COMPUTER ASSISTED RATING VALUATION OF COMMERCIAL & INDUSTRIAL PROPERTIES IN MALAYSIA: DEVELOPING AN EXPERT SYSTEM FROM A MULTIPLE EXPERTS KNOWLEDGE ELICITATION METHODOLOGY

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ABSTRACT

The feasibility of developing an expert system in the valuation of commercial and industrial properties for rating purposes in Malaysia from several experts was investigated by empirical research. Knowledge was elicited mainly from these experts using various techniques: separate interviews, group interviews and observation. A simple regression analysis to find the weightings of the main factors was also incorporated in the knowledge-base for the purpose of complementing the heuristical approach. The knowledge-base was analysed and represented in a prototype consisting of four modules purpose-built office complex; shopping complex; shophouse/ flat/ office and factories. The prototype was evaluated through valuers commenting upon the knowledge-base contained in the prototype and by a comparison of actual valuation against the prototype's predictions.

Keywords: expert system, rating purposes, empirical research, knowledge elicitation process, elicited knowledge, prototype and evaluation

Introduction

Aim of the Research

The main aim of the research was to investigate the use of knowledge from a number of experts in developing an expert system for rating valuation of commercial and industrial properties in Malaysia. This paper reviews (1) the background to the research, (2) the process of eliciting the knowledge, (3) the knowledge that has been elicited, a description of the prototype (i.e. the system that represents the knowledge) and its evaluation, and the conclusions drawn.

Background

Regular revaluations have always been difficult for local authorities in Malaysia (Nahappan, 1968; Manuel, 1986; Hizam et al, '99°). While political pressures may sometimes be contributory to revaluation delays (Othman, 1986), shortage of qualified personnel is significant. Expert systems, which were being marketed as a means of "deskilling" areas where "experts" were in short supply (Jenkins, **1992,** p.2), could be an appropriate information technology strategy to alleviate the problem.

Expert System

An expert system can be defined as "a computer system which contains knowledge pertaining to an area of human specialisation. The system can also implement that knowledge in such a fashion

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as to be able to act as a consultant expert in that field of specialisation" (Scott, 1988, p.27). The development of an expert system is thus centred on the elicitation of the knowledge from an expert or experts, and representation and validation of that knowledge in a computer program.

Nature of Properties in the Research

The scope of properties in the research includes purpose-built office complexes (of more than storeys), shopping complexes, shophouse/office/fiat and industrial properties. The wide spectrum of
commercial and industrial properties was selected to investigate the possible variability of knowledge used within the same generic class of property and between different types of properties.

The Core Principle of Rating Valuation in Malaysia: Annual Value

The concept of "annual value" forms the basis for rating assessment in Malaysia (except for Johor state which uses the "improvement value", i.e. capital value) (Hizam, op cit., p.46). "Annual Value" can be interpreted from Section 2 of Part XV of the Local Government Act 1976 as the estimated gross annual rent at which the holding might reasonably be expected to let from year to year having no regard to any restrictions or control on rent and also disregarding enhanced rent resulting from use of machinery for certain purposes. The knowledge to be elicited is all sub-sets of knowledge related to the process of estimation of the gross annual rent using the comparison method of valuation i.e. a method of formulation of opinion of value (in this case rental value) at a particular date (date of revaluation or date of tone of the list) based on comparison of market rentals and characteristics of the subject property and other comparable properties (Emeny and Wilks, 1984; Mahadi, 1988; Millington, 1988).

The Knowledge Elicitation Process

The Targeted Experts

The research commenced with knowledge elicitation from valuers from the City Hall of Kuala Lumpur, City Hall being the main collaborating local authority in this project. Due to the large number of commercial holdings and their complex nature in Kuala Lumpur and the range of experience of the valuers in valuing these properties, it was decided that the main source of knowledge of "core valuers" would come from City Hall.

Their knowledge would be complemented by the knowledge of other local authority valuers to bridge the gap of contextual knowledge from valuers from other geographical and market conditions e.g. the effects of the siting of shophouse on its rental in towns, which mainly consisted of such properties.

Within the valuation, an element of forecasting is necessary, especially when there is a significant gap between rental evidence dates and the date of valuation. Market knowledge of private valuers, who are generally more in touch with the market, could provide assistance to the valuers in making the forecast and so private valuers would form a distinct group within the knowledge elicitation process.

The legal knowledge of the rating valuers was mainly embodied in their working practice in terms of selecting suitable rental evidence and the application of the concept of rebus sicstantibus. An academic was included in the knowledge elicitation strategy to bridge any possible gap in the legal knowledge.

Other local authorities' valuers, private sector valuers and academics are referred to as "complementary valuers" in this research. For the purpose-built office complexes and shopping complexes, it was found that certain gaps in the knowledge of the core valuers existed in making objective comparisons on factors related to building characteristics and, in the case of shopping complexes, the status and tenant mix.

Throughout the knowledge elicitation with the valuers, a more detailed means of comparison would be useful to supplement the broad heuristic in making comparison and adjustment. For these reasons, the elicitation process was further broadened to encompass supporting specialists, property managers, building-related experts, a transport officer and an economic planning officer. The general framework of the multiple experts knowledge elicitation approach adopted is illustrated in **Figure 1.**Although for the majority of the work the knowledge of experts was elicited, the research also sought to complement the whole knowledge by obtaining opinions from "non-experts" i.e. tenants.

Methodology

Within the methodology defined here, the function of the core valuers is to act as the central knowledge source as well as to act as the main "panel" to comment on the knowledge coming from the other sources.
The knowledge elicitation from the complementary valuers and supporting specialists was undertaken separately but iteratively with the knowledge elicitation from the core valuers.

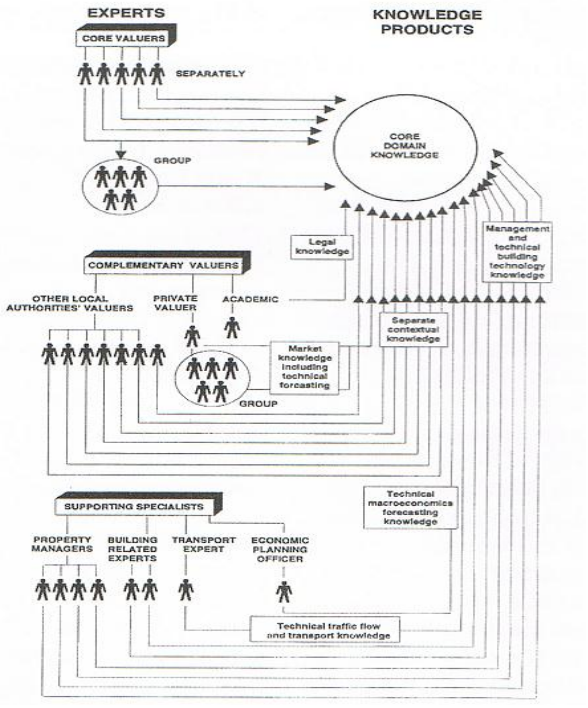

Figure **1:** Framework of the Multiple Experts Knowledge Elicitation Approach

Selection of Experts

The criteria in the selection process was mainly divided into first, selection of the organizations from which the experts should come and second, selection of the individual experts themselves.

i) The Experts
The group of multiple experts chosen consists of (1) five core valuers; (2) nine complementary valuers; namely, seven local authority valuers (i.e. a valuer from each of the six local authorities and an ex-valuer from the Ipoh City Hall who had wide and long experience in rating valuation), an academic and a private valuer and (3) eight supporting specialists; namely, four property managers, two building-related experts, a transport expert and an economic planning expert.

ii) Other Knowledge Sources
The secondary source served as a form of triangulation (to complement the knowledge from the primary source'). This comprised, mainly of relevant valuation documents, objection hearings, site visits and assistant valuation officers and technicians.

Knowledge Elicitation Approach

Individual consultations were adopted for each of the core valuers, complementary valuers and the supporting specialists. In addition, the core valuers were also referred to as a group to study the extent to which the difference of approach could be reconciled in a group in the form of consensus.

Knowledge Elicitation Techniques

Traditional active knowledge elicitation techniques (Scott op.cit) were adopted; namely, interviews and observation for both individual and group consultations with the experts. Observations were also made to the secondary knowledge sources. Simulations (Crofts, op.cit) of core valuers' work on actual data were also undertaken individually and discussed in a group.

The Knowledge Elicited And Its Representation

The total number of hours of formal interview with the core valuers, complementary valuers and supporting specialists was approximately 59 hours, 30 hours and 17 hours respectively. The general representation of the knowledge of the valuers is illustrated in Figure 2. Within this general representation there were, however, variations. For example, in the selection and analysis of rents, comparables to some valuers would come only from the same general location, whilst to others they would come from specific sub-locations. Each group of experts contributed to the whole knowledge base in their respective areas of knowledge.

The research has also attempted to investigate the application of simple regression analysis to be incorporated in an expert system model (Jensen and Wadsworth 1990) to find Location and Building weightings (for office complexes) and Location, Building and Status weightings (for shopping complexes). The methodology here thus was not strictly heuristic and was intended to simplifi the valuation process, serve as an empirical comparison and complement the heuristic approach developed in the research.

Incorporation of the Simple Regression Model in the Knowledge.Base

This was applied to the purpose-built office and shopping complexes in Kuala Lumpur. The purpose of the model was to establish and provide a detailed and structured comparison of the standard lots rental of the individual properties. The development of this model comprised several stages.

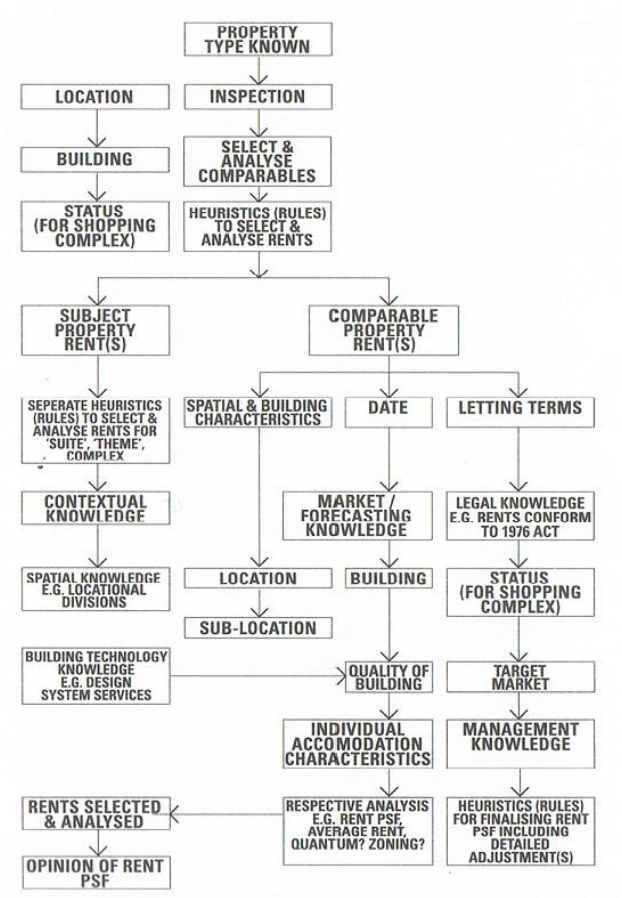

Figure 2: General Representation of Knowledge in the Valuation Process

Stage 2:- Establishing classes of situations

This stage attempted to refine the granularity of the knowledge-base. For example, in the case of the purpose-built office complexes, the classes of situations for second level sub-attributes for Location distance from area core, were "within the city core", "up to i kilometre" and 'more than i kilometre.

Stage 3:- Eliciting Valuers' Opinions (in Terms of Point Scores) on Classes of Situations and combining Them with Tenants' Opinions

This involved eliciting opinions from the core valuers on the importance of each class of situations for each second level sub-attribute in some numerical measurement context. A method more akin to the Likert Scaling **(** a method of measurement of opinion based on numbered scales) was adopted based on the nature of the many second level sub-attributes (Husin, 1993).

A questionnaire based on the knowledge from the two previous elicitation stages was distributed to each core valuer requesting hin/her to provide their opinions on the importance based on a point score scheme of 0(lowest score) to 10 (highest score). Two separate sets of questionnaires of Tenants' Stated Preference Study (TSPS) were designed in accordance with the knowledge-base, for tenants of the office complex and tenants of the shopping complex respectively. The main aim was to obtain tenants' opinions on the degree of importance of the second level sub-attributes. This was based on a Likert scale of o (lowest rating) to 10 (highest rating). A rating of, 0 would mean that the tenant was of the opinion that a sub-attribute was very important and this will be 'translated" as full 100% importance and equivalent to multiplier 1.0. The multiplier represented the weighting (of importance) placed by the tenant on the sub-attributes. It followed that the middle and lower end of the rating would have multipliers of 0.5 and 0 respectively. The aim of the multipliers was to facilitate combination of valuers' opinion and tenants' opinions on the importance of the sub-attributes.

The means of tenants' opinions were combined with the valuers' point scores producing a set of point scores for each second level sub-attributes. This approach, agreed with the valuers, served to complement their opinions providing a composite point score.

Stage Four: - Inspection of Properties

The fourth stage in the process of construction of this model was to conduct the inspection of properties based on the attributes and sub-attributes. A total of 92 purpose-built office complexes and 14 shopping complexes throughout Kuala Lumpur City were inspected and the point scores for each individual second level sub-factors were noted.

Stage Five: - Finding Weightings of Main Factors

Rentals of 'standard lot" for the purpose-built office complexes and shopping complexes were compiled. The objective was to find the relative weighting of the main attributes. This involved simple regression of rentals against the proportion to maximum score for each main attribute using Minitab statistical package.

For the proposed current revaluation exercise, the current rental was at most 2 years back. Rental evidence of standard office space of 54 different purpose-built office complexes and 12 different shopping complexes within the Kuala Lumpur City were collected.

The weightings were used to predict rental per square foot of other office buildings in the same geographical area. In the case of the purpose-built office complex, Figure 3 below provides an illustration of the prediction model.

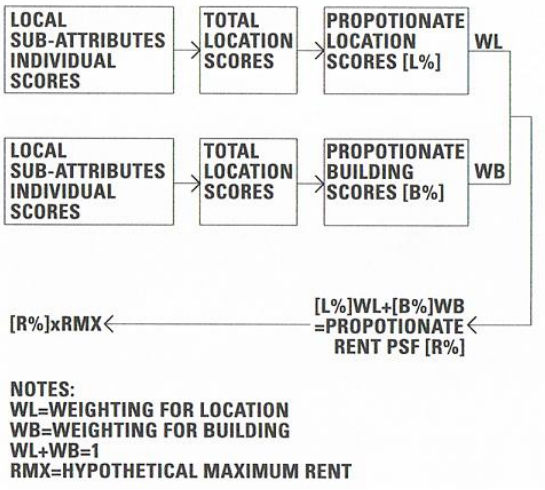

Figure 3*:* Rental Value Prediction Model for Office Complexes

The simplistic nature of the model provided an objective, easily understood comparison between properties in the form of point scores of each individual main and sub-attribute.

The Prototype And Evaluation

Validation and Concept of Prototyping

The validation process involved valuers' evaluation of the knowledge-base as the knowledge elicitation proceeds (dynamic evaluation) to achieve knowledge completeness (Shaw and Woodward, 1988).

The Basic Prototype

A prototype was developed at a stage of the project when it was felt that the knowledge was adequate to stand as a platform for discussion among experts. The prototype is divided into four modules. Each module embodies the specific knowledge-base of a particular type of property. The purpose-built office complex module contains a series of "screen displays" embodying the knowledge of the experts integrated with the structured comparison format based on Locational and Building attributes (with both first level attributes and second level sub-attributes incorporated). The questions in the system are based on the second level sub-attributes. The computer incorporates rules intelligently to relate the answer given to the system to the combined scores of the valuers and the tenants'opinions through the array facilities in the system. Predictions of rentals are made based on the prediction model stated in Stage 5 of the model above.

During evaluation, valuers expressed the need for the system to provide information (if any) about the actual rents (average rents) of the subject property and its comparables as a check to the prediction.
The second part of the module contains the detailed accepted heuristic knowledge of the experts, which comprise the valuation of individual accommodation in the office complex such as the penthouse and sports club, and swimming pool where rental evidence may be limited. Module 2 for the valuation of shopping complexes has a similar format to Module 1.

It contains the knowledge-base relating, for example, to the position of the individual shop lots, the sensitivity of the rentals to size and the layout of the complex. Module 3 for the valuation of shophouse/office/flat contains a section analysing the general locational situation of the shophouse and an analysis of its detailed position. Where rental evidence in the immediate vicinity is scarce, appropriate heuristically assigned adjustment will be made in relation to other comparables located farther away. The second section comprises questions relating to the internal valuation of the shophouse, such as valuation between the different floors.

Module 4 consists of a knowledge-base of industrial properties. The rules for location in each are rather broad reflecting the less sensitive nature of factories' rentals to different positions. The second part of the module comprises valuations of accommodation within factories. Heuristical judgment is inherent in the valuation of factories, reflecting specialised valuers' knowledge. For example, in making adjustment for size, a sliding scale in the form of percentage deduction with increasing size of the factory space is embodied in the prototype.

Evaluation and Further Knowledge Elicitation

In general, the valuers were in agreement with the knowledge represented in the system.
i) Objective Testing of Shopping Complexes and Office Complexes Modules An objective testing of the accuracy of the opinion of the system (which incorporates simple regression for twenty one purpose-built office complexes and nine shopping complexes in Kuala Lumpur) was undertaken against the valuation of an experienced core valuer. The results of the testing of the model for office complexes valuation are summarised in **Table 1** below.

BUILDING	Loc Score (Max. Score =87)	Bldg Score (Max. Score =170)	Loc Proportionate (%) to Max. Score	Bldg Proportionate (%) to Max. Score	Rent Proportionate (%) to Max. Hypo. Rent	Predicted Rent psf (MR)	Valuer's Opinion on Rent psf (MR)	Difference (%)	Confidence Level (%)
S. ISMAIL RD									
SPK	71	94	81.6092	55.2941	65.0000	4.29	4.00	7.25	90
SMK	70	76	80.4598	44.7059	58.0303	3.83	3.50	9.43	90
Nusantara	71	74	81.6092	43.5294	57.7273	3.81	3.50	8.86	90
Aik Hua	54	92	62.0690	54.1176	57.1212	3.77	3.50	7.71	90
AMPANG RD									
Getah Asli2	62	103	71.2644	60.5882	64.7154	3.98	3.80	4.74	90
S.Dredgin	68	108	78.1609	63.5294	68.9431	4.24	4.00	6.00	90
MCA	70	103	80.4598	60.5882	67.9675	4.18	3.80	10.00	90
LUTH	58	130	66.6667	76.4706	73.3333	4.51	4.00	12.75	<90 *
RHB	54	129	62.0690	75.8824	71.3821	4.39	4.50	-2.44	95
R. LAUT RD									
Bumi Raya	75	84	86.2069	49.4118	63.0252	3.75	3.50	7.14	95
C&Carriage	65	124	74.7126	72.9412	67.5630	4.02	4.00	0.50	95
PKNS	75	84	86.2069	49.4118	63.1933	3.76	3.50	7.43	95
City Center									
Public Bank	62.5	96	71.8391	56.4706	63.9344	3.90	4.00	-2.50	95
UMBC	58.5	103	67.2414	60.5882	63.9344	3.90	4.00	-2.50	95
KOP	55.5	69	63.7931	40.5882	51.6393	3.15	3.00	5.00	95
TSMB	58.5	98	67.2414	57.6471	62.4590	3.81	3.50	8.86	90
Bangkok B.	62	71	71.2644	41.7647	50.8197	3.10	3.00	3.33	95
BD.Zainal	62	90	71.2644	52.9412	61.6393	3.76	4.00	-6.00	90
FRINGE AREA									
IGB Plaza	53	89	60.9195	52.3529	54.5098	2.78	3.00	-7.33	95
Perkim	59	81	67.8161	47.6471	50.5882	2.58	2.50	3.2	95
Pengkalan	51	106	58.6207	62.3529	61.7647	3.15	3.00	5.00	95

Table 1: Purpose-Built Office Complex Results of Computerised Model Testing Against Valuer's Opinion (Rent of Standard Office Space)

The test showed a difference of within io% compared to the core valuer's valuation for twenty of the properties. There was a difference of 12.75% for LUTH Building, with the prediction falling outside the 90% confidence interval. A discussion with the valuer revealed that LUTH was valued lower by the valuer despite its high building score as it was mainly let to special tenants. Rules relating to type of tenants were incorporated for flexibility.

As a whole, the valuers agreed that such a model would be useful in providing structured explanation.

ii) Comments on the Use of Regression in the System Despite the usefulness of incorporating a regression model based on the dynamic evaluation undertaken, it was found that some elements of rigidity existed. These were in terms of 'imposition" of fixed weightings, inability to work with limited data and inflexibility to accommodate new developments in the market.

Conclusions

The research has shown that an expert system for the valuation of commercial properties for rating purposes in Malaysia can be developed from the knowledge of several experts. The system could benefit from enriched consensus knowledge of experts as well as multiple lines of reasoning.

The regression model incorporated in the system provided a structured and simplified dimension by providing general weighting of main attributes with a prediction generally within 10% difference from the valuers' opinion.

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