Sahadevan, V., and Varghese, K. (2018). "Stakeholder Value Evolution, Capture and Assessment in AEC Project Design." In: *Proc. 26th Annual Conference of the International. Group for Lean Construction (IGLC), González, V.A. (ed.)*, Chennai, India, pp. 549–559. DOI: doi.org/10.24928/2018/0403. Available at: www.iglc.net.

STAKEHOLDER VALUE EVOLUTION, CAPTURE AND ASSESSMENT IN AEC PROJECT DESIGN

Vijayalaxmi Sahadevan[1] and Koshy Varghese[2]

ABSTRACT

The success of a design lies in its ability to fulfill client values. However, the ambiguity in identification of values by clients renders the task complex and challenging. The investigation of the dynamics involved in stakeholder definition of the project values entails the need for research methods used in social sciences. This paper first presents the process of client value generation and evolution based on an ethnographic study of the architect selection process of two institutional buildings. The study consists of participant and non-participant observations of the project conceptualization and architect selection process. It is observed that along with client requirements incorporated in architectural design, the design delivery efficiency criteria of the architect have equal considerations in architect selection. Therefore, the values in Architecture Engineering and Construction (AEC) design can be categorized into Project Design Delivery Values (PDDVs) and Architectural Design Values (ADVs). The paper proposes a framework for the evaluation of design of a built facility using suitable Multi-Criteria Decision Making (MCDM) technique.

KEYWORDS

Choosing by Advantage (CBA), Set Based Design (SBD) and Target Value Design (TVD), Value in Design

INTRODUCTION

As per the Transformation Flow Value (TFV) theory, it is imperative that AEC project design be viewed through the lens of value in addition to transformation and flow (Ballard and Koskela 1998). Product design and development in general is getting more customer focused (Boztepe S. 2007) with growing impetus on definition and measurement of client satisfaction. However, in the AEC industry the definition of client requirements in itself is challenging due to the presence of diverse perspectives of project

[1] Doctoral Student, Dept. of Civil Engineering, Building Technology and Construction Management, Indian Institute of Technology Madras, India, svijaya16@gmail.com

[2] Professor, Dept. of Civil Engineering, Building Technology and Construction Management, Indian Institute of Technology Madras, India, koshy@iitm.ac.in

performance of multi stakeholder client bodies (Thomson 2011). A study on the design process for residential and commercial projects in India revealed that the strategies and the durations of the design of a particular organization was dependent on its design objectives (Joe et al. 2017). This property of variability in outcomes is one of the basic differences between designing and building leading to the unpredictability of the design process (Ballard and Zabelle 2000).

Understanding client value in construction is challenging owing to the extended time taken for completion of projects and the presence of stakeholders with conflicting objectives. Due to the multidimensional, subjective and dynamic nature of value, arriving at an agreement on a set of values for an AEC project is a challenge. It can be stated that, the success of a design lies in its ability to fulfil client values. However, the ambiguity in the identification of values by clients renders the task complex.

This paper presents the process of client value generation and evolution which are based on an ethnographic study of the architect selection process of two institutional buildings. Section 2 presents findings from the literature on value in design. Section 3 describes the scope and methodology of the exploratory study. The accounts of the ethnographic study and its findings are presented in section 4. Section 5 presents a framework for assessing the value in design as a method for choosing between design alternatives. The final section summarizes the current work and recommends scope for further research.

LITERATURE REVIEW

Despite ongoing efforts by researchers to develop a theory of value in the construction industry, a common definition has not materialized. Value has been defined variedly in literature (Derek et al. 2003). Traditionally, the values in an AEC project have been related to time, cost, quality, safety, environment, function, etc. However, studies show that investment in a good design produces economic and social returns. These studies provide evidence in the areas of healthcare, education, housing, business, crime prevention, civic pride and cultural activities. However, value and cost are not linearly related and returns of the cost expended on design are usually intangible (MORI 2002). Unlike product design, design brief in AEC is not limited to initial requirement definition but includes a constant dialogue between stakeholders (Thomson 2011).

Literature has reported a number of tools and techniques for value capture in the AEC industry. Researchers at the Loughborough University have developed the technique to deliver value integrating stakeholder judgement into the design process known as VALiD®. It consists of a platform for understanding, defining and assessing the value proposition. The technique calls for workshops for aiding the stakeholders to have a common vision and understanding of set of values for an AEC project (Thomson et al. 2006).

Quality Function Deployment (QFD) is another tool that has been adopted successfully in the manufacturing industry for capturing client requirements. Literature has also reported the application of QFD to address client requirement capture in

construction. However, the role of QFD is limited to the pre-design phase and is market focussed. The complicated nature of construction projects renders the process of development of QFD matrices large and complex (Pheng L. S. 2001). Further, client requirement capture in QFD are predominantly static in nature and the model does not provide for the stakeholder subjectivity. Similarly, the concept of value in design is often confused with Value Engineering technique, which predominantly focuses on value for money in terms of construction techniques and materials, rather than stakeholder aligned requirements.

The Technique of Target Value Design (TVD) is believed to have the potential to address this dynamic nature of values through stakeholder interactions throughout the design process. TVD is a process that aims at providing best value to the owner through pain share gain share mechanism, between the stakeholders. Although TVD has the potential to reduce the likelihood of cost overruns, it has not been widely adopted in the construction industry. This is due to the inherent difficulties in measurement of value and design quality and the need to perform frequent cost-benefit analysis (Orihuela et al. 2015).

Literature reports number of tools and indices for assessing design quality. Design Quality Indicator (DQI) developed based on a research project in UK, is one such toolkit for measuring the quality of a built facility and to aid in the decision-making process during design (Gann et al 2003). Other tools include the Post-Occupancy Review of Buildings and their Engineering for post occupancy evaluation (Leaman and Bordass, 2001), Housing Quality Indicator (HQI) for housing projects (DTLR, 2000) and Building Research Establishment Environmental Assessment Method (BREEAM) which provides measures of energy use in construction.

Literature confirms that stakeholder requirements in AEC projects are pluralistic and complex in nature. Moreover, the iterative, explorative and reflective nature of design suggest limitations in effective applications of the existing tools in managing design requirements (Thomson 2011). In order to develop a strategy for value assessment, the emergence of stakeholder requirements through the design process needs to be studied.

SCOPE AND METHODOLOGY

This work explores the process of client value generation and evolution which are based on ethnographic study of the architect selection process of two institutional buildings. Ethnographic study typically involves spending extended periods of time on the field that one researches, employing participant and non-participant observations, memoing, interviewing and reflecting their own role in the research setting. However, due to its time consuming nature, recent approaches employ techniques that are participatory and that can be tailored to the specific research objectives and settings (Pink et al. 2010).

In the current study, the two institutional buildings were chosen based on convenience sampling. The total area of both the institutional buildings is approximately 500 acres and the scope of work covered development of the master plan for the entire campus, including detailed design of academic zone and common bulk services and development.

In both the projects, the proposed master plan was to be designed for a capacity of 20,000 students, to be developed in three phases over a span of 20 years.

The ethnographic study consisted of participant and non-participant observations of the project conceptualization and architect selection process. The first author was a part of the team involved in the drafting of design brief for the project, studying and analysing the proposal documents submitted by the architects. The second author was a member of the committee involved in design evaluation. In addition, semi-structured in-depth interviews of nine key informants and document analysis were conducted. The key informants in this study were the committee members consisting of architect consultants, engineering consultants, directors of the respective institutions and other members who are experts in the field of engineering, project management or architecture.

The main objective of the interviews was to study the difficulty in specifying stakeholder requirements in the design brief. The key informants included committee members The overall objectives of the ethnographic study were threefold: (i) to study the stakeholder understanding of value in design and the current practice of value capture, (ii) to study the dynamics of stakeholder values through the design process and (iii) to derive a set of stakeholder values for a typical institutional building. The interview transcripts, documents and memos were analysed using content analysis using open coding. The outcomes of the study are discussed in the next section.

OUTCOMES OF THE EXPLORATORY STUDY

The documentation and analysis of the exploratory study a number of outcomes were observed with respect to the constraints in the selection process, design process and design requirements. This section discusses these outcomes. Due to space constraint single interview intercept has been included with respect to each outcome.

CONTEXT AND CONSTRAINTS OF THE ARCHITECT SELECTION PROCESS

The design and construction of the two Institutional buildings are funded by the Government of India and the selection and employment of architect consultant is governed by General Financial Rules (GFR), which is a part of the Ministry of Finance, Government of India. The GFR has been formulated to standardize the procurement of consulting services across government agencies with mandated levels of objectiveness and transparency (MoF 2017). According to the GFR rules, the architects are evaluated in three broad stages: the eligibility, the technical and the financial bid.

The selection framework entails a procedure that mandates 'Combined Quality cum Cost Based System' for architect evaluation. In this system, the pre-qualified architects are evaluated based on the design proposal and financial bid carrying weights in the ratio of 80:20. The intent of keeping the above ratio is to select an architect deemed most competent for the work rather than evaluating them solely based on price. A higher weight for the technical bid was deliberated for the process instead of equal or nearly equal weightage. This is to avoid an architect from winning the bid by quoting a very low

price, despite of a poor performance in the technical bid. The overall procedure for architect selection consists of the steps illustrated in figure 1.

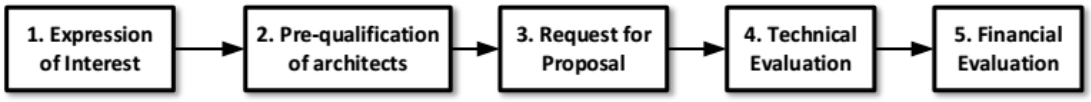


Figure 1: Steps in Architect Selection Process

Step 1: The process of architect selection begins with the publishing of Expression of Interest which gives information regarding the scope and pre-qualification criteria. The criteria evaluate the experience and competency of the participating architectural firms.
Step 2: The interested architects submit applications out of which only the technically competent architects are qualified based on the given criteria for technical evaluation.
Step 3: The pre-qualified architects are provided with the Request for Proposal (RFP) containing the design brief.
Step 4: The submitted design proposals are assessed to determine how well it caters to the requirements as mentioned in the design brief. The technical evaluation thus consists of an initial shortlisting of design proposals of prequalified architects. The shortlisted architects have to present a modified design by incorporating the suggestions from the stakeholders. At the end of the technical stage the architects are scored based on their design proposals.
Step 5: The financial bid of the top three architects of the technical stage is opened. The architect with the highest combined final score (technical score + financial score) is awarded the work.

EARLY INVOLVEMENT OF KNOWLEDGEABLE PROJECT STAKEHOLDERS

The director of institution 1 has served on committees for setting up of a number of new campuses in India among other responsibilities. The director elaborated on the owner's role in specifying design requirements as follows:

"The requirements have to come from the owners and if they don't have the capacity, they have to get good advisors to work with them. Either hire or appoint people with experience to understand academic building requirements to understand design and construction and appoint few advisors, to work with them."

The design brief is prepared by a committee consisting of the director and other experts in the area of architecture, engineering and project management to develop a design brief. The committee in this case represents the clients of the project. The early involvement of various experts can bring the knowledge and expertise of diverse fields together. The following paragraph describes the emergence of social value characterised by interdisciplinary interactions that evolved through such dialogues between stakeholders.

SOCIAL VALUE OF INSTITUTIONAL BUILDINGS

A senior retired officer of a public works agency, who is a committee member, spoke about social value in institutional buildings:

"We can't have a department functioning solely on its own, independently without interacting with others. In the whole campus this interdisciplinary interaction has to be brought in. How are we going to bring it, is for the architect and for us to discuss and bring it (in design). That's a challenge."

The design of institutional buildings should cater to the needs of fast growing interdisciplinary research. Apart from labs, the functional planning of the campus and individual buildings should cater to creating environments and opportunities for interactions of students and faculties to the maximum. Interdisciplinary interactions form the social value of a built facility.

As the design progresses, retrospection and reflection through dialogues between project stakeholders aided in specifying requirements such as provision of cafes and positioning of departments to facilitate interdisciplinary interactions. It was observed that stakeholders usually go back and forth with design solutions arising from differences in perspectives and finally arrive at a consensus through mutual agreements on trade-offs. The following paragraph discusses how iterations in design are essential in avoiding ambiguity in providing design requirements.

DESIGN AS AN ITERATIVE PROCESS

The director of institution 2 expressed his difficulty in giving requirements for design.

"The problem is to decide, to what level we should specify the requirements, because if you specify too much, then we will probably remove all the freedom which the architect should have in the design."

Clients articulate their values in the form of requirements in the Request for Proposal (RFP), which is a document that solicits proposals through a bidding process. The RFP gives brief details on the project background, site details and requirements, facilities to be planned, scope of work, etc. With the progress of the design, clients becomes more and more aware of his requirements. There is a collaborative effort in the form of dialogues between the client and the designer to improve the design to best meet the stakeholder values. In ideal situations, it is imperative that a design should undergo a number of iterations until any further meetings do not add value to the design.

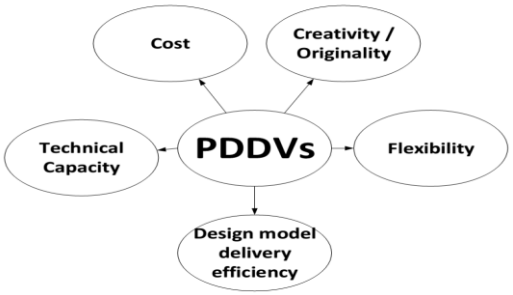
Through the process of iterative dialogues between the stakeholder groups a number of values were captured and further these values evolved into detailed design requirements. These design values can be either subjective or objective in nature which are discussed in the following section.

PROJECT DESIGN DELIVERY AND ARCHITECTURAL DESIGN VALUES

The pre-qualification of the architect is based on the criteria such as organisational strength of the applicant, experience of work and financial capability. Apart from this, during the final presentations of the design proposal the committee tries to understand the design delivery capabilities of the architect. This is assessed based on the firm's history of successful design delivery, cohesive functioning of the design team, BIM platform, coordination and integration with lead consultant office, organizational setup for quick

response, etc. These criteria point to Project Design Delivery Values (PDDVs), which are said to have significant influence on the performance as an architect consultant.

In institutional buildings, in addition to traditional values of time, cost, safety, quality and sustainability, there are a number of other architectural design considerations which have direct impact on the users of the facility. These values are Architectural Design Values (ADVs) and can be either subjective or objective in nature. From the study of the various stages of architect selection process the following set of PDDVs and ADVs were derived.



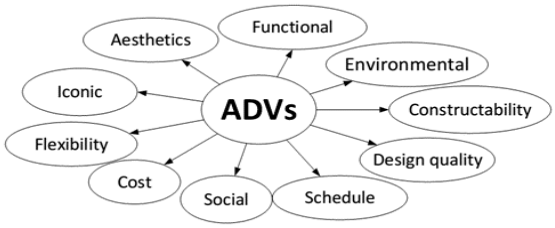


Figure 2: Project Design Delivery Values **Figure 3: Architect Delivery Values**

Figures 2 and 3 illustrate a set of stakeholder-aligned values for both the institutional projects. PDDVs reflect the project management capabilities of an architect and gives indications about the delivery performance of an architectural team. Technical capabilities of an architect are criteria such as previous experience, organizational, technological and financial capabilities of the firm which are purely objective in nature and form the eligibility criteria for competing in the bidding process. The other PDDVs include cost, creativity and originality, flexibility in making changes to the design and the efficiency with which the architect delivers the design documents.

The PDDVs are considered objective in nature as some criteria can be judged based on the quality and scale of the team's previously delivered projects and others that can be tied to the contractual agreement. These values can be associated with the character and commitment of the architectural team. The study of the technical evaluation process revealed ADVs, which are related to the technical and quality aspects of the designs. These values are related to the stakeholder requirements for the built facility as specified in the RFP. ADVs are inherent in the architectural plans and features of a building design. These values are tailored to the specific project and need careful consideration of client behaviours and demands.

As discussed in the previous sections, design values have different levels of abstractions. A few of these values, such as aesthetics, are predominantly subjective in the initial stages and evolve into objective specifications with the progress of the design process. The next section explains this aspect with an example of functional value of design.

VALUE ASSESSMENT

Values as derived from the design brief are usually abstract which evolves into more detailed design requirement with the progress of design. As a result, although values that appear to be subjective during the initial stages of the design, can be broken down into more objective details. Figure 4 illustrates the different abstraction levels of 'functional' value of design.

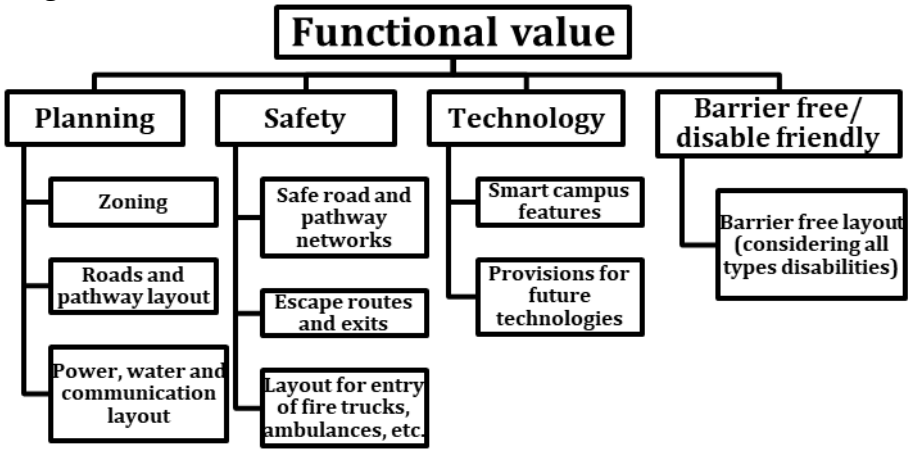


Figure 4: Abstraction levels of ADV value

The abstraction levels are derived from the architect selection process through design iterations and stakeholder dialogues. It is clearly observed that at lower levels, the values are more objective in nature. This paper proposes a framework for assessing the value of a design alternative based on the parameters obtained from the ethnographic study.

DESIGN AS A MULTI-CRITERIA DECISION MAKING PROBLEM

In the ethnographic study a number of instances emerged where the incorporation of one value was conflicting with another. The discussions between project stakeholders during the technical evaluation revealed a number of instances of conflict between design values. The inception of any technical institute is subjected to a number of uncertainties such as, the type of research that the institute will pursue in the future. During the design of the master plan however, specification of requirements is essential in order to provide for research facilities. In the current study the master plan is to be planned keeping in view the provisions for the next 20 years. This calls for flexibility in design. In many institutes the concept of flexibility is met through open buildings or modular designs, wherein the labs can be easily customised to cater to future requirements. However, this solution can constrain designs with specific aesthetic design requirement.

Similarly, the site of one of the institutes was characterised by the presence of a number of water bodies, rocky outcrops, marshy areas and paddy fields. The consideration and preservation of these features pose major constraints in designing the layout of the master plan and the total buildable area.

Due to the above trade-off problem, arriving at a consensus on design alternative can be challenging, especially with the presence of multiple stakeholders with diverse

expertise and objectives. Multi-Criteria Decision Making (MCDM) techniques are used in ranking and choosing from available alternatives based on weights given to the criteria which are sometimes conflicting (Ho 2008). MCDM techniques have been applied to a wide range of areas such as business, production, energy and environment, economy, etc. (Mardani et al. 2015). The AEC and lean design management literature has reported the use of Choosing by Advantage (CBA) for decision making processes. CBA developed to compare advantages of alternatives. The technique is again based on criteria of alternatives and stakeholder preferences for the advantages. The application of CBA in SBD and TVD have also been discussed in lean literature (Arroyo 2014).

The current work proposes that choice of design alternatives be viewed as an MCDM problem, wherein given multiple design alternatives, the best design can be chosen considering design values as criteria. The following section describes a framework for evaluating and ranking the design alternatives.

FRAMEWORK FOR EVALUATION OF VALUE IN DESIGN

The proposed framework in this work uses MCDM technique to choose between design alternatives. The figure below represents the steps involved in the framework.

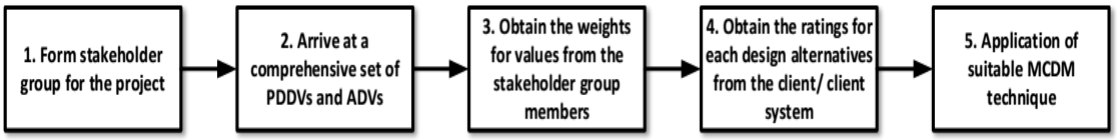


Figure 5: Framework for evaluation of value in design

The steps involved in the framework are as explained below.

Step 1: Form a stakeholder group consisting of representatives/experts from domains which are part of the entire lifecycle of the project.

Step 2: Arrive at a comprehensive set of aligned PDDVs and ADVs depending upon the type of project and the stakeholder group aspirations. The set of values utilized in arriving at criteria can be used as inputs for the questionnaire survey to obtain ratings from the client system in step 4 of the framework.

Step 3: Experts from diverse areas tend to have differing opinions and objectives, because of which all values will generally not assume equal weights. Weights given to PDDVs and ADVs reflect the relative importance to aid in the evaluation and ranking of the design alternatives.

Step 4: The ratings given against a particular value could be subjective or objective in nature. The ratings for each value are solicited from the client in the form of a questionnaire survey that considers the PDDV and ADV criteria derived in step 2.

Step 5: This step involves the choice and application of suitable MCDM technique. The technique chosen should facilitate group decisions. The choice of MCDM technique will depend on whether the user aims to choose, rank or classify the alternatives.

SUMMARY AND SCOPE FOR FURTHER RESEARCH

The paper initially provides an account of the study that was conducted to understand the process of definition design values of two institutional buildings through an ethnographic study. The study reveals the significance of the presence of diverse experts and their involvement in defining the design brief. The study gives accounts of the capture and evolution of a comprehensive set of design values through iterative dialogues between stakeholders. Two categories of design values, viz. PDDVs and ADVs, for construction project designs were identified. Further, the study witnessed the evolution of PDDVs and ADVs into objective detailed design requirements.

The outcomes of the study provide a foundation for a new framework for assessing a design based on these values. The framework mainly considers stakeholder group preferences for evaluating and ranking design alternatives using appropriate MCDM technique.

The proposed framework can be modified to suit any type of AEC project to aid in decision-making between design alternatives. The scope for incorporating this framework into design visualisation tools requires further exploration. While the technique would aid in assessing and hence choosing between designs, its application can be further extended to provide automated value assessment of design for software that explore and generate multiple design alternatives.

REFERENCES

Arroyo, P., Tommelein, I. D. & Ballard, G. (2014), “Comparing AHP and CBA as Decision Methods to Resolve the Choosing Problem in Detailed Design”, *Journal of Construction Engineering and Management*, 141(1).

Ballard, G. & Koskela, L. (1998), "On the Agenda of Design Management Research", *6th Annual Conference of the International Group for Lean Construction*. Guarujá, Brazil, 13-15 Aug 1998.

Ballard, G. & Zabelle, T. (2000), "Lean Design: Process, Tools & Techniques", *Lean Construction Institute White Paper-10*, October 20, 2000.

DTLR (2000) "Housing Quality Indicators", *DTLR*, London.

Gann, D. M., Salter, A. J. & Whyte, J. K. (2003) "Design Quality Indicator as a tool for thinking", Building Research & Information, Vol 31(5), September- October, pp.318-333.

MoF (2017) "General Financial Rules", *Department of Expenditure*, India

Ho, W. (2008). Integrated analytic hierarchy process and its applications – a literature review. European Journal of Operational Research, 186, 211–228.

Hwang, C. L. and Yoon, K. S. (1981) "Multiple attribute decision making: methods and applications." *Springer-Verlag*, Berlin.

Joe, M., Sahadevan, V. & Varghese, K., (2017) "Design Process Standardization for Building Projects in India." *The 6th World Construction Symposium 2017*, Colombo, Sri Lanka, 30th June - 2nd July 2017.

Leaman, A. & Bordass, B. (2001) "Assessing building performance in use 4: the Probe occupant surveys and their implications" *Building Research & Information*, 29(2), 129–143.

Mardani, A., Jusoh, A., Nor, K. M. D., Khalifah, Z., Zakwan, N., & Valipour, A. (2015) "Multiple criteria decision-making techniques and their applications – a review of the literature from 2000 to 2014", *Economic Research*, 28:1, 516-571

MORI (2002) "Public attitudes towards architecture and the built environment". Research carried out by the MORI Social Research Institute for CABE.

Pheng, L. S. & Yeap, L. (2001) "Quality Function Deployment in Design/ Build Projects" Journal of Architectural Engineering, Vol. 7, No.2, June, 2001.

Pink, S., Tutt, D., Dainty, A. and Gibb, A. (2010) "Ethnographic methodologies for construction research: knowing, practice and interventions." *Building Research and Information*, 38(6), pp. 647-659.

Thomson, D. S. & Austin, S. A. (2006) "Using VALiD to understand value from the stakeholder perspective." *Proceedings of 46th SAVE International Annual Conference*, 4th-7th June 2006, Savannah, Georgia.

Thomson, D., (2011) "A pilot study of client complexity, emergent requirements and stakeholder perceptions of project success." *Construction Management and Economics*, 29:1, 69-82