premises	1995	Taman Tun Dr Ismail
	1 unit of shop premises	1995	Kuantan, Pahang
	1 unit of shop premises	1995	Kota Kinabalu, Sabah
	1 unit of shop premises	1996	Miri Waterfront, Miri, Sarawak
	3 units of shop premises	1996	Taman Melawati, Kuala Lumpur
	1 unit of shop premises	1996	Taman Inderawasih, Penang
MPT	14-storey office building	1990	Bangunan Mayban Trust, Lebuh Penang, Penang
	15-storey office building	1990	Bangunan Mayban Trust, Jalan Tun Sambanthan, Ipoh, Perak
	5-storey shop-office	1991	Bangunan Mayban Finance, Medan Tuanku, Kuala Lumpur
	7-storey shop-office	1991	Plaza Mayban Trust, Jalan Masjid India, Kuala Lumpur
	9 1/2-storey office building	1997	Bangunan TAR, Jalan Tuanku Abdul Rahman, Kuala Lumpur

Source : Annual reports of AHP, AMFPT, FMPT and MPT.

Brief Notes on Land Acquisition Practice - Part III

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Compensation for Disturbance and Other Losses

Under normal circumstances, when an owner sells property, no allowance is made for removal costs or other consequential losses. However, in view of the acquisition forcing upon the owner expenses which he could have avoided if not for the acquisition, the owner is allowed to claim certain losses.

The framework under which compensation for disturbance can be claimed is subject to the following principles:-

(1) A right to disturbance compensation only arises where a claimant is expropriated or dispossessed.

- disturbance can be claimed only when a claim for land is established
- dispossession must also be established. "...disturbance must, in my judgement, refer to the fact of having to vacate the premises" **(Lee vs. Minister of Transport 1961).**

(2) The compensation is limited to the actual loss suffered as proved by the owner or to an estimate of that loss if it has not been incurred at the time. The intention is to ensure that, as far as possible, the claimant finds himself in a similar financial position as before - no worse nor better. (See Ricket's, 1867)

(3) The loss must be capable of assessment; speculative and other losses that are too remote must be disregarded. A loss is compensatable as disturbance "provided, first, that it is not too remote and secondly, that it is the reasonable consequence of the dispossession of the owner" **(Romer L. J. Harvey vs. Crawley Development Corporation 1957).**

(4) Where an expropriated and dispossessed owner replaces lost property, no compensation will be payable for disturbance in respect of that expenditure.

According to Lord Dennings in **Harvey vs. Crawley Development Corporation,** if an owner pays a higher price for the new house, he would not get compensation on that account because he would be presumed to have got value for money. The principle of 'value for money' relates to extra cost involving:

- a new house or shop and also all items of claim related to it
- where it is apparent the claimant places himself in a better position after the acquisition.

This value for money concept leads on from the dictum of Scott LJ in **Horn vs. Sunderland Corporation** where the "claimant gains the right to receive a money payment not less than the loss imposed upon him in

the public interest, but on the other hand no greater"

(5) There must be consistency in the claim. Compensation payable under various heads is to be treated as one amount of compensation and therefore, all items must be consistent with one another. This follows from **Horn vs. Sunderland Corp.** and **Mizzen Brothers vs. Mitchum Urban District Council** as quoted by Razak J in **Ng Chin Siu & Sons Rubber Estate Ltd. vs. CLR Hilir Perak**.

> *"That the claimants were not entitled to combine in the same claim a valuation of the claimants' land upon the footing of an immediate sale for building purposes with vacant possession and a claim for disturbance and consequential damage upon the footing of interference with a continuing business."*

No disturbance compensation should be paid where the claim for land taken is based wholly on development value and the valuer should always consider the following two bases: -

(i) existing use value and disturbance; or

(ii) development value, whichever the higher.

(6) The claimant owes a duty to mitigate losses. It has been established that an owner must attempt to mitigate or reduce his losses and if alternative accommodation were available, he should avail himself of it.

Heads of Claim

The claims that are payable are:-

(i) reasonable expenses incidental to such changes

(ii) accommodation works

(iii) loss of earnings

Under reasonable expenses incidental to such changes, the claims which are normally claimed and allowed are:

Removal Expenses

These are the most obvious items of disturbance for a person affected by acquisition because he must move to some other place:

(1) cost of lorry or other transport must be paid

(2) owner must mitigate loss by moving to the nearest available place.

Costs include:

(i) cost of temporary storage

(ii) damage to goods during transit.

Other costs, incidental and part of removal often claimed are as follows (however, much of these claims are subject to proof of actual loss by way of receipt):

a. Adaptation of fixtures, fittings and chattels.

b. Replanning and adaptation of new premises and in certain cases replacement of carpets and curtain.

c. Publicity costs including letterheads, business cards and advertisement cards.

d. Costs reasonably incurred in looking for alternative accommodation including surveyors' fees, as per **Harvey vs. Crawley**, loss compensatable provided it is the natural and reasonable consequences of the dispossession and it is not too remote, i.e. fees of lawyer, surveyors and valuer (but see "value for money").

Damage for Loss of Earnings

Meaning of "earning" is 'money acquired by labour, service or performance'. Income from land is not earning in this context because it is rent, and market value would have covered that portion of income.

The loss of earnings refers to the loss of earnings from a business that at the time of the acquisition was a going concern. The claims arise when, because of the acquisition, the occupier is forced to close his business or is removed to another place. This is also any provable diminution in the value of the goodwill in his trade consequent on the taking of the premises in which such trade is carried on and the consequential loss of his earnings. It would not include prospective earnings.

Loss of earnings depends upon the nature of business. If the business can be successfully relocated without loss of income then there is no loss in earnings.

Measure of Damage or Loss

(i) ***Fixtures***

Fixtures by the tenant, if proven, are allowable claims. An owner has the choice to leave either the fixtures behind or to remove his fixtures. If left behind, then the extra value "reflected in the compensation for the interest in the property is the deemed value for the fixtures. Therefore no further value would be recommended for fixtures. If the renovations and additions had been put up recently, the first plaintiff could in my opinion successfully claim the cost under the law."

If taken by the tenant, then three possibilities occur in assessing compensation:

(1) Owner can elect to sell it to the acquiring authority. Therefore, compensation is based upon the value to an incoming tenant. This provides the maximum compensation.

(2) Cost of removal and reinstallation plus depreciation in value due to the removal. Actual estimates should be obtained.

(3) The difference between value to incoming tenant and forced sale value. If this basis is adopted then the owner is assumed to have taken it with him and sold them in the market.

(ii) ***Depreciation of Stock***

This arises from delays and rough usage on removal. Measure of damage would depend upon the nature of the trade and stock, e.g. glass merchant and iron monger.

In the Malaysian case of **J.B. Ponnambalam,** the following costs were allowed:

- claim for drugs lost, damaged or destroyed

- cost of repairing a damaged refrigerator
- cost of replacing a German Steriliser.

Temporary Loss of Profits

In the course of removal to a new place, the business would have to be closed for a period of time until the new premises are ready. Even then business may not pick up to previous levels. In such cases temporary loss of profits can be claimed. In J.B.Ponnambalam three weeks' loss when practice was stopped to move to a new place was allowed.

Loss of Goodwill

Goodwill may be taken to mean the probability of the business being maintained at a certain level of profit when it is continued at the same place. The measure of loss in the value of the goodwill would be the diminution of this probability when the business is removed to a new place or when it is extinguished altogether.

Definition of goodwill: "The probability of continuance of a business connection".

(a) Such a probability will normally command a market value. Compulsory acquisition of such premises may result in the loss of the probability of a business connection. Therefore, compensation is required to place the claimant in the position as though his business is not taken away from him. Goodwill can be regarded as the probability that old customers will continue to resort to the same place of business.

There are two elements to goodwill:

(i) Personal goodwill

(ii) Locational goodwill

It is generally argued that personal goodwill in which the goodwill is attached to the special skill of the proprietor and whose business is dependent upon the proper and effective execution of those skills will not attract any payment. Andrew Baum says that "the attractiveness of the personality of a proprietor is eventually translated into vocational goodwill".

(b) What is important is the degree to which the profit-making potential of the business is affected by the compulsory acquisition of its premises. Where there is:-

(i) no damage at all, there is no claim

(ii) total extinguishment of the business, duty of mitigation (maximum claim) of loss lies with the claimant.

(c) Disturbance compensation is payable as part of the purchase price of the land acquired. No claim for disturbance compensation arises where the expropriated business has no interest in the land.

Permanent Loss

There are two types of permanent loss:

i) total loss

ii) partial loss.

The type of losses depends upon:

(i) the facts of the case

(ii) the nature of the business

(iii) the location of the business

(iv) the availability of alternative accommodation

(v) the new location.

Therefore, event though there is removal, there could be total loss of profit as there have been cases where ninety per cent of loss have been allowed **(Massie vs. Liverpool Corp)**.

Basis of Claim

The basis of a claim for total extinguishment is the capitalised value to the claimant of the likely average future net profit to be made at the acquired premises in the absence of the compulsory acquisition and subject to certain adjustments.

(1) The likely average future net profits should be calculated

To avoid exceptionally good and bad years, three-year average should be taken. Although future profits are required, extrapolation should only be made on the basis of previous profit and any expectation of increases or falls in the profit level should be reflected on the average figure.

(2) Adjustment

(i) Rent or Profit Rent

Any new owner must pay a full rent for taking over new premises and therefore the profit for the business must be nett of rent. Therefore full market rent must be deducted especially in the cases of:

- Owner occupier
- Leaseholder sitting on a profit rent.

This is because market value is already paid for the premises, the value of rent is already compensated, and not deducting would be double counting.

Another approach for an owner occupied investment is capital invested that could earn an income. This has nothing to do with profit and if full rent is paid, the rents would be less. Therefore the rental value should be deducted.

(ii) Interest on capital

The businessman has capital tied up in his business. Capital is in the form money, machinery, stock, raw materials, etc. If this capital is invested elsewhere or available to him, he could earn interest. Therefore, his amount should be deducted to show the true income from the business alone.

(iii) Directors' remuneration

Accounts normally allow for deduction for salaries and wages. Directors and proprietors customarily derive an income from the business by salary or profit shares. If there is suspicion that the level shown is not the level normally allowed, then an adjustment must be allowed.

See **Shulman (Tailors) Ltd. vs. Greater London Council (1968)** :

> *I accept evidence that in the great majority of small family business, profitability is more reliably measure by ignoring the director's fees actually charged and substituting instead a reasonable figure being the value of the directors' services had they been employees.*

Sometimes wife's and children's names are used for purposes of reducing income tax liability. If they do not do anything, then the amount should be added back to the income.

Generally, no allowance for wages is allowed for single proprietor's wife running her own business. See **Zarraga vs. New Castle Upon Type Corporation**.

Although it would be correct to deduct the wages of the operator to arrive at the nett operating project since **Perezic vs. Bristol Corporation**, it has been held that in one man operating business, there is no need to deduct wages.

(iv) Saving of head office expenses

When a branch office is acquired, the saving by the head office for operating the branch office should be deducted.

(v) Account to be scrutinised

Proper scrutiny of the accounts should be made to take into account allowable expenditure so that unduly inflated accounts are not submitted. These include:

- proper amount allowed for repairs to and maintenance of the buildings
- stock is valued at a realistic price
- the amount kept is not too much or too little for the efficient running of the business
- bad debts are dealt with adequately.

(3) The adjusted profit figures from three or more years should be averaged, and then should be converted to a capital figure by capitalising the result.

Factors influencing the choice of capitalising rate are:

- whether the profits are rising or falling
- how long has the business been established
- how much of the goodwill is personal
- the nature of the business and the risks attached to it
- potentialities for expansion.

It is well to remember that it is not the market value of the goodwill that is to be ascertained but the value of the damage to the profit earning capacity of the business due to transference to other premises, i.e. the value of the goodwill to the owner.

Consistency in Claims

One of the most important considerations in any valuation is consistency in principles, methodology and approach. It is more so in the case of claims for severance and

injurious affection. It must always be borne in mind that all claims for severance and injurious affection are made to put back the owner in the same position as he was before the acquisition. The claims for severance and injurious affection and the value of land taken plus the value of the remaining land should equal the value of the whole before the acquisition. Therefore the basis of the claim for value for land taken would determine the basis for severance and injurious affection.

If the claim is on agricultural user, it should follow that all related claims should be for damages arising from the disturbance of such user.

On the other hand, if the claim is for potential user then the claims for damages should be on damages to the potentialities. It cannot include claims for agricultural damages.

In this context it is relevant to recount the rule laid out in **Horn vs. Sunderland Corporation**:

> *Where, by reason of the notice to treat, an owner is enabled to effect an immediate realisation of prospective building value, and thereby obtains a money compensation which exceeds both the value of the land as measured by its existing user and the whole of the owner's loss by disturbance, to give him any part of the loss by disturbance on top of the realisable building value is, in my opinion, contrary to the statutes" per Lord Scott LJ.*

The Horn principle outlined above is actually an extension of an earlier principle established in the case of **Mizzen Bros vs. Mitchum**. Razak J. accepted this principle in the case of **Ng Chin Siu & Sons Rubber Estates Ltd. vs. CLR Hilir Perak**:

> *"But what he (Legal Adviser) contended was that if you claim, as in this case, that the agricultural land has building potential value as well then he says, quite rightly, the Mizzen case lays it down quite plainly that you cannot claim also the value of whatever there may be on the land which will have to be pulled down or destroyed when the building potential is finally exploited. I think that is only common sense."*

It must be admitted however, Abdul Hamid J. referred to the principle in Mizzen Brothers in his judgement of **Hong Bee Realty Ltd. vs. CLR Kuala Lumpur** and expressed some doubts as to its applicability especially in cases where remote potential is present –

> *He submitted that in the present case, the land has agricultural value and development potential and the potential value should supersede the agricultural value. There is some validity in the argument although this may not be true in every case. It depends largely on the degree of the development potentiality and the extent to which it exceeds the existing use value.*

Be it as it may, the practice is well established that with regards to compensation, consistency in approach and principles should always be uppermost in the minds of valuers.

The valuer should always consider the following two bases:

- existing use + disturbance + severance and injurious affection (relates to the existing use)

- development value + severance and injurious affection (relates to the development value).

Mitigation of Damages

It is not possible for the acquiring authority to compensate for every conceivable loss sustained by the owner. The owner on his part must try to minimise his losses . He must not obtain "value for money" by claiming something better than what he had before. It is a valuer's task to see that fair and adequate compensation is paid to the owner whose land is partially affected by acquisition.

Ex-gratia Payments

In some jurisdictions it has been a practice to pay ex-gratia payments over and above what is normally payable under any law. This is sometimes to overcome any known or unforeseen hardships that the persons dispossessed of property may incur. It is suggested that such payments, if felt reasonable, should be included in legislations to avoid ambiguity or doubt.

Other Payments

There are jurisdictions that legally allow the payment for other losses that may result from the acquisition. Here again it is submitted these losses should be in legislation. This is so that the application of the law would be uniform and be seen to be fair.

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A National Research Centre for the Malaysian Real Estate Industry?

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Introduction

For centuries, people have been making decisions based on observations or mere gut feelings. However, today's business decision-makings are growing out of the trend of gut feelings or the chart-and-table presentations. Due to the increased risks and uncertainties in the business circles where global exposures are high, sophisticated analytical tools are now the order of the day.

In general, these tools involve specific research procedures to come about with inferences. In businesses, researchers now employ scientific approaches in search for insights and not merely exploring possible solutions. Taking the real estate industry as an example, the Risk-Return Analysis may be employed to explore the risks and returns from investments in shares compared to investments in real estates; predictive indicators may be developed to assist in gauging the future performances of the different sectors of the real estate industry; statistical models may be developed to forecast the demands towards sub-sectors or selective sectors of the real estate.

In countries with developed economies such as the United States of America, the United Kingdom and Australia, scientific research in the real estate sector is well-developed. In Malaysia there has been an awakening of this trend in recent years. However, researches undertaken in the real estate industry are subjected to requirements of the various research agencies and are therefore not focused and coordinated towards the needs of the nation's real estate industry.

It is therefore timely for the nation to have a central body to coordinate our research needs in the real estate sector for the benefit of the whole real estate industry. This paper aims to explore the preparedness and adequacy of several research providers as potential candidates for the role of a national research centre. It also intends to identify the most viable real estate research provider for coordinating real estate research needs for the country.

The Research Process

Before going any further, it is pertinent to ask what the components of a research process are.

'Research' is a word used often in our daily life as well as in publications and write-ups. However, it is rarely defined. In dictionaries, 'research' is defined as:

- 'The systematic investigation into and study of materials, sources, etc, in order to establish facts and reach new conclusions; an endeavour to

discover new or collate old facts, etc., by the scientific study of a subject or by a course of critical investigation.'

- 'Organised scientific investigation to solve problems, test hypotheses, or develop or invent new products.'
- 'Systematic investigation towards increasing the sum of knowledge.'

These definitions suggest that data or materials are transformed into useful knowledge through a systematic or organised or scientific process. Data by themselves are of no use to the industry practitioners unless they serve as relevant information for decision-making in a problem situation. The information is then turned into facts to support a decision and the facts are eventually turned into knowledge to assist a successful decision-making by the industry practitioners.

'Research' thus connotes the analyses of appropriate data through a systematic or organised or scientific process to achieve end results that are useful to industry practitioners in making decisions or predictions that will boost their competitive edge.

It will therefore mean that in a research process, there need to be present appropriate data, the analysts or researchers to turn these data into useful knowledge using the appropriate analysis tools and finally the industry practitioners to utilise the knowledge.

Characteristics of a Real Estate Research Centre

The research process therefore spells out two basic needs for carrying out any research, namely the data and the researchers.

It is imperative that the data be adequate and valid, and are obtained from reliable sources. It is an advantage if these data are also easily gathered. A research provider with historical data or who knows the sources of data has an advantage over one without.

The human element in the research process is the researchers. Ideally, these are the people who are able to specify the research question(s) according to the needs of the industry practitioners. They are responsible for the design of the experiment to be carried out, plan the logistics for the data collection process so that the research process is completed on a timely basis, identify the various statistical tools available but specific to the types of analyses so as to be able to draw inferences and interpretations from these results to enable the industry practitioners to use in their predictions or decision-makings. As research problems are wide and varied, a research centre may not possess all the required expertise. However, the ability to network is a great advantage in this situation.

Besides the two basic needs stated above, a research centre in real estate on a national basis should also be a body that has the recognition of being credible and authoritative in the eyes of the industry practitioners and the various government agencies, both domestically and internationally.

The Candidate

In the Malaysian scenario, research providers in real estate are few.

Within the academic circle, the academic researchers are deficient in data and lack the industry knowledge to formulate good research questions and ultimately to come

out with useful knowledge for the industry practitioners to utilise. They usually carry out research as partial fulfillment of their job specifications and therefore research results are for internal consumptions.

In the real estate industry of Malaysia, even though the industry practitioners may have research houses, they are rarely equipped with analysts or researchers who are well versed with the research process and the research techniques. They may be rich in the data needed for research but these data are usually not extensive. Furthermore, there are not many real estate organisations with research arms. These industry practitioners are not fully aware of the usefulness of well carried out researches. Consequently real estate researches by the real estate practitioners are very elementary or are handled by consultants who are not equipped with adequate knowledge of the real estate industry. As researches carried out are tailored to the specific requests of their clients the research results are of limited use and do not carry weight in the overall real estate industry.

From the government sector, the authority in valuation and services in real estate rests with the Department of Valuation and Property Services of the Ministry of Finance. Since 1985, this department has been carrying out training programmes in human resource as well as research in relation to the real estate sector.

The Department of Valuation and Property Services possesses an edge over the academic researchers, as its staff comprises real estate professionals and sub-professionals. As such, besides knowledge of the industry, research skill is present, a plus point over the industry research providers. Historical data are abundant in this department, and had since been put into good use for the good of the industry by way of well-received and recognized publications. This department also has an on-going programme to train its staff in the various aspects of the real estate industry. Added to this is the availability of physical infrastructure in the form of premises, and software and hardware to undertake research.

Conclusion

From the foregoing, it is clear that the role of a central body to coordinate research needs of the real estate sector for the benefit of the whole real estate industry can easily be filled by the Department of Valuation and Property Services, a research provider that possesses the required data, professionals and credibility to execute the tasks as a national real estate centre efficiently.

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Land Ownership under the Malaysian Torrens System

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Introduction

Conveyancing lawyers in this country do not, as a rule, pay attention to or cite criminal cases when asked to explain a point involving land law. In the 1998 case of **Public Prosecutor vs. Tan Sri Muhammad Taib [1999] 2 MLJ 305**, they had to make an exception. It is an important case that spanned across the judicial divide, where substantive rules of land law become relevant for the trial court to consider and hold whether a criminal offence has indeed been committed or otherwise.

This criminal case is important for conveyancing lawyers not because the accused was (at that point in time and still is) a political figure to be reckoned with, apart from being a former Menteri Besar (Chief Minister) and a senior member of the UMNO Supreme Council, but because the grounds upon which the learned trial Judge acquitted him was pure land law, and it is these rules of substantive land law which in the end effectively negate the *mens rea* necessary for his conviction.

The Charge

The accused was charged with failing to declare certain assets belonging to him, his wife and children, as required by the Public Prosecutor through a notice issued to him under Section 25(1)(a) of the Prevention of Corruption Act (Act 57). The notice was issued to the accused on April 10 1997. The accused was alleged to have committed the offence at the Anti-Corruption Agency headquarters in Persiaran Duta in Kuala Lumpur on May 26 1997. The accused pleaded not guilty.

The Acquittal

After hearing nine witnesses called by the prosecution, the court held that a *prima facie* case had been laid down against the accused, and his defence was called. The accused refuted the charge by calling seven witnesses in his defence. At the end of the trial, which lasted eleven days, the learned trial Judge gave him the benefit of the doubt, acquitted and discharged him.

Had he been convicted, the former Menteri Besar could be given a maximum sentence of one year imprisonment, a fine of RM2,000 or both. It would mean the end of his political career.

The trial Judge said it was not disputed that the properties mentioned in the proceedings were all registered in the names of the accused and his wife. The Judge, however, accepted the accused's explanation for his non-declaration - which was that he (the accused) believed that since the said properties had been disposed off, he did not have any more beneficial interest in them.

The Judge said that the evidence of the disposal of the accused's interest in the properties was corroborated; there was ample evidence of land transfers being executed. The Judge also observed that the accused's testimony in court had not been challenged or shaken in cross examination. The Judge reiterated that our land law recognises legal ownership as being distinct and separate from equitable ownership.

The Judge also said that as a Menteri Besar (at the relevant time), the accused could not possibly imagine that he could avoid

detection (i.e. that his ownership of the said properties would not have been known by the public). He remarked that "our laws and system of justice would have failed him (the accused) if he is not at least given the benefit of doubt."

The Judge further held that under Section 182(a)(3) of the Criminal Procedure Code, the accused ought to be acquitted and discharged on the grounds that the prosecution had failed to prove their case beyond reasonable doubt. The accused was accordingly acquitted and discharged.

Meaning of "Ownership" Under the National Land Code

Ownership of land, as far as the National Land Code 1965 (NLC) is concerned, is very easy to prove. A quick search at the relevant registry will tell whether a person is indeed the land's registered proprietor or not. Whilst the issue document of title (IDT) is good *prima facie* evidence of ownership, the register document of title maintained at the appropriate land registry provides conclusive evidence (Section 89 of the NLC).

If the person's name appears on the register, his ownership of the land is thus recognised, protected and guaranteed by law. This is the combined effect of Sections 89 and 340 of the NLC.

That, however, is not the end of the story. Whilst the backbone of the Malaysian Torrens system is the NLC, the courts have always been receptive to the continuing role of equity under our land law. Consequently, alongside "legal ownership" of land under the NLC, the courts have also recognised "equitable ownership".

Equitable Ownership

The issue of equitable ownership becomes important when the registered owner (vendor) has sold the land to another (purchaser). There is a long line of judicial decisions which say that if a vendor has signed a sale and purchase agreement with a purchaser, and:

(a) the purchaser has paid in full the purchase price to the vendor;
(b) the purchaser has been given the Issue Document of Title (IDT) by the vendor;
(c) the parties have both executed the relevant instrument of transfer (Form 14A); and
(d) the purchaser has been allowed to enter onto (occupy) the land;

the vendor will, to all intents and purposes, be regarded by the courts as a bare trustee for the purchaser (even though his name is still on the register) whilst the purchaser is now regarded as the equitable owner (i.e. the true beneficial owner) of the land.

In **Borneo Housing Mortgage Finance Berhad vs. Time Engineering Berhad [1996] 2 AMR 1537**, a decision of the Federal Court, Edgar Joseph Jr. FCJ said that "it is too late now to question the applicability of the concept of the bare trustee in a vendor/purchaser situation in Malaysia".

The learned Judge noted that the question when the vendor becomes a bare trustee for the purchaser in Malaysia "has not been uniformly answered" in the past. In the old case of **Temenggong Securities Ltd. vs. Registrar of Titles Johor [1974] 2 MLJ 45**, H. S. Ong FJ held that the vendor becomes a bare trustee when the full purchase price has been paid and the vendor has given possession of the land to the purchaser.

In **Ong Chat Pang vs. Valiappa Chettiar [1971] 1 MLJ 224**, Gill FJ held that the vendor becomes a bare trustee when "he has done all that is necessary to divest himself

of the legal estate" to the purchaser. In **Karuppiah Chettiar vs. Subramaniam [1971] 1 MLJ 116**, however, the court held that a vendor is said to have divested himself of all his interest in the land when he has received the purchase price in full and has executed the memorandum of transfer in favour of the purchaser.

Having considered all these earlier decisions, Edgar Joseph Jr. FCJ consequently held that "the contractual events" which result in the vendor becoming a bare trustee for the purchaser is the "completion" of the sale, that is to say, when:

(a) the full purchase price has been paid to the vendor;
(b) the parties have executed a valid and registrable instrument of transfer of the land.

To sum up, the court will consider the vendor to have fully divested his interest in the land after he has done all the above. From that moment on, although the vendor's name is still on the register, his status is merely that of a bare trustee - legally, he does not have any more interest in the land.

It is in the light of this dichotomy between legal and equitable ownerships that the acquittal of the former Selangor Menteri Besar must be understood.

Conclusion

Whilst the Torrens purists may not like the idea of the ghost of equity continuously haunting the Torrens system (with its perennial claim that "the register is everything"), it is now too late to do anything about it. As Edgar Joseph Jr. FCJ candidly said in the Borneo Housing case, it is now too late to question the existence of equity on these shores.

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The Journal of Valuation and Property Services (JVPS) is a major publication by the Valuation and Property Services Department, Ministry of Finance Malaysia. JVPS is an international journal that provides a forum for critical appraisals of fundamental issues affecting the real estate industry. It is specially intended for real estate professionals to keep abreast with developments in the real estate industry as well as the real estate profession.

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Lim, K. K. (1990), *Valuation Methods*, Pelandok, Kuala Lumpur.

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Zahuruddin A. (1994), "The New Economic Policy and the Integrated Housing Model ", *Ilmu Alam*, Vol. 2 No. 7, pp 23-35.

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