Understanding of clients' perspective of engineers' service quality can inform engineering education and practice

Dr Emily S. Tan[a]; Professor James P. Trevelyan [b]
The University of Western Australia
Corresponding Author Email: emilytan@mech.uwa.edu.au

Structured abstract

CONTEXT
This study sought to understand the factor(s) underlying the persistently low client (industry) perception of consulting engineers' service quality (performance). Previous studies regarding the service quality of engineers give no clear indication of the nature of the problems or guidance to enable engineering educators and engineering firms to make the necessary improvements.

PURPOSE
To identify the key factors involved in engineers' service quality and to present these factors in a model to be taught to young engineers.

APPROACH
In-depth interviews were conducted with ten different disciplinary engineers, six architects, two project managers, one builder, two drafters, two tradespeople, and three engineering educators. This study extended Parasuraman's SERVQUAL/Gap Model (1988) which has previously been used to measure the gaps between expectation and satisfaction of engineers and their clients.

ACTUAL OUTCOMES
This study explored numerous engineering service quality problems as perceived by clients. Many of the identified problems stem from engineers' ineffective use of communication and collaborative skills. The result shows a richer understanding of what communication entails, a better understanding of the nature of engineering itself, and overall better reflectivity, all of which underpin improved service quality performance.

CONCLUSIONS
The study identified more factors that facilitate or inhibit service quality than those uncovered by earlier research. These factors are incorporated into a model which may be useful for engineering educators to use in teaching students, with the ultimate aim of improving the service quality of their graduates.

KEYWORDS
Communication & collaboration skills, reflective practice, engineers' service quality

Introduction

Whilst engineers have scored lowest on industry surveys of service quality (Beaton, 2007-2011) and there is widespread recognition that miscommunication between all parties in the building industry leads to increased costs for building projects (Latham, 1994; EFC, 2007), there has been little work that attempts to actually work out the real issues behind these problems.

This study examined this important issue of the architect-engineer divide (Chilvers &Bell, 2013) that has received little attention in previous work by exploring the complex and vexed relationships between consulting engineers and architect clients involved in building projects. The aim is to produce results to be able to contribute to achieving greater productivity in the building industry and to be useful for engineering educators. It is also to understand enough to guide individual engineering firms and their engineers to improve service delivery.

Method

The Parasuraman's SERVQUAL/Gap Model (1988) is a well-supported quantitative instrument to investigate service quality (Buttle, 1996). This study extended the Gap Model to explore expectation and perception of service quality from engineers and architects from a qualitative perspective.

This study seeks to understand the factor(s) that could help explain the persistently low client perception of engineers' service quality, to a sufficient extent, to be useful for engineering educators, and to understand enough to guide individual engineering firms and their engineers to improve service delivery.

The qualitative interview method was selected to answer these questions because it is an appropriate tool for accessing and understanding social expectations and perceptions (Gubrium, 2002) and provides valuable information regarding interviewees' personal experiences and encounters (Rubin, 2005).

The first phase of interviewing with a sample of five consulting engineers was an exploratory investigation of the issues involved in consulting engineering. It was also aimed at confirming who the direct clients of consulting engineers are. The interviews were also designed to obtain data from participants that could inform a broader and more comprehensive study.

The next step involved understanding client expectations of engineers. In-depth interviews were conducted with architects and other project stakeholders. These interviews were aimed at investigating participants' experience from actual events. This was to determine if there were disparities between expectations and perceptions of engineers and their architect clients. Altogether, ten different disciplinary engineers, six architects, two project managers, one builder, two drafters, and two tradespeople were interviewed. Three engineering educators were also interviewed to gain their perspectives on engineering education in Australian universities. The results of interviews were examined and engineers' perceptions of their own service quality were compared with architects' expectations and perceptions of engineers' service quality to reveal the apparent gaps.

The data collected from interviewees were pooled together and analysed in a careful iterative process to identify a set of distinctive categories. The themes emerged during coding were used for comparison with those themes that emerged from the transcripts. These comparisons were ongoing (Glaser, 1977). A number of persistent themes emerged from the data analysis. Each major theme was followed by an extensive literature survey.

Results

The qualitative interview approach has encouraged many more issues to emerge and additional gaps were found when compared with Samson's survey results (1994). The qualitative research method reinforces Samson's earlier study but picks out in more detail many additional themes. The results showed there is a gap in the current understanding of perceptions of service quality of engineers.

The study results suggest that communication and collaboration in the work of engineers are of primary importance for improving perceptions of service quality. Both communication and collaboration skills are learned behaviours that can be improved through instruction, practice, feedback, and reflection. This paper consolidates all the results of this study, some of the results such as problem comprehension, communication, and collaboration were previously presented. This study identified the following key service quality skills of consulting engineers:

Creative thinking/“Hidden” creativity of engineers

In the interviews, architects often described engineers as lacking in creativity. However, this study shows that problem-solving capacities are closely linked to creativity and that engineering creativity is hidden in projects. While architects work with the elements of the structure that are visible, such as spaces and external finishes, engineers work within the parts that are not visible. Engineers creatively work within the invisible spaces that do not intersect the architect’s visible space. For example, columns are hidden within partition walls, and load-bearing structures (foundations) are below ground level. The services piping/ducting and electrical wiring are concealed within walls and columns, above ceilings, and behind architectural finishes. Thus the work that engineers undertake is often invisible once construction is completed.

The in-depth interviews found that engineers must develop solutions that are realistic, economically feasible, environmentally sound, culturally appropriate and ethical. During the interviews, the engineers explained that these solutions also need to adhere to accepted health and safety standards. Engineers have to cover all the economic requirements the client demands, both articulated and implied. They also need to take into account the capacity of the firm they belong to. Hence, engineers need to be creative to provide technical innovation to add value as well as justify incurred costs. Unless engineers provide useful design solutions and design service to their clients, their service quality will always remain poor. Thus, what can educators learn from this and be able to provide situation for students to learn appropriate creativity?

Influencing

Design in the built environment has normally been performed by project teams, with each team member having expertise in a specific engineering discipline such as structural, mechanical, and electrical. Each team uses its members' experience and judgement to develop a workable design. This study recognises the reality that engineering is as much about influencing other people as making use of technical knowledge.

Engineers need to influence the expectations of architects by educating them about the constraints of engineering and the background work required for the preparation and implementation of work. Engineers need to convince clients of the soundness and creativeness of their design proposals and solutions, and persuade co-workers to cooperate with them. If effective communication skills are applied while interacting with clients in order to influence their expectations, client’s perceptions of engineers’ service quality are likely to improve. However, little attention seems to be given to influencing others in engineering courses.

Decision-making

Architects observed that engineers are reluctant to make decisions. Data analysis showed that decision making is an important part of engineering activities especially when dealing with problems resulting from poorly coordinated work. However, engineers are reluctant to make these decisions because they bear the ultimate responsibility for them, especially since they often have to make decisions on the basis of incomplete, inconclusive or contradictory information. This is because architectural design is a process of transforming and merging structural, functional and circulation diagrams (Lockard, 1977; Rowe, 1991; Graves, 2005).

Architectural practices, through discovery, is often not capable of ‘defining desired affects until the design process is well on the way’ (Kalay, 1997). Evidence shows that the consulting engineering profession constantly deals with uncertainty, incomplete data, and competing or often conflicting demands from clients, government, environmental groups and the public (Spangaro, 2002). Making a decision often requires engineers to apply their knowledge, available information, experience and creativity to make informed decisions, so that work on site can proceed and is not delayed. Here the use of effective communication is to seek multiple perspectives for effective decision making.

Problem comprehension

This study established that the most important problem-solving process is at the initial phase which involves understanding the problem. In order to provide appropriate solutions, it is imperative to understand the nature of the problem. This allows the real problem to be identified right from the beginning so that valuable time and effort are not wasted (Tan & Trevelyan in 2011).

During the interview, an architect stated:

> *“Engineers are trained to solve given problems and not well equipped to find the actual problem.”*

This may stem in part shown from the way in which problem-solving is taught (for example, educators often seem to give less attention to problem perception skills and problem formulation) and the ways in which problems in schools or laboratory settings are often presented to students. Engineering educators may need to think about ways to give their students opportunities to go beyond written problem descriptions and explore problem understanding through dialogue and social interactions with clients and stakeholders.

Richer understanding of the role of communication

While Samson (1994) pointed to communication issues, what is really needed is a richer understanding of what communication entails. This study shows there are opportunities for engineers to use effective communication to clarify problems with clients in order to understand and determine their intrinsic needs and wants (Tan & Trevelyan 2009).

Negotiation

In the judgment of architects, engineers are unable to meet deadlines. During interviews, engineers acknowledge they are not assertive in negotiating a realistic timeframe for the completion of these tasks with the architects. The work of consulting engineers and their project architect are interdependent – a cooperative and collaborative work arrangement and a process of negotiation among them. Engineers need to use effective communication to negotiate the physical space for engineering elements, and also a realistic timeframe for service delivery.

Regular feedback

Communication in the form of regular feedback can maintain good client relationships. Clearly, effective communication is promoting good interaction. With effective communication and mutual understanding, providing and seeking feedback, the chances of mistakes and misunderstandings are greatly minimised.

Collaboration in multidisciplinary projects

In the opinion of architects, engineers do not coordinate projects well. Interviews with both engineers and architects highlighted the vital need for cooperation between these two parties (Boström, 1995). Engineers and architects working together on a collaborative task possess different kinds of knowledge and skills and will engage in interactions that will allow them to pool the various resources to accomplish their tasks. Social processes of engineering work often introduce greater complexity, ambiguity and subjectivity than expected (Spangaro, 2002). However, collaboration brings out tacit knowledge embedded in individuals (Orr, 1998) and expedites information sharing.

Collaboration allows engineers to make informed decisions and also brings project team members together to develop relationships (Tan & Trevelyan, 2010). To continuously improving these key skills, engineers may benefit from the practice of self-reflection.

Requirement of a common framework for sharing

Engineering problems often involve complex systems and therefore require a diverse range of expertise for resolution. Engineers must unify these experts' views by leveraging their knowledge and skill sets through effective dialogue. It is important that an appropriate framework is developed for these engineers, architects and other stakeholders in the project, so that information and knowledge sharing is promoted and different perspectives are better understood and opposing views are reconciled. The use of a common framework may facilitate effective design, problem-solving and decision making among engineers and architects. This may be solved by the emerging developments around BIM (Building Information Modelling) and the significant implications that these will have in the future around communication, collaboration and project delivery for the architects, engineers, and constructors (AEC) professions, and education for these professions. Note that BIM is to be implemented in the year 2014 for the AEC sector.

Reflective practice

The summary of all the results naturally brings one's attention to the benefits engineers could gain from practicing self-reflection. The capacity to reflect on actions and thereby engage in continuous learning is one of the defining characteristic of professional practice (Schön, 1983). Continuous learning involves paying critical attention to the practical values which inform everyday actions and examining practice reflectively and reflexively. This leads to developmental insight (Bolton, 2010).

Reflective practice can be an important tool in engineering and other professional settings requiring practice-based learning. In these settings, engineers learning from their own professional experience, rather than from formal teaching or knowledge transfer. It may be the most important source of personal professional development and improvement. Central to the reflective practice was the cyclic pattern of experience and the conscious application of learning experience. Schön (1983) used concepts such as 'reflection on action" and "reflection in-action" to describe the processes involved in meeting work challenges by improvisation learned in practice.

Engineers could use reflective practice to continuously engage in the reflection of situations they encounter in their workplace. It is associated with learning from experience and is an important strategy for engineers who embrace lifelong learning. Owing to the ever changing context of the engineering profession and the continual growth of technical knowledge, there is a high level of demand on professional expertise (Bolton, 2010). Due to this complex and continually changing environment, individuals could benefit from the reflective practice (Bolton, 2010). It allows individuals to continually update their skills and knowledge and consider ways to interact with their colleagues (Somerville & Keeling, 2004).

Somerville and Keeling (2004) support reflective practice for professionals. They argue that reflective practice moves educators from their knowledge base of distinct skills to a stage in their careers where they are able to modify their skills to suit specific contexts and situations, and eventually to invent new strategies. In implementing a process of reflective practice educators will be able to move themselves, and their schools, beyond existing theories in practice (Leitch & Day, 2000). Reflexivity involves a self-conscious reflection, monitoring and questioning of one's own behaviour and the behaviour of others (Mead, 1934; Beck, 1992).

The insight students can gain from reflecting on their relationships with others, and how those relationships assisted or detracted from the problem solving process; will assist them in building stronger collaborations when working in groups and teams in the future.

Engineers' ability to practice self-reflection is likely to improve their performance and thus influence their clients' perceptions of their service quality. Similarly, both engineers and engineering educators can learn from their own professional experiences and they may engage in a process of continuous learning and improving through the practice of self-reflection. The improvement of efficiency and effectiveness of engineering practice will pass on the ultimate benefits to the final users and society at large.

Reflective practice is in the literature and its value has been known for a long time, and communication difficulties persist despite us all knowing about reflective practice for 30 years or so. Why have engineers not understood this? Are reflective practice and effective communication too difficult to apply? Or, are they being ignored?

Comparison of Samson's quantitative results with qualitative results

The qualitative interview results were compared with Samson's quantitative survey results.

Similar results are as follows:

- failure to meet deadlines;
- failure to address client requirements;
- inflexible attitudes;
- lack of innovation/creativity;
- unrealistic cost estimates;
- poor coordination of services;
- inaccurate documentation; and
- inadequate communication.

Additional results from the qualitative study are as follows:

Engineers themselves think they are not assertive in negotiating for a realistic timeframe, incomplete understanding of client problems, reliance on technology (computers/ calculators) without applying engineering judgement, engineers are uncooperative, not proactive, no job commitment, do not pay attention to every project, quoting low fee to secure jobs, poor workload management, suspicions of engineers overdesigning to protect themselves, design is interdependent between design architect and multidisciplinary engineers, prevailing master-servant mindset, engineers are expected to know architects' preferences, engineers are expected to provide engineering advice of various architectural options without additional fee for every design change, architects are willing to learn from engineers, and architects only work with engineers they could trust.

Table 1: Detail of Participants

Particulars of participants:

No	Ref	Discipline	Gender	Years of experience	Years with current firm	Years in Consulting role	Nos. of architects or engineers under their supervision
1	A1	Architect	Male	25	4	25	6
2	A2	Architect	Male	25	15	25	30
3	A3	Architect	Male	25	15	25	4
4	A4	Architect	Male	30	17	30	8
5	A5	Architect	Male	16	16	7	9
6	A6	Architect	Female	4	2	3	1
7	E1	Structural	Male	15	15	15	3
8	E2	Mechanical	Female	7	4	7	40
9	E3	Geotechnical	Male	25	1	20	12
10	E4	Civil	Male	25	18	25	4
11	E5	Environmental	Female	14	4	14	25
12	E6	Civil & Structural	Female	22	22	22	180
13	E7	Electrical - Regulatory	Male	33	5	NA	5
14	E8	Mechanical -Gov. Representative	Male	35	32	NA	NA
15	E9	Mechatronics	Male	35	32	32	8
16	E10	Civil/Structural	Female	10	3	5	2
17	B1	Builder	Male	26	7	26	16
18	M1	Project Manager (Civil)	Male	31	30	16	22
19	M2	Project Manager (Building)	Male	17	17	17	6
20	D1	Architectural Drafter	Male	15	5	15	0
21	D2	Architectural Drafter	Male	12	4	12	0
22	T1	Tradesman	Male	30	20	NA	0
23	T2	Tradesman	Male	10	8	NA	0
24	P1	Educator	Male	35	32	30	NA
25	P2	Educator	Female	18	2	0	NA
26	P3	Educator	Female	10	7	0	NA

Table 2: Matrix - Expected attributes between Engineers (E) and Architects (A)

E \ A	Reliable	Responsive	Assured	Tangible	Empathic
Reliability	Respectable reputation in cost, time, quality, experience, performance & project portfolio Trustworthy work & service relationship Up to date regulatory knowledge Adequate attention paid to all projects Stable organisation	Provision of timely architectural plans Efficient project management Receptive to new ideas	Adequate project briefing Clear objectives/goals Well defined scope of work Effective coordination Reasonable use of litigation	Courteous & competent staff Prompt certification of payment	Realistic timeframes Explicit needs & wants Good understanding of engineering limitations Awareness of ethical demand Conscious of environmental impacts
Responsiveness	Timely delivery & meeting deadlines Proactive in offering design solution Effective workload management Prompt response Willingness to offer alternative solutions High availability	Timeliness Proactive & receptive to proposals Effective workload management Prompt response Flexibility in design High accessibility			

Assurance	**High technical competency** **Willingness to coordinate work** **High level of work commitment** **Good understanding of brief, objectives & requirements** **Accommodate changes/variation without charges** **Exude confidence in work performance** **Ample workforce at all times**		**Good technical knowledge** **Effective coordination** **High level of work commitment** **Good understanding of brief & objectives** **Willingness in incorporating changes** **Well defined scope of work** **Exude confidence in work performance**		
Tangible	**Cost effective, innovative, sustainable design** **Adequate detail & clear documentation** **Competent & qualified staff**			**Cost effective, innovative, & sustainable design** **Adequate detail & clear drawing** **Competent & qualified staff**	
Empathy	**Complete understanding of problem and willingness to offer appropriate solution** **Full awareness of architect's preference** **Effective communication** **Proficient cooperation**				Mutual obligation Good understanding of preference Full comprehension of problems Effective communication Cooperative interaction

Figure 1: Model of Engineers' service quality

Model of Engineers' service quality

The aforementioned key skills form the basis of a model (Figure 1) for the continued improvement of perceptions of engineers' service quality. This model comprises: problem comprehension, creative thinking, influencing, decision making, negotiation, feedback, effective communication and collaboration. All of which are underpinned by reflective practice.

This model helps explain why the traditional focus on communication skills is inadequate. Instead, educators need to focus on collaboration skills that comprise elaborate combinations of different communication genres. Merely teaching communication skills (typically technical writing and formal presentations) provides little preparation or awareness of the kinds of collaboration that are needed if engineers are to deliver service quality that meets expectations of clients.

Conclusions

Engineers need to be flexible and adaptable in the face of constant change in a dynamic world. The constraints that are most influential in shaping the landscape of engineering practice reflect the necessity for collaboration by the diverse people and stakeholder groups involved in an engineering enterprise. Solutions are only rarely achievable within purely technical considerations within a recognisable academic discipline such as mechanical or civil engineering. Therefore, it follows that if consulting engineers develop these key skills in the model, their design and design service may improve. Furthermore, the results and insights gained from this study provide resources that could be used to improve learning materials for engineering educators and practitioners. This is also likely to be of great benefit to engineering firms, as knowledge gained from this learning is a form of capital that may be transferred from individuals as increased productivity for their firms.

Implication for educators

This paper re-affirms the need to embed professional skills in the engineering syllabus. Both communication and collaboration are key issues in client-engineer relationships. These are important lessons for engineering educators. They need to do more in this area, even though many engineering students seem to develop the belief in technical skills later in their university studies and convinced that they only need technical skills and that learning to work with difficult people in teams is a waste of their time.

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