# MODEL SELECTION CRITERIA IN BUILDING PROJECT PRICE FORECAST FORMULATION

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Clients of the building industry expect to obtain high levels of quality from all decision makers involved with the delivery of their projects. High quality forecasts of the construction costs of potential buildings are central to the estimation of a scheme's value for money. The decisions that effect the quality levels of such forecasts involve the selection of appropriate models and the exercising of professional judgement, both in the formulation of the advice itself and in its transmission to the client. This paper addresses issues connected with the formulation of early stage building project price advice for clients. Initially, the paper reviews, identifies and classifies factors identified from both domain specific and general business literature that are thought to influence practitioner selection of building project price forecasting models. This analysis is used as a basis for the development of a preliminary conceptual model selection framework. The paper concludes by describing a research design that will be used to be collect data to support that the development of a decision support mechanism for building project price forecasting model selection.

Keywords; Building project price models, formulation, selection criteria.

## INTRODUCTION

The determination of a building project's potential construction costs is central to the estimation of its value for money and is one of the core criteria that clients use to measure quality levels. The provision of building price forecasts for clients influences the construction process by helping to ensure that scarce resources are put to their most effective use. The determination of a building project price forecast is a complex activity and the issues surrounding the criteria used to select appropriate price forecasting models are not yet fully understood.

The research agenda on building price forecasting has in the past been driven by the need firstly, to identify and assess the accuracy of all the existing models suspected in use and secondly, to develop newer computer based non-deterministic models and knowledge based systems that could take more account of risk and uncertainty. More recently the agenda has shifted to consider quality issues. Work in this field has become more people orientated rather than being entirely model-centred as research on matters connected with the personal attributes of forecasters themselves, their levels of expertise, methods of price message communication, types of bias and judgmental skills have been reported.

Quality of building price forecasts is affected by both the technical formulation of the price forecast and the human processes involved with the interpretation and transmission or communication of the price forecast to clients. The human processes involved in the transmission of price advice to clients is affected by the interpersonal

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communication process itself and issues connected with judgement, such as bias, errors and heuristics. Work on interpersonal communication processes and issues connected with judgement have been the subject of separate studies by Bowen (1995) and Fortune and Lees (1996).

This work is centred on the people issues connected with the formulation of strategic price advice for clients. I aims to develop a selection mechanism that ensures that price forecasters use the most appropriate forecasting techniques for any given set of project circumstances. This focus will also encompass people or human issues related to intuition, personal style, and the potential for bias, error and heuristics of the forecasters involved with the model selection process.

The study will contribute to the research agenda on quality in building price forecasting by establishing an applications based theme that brings together the model-centred school of research, as championed by Skitmore (1990) and Newton (1991), and the forecast preparer and user or people-orientated school of research, as championed by Raftery (1993), and Fortune and Lees (1996). The establishment of such an applications based research theme and the eventual development of a model selection mechanism will need to consider factors related to the attributes of (I) the client or forecast users, (ii) the forecast preparer, (iii) the forecaster's organisational setting, and (iv) the forecasting models themselves.

This paper is structured so that it firstly sets out the context for the work by establishing its relevance to building clients , their cost consultants and other researchers by defining terms such as 'quality' and 'price forecasting'. The paper then reviews some of the relevant subject specific and general business related literature on price forecasting in order to identify the factors suspected as being criteria for model selection. The model selection criteria that have been identified are then brought together for the first time and classified into a preliminary conceptual framework that could be used to model the selection of building project price forecasting techniques. The paper concludes by setting out an action plan to ground the outline conceptual selection model in the actual experiences of practitioners involved in the selection of building price forecasting models for use.

## CONTEXT

The relevance and importance of early stage construction cost advice for clients has been reported by Skitmore (1985), Ashworth (1986) and more recently, by Latham (1994). It is now widely accepted as a key factor in the decision to proceed with a proposed building project. Conventionally, the provision of this advice has been the responsibility of the clients' cost consultants who, in the UK, are known as quantity surveyors. It has been pointed out by James (1954) and Male (1990) that this advice is of importance to quantity surveyors in that it is an activity that is central to the claims of quantity surveying to be considered as a "profession". This is because the formulation and transmission of this strategic financial advice is arrived at in circumstances which Male (1990) described as being "...of great uncertainty, where expertise and judgement needs to be exercised within a high discretion role". The provision of reliable advice in such circumstances was also been identified by Male as being advice most often associated with a truly professional person.

In providing this advice for clients it is necessary for quantity surveyors to predict future uncertain events. Such predictions are in fact forecasts of prices to be charged by contractors to clients for the construction of their building projects. Forecasting

has been generally defined in business and management theory terms as being an aid to decision making and that it is achieved by "looking at what has happened in the past and attempting to project this historical experience into the future", Chambers *et al* (1974). Taylor and Bowen (1987) suggested that building project price forecasting was the "combination of decision theory and econometrics to predict tender prices". So it may be seen that building project price forecasts must include not only estimates of contractors' own estimates of resource costs that are likely to be incurred in the execution of the projects but also predictions or judgements of the likely market forces that will be prevailing at the time contractors bid for the work.

Forecasts prepared and applied in general business are judged to be a success if a good quality decision has been made regardless of the perceived level of accuracy achieved by the forecasting model selected, Makridakis *et al* (1983). Literature reviewed has indicated that the achievement of quality in terms of the provision of building price forecasts can be clearly affected by a number of factors. Bias, consistency and accuracy of price forecasts as compared to actual bids accepted by clients have been identified by Skitmore (1991) as being influential quality factors that emerged from the analysis of thirty three separate studies reviewed in his work on building price forecasting performance. Other comparative studies by James (1954), McCaffer (1975) and Ross (1983) considered quality only in terms of accuracy of building price forecasts given and tender prices received using the m3, m2 and storey enclosure methods (James), multiple regression methods (McCaffer), and different approximate quantities methods (Ross).

However, it was pointed out by Raftery (1991) that factors solely related to the outputs of models, such as accuracy, can be of only limited value as measures of quality, as they do not assess the process by which the building price forecast has been compiled. A broader definition of quality and its assessment in terms of the provision of building price forecasts was offered by Skitmore *et al* (1990). Firstly they suggested that quality should be considered as a measure of "the satisfaction obtained by the purchaser of the forecasts". It was further suggested that this satisfaction was a function of the purchasers perception of the usefulness of the forecasts received and that it may be influenced by factors such as the purchasers expectations, relationship with the forecaster, presentation and explanation of the forecasts and the impact on the purchasers resources. Given this wider definition, Skitmore *et al* (1990) went on to suggest that quality in building price forecasts can be determined by "(a) the nature of the target, (b) the information used, (c) the forecasting technique used, (d) the feedback mechanisms used, and (e) the person providing the forecasts". Therefore it can be seen that this work intends to focus mainly on item (c) the forecasting techniques and to a lesser extent on item (e), the person providing the forecasts, in order to contribute to the development of quality in building price forecasting.

Having defined "quality" and "forecasting" in terms of building project prices and set out the context and relevance of this work for clients, cost consultants and other researchers it is now necessary to consider the previous work done in this area. The review will firstly consider material related to the identification of factors thought to influence building project price forecasting model selection and then secondly consider factors that have been advanced as influencing forecasting model selection in general business theory.

## MODEL SELECTION CRITERIA IN BUILDING PROJECT PRICE FORECASTING (BPPF)

Work by Raftery (1984), Taylor and Bowen (1987), Skitmore (1990), Bowen (1995) and Ashworth (1994) together with the empirical study reported by Fortune and Lees (1996) have identified a number of potential criteria (1) to (16) (see below) that are thought to be influential in the choice of which BPPF model to use in practice.

Raftery (1984,) identified different criteria that could be used in the assessment of model performance, namely, (1) the data, (2) the data / model interface, (3) model attributes or ease of application, (4) interpretation of output and (5) the nature of the decision making process" Taylor and Bowen (1987) in their paper on forecasting models and their applications asserted that the use of any model was dependent on factors such as, the nature of the forecast being made and the nature and availability of the data, that have already been identified by Raftery (1984) above, as well as additional criteria such as, (6) the time horizons available, (7) the relative accuracy of the available models, (8) the resources available, and, (9) the responsiveness of the forecasting model to changing environmental and technological conditions. Skitmore (1990) suggested that by inputting the level of information available - as criteria (1) above, (10) the type of project, (11) the feedback system used, "it was theoretically feasible to predict which model will give the “best figure in terms of a price forecast for a client”. Skitmore’s model-centred school of research was supported by the work of Newton (1991) who sought to set out a classification system for cost and price forecasting models used in building and engineering works. Newton’s classification framework was bounded entirely by model-centred parameters such as relevance, units, cost/price, approach, time point, model type, assumptions, uncertainty. This model-centred school of research reflected the concerns of an earlier paradigm that was focused on the development and assessment of cost models in use. That paradigm has been supplanted in the later literature by the recognition of the contribution made by people to the provision of strategic building project price advice.

Raftery (1993) gave a voice to this people orientated research theme in building project price forecasting when he identified in his keynote CIB conference address that the judgement and expertise of the forecasters themselves were significant features in effective building project price forecasting. The amount of judgement required to be applied to a forecasting model was also identified by Fortune and Lees (1996) in their empirical investigation of models in use. Therefore (12) the amount of judgement required can also be considered as a potential selection criteria. In addition Fortune and Lees found evidence that the main reason for the non-use of potential cost models was the lack of understanding of the models concerned by the forecast preparer. So a further potential model selection criteria could be considered to be (13) the lack of understanding of the models available.

Fortune and Lees went on to speculate that other factors affecting the non-use of particular models included, the inaccuracy and unreliability of the cost information produced by the model (previously identified as a selection criteria (7) above, (14) the experience or familiarity of staff responsible for forecast preparation and (15) the availability of computers to the forecast preparers in their organisational settings. Ashworth (1994) asserted that factors affecting the use of forecasting techniques included; amount of project information available, the amount and type of cost data available, the ease of model application, the familiarity of the user with the model, the speed of the model in use, the time available for the production of the price forecast,

the experience of the forecaster and the level of accuracy achieved by the model. All the factors listed by Ashworth have been previously identified as potential selection criteria except (16) the speed of the model in use.

The work reviewed above has indicated some consensus on the identification of model selection criteria. However, there has been a reluctance to identify those criteria that may be more influential than others in the selection of building project price models by practitioners. As yet there has been no empirically based work reported that has attempted to confirm the above findings or rank the criteria identified above for importance. It was decided to expand the literature reviewed on this topic to include literature related to general business theory in order to investigate whether material in this wider domain would confirm and/or expand the number of model selection criteria identified above.

## MODEL SELECTION CRITERIA IN GENERAL BUSINESS FORECASTING (GBF)

A review of work by Chambers and Mullick (1971), Chambers *et al* (1974), Milne (1975), Sullivan and Claycombe (1977), Fildes and Howell (1979), Makridakis *et al* (1983) and Lancaster and Lomas (1985) as well as material reporting empirically based studies by Wheelwright and Clarke (1976), Fildes and Lusk (1984), Mentzer and Cox (1984), Sparkes and McHugh (1984) and Mentzer and Khan (1995) has provided an insight into the competing criteria that are thought to influence GBF model selection.

Accuracy or amount of acceptable error in a forecast was identified as a selection criteria by each of the studies cited above. Other criteria that were identified in the literature quoted above have been listed below in descending order of popularity amongst the sources indicated :- data available, cost of using a forecasting model, the experience of the forecaster, ease of forecasting model application or model complexity, the creditability or plausibility of the model, the forecasting organisation's technical capability, the nature of the client, the purpose/context of the forecasting problem, the time available for the price forecast to be formulated, the time period to be forecast, the forecaster's education/training/awareness and the nature of the manager/forecasters interaction or relationship. Of the selection criteria identified above the following, namely, (17) the cost of using a model and (18) the nature of the manager/forecasters relationship and (19) the nature of the client were not identified in the literature reviewed on BPPF models and so can be considered as potential model selection criteria.

Empirical studies undertaken by Dalrymple (1975) and Wheelwright and Clarke (1976) sought to identify the important variables used in the selection of GBF models. The studies identified that the GBF forecasting models used in practice at that time depended upon the stage of development that the business organisation viewed itself as being in. This factor has been recently developed in the work of Pedler *et al* (1997) who have now advanced the concept of the learning company. This factor namely, (20) the stage of learning that a forecasters organisation sees itself as attaining has been listed as an additional model selection criteria. The potential model selection criteria identified above have been listed in Table 1.

Makridakis *et al* (1983) in their textbook on forecasting as well as Mentzer and Cox (1984) and Mentzer and Khan (1995) in their empirical studies identified forecast accuracy as being the most important of the selection criteria listed above. This

finding contrasts with Lancaster and Lomas (1985) and Fildes and Lusk (1984) who thought that the purpose or context for the forecast and forecasters education / training / awareness respectfully were the most influential of the selection criteria indicated in the literature on GBF

Makiridakis *et al* (1983) commented that they thought practitioners commonly evaluated differing forecasting models on a single criterion, namely, “perceived levels of model output accuracy”. However, they went on to point out that accuracy cannot be considered as the sole criterion of forecasting model selection as it is not necessarily the product of the model that is the factor that needs to be evaluated. Makridakis *et al* pointed out that "if a forecaster models a situation well in the face of uncertainty then there is reason to support the forecast regardless of accuracy", (p.761). Thus it can be seen that it is the process in which the forecast was formulated that leads to real quality in the decision making of forecast users.

Thus the GBF literature identified above has been found to be generally supportive of the selection criteria identified in the subject specific work on BPPF models. The work reviewed on GBF has revealed a lack of concensus on which of the selection criteria identified could be considered to be the more influential in the selection of particular models. Furthermore, Fildes and Howell (1979) identified that the difficulty facing the forecast preparer was that there was no theoretical basis on which to choose a forecasting model appropriate to a given situation. Therefore, it is the way in which the forecast preparer is influenced by the potential selection criteria indicated above that needs to be investigated and data grounded in forecasters experiences gathered, so that a conceptual selection model can be developed that would enable better quality decisions to be made by clients of the building industry.

## PRELIMINARY CONCEPTUAL BPPF MODEL SELECTION FRAMEWORK

Table 1 illustrates the potential model selection criteria i.e. (10 to (20), that have been identified from the subject specific and general business literature reviewed. In order to develop an outline conceptual model that could be given shape and form by gathering data grounded in practitioner’s experience it was decided to investigate whether the potential criteria could be grouped together or classified.

Wheelwright and Clarke (1976) also suggested a classification system that could be used to group individual selection criteria so that a selection framework could be developed to aid model selection. This classification system had three categories, namely, (1) user environment - including criteria related to users level of forecasting knowledge and relationships between forecast users and forecast preparers, (2) forecast production costs - including criteria related to computer costs, data costs and time costs of users and preparers, and (3) problem specific criteria - including issues related to time horizons, level of accuracy and degree of management support. Given the technological changes and increases in problem complexity that have occurred since Wheelwright and Clarke's classification system was advanced it can be seen that the model selection criteria illustrated in table 1 now need an alternative grouping to facilitate their evaluation

Therefore, an attempt to group the identified criteria into a preliminary classification framework has been advanced. It seeks to place each of the model selection criteria (10 - (20) within an influence “field” or “environment”. The influence or “environments” that have been advanced are related to Wheelwright and Clarke’s

(1976) model and have been labelled (**A**) the forecast users environment, **(B)** the forecast preparer's environment, (**C**) the forecaster's organisational environment, and **(D**) the forecast model(s) environment.

Category **(A**) the forecast users environment - includes criteria related to the client, the data available, the time available for the forecast production, the type of project, the provision of feedback from past schemes and the client's understanding of the model's usage. Table 1 indicates that the following model selection criteria have bee allocated to this influence environment namely, (1), (5), (6), (10), (11), (13) and (19).

Category **(B)** the forecast preparer's environment - includes criteria related to the use of the data available, the forecaster's understanding, experience and ease of use in terms of available models, the forecaster's assessment of accuracy of the model's output, the forecaster's assessment of the project type that the forecast is required for, the forecaster's use of judgement and the nature of the relationship between the forecaster and the forecaster's manager. Table 1 indicates that the following model selection criteria have been allocated to this environment, namely, (1), (2),(3),(4),(7),(10),(11),(12),(13),(14) and (18).

Category **(C)** the forecaster's organisational environment - includes criteria related to the resources available, the availability of cost data, the feedback system used, the availability of computers, the nature of the relationship between the forecaster and the manager and the organisation's own assessment of its stage of learning or development. Table 1 indicates that the following selection criteria have been allocated to this environment, namely, (1),(8),(11),(15),(18) and (20).

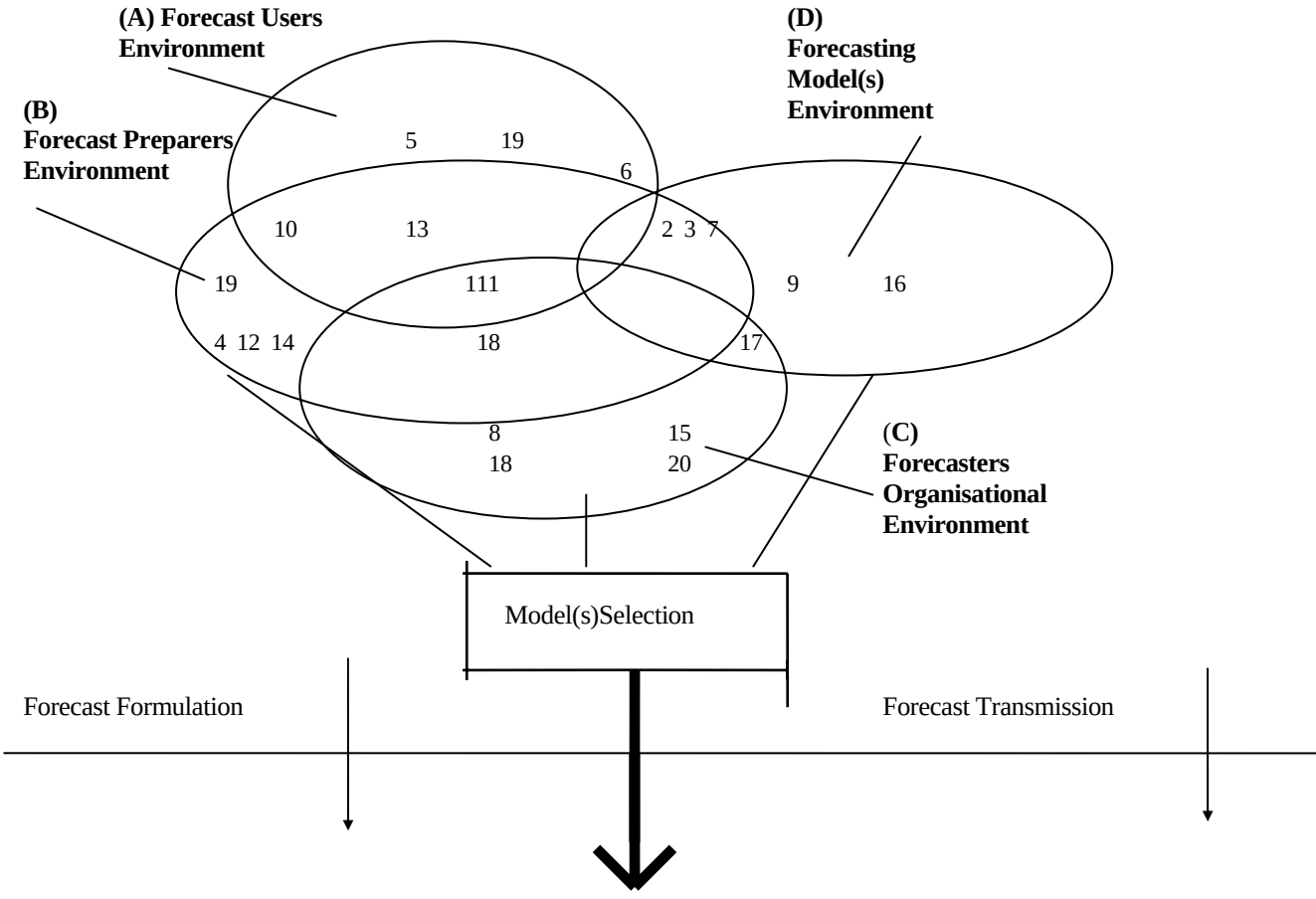
Category **(D**) the model's environment - includes criteria related to the data/model interface, the time available for the production of the forecast, the speed and costs of the model in action, the accuracy of the model's output and the model's responsiveness to change. Table 1 indicates that the following selection criteria have been allocated to this environment, namely, (2),(3),(6),(7),(9),(16) and (17).

It can be seen from Table 1 that this preliminary classification has indicated that some of the individual criteria identified from the literature reviewed above have been allocated to more than one of the influence environments advanced in the conceptual framework. The diagram seeks to reflect the major divide in the provision of early building project price forecasts for clients, namely the divide between forecast formulation and transmission. This clear divide has been identified from the material reviewed above. Fig 1 also advances a view of the conflicting influence environments [(A),(B),(C),(D) above] that have been developed conceptually following the identification of the individual selection criteria revealed in both the subject specific and general business literature considered above. The classification of the model selection criteria has indicated that the influence environments cannot be considered to be independent of each other. There is a blurring of the boundaries between one influence environment and another. The overlapping of the influence environments and their respective criteria indicates an interaction between criteria that may change due to differing project circumstances. The confirmation or otherwise of the selection criteria, their classification and the shape and size of each of the influence environments in terms of impact on actual model selection needs to be determined following the execution of an appropriate investigation amongst experts in the field.

**Table 1 - Model Selection Criteria Identified from Literature Review**

| Criteria Nr | Selection Description | Influence Environment |
|---|---|---|
| 1 | Data availability | A,B,C |
| 2 | Data / Model interface | B,D |
| 3 | Ease of application | B,D |
| 4 | Interpretation of output | B, |
| 5 | Nature of decision making process | B |
| 6 | Time horizons | A,D |
| 7 | Model accuracy | B,D |
| 8 | Resources available | C, |
| 9 | Models responsiveness to change | D |
| 10 | Type of project | A,B |
| 11 | Feedback system used | A,B,C |
| 12 | Use of judgement | B |
| 13 | Forecaster's u/standing of model | A,B |
| 14 | Experience of forecaster | B |
| 15 | Availability of computers | C |
| 16 | Speed of model in use | D |
| 17 | Costs of using model | D |
| 18 | Manager/forecaster relationship | B,C |
| 19 | Nature of client | A |
| 20 | Stage of organisational development | C |

**Fig 1 Building Project Price Forecasting - Preliminary Model Selection Framework**



## FUTURE ACTIVITIES

The necessary investigation will have to have features that are both exploratory and explanatory in nature. The first phase of the study will involve exploratory work that will entail finding out what building price forecasting models are in use and at what incidence. The second phase of the study calls for the identification and evaluation of influential factors that affect the selection of particular building price forecasting models in use. Therefore, a research design has been developed that uses a quantitative approach to phase one and a qualitative approach to phase two. The second phase of the work has attracted financial support from the RICS Education Trust and is expected to commence in the summer / autumn of 1997.

## CONCLUSIONS

This work has sought to set out a case for an investigation into the criteria that influence forecasters involved with the selection and use of appropriate building project price forecasting models. The paper has set out the context for the study and it has reviewed relevant subject specific and general business literature in order to identify criteria that could influence professionals in the selection of appropriate forecasting models. The literature reviewed revealed a lack of consensus on which criteria could be more influential than others in selecting a BPPF model. The paper advanced an outline preliminary selection framework that will be given shape and focus by collecting data grounded in professionals experiences in the field.

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