

PPP in Switzerland - Economic Comparison For Street Maintenance and Rehabilitation Delivery Models

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Abstract

For performing public works project delivery models such as Public Private Partnerships (PPP) offer opportunities to increase efficiency. However, PPP should only be selected as the project delivery form if the taxpayers can be guaranteed value for money. This necessitates economic comparisons in various phases of the project. In the case of pure street maintenance and rehabilitation works without any investment, qualitative decision-making criteria become more important. In order to be able to include a meaningful and objective consideration of these criteria, the value benefit evaluation is subjected to Monte Carlo simulation within the economic comparison. The use of bandwidths and their simulation reveal comprehensive scenarios that can be used as a decision-making aid by the public decision makers.

Keywords

PPP-Model, economic comparison, street maintenance, cooperation, decision-making aid

1. Introduction

Communities' advantages of location are based primarily on the quality of the communal infrastructure, especially on the quality of the inner-city street networks. Guaranteeing high levels of street network quality with limited budgets can only be achieved using efficient cost/performance structures. The spectrum of possible delivery models for maintenance and rehabilitation of communal street networks ranges from the public authorities doing all the works themselves, to cooperation projects with private enterprises, to total privatization. Public Private Partnerships offer one possible approach to increasing efficiency. Such partnerships have already resulted in savings potentials of up to 17 % in Great Britain (HM Treasury 2000). To support the decision-making process of the responsible local authorities with regard to an efficient form of delivering street maintenance the Institute for Construction Engineering and Management at SFIT Zurich is developing a street maintenance delivery model in the form of a public private partnership (PPP) in conjunction with the Federal Transport Ministry. One of the areas of focus of the model is an economic comparison to verify whether a PPP guarantees the taxpayers value for money. In order to evaluate a Public Private Partnership as a model for delivering street maintenance, an economic comparison should be conducted in line with the following steps (acc. to Jacob 2003):

- Project definition and structure;
- Design of the Public Sector Comparator;
- Design of the Public Private Partnership approach;

- Cost calculations and comparison using value benefit evaluation.

Since the PPP Project at SFIT Zurich focuses on pure maintenance and rehabilitation works without any investment, where the public authorities do not gain any benefit from the procurement of private capital to finance public works, target focus is more closely aligned to qualitative target criteria, which aim at cost efficiency by synergies because of partnership, in addition to cost aspects. The aim of the economic comparison must therefore be to suitably evaluate qualitative, synergetic criteria, in addition to the cost aspects, in order to ensure that the price does not represent the sole evaluation criterion. This paper therefore presents a new approach to evaluating quantitative and qualitative criteria in the form of a value benefit evaluation, which involves subjecting the value benefit evaluation to a Monte Carlo simulation.

2. Research methodology

The constructivist research approach is suited to developing an economic comparison model since it construes social systems based on an intended input-output effect. The theory-based structure of the model is derived from a constructive-deductive approach based, firstly, on scientific (financial) mathematical methods, such as cost and investment calculation, and, secondly, with regard to the calculation process on the simulation of fuzzy variables. Triangulation is used to ensure validity and reliability, on the one hand by means of the theory-based scientific structure, and on the other hand by the realizability test performed by the communities involved in the research project.

3. Economic comparison

3.1 Qualitative criteria

Within the framework of the SFIT project, the fundamental qualitative decision-making criteria for a realistically meaningful economic comparison of maintenance and rehabilitation works for communal street networks were defined as follows:

- Risk-distribution in street maintenance and its capturing in cost-terms;
- Evaluation of the new risks arising from the partnership;
- Loss of synergy potential among the local authority's departments;
- Use of synergy potential from partnership cooperation; and
- Efficiency potential from long-term life cycle orientation.

These qualitative decision-making criteria can vary from one community to the next, but will generally be assignable to the superior targets of value preservation, securing network quality, availability of the street network and safety of the users. Since the qualitative criteria can be applied variably, each community can adapt the evaluation revealed by the value benefit evaluation to its own situation in line with its prioritized goals.

3.2 Suitable approach to incorporating qualitative target criteria

A value benefit evaluation linked to the pure cost comparison is a practical means of incorporating qualitative, synergetic factors in the process to decide a suitable project delivery model. The value benefit evaluation is subjected to a Monte Carlo simulation in order to ensure the objective evaluation of the quantitative and qualitative criteria. A Monte Carlo simulation simulates bandwidths of the target achievement figure specific to the virtual project (stef), which can be used to clearly reveal the quantitative and numerically evaluated qualitative differences between the delivery models. This process objectifies the value benefit evaluation, makes it possible to evaluate project delivery models in scenarios and, in doing

so, is an invaluable aid towards reaching a meaningful decision. To date the Monte Carlo Simulation has been used in science for evaluating the risks of a construction project (Busch 2003) and the subsequent choice of a suitable building contract (Girmscheid 2004) respectively of a suitable project delivery model.

3.3 Value benefit evaluation process

The value benefit evaluation outlined in Fig. 1 is based, on the one hand, on the cost calculation for performance of the works by the public authorities themselves in the form of a Public Sector Comparator (PSC) and on the costs of a virtual PPP project (Girmscheid, 2005), and, on the other hand, on the pre-defined qualitative decision-making criteria. The value benefit evaluation is a process involving the following three steps:

3.3.1 Initial parameters for a risk-based selection

- Setting up the maintenance and rehabilitation objectives for the local authority (primary and secondary objectives) and their target hierarchies for the specific tasks to be performed by local authorities
- Definition of the various weighting factors (wf), absolute and relative, of the primary and secondary objectives at each level
- Identification and collation of possible opportunities and threats (risks)
- Allocation of opportunities and threats to the individual primary and secondary objectives to evaluate the target achievement figures, irrespective of the virtual project (itaf)
- Therefore a scale of 0-5 is available to determine that target achievement figure, irrespective of the virtual project (itaf), whereby the grades are interpreted as follows: 0: No target achievement possible; 1: Very low level of target achievement; 2: Low level of target achievement; 3: Medium level of target achievement; 4: High level of target achievement; 5: Very high level of target achievement. The target achievement figure, irrespective of the virtual project (itaf) outlines the level at which the secondary objective will generally be achieved by the corresponding project delivery form taking the opportunities and threats (risks) into consideration.

primary objectives	target hierarchy (absolute)	secondary objectives	weighing factors (wf)		delivery forms						
			(absolute)	(relative)	PSC			PPP			
			itaf	staf	stef	itaf	staf	stef			
costs of the virtual project	65.00%	costs of the periodical routine measures	2.50%	1.63%	2	1.00	0.03	4	1.0	0.07	
		costs of the unscheduled ad hoc measures	2.50%	1.63%	2	1.00	0.03	4	1.0	0.07	
		hourly wages	2.50%	1.63%	3	1.00	0.05	4	1.0	0.07	
		wages of project costs	2.50%	1.63%	3	1.00	0.05	4	1.0	0.07	
		total costs	60.00%	39.00%	3	1.00	1.17	4	1.0	1.56	
		minimisation of failings in execution	5.00%	3.25%	4	1.00	0.13	3	1.0	0.10	
		minimisation of supplementary amendments	5.00%	3.25%	2	1.00	0.07	4	1.0	0.13	
		risks for the community	5.00%	3.25%	2	1.00	0.07	4	1.0	0.13	
		synergy potential from partnership cooperation	5.00%	3.25%	0	1.00	0.00	4	1.0	0.13	
		synergy potential among the local authority's departments	5.00%	3.25%	3	1.00	0.10	0	1.0	0.00	
		efficiency potential from long-term life cycle orientation	5.00%	3.25%	2	1.00	0.07	4	1.0	0.13	
sum = 100 %											
organisation / process of decision	15.00%	flexibility in service performance	20.00%	3.00%	5	1.0	0.15	2	1.0	0.06	
		response time of service performance	20.00%	3.00%	5	1.0	0.15	2	1.0	0.06	
		coordination of performance to a long-term life cycle orientation	40.00%	6.00%	2	1.0	0.12	5	1.0	0.30	
		audit	20.00%	3.00%	2	1.0	0.06	4	1.0	0.12	
sum = 100 %											
operational availability / users' safety	10.00%	unrestricted operational availability	50.00%	5.00%	3	1.0	0.15	4	1.0	0.20	
		guarantee of users' safety	50.00%	5.00%	4	1.0	0.20	3	1.0	0.15	
sum = 100 %											
quality of street network	10.00%	quality of the periodical routine measures	30.00%	3.00%	4	1.0	0.12	3	1.0	0.09	
		quality of the unscheduled ad hoc measures	30.00%	3.00%	4	1.0	0.12	3	1.0	0.09	
		quality of rehabilitation	30.00%	3.00%	3	1.0	0.09	4	1.0	0.12	
		QM-system existing	10.00%	1.00%	1	1.0	0.01	4	1.0	0.04	
			sum = 100 %	sum = 100 %							
					total staf PSC: 2.93		total staf PPP: 3.67				
itaf = target achievement figure, irrespective of the virtual project staf = target achievement figure, specific to the virtual project stef = target expectancy, specific to the virtual project total stef = total target expectancy, specific to the virtual project the higher the total swtef, the better the community's demands are achieved PSC = Public Sector Comparator PPP = Public Private Partnership											

Figure 1: Value benefit evaluation matrix PSC and PPP

- Creation of a target achievement figure specific to the virtual project (staf). The target achievement figure specific to the virtual project (staf) estimates the extent of target achievement situatively for the virtual project being calculated, e.g. using the Delphi method or an estimate by an individual expert. It (staf) serves to adjust the specified target achievements figures, irrespective of the virtual project (itaf), independently of the virtual project for the project delivery models being studied, to the specific circumstances of the virtual project and can vary from zero to one. If the target achievement figure specific to the virtual project (staf) is achieved in full in the virtual project, then the target achievement figure, irrespective of the virtual project (itaf) is equal to one. If staf is not achieved, itaf is equal to zero. Decimal points can be used to achieve possible nuances, especially for the input values for the Monte Carlo simulation (section 3.3.2)

3.3.2 Risk-based evaluation process

The specific target expectancy figures (stef) of each secondary objective are evaluated by multiplying the target achievement figure, irrespective of the virtual project (itaf) with the target achievement figure specific to the virtual project (staf) and the relative weighting factor (rel. wf). An aggregation of the target expectancy figures for all the secondary objectives produces the total target expectancy figure of each delivery model (traditionally or PPP) as a deterministic value. To evaluate the variation of the total target expectancy figure (total stef) and the related sensibility in regard to changes or variation of the specific target achievement figure for each secondary objective (staf), each staf must be defined by three values (min staf, staf_{EP}, max staf) and a discontinuous or continuous distribution function. During the Monte Carlo simulation “j” random numbers are generated for each secondary objective and aggregated in each simulation run (Fig. 2). The Monte Carlo simulation simulates different cases “j” where the staf factor and their different characteristic of combination with all the secondary objectives will be analysed in relation to the total stef_j per simulation run..

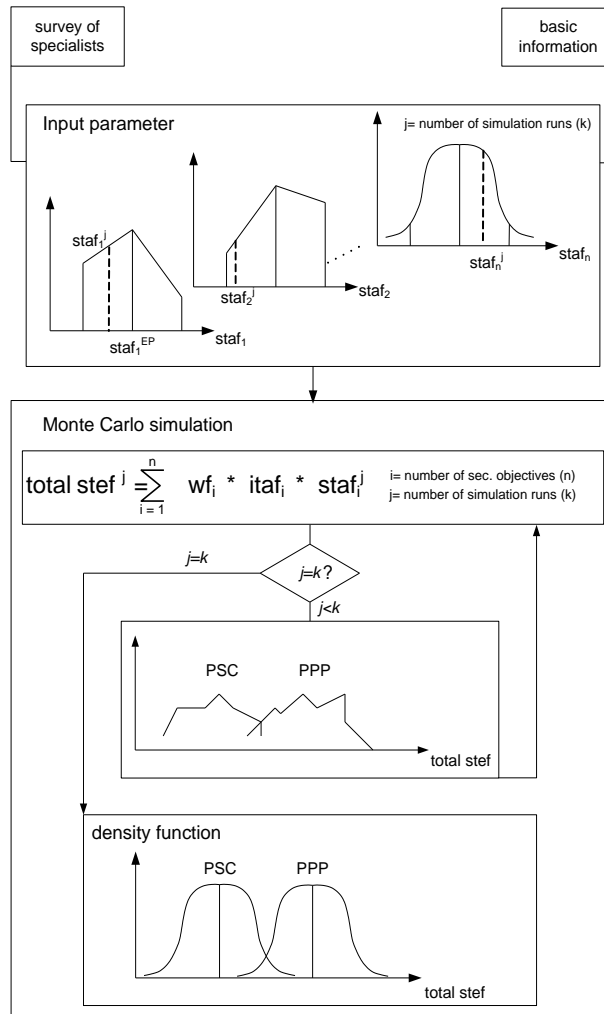


Figure 2: Monte Carlo Simulation

The bandwidth of possible value benefits can be illustrated by the Monte Carlo simulation by simulating the project-specific target achievement levels of a project delivery model. Each simulation run produces a possible scenario. 10000 runs produce 10000 scenarios, whose probability distribution can be illustrated using a density function.

3.3.3 Information provided by risk-based evaluation

The risk-based evaluation supplies three statements. It generates information on the choice of the most efficient delivery model for street maintenance and rehabilitation of the relevant community on the basis of the various primary and secondary objectives to aid the decision-making process. Using Monte-Carlo simulation the entire probable bandwidth of possible target achievement levels and their likelihood of occurrence can be revealed. The total target expectancy figure for each street maintenance delivery form (total stef) produces a risk-oriented objectified decision-making basis for the selection of the most efficient delivery model for street maintenance and rehabilitation .

4. Conclusion

By using Monte Carlo simulations in the value benefit evaluation, communal decision makers achieve a basis for evaluating their decisions with possible bandwidths (function) for the total target expectancy figure

for each street maintenance delivery model (total stef) in order to be able to select a delivery form offering the most efficient cost/performance structure. Within the framework of the multi-level decision-making process for or against the use of a PPP, the method presented in this paper can be used, both prior to the PPP for initial rough analysis of cost efficiencies, and as proof of the actual cost efficiency, based on the bids submitted by the contractors. The economic comparison resulting from this research project is being developed directly for practical use. It can be flexibly applied to other areas of public sector works, e.g. building maintenance. The method can also be used for the cantonal and federal road networks in Switzerland since, by examining the communal street network, the most complex form of road infrastructure in both technical and organizational terms was analyzed.

5. References

- Busch, Th. A. (2003). "Risikomanagement in Generalunternehmen: Identifizierung operativer Projektrisiken und Methoden zur Risikobewertung", Eigenverlag des IBB, ETH Zurich, Zurich.
- Girmscheid, G. (2004). "Projektentwicklung in der Bauwirtschaft", Springer Verlag, Berlin.
- Girmscheid, G. (2005). "PPP Delivery Models for Maintenance and Rehabilitation of Community Street Networks in Switzerland", *Proceedings of ISEC 03*, Shunan, Japan.
- Grimsey, D. and Lewis, M. K. (2004). "Public Private Partnerships", Edward Elgar Publishing Inc., Massachusetts.
- HM Treasury (2000). "Public Private Partnerships: The Governments Approach", Printed in the United Kingdom for The Stationery Office, London. (<http://www.hm-treasury.gov.uk/media/1D111/80.pdf>)
- Jacob, D. and Kochendörfer, B. (2002). "Effizienzgewinne bei privatwirtschaftlicher Realisierung von Infrastrukturvorhaben". Bundesanzeiger Verlag, Köln.
- Jacob, D. (2003). "Erstellung eines Gerüsts für einen Public Sector Comparator bei vier Pilotprojekten im Schulbereich", Technische Universität Bergakademie Freiberg, Freiberg. (<http://www.ppp.nrw.de/>)
- Merna, T. and Owen, G. (1998). "Understanding the Private Finance Initiative", Asia Law & Practice Publishing Ltd., Hong Kong.
- Yin, R. K. (1994). "Case study research: design and methods", Sage Publications, Inc., Thousands Oaks.

Reducing Overruns In a Volatile AEC/FM Market: Can Vendor Planning and Estimating Software Help?

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Abstract

The 21st Century has seen an intensified usage of IT systems in almost all human operations. Faced with the pressure of management of information and or lack of it, highly competitive and complex work environments coupled with the multidisciplinary nature of the work place and diverging interests, post-modern managers have resorted to designing gadgets and/or systems that do not think independently per se, but are faster in information processing. Such systems support managers in dealing with the challenges of project related work, more so in developing nations where economic volatility is usually the norm. However, the availability of the much-needed information and communication technology (ICT) systems essential to cost engineering are pricey and may not be guaranteed in certain situations; hence optimising available systems cannot be over emphasised.

This research looks at the possibility of using basic vendor software for planning (scheduling) and estimating to reduce time and cost overruns in the Architecture, Engineering, Construction and Facilities Management (AEC/FM) industry in Zambia.

Keywords

AEC/FM Market Volatility, Time and Cost Overruns, Planning and Estimating Software

1. Introduction

The generic nature of Architectural, Engineering, Construction and Facilities Management (AEC/FM) business is such that it is highly complex and competitive, and uses a multidiscipline work force. As a result there is constant pressure to manage business knowledge and information. Therefore, information and communication technologies (ICT) are handy because they are faster at information processing; hence facilitating decision-making. Such systems support managers in dealing with the challenges of project related work, more so in developing nations where economic volatility is usually the norm. However, the availability of the much-needed information and communication technology (ICT) systems essential to total

cost and schedule management are pricey, and may not be guaranteed in certain situations; hence the optimising of available systems cannot be over emphasised. This research covers a validation exercise on the possibility of using basic vendor software for planning (scheduling) and estimating to reduce time and cost overruns in the Architecture, Engineering, Construction and Facilities Management (AEC/FM) industry in Zambia.

1. Construction Time and Cost Overruns Trends in Macro-Economic Zambia

From the 1980s, the Zambian economy has been exhibiting a downward trend (Lopes, 1998). However, construction still contributes a huge percentage to the Gross Domestic Product (GDP). According to the Ministry of Finance and Economic Development (MOFED, 2000), economic indicators such as inflation, interest rates, base rates and currency strength have been fluctuating at increasingly unpredictable rates. For instance, in 1991, inflation was 93.4% while in 1999, it was 20.6%. Even though a downward trend has been the case with inflation rates, they still remain extremely high at 17.4% in the first quarter of 2005. Because of the macro-economic environment in Zambia, most construction projects encounter severe time and cost overruns. For instance, in the year 2000, research based on questionnaire response from 33 professionals found that 47% of them were experiencing time and cost overruns on their projects, even though fluctuations were taken care of separately (Matipa, 2000). Therefore, a lot more needs to be done to reduce overruns in the construction business.

1.1 Key Drivers of the Demand for Automated Systems in Planning and Estimating

The key drivers of the increasing demand for automating the planning and estimating processes in construction in the Zambian construction industry (ZCI) have been:

- the increase in speed with which data can be analysed and used to make a plan;
- the efficiency of the planning and estimating processes, and increased accuracy of the plans;
- increased demand by clients for technical competence, and the reported benefits of such systems;
- a volatile social, political, and economic environment;
- a lack of a continuous supply of construction projects;
- the general lack of central construction business information (Matipa, 2000);

1.2 General Overview of Planning and Estimating

Planning influences the future by facilitating the making of decisions based on the identification of missions, needs, and objectives (Bates, 2004). It is used to define the actions and activities, the time and cost targets and the performance milestones that will result in the successful achievement of objectives (ibid). The major elements of planning in the construction business include 'Time Planning', 'Cost Planning', 'Resource Planning', and 'Quality Planning'. Once the plan has been converted into a road map it would, if followed, assure timely project completion. Once completed, planning changes into scheduling (ibid). Scheduling provides a basis for management of the work, improves communications and facilitates coordination. Using a schedule improves the effective use of resources (Werderitsch, 2004). The Chartered Institute of Building (CIOB, 1997) defines construction estimating as the process of predicting costs of construction. However, the further into the future we go, the more uncertain and complex the process becomes (Smith, 1995). Planning and estimating the cost of construction business products in a volatile economic environment is relatively complex, hence the need to use automated systems to capture, assimilate, and disseminate key business data. Therefore, integrating planning and estimating activities is crucial for the construction business.

2. Anticipated Benefits of Using Combined Schedule and Cost Data in Construction Business

There are various systems used to integrate schedule (time) with cost information when running a construction project. The fundamental argument is that because cost can be a function of time, they can affect each other (Kerzner, 2003). Earned value analysis (EVA) is a well-established system that integrates schedule and cost data. It can be defined as the value – expressed in monetary terms – of the work accomplished up to a point in time based upon the estimated value of that work (Brandon, 1998). Implementation of EVA, according to Mahler and Mazina (1980), can be achieved if schedule data (time planning) and cost estimate data (cost information) is integrated to produce performance reports. The benefits of using this concept have been reported worldwide (Kerzner, 2003); making EVA one of the best systems for use in project based business management. The proliferation of software systems that support earned value analysis has made it easier to integrate schedule and cost data. Theoretically, such a development is key to nations that have volatile economic environments because the process of integration is simplified. However, there has been a severe underutilisation of such software systems (Matipa and Kashweka, 2004). This paper reports a validation research exercise on how professionals in the Zambian construction industry rate the environment in which they work, and how they rate their ability to use planning and estimating software, with a view to reducing time and cost overruns.

3. Research Design and Data Collection

The professionals that participated in the research are tabulated in Table 1. There was no key criterion for sampling respondents because the number of registered professionals within the built environment is fairly limited. Therefore questionnaires were availed to every registered professional. Those that participated in the research formed a sample of the general population obtainable from registration authorities, such as the National Council for Construction. Because of the geographical dispersion of respondents it was prudent to use a questionnaire as a data collection tool. Out of a total of 60 construction related professionals, 33 responded to the questionnaire, which works out to 55% percent response rate. This response rate is sufficient enough to form a conclusion.

Table 1: Category of Respondents and the Response Rate

Respondent Category	Sample (n)	Response (Nr)
Engineers	10	5
Local Contractors	22	8
Property Management/Valuation Surveyors	6	3
Quantity Surveyors	8	7
Architects	11	7
Co-operative Organisations	3	3
Totals	60	33

4. Data Presentation, Analysis and Validation

Data presentation and analysis in this research paper is extremely brief because of the general limitation on the length of the paper. Sixteen conclusions were arrived at in the overall research, indicating that:

- (i) A 55% response rate was representative enough for the Zambian industry to respect the research results;
- (ii) 47% of the projects worked on by respondents, since 1985, experienced time and cost overruns;

- (iii) Consultants handle the management of more projects than contractors;
- (iv) Two out of three projects ended at documentation stage, i.e. were never constructed;
- (v) The economic indicators in Zambia are highly unpredictable and volatile;
- (vi) 88% of respondents used computer packages and that, on average, 1993 was the commencement year for automating business processes;
- (vii) Contractors had a better record of computer usage, followed by quantity surveyors, then architectural firms, and others;
- (viii) 84% of respondents had word processing and spreadsheet packages;
- (ix) Planning (scheduling) and cost estimating is largely a preserve of the quantity surveyor;
- (x) There were only three firms who had dedicated planning and estimating software;
- (xi) On 156 projects, 26% of them had overruns despite using application software;
- (xii) Despite rating the economic environment, 53% of professionals rely on approximate estimating systems such as cost plus percentage;
- (xiii) 84% are of the view that planning and estimating software is crucial to the industry;
- (xiv) Every respondent views the traditional procurement system as having a large influence on construction business systems available in Zambia;
- (xv) It is possible to reduce time and cost overruns using planning and estimating software;
- (xvi) The industry has enough computer resources to implement recommendations.

Using a scale of 1 – 10, respondents were asked to grade these findings. Figure 1 shows the results of the validation exercise. The figure shows findings denoted with the abbreviation ‘Ob’ to stand for ‘Observation’, and a number. Response rates show a general trend in the way professionals perceive the research findings. A critical review of the curvature of the graph shows a uniform pattern. For instance, not all respondents rated observation three (Ob-3) as highly as they did observation twelve (Ob-12), indicating that they were not comfortable with the conclusion that more projects were attributable to consultants than contractors, yet they all observed that overruns are endemic in the industry and that as a result it is necessary, in their own view, to use planning and estimating software to reduce the time and cost overruns.

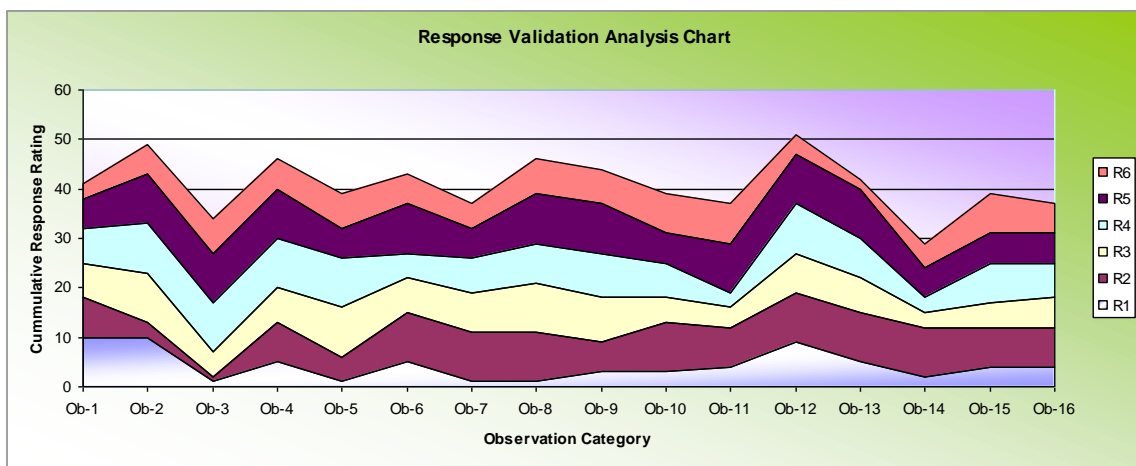


Figure 1: The Response Validation Analysis [Source: Author, 2005]

5. Conclusion and Recommendations

Generally, the AEC/FM industry based business is highly competitive, complex, and has a multidiscipline professional base. Operating in such an industry in a nation that has a volatile social economic and political environment exacerbates the problems typically associated with construction. Time and cost overruns are inevitable. However, the speed with which a professional can capture, assimilate, synthesise and disseminate relevant data is crucial to the overall schedule and cost management of construction business. Vendor time and cost management systems such as planning and estimating packages are particularly useful in such an endeavor. However, software of itself cannot solve the problem unless professionals are able to integrate the data created by the several automated systems so that they can optimise the power of the different software packages. Although customised software is available, it is usually too expensive for most professionals in developing economies, such as that in Zambia; hence using of-the-shelf available systems, such as the MS suite, could alleviate the problem of time and cost overruns in the short term. However, in the long term the development of transferable data files is absolutely essential. This forms the next tanche of the authors planned research.

6. References

- Bates, J. (2004). "Planning", *Skills and Knowledge of Cost Engineering 5th Edition*, AACE International, Morgantown, USA, Pp 12.1 – 12.6, Editor: Amos, J. Scott
- Brandon, D. M. (1998). "Implementing Earned Value Easily and Effectively", *Project Management Journal*, PMI, Vol. 29, Pp 11 – 18.
- CIOB (1997). *Code of Estimating Practice, 6th Edition*, CIOB & Longman, Hampshire, UK.
- Kerzner, H. (2003). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 8th Edition*, John Wiley & Sons, Hoboken, New Jersey, USA.
- Lopes, J. (1998) "The Construction Industry and Macro economy in Sub-Sahara Africa post 1970", *Construction Management and Economics*, Vol. 16. No. 6, Pp 637 – 649, E & FN Spon, London.
- Mahler, F. and Manzina, M. (1980) "Implementing earned value reporting" *AACE International's Professional Practice Guide to Earned Value 1999 Edition*, Morgantown, USA, Pp A8.1 – A8.4, Editor: George R. Stumpf.
- Matipa, W.M. (2000). "Reducing Time and Cost Overruns in Zambia: The Project Planning and Estimating Software Way", M.Sc thesis, Heriot-Watt University, Edinburgh, Scotland.
- Matipa, W.M., Kashweka, S. M (2004). "Evaluating a Construction Business Information Service (CBIS) for a Developing Country: A Case of Zambia", *Journal of Engineering, Design and Technology*, Vol.2, No.1, June 2004, Pp1 – 15.
- MOFED (2000). "Economic Report 1999", Ministry of Finance and Economic Development, Lusaka, Zambia.
- Smith, N. J. (1995). *Project Cost Estimating: Engineering Management*, Thomas Telford, London, UK.
- Werderitsch, J. A. (2004) "Scheduling", *Skills and Knowledge of Cost Engineering 5th Edition*, AACE International, Morgantown, USA, Pp 13.1 – 13.8, Editor: Amos, J. Scott, The Education board of the AACE.