

## **Exploring Estimator Behaviour in Pricing Road Projects**

Charles Afetornu, Francis Edum-Fotwe, Ronald McCaffer

*Dept of Civil and Bldg Engrg, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK*

Alex Twumasi-Boakye

*Chief Director, Ministry of Transportation, Accra, Ghana*

Frank Desmond Kofi Fugar

*Department of Building Technology, KNUST, Ghana*

### **Abstract**

Cost estimates form a key element in the planning and management of projects. It is therefore common to find that project staff devotes considerable effort to attaining accurate estimates. The ability to produce cost estimate to a reasonable level of accuracy and in a timely fashion to support the efficient planning of a project is influenced by a number of factors. These include the skill levels and numbers of estimators, national, industry and project related factors, as well as the decision orientations of cost estimators. The current notions support the argument that the amount of information available to estimators at the point of their decision influences the accuracy. While this is true in very many cases, it does not explain fully the contribution to estimating accuracy. Estimator behaviour has a significant contribution to achieving a high level of accuracy. In this paper, the authors focus on the subject of estimator behaviour in project cost decision making, and how the effects of the behaviours influence the accuracy of project cost estimates. The paper explores the personal and situational factors that are associated with the accuracy of estimates and proposes how these factors could be addressed for improved accuracy in cost estimating within the construction industry.

### **Keywords**

Construction, Projects, Estimator, Cost estimate, Estimator behaviour

### **1. Introduction**

Estimators play an important role in the management of projects and business activities of construction organizations. Their actions can have a direct impact on the success of the projects they are involved in, and consequently, the prospects of the companies they work for. It is in this vein that the decision behaviour of estimators in cost estimating is crucial for effective management of construction business activities.

Cost estimates form a key element in the planning and management of the project, and project staffs apply considerable effort to preparing the estimates. The ability to produce cost estimates to a reasonable level of accuracy and in a timely fashion to support the efficient planning of a project is influenced by a number of factors. These include the skill levels and numbers of estimators, as well as national, industry and project related factors, which can be considered as *objective factors*. For example, Harris *et al.*, (2006)

considered many of the objective factors that influence estimating accuracy, and associated availability of more information with greater accuracy. Other writers on the subject, including, Touran and Lopez (2006), Skitmore and Thomas (2002), Tas and Yaman (2005), Williams (2003), Wong and Hui (2006), and Edwards and Bowen (1998; 2005), concur on the role information plays for establishing accurate estimates and subscribe to the *information school* of thought. The implication from the greater information school of thought is that all other external factors being equal, two different estimators should arrive at the same project cost given the same amount and quality of information. While the assertion of the information school is predominantly true, it ignores the influences that internal factors, such as estimator behaviour and decision orientation have on the choices exercised by individual estimators. The internal factors constitute what heretofore is described as *subjective factors*. This paper explores these subjective factors that influence the behavioural aspects of estimators, and delves into the extent to which these behavioural factors influence the production of accurate estimates. The paper has put forward the argument that personal and situational factors are associated with the accuracy of estimates and proposed how these factors would be addressed for the realisation of accurate cost estimates on construction industry.

## **2. Background on the Role of Estimator**

Estimators are individuals or group of people that predict cost of future events of projects before it is implemented (Archibald and Villoria, 1967). The classical role of estimators comprises of compiling and analysing data on all factors that can influence cost, such as materials, labour, equipment, duration, location, special machinery requirements among others. Often the type and size of the project determines the scope of duties that an individual estimator will be required to perform. The ability of the estimator to predict the future cost of materials, labour and other inputs has a direct impact on the accuracy of the proposed cost of a project. The availability of the requisite information in the right amounts and on a just-in-time basis assists the estimator to make an effective decision given the conditions at the time of the decision. In construction, it is the norm for organisations to employ people with a formal education and training to undertake estimating. However, there are cases where estimators progress through experience. The importance of the estimator's experience for establishing an estimate is reflected by Archibald and Villoria (1967) that an *estimate is the manager's experience reflected in a numerical guess*. Viewed from this perspective, the ability of the estimator to achieve the defined role and activities depends to a large extent on the personality and psychological orientation of the estimator in decision making given a typical quantity and quality of information available. It is the assertion of the authors that it is the decision making orientation, which, is an inherent character in each individual that accounts for the differences in estimates prepared by two estimators that are given the same amount and quality of information. The personal characteristics of estimators and its effects on the accuracy of cost estimates will be discuss in detail in the subsequent sections of the paper.

## **3. Decision Orientation of Estimators**

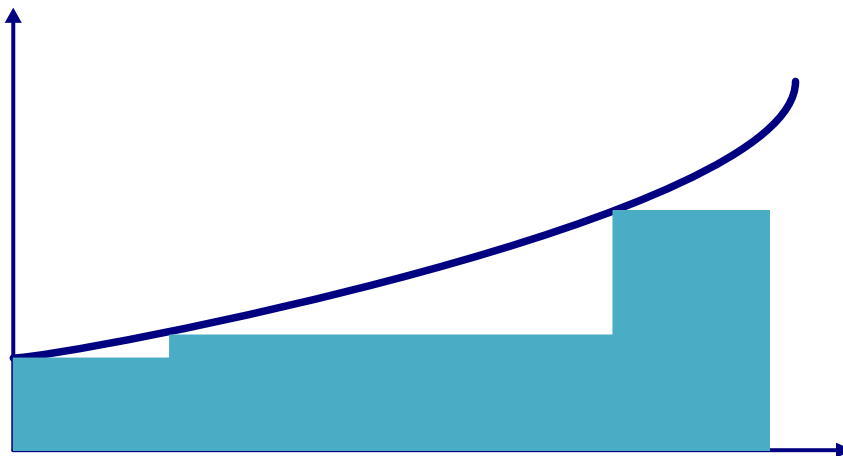
A decision maker estimates the probable outcomes of a choice in terms of future events and makes decisions based on these estimates. Thus, estimating procedures may be subjective such as the manager evaluating his control measures for future period, designing operation system or through the use of quantitative techniques. In both cases, the accuracy of the estimator's decision in the operational environment would have direct effect on the estimate that would be produced. This position was emphasised by Adams and Swanson (1976) and Archibald and Villoria (1967). Adams and Swanson (1976) concluded that the fundamental ingredient in making reliable decisions derives from the manager's ability to accurately in estimate future events. Archibald and Villoria (1967) also undertook investigation on factors that influence estimator behaviour in cost estimating. The researcher concluded that motivation,

amount of effort the estimator is willing to expend in the search of accuracy, job-related conditions in the operational environment, characteristics of estimator himself, and manner in which information is processed determines accuracy of estimates. These factors can be categorised into external and internal to the estimator. The internal factor which relates to the estimators personal decision making orientation is the subject of this paper.

The ability of the estimator in making sound judgment of future events determines to a large extent his skills and reputation and hence the estimate that would be produced. In making this judgement and decisions, estimators are influenced by internal and external factors. The estimators' ability in combining logic common sense, experience, judgement and skills in making informed decisions on information and events has a direct impact on the accuracy of estimates. In performing these duties, estimators make assumptions in their judgement. Assumptions made by estimators are based on experience and the ability of the estimator in making sound judgement. This observation agrees with a number of researchers which include Abernathy, (1971). Abernathy, (1971) conducted investigations into the accuracy of estimates and the experience of the estimator in the area of estimating. The researcher identified that estimates improves as the estimator gains experience. Thus, it could be argued that the accuracy of estimates is directly proportional to the level of individual's decision making capabilities. If A =accurate estimate, and I = decision making orientation of the estimator, then

$$I \propto A \quad (1)$$

The above equation shows that as the estimator makes quality decisions, the accuracy of the estimate increases. The decision making orientation is a personal characteristics of an individual. Decisions are made on future events in estimating. Since the future is unknown, the ability of the estimator in making good decisions is depended on how the estimator assesses risk. Estimators that are risk prone, take early decisions ( $T_1$ ) with the often limited information they hold ( $I_1$ ), while those that are risk averse take a relatively longer time ( $T_2$ ) to analyse the events before committing themselves to a particular decision option. This situation is presented in figure 1.



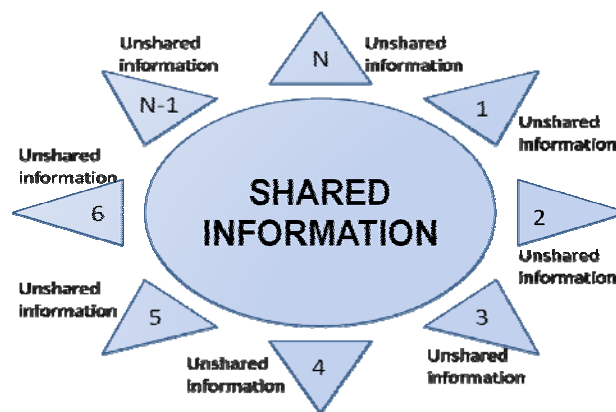
**Figure 1: Estimator Decision Behaviour**

Where  $T_1$  = Time that risk prone estimator makes decision,

$T_2$  = Time that risk averse estimator makes decision,

$T_c$  = The realistic time for estimator makes decision, and

From Figure 1 the risk prone estimator has an accuracy of  $A_1$  and the risk averse estimator an accuracy of  $A_2$ . The relevance of the decision taken by either type of estimator at the time of their decision is often not apparent and this is fully appreciated only after they have been implemented and the results known. In all cases the aspiration of the estimator is to exercise the most accurate or reliable decision option ( $A_c$ ) compatible with an optimum time ( $T_c$ ). The coordinates of the point of accurate decision and optimum time ( $A_c, T_c$ ) would lie along the trajectory between the risk prone ( $A_1, T_1$ ) and risk averse ( $A_2, T_2$ ) positions. The early realisation of ( $A_c, T_c$ ) is often influenced by the information sharing culture within the project stakeholders, as well as the behaviour characteristics of the person exercising the estimating decision. Figure 2 shows the nature of information that is held within organisations at both the company and project levels. Several reasons have been put forward to account for the existence of unshared information in project environments (Barrick and Mount, 1991). However, there is evidence to support the notion that the larger the core of shared information, the earlier the realisation of the ( $A_c, T_c$ ). Equally, the tendency to have a greater or smaller proportion of shared information is driven by the psychometric archetypes of individual estimators (Goldberg, 1990).



**Figure 2: Information Sharing in Estimating Environments**

The psychometric leanings of the estimators are influenced by a number of internal and external factors. Some are related to the conduct and personal characteristics of the estimator and others are related to the work environment, such as the culture of information sharing. Factors that are related to the estimator's conduct include the trust the estimator has for the information available, personal character of the estimator, the amount of time and effort invested in achieving a high level of accuracy, and relating to the other workers in the project or corporate environment. In undertaking these functions, the attributes of the estimator influences the decisions that are made. This section discusses how these attributes affect the decision making orientation of estimators.

### 3.1 Trust

Trust is an attitude which can only be shown by people rather than the organisation. Hansen (1994), Uzzi, (1997), and Dyer and Chu (2003) identified that the level of trust the estimator has in the organisation lowers transaction cost. As such, an organisation with a high level of trust culture should arrive at the point ( $A_c, T_c$ ) much earlier than one with less trust. Trust is as much a reflection of an organisational culture as it is an indication of individual attitude. The trust leaning of estimators therefore become an important attribute to the early realisation of ( $A_c, T_c$ ). Trust within an organisation can be seen as having an impact on the quality of estimates. In organisations where there is no trust, estimators exhibit high level of transparency in performing their work. This means the estimator is mindful of that the outcome of the estimate could be cross check hence does its work with diligent. This estimates that are produced from

this type of work environment where there is no trust is more accurate than the work environment where there is trust.

### **3.2 Ethics**

Estimators are required to exhibit personal professional discipline in all aspects of their work by exercising high level of ethical conduct and moral judgement in preparing cost estimates on projects. The ethical behaviour of project stakeholders including estimators has been explored in depth by Kang *et al.*, (2006). Similar to trust, issues of ethics decompose into organisational and personal dimensions.

### **3.3 Integrity**

Integrity can be described as a consistency of actions, values, methods, measures and principles adopted by each individual. Integrity is also attributed to various parts or aspects of person's life. In general the quality of the person's character is the most important philosophical representation of their integrity. A person's character portrays how the person behaves in the performance of its duties. Estimators are often directly influenced by their inherent characters in making decisions in their cost estimating processes.

### **3.4 Judgement**

Rush and Roy (2001) established that quantitative knowledge is the elements of known cost and product structures which form the basis of cost estimating and are measurable, while qualitative knowledge relates to the assumptions and *judgements* that cost estimators make during the process of estimating. Estimates are predictions of the future hence expert judgement is vital for the realisation of accurate predictions. The estimator makes this judgement based on their experience and information on past projects in order to make an informed decision on the new project. Much of the reasoning and logic in estimating are understood by only experienced estimators. It should be noted that human beings naturally turn to loss memory with time. This is why assumptions made in cost estimating must be properly documented

### **3.5 Experience and Environment**

Thompson *et al.*, (1994) showed how influence from experience affects the skills and judgement of people. The conclusion of Thompson *et al.*, (1994) agreed with Abernathy (1971) who concluded that estimates improve as estimators gain experience. This therefore, substantiates the fact that expert judgement is used extensively during generation of cost estimates due to the fact that estimates are on future events. Any event in future is unknown. Estimators would have to make numerous assumptions and judgments about what they think that future event would cost. Rush and Roy (2001) concluded that cost estimators constantly apply a combination of personal characters in estimating. The researchers identified these as combination of logic, skills, experience, common sense, and judgement. Rush and Roy (2001) therefore agreed with the earlier philosophers that individuals are either born with or develop certain preferred ways of thinking and acting. If this is true, then we expect individual estimators to act differently under the same work environment. These attributes of each individual estimator are always reflected in the estimates produced by each individual estimator in the same work environment with the same information. These attributes are a direct reflection on how the estimator assess risk. An estimator that is risk prone takes early decisions without thoroughly spending time and assessing the situation whiles the estimator that is risk averse may require extended time duration. Since projects are time bound, the relevance of the decision of the risk-averse estimator will be a delay beyond the time the decision is required.

The conditions of the work environment influence the estimators' behaviour in estimating. In some organisations, the ratio of projects to experienced estimators is very high. In such situations, the high workload on the estimator will affect the manner in which decisions are taken. Mei-Yung *et al.*, (2005) researched into factors that affect accuracy of cost estimates and concluded that stress on an estimator can impact negatively on the accuracy of cost estimates. The researcher identified some of the critical stress factors such as excessive workload, conflict of role, job ambiguity, and work environment among others have influence on the decisions of the estimator. An estimator who is stressed due to workload will not be diligent in performing its duties. The decisions that such estimator takes are not based on detail assessment of the information due to high workload. The amount of shared information existing within the organisation affects the estimator's ability in making sound and logical judgement. The estimator has very little time in analysing information thoroughly before making decisions under such work environment. Therefore, the behaviour of the estimator under such work environment is greatly influenced by any stress. The resultant effect is the outcome of estimates produced under such work environment is likely to be less accurate.

Another work environment factor which affects accuracy of estimates is motivation. McClelland (1969), Meyers (1964), and Kahn (1964) among others have indicated positive relationship between motivation and outputs. In organisations where remuneration is generally low, the employees in most cases are engage in other activities to supplement their income. The estimator in such work environment will have very little time to think thoroughly about issues before taking decisions. The ability of the estimate to make informed decisions under such circumstances is sometimes impaired. In the situation where the ability of the organisation to increase the remunerations of its employees is limited, how can the estimators be motivated at the same time not disturbing the equilibrium of the work environment. It will be argued that will the motivation be accepted to reflect in the personal characteristics of the estimators? This is where the superior has to study the employees to identity the form of motivation that will be accepted for the employee to be happy thus reflecting in the employees actions.

Pressures from superiors on estimators have negative impact on the free judgement on the part of the estimator. The accuracy of the estimate will seriously be undermined if such pressures are not well managed by the estimator. Pressures are also exerted by politicians in their anxiety of campaigning for votes. Construction of roads is one of the main campaign strategies for political parties. In view of this, pressures are more pronounced in election years. In situations like this, the estimator being an employee of the source of pressures is normally put into a state of uncertainty in excising their judgement for fear of being victimised should the judgement turn out not to be in favour to the source of pressure. The issue is how can the estimator feel protected under such situation to make informed decisions which might not be the choice of the pressure sources? Estimators should however appreciate that it is part of their duty to develop ability to resist such pressures.

#### **4. Discussion**

The decision orientation and behaviour of estimators has some influence on the efficiency and accuracy of estimating in project environments. Thus far, no meaningful studies have been conducted to shed light on the scale of the influence that behaviour of estimators coupled with their soft environment plays on the accuracy of project cost estimates. The decision orientation of estimators in work environment where project to estimator ratios are high could be enhanced by adopting short term and medium-long term strategies. In the short term, the few experienced estimators should undertake vigorous on the job training for employees identified as capable for the task within a specified time frame. The time frame will depend on the level of effect this has on the organisation. The short term measures are within the capabilities of the organisation itself. The medium to long term measures however are beyond the control of the organisation since it depends on the country's policy direction. The construction industry accounts for

significant portion of each country's gross domestic product. The industry also employs a lot of people hence help in controlling the unemployment rate and therefore has an impact on the macroeconomic indicators of any nation. It is in this vein that the survival of the construction industry should be of outmost concern to any government. This is where the government have to be prompted by the stakeholders for the need to put adequate measures that will attract people to enrol in the estimating programmes in the countries academic institutions. The decision making orientation of estimators with respect to assessing risk has to be done having in mind that early decision will result to losing too many vital information and thus affecting the accuracy of the estimate, and late decisions will result to loss of memory and the relevance of the information, thus the estimate will be ready when the project has been completed or in progress. The mean of the two decision making orientations of estimators with respect to risk assessment is recommended ideal for estimators for the realisation of accurate estimates.

## 5. Summary

The discussions revealed that the accuracy of estimates is largely depended on the decision making orientations of estimators. Estimators that are risk prone turn to make decisions that will loss some vital data due to the limited time for search of accuracy. On the other hand, estimators that are risk adverse take longer time in search of details in making decisions. The attributes of individuals influence their decision making orientations. Therefore, estimators' attributes such as trust, good ethics and integrity, and proper judgement influence the decision that estimators take. For work environment conditions, estimators should be motivated where remunerations are low, and adequate number of estimators with the requisite tools should be made available. To conclude, the discussions revealed that accuracy of estimates is largely depended on factors which are within the control of the estimator.

## 6. References

- Abernathy, W.J. (1971). "Subjective estimates and scheduling decisions", *Management Science*, 18(2), pp. B80-B88.
- Adams, J.R., and Swanson, L.A. (1976). "Information processing behaviour and estimating accuracy in operations management". *The Academy of Management Journal*, 18(1), pp. 98-110.
- Archibald, R.D., and Villoria, R. L. (1967). *Network-Based Management System (PERT/CPM)*, pp. 87, Wiley.
- Barrick, M. R., and Mount M. K. (1991). "The big five personality dimensions and job performance: A meta-analysis". *Personnel Psychology*, 44, pp. 1-26.
- Dyer, J. H., and Chu, W. (2003). "The role of trustworthiness in reducing transaction cost and improving performance: Empirical evidence from the US, Japan, and Korea". *Organisation Science*, 14(1), pp. 57-68.
- Edwards, P. J., and Bowen, P. A. (1998). "Practice, barriers and benefits of risk management process in building service costs estimation: Comment". *Construction Management and Economics*, 16, pp. 105-108.
- Edwards, P. J., and Bowen, P. A. (2005). *Risk Management in construction projects*, UNSW Press, Sydney.
- Goldberg, L. R. (1990). "An alternative description of personality: The big-five factor structure". *Journal of Personality and Social Psychology*, 59, pp. 1216-1229.
- Harris, F., McCaffer, R., and Edum-Fotwe, F. (2006). *Modern Construction Management*, 6<sup>th</sup> edition, Blackwell Publishing, Oxford.
- Kang B.G., Price A.D.F., Thorpe A. and Edum-Fotwe F.T. (2006). "A managed approach to ethical decision making on construction projects". *Construction Information Quarterly*. 8(2), pp. 92-97.

- Kardi, T. (2006). What is belief, perception and attitude? <http://people.revoledu.com/kardi/idea/smatness/BeliefPerceptionAttitude.htm>, accessed on 06/10/08.
- Mei-Yung, L., Thomas, S., Skitmore, M., and Sal-On, C. (2005). "Critical stressors influencing construction estimators in Hong Kong". *Journal of Construction Management and Economics*, 23(1), pp. 33 – 34.
- Rush, C., and Roy, R. (2001). "Capturing quantitative and qualitative knowledge for cost modelling within concurrent engineering environment", *8<sup>th</sup> ISPE International conference on Concurrent Engineering Research and Applications*, Anaheim, California, July 29<sup>th</sup>-August 1<sup>st</sup>, CETEAM International, USA, pp. 209-218.
- Rush, C., and Roy, R. (2001). "Knowledge in cost modelling", *The Cost Engineer: Journal of the Association of Cost Engineers*, 39(1), pp. 10-12.
- Skitmore, M., and Thomas, S. (2002). "Analytical and approximate variance of total project cost". *Journal for Construction Engineering and Management*, 5, pp. 853-860.
- Tas, E., and Yaman, H. (2005). "A building cost estimating model based on cost significant work packages". *Engineering, Construction and Architectural Management*, 12(3), pp. 251-263.
- Thompson, R. L., Higgins, C.A., and Howeh, J.A. (1994). "Influence of experience on personal computer utilisation: Testing a conceptual model". *Journal of Management Information Systems*, 11(1), pp. 167-187.
- Touran, A., and Lopez, H. (2006). "Modelling cost escalation in large infrastructure projects". *Journal for Construction Engineering and Management*, 132(8), pp. 853-860.
- Uzzi, B. (1997). "Social structure and competition in interfirm networks; the paradox of embeddedness". *Administrative Science Quarterly*, 42, pp. 35-67.
- Williams, T.P. (2003). "Predicting final cost of competitive bid construction projects using regression models". *International Journal of Project Management*, 21, pp. 593-599.
- Wong, J. T. Y., and Hui, E. C. M. (2004). "Construction project risks: Further considerations for contractors' pricing in Hong Kong". *Construction Management and Economics*, 24, pp. 425-438.
- Zaheer, A., McEvily, B., Perrone, V. (1998). "Does trust matter? Exploring the effects of inter-organisational and inter-personal trust on performance". *Organisation Science*, 9(2), pp. 141-159.