Acta Structilia

Journal for the physical and development sciences

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### Inhoud • Contents

#### Navorsingsartikels • Research articles

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative content analysis from the lean construction perspective: A focus on supply chain management</td>
<td>FA Emuze</td>
<td>1</td>
</tr>
<tr>
<td>Perceptions of the quality of low income houses in South Africa: Defects and their causes</td>
<td>N Zunguzane, JJ Smallwood, FA Emuze</td>
<td>19</td>
</tr>
<tr>
<td>A linear regression modeling of the relationship between initial estimated and final achieved construction time in South Africa</td>
<td>OA Aiyetan, JJ Smallwood, W Shakantu</td>
<td>39</td>
</tr>
<tr>
<td>’n Model vir die meting van die bourekenaar se kommunikasievolwassenheid</td>
<td>FH Berry, JJP Verster</td>
<td>57</td>
</tr>
<tr>
<td>Assuring health and safety (H&amp;S) performance on construction projects: Clients’ role and influence</td>
<td>I Musonda, JHC Pretorius, TC Haupt</td>
<td>71</td>
</tr>
</tbody>
</table>

#### Oorsigartikels • Review articles

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project cost estimation techniques used by most emerging building contractors of South Africa</td>
<td>SM Seeletse, MW Ladzani</td>
<td>106</td>
</tr>
<tr>
<td>Financial implications for built environment consultants working at risk in South Africa</td>
<td>C Adendorff, B Botha, A van Zyl, G Adendorff</td>
<td>126</td>
</tr>
</tbody>
</table>

#### Inligting aan auteurs • Information for authors

153
The South African Council for the Quantity Surveying Profession endorses

*Acta Structilia*

The South African Council for the Quantity Surveying Profession (SACQSP) has simplified the submission and assessment of Continuing Professional Development (CPD) requirements of registered persons. CPD submission now requires disclosure of the number of hours invested meaningfully in activities in two main categories. Category 1 activities are those arranged or presented by or to ‘external’ organisations such as participation in conferences, congresses, workshops or seminars, presentation of lectures, external examination for academic programmes, publication of articles in journals or magazines, other similar activities. Category 2 activities are less formal ‘internal’ activities such as in-house training or seminars, small group discussions, self-study of journals, magazines, articles on web pages, etc.

To assist registered persons with access to journal articles related to quantity surveying and, more generally, built environment issues, the SACQSP at its meeting in March 2007 adopted a recommendation to endorse the journal, *Acta Structilia*, which publishes quality, peer-reviewed articles and is accredited by the Department of Education.

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Professor RN Nkado
President

Royal Institution of Chartered Surveyors (RICS) supports

*Acta Structilia*

Royal Institution of Chartered Surveyors (RICS) supports the aims and objectives of *Acta Structilia* and welcomes the efforts being made to improve our knowledge and understanding of the built environment, particularly in an African context.
Qualitative content analysis from the lean construction perspective: A focus on supply chain management

Abstract

The performance of projects in terms of targeted objectives has always been a very contentious issue in the construction industry. The constant issue at stake is the inability of projects to satisfactorily meet agreed delivery targets. In order to address this quagmire, performance improvement tools such as supply chain management (SCM) were introduced into the industry.

The central theme of this discourse is thus concerned with the need to promote performance improvement in construction through the exploitation of the concepts inherent in SCM from the perspectives of lean construction researchers as documented in the annual International Group for Lean Construction (IGLC) conferences. The methodological approach adopted for the discourse is qualitative in nature as recent SCM literatures available on the IGLC web portal were subjected to a qualitative content analysis.

The research outcomes, which have implications for South African construction, attempt to offer solutions to the mirage of performance-related project management and/or supply chain problems, especially in terms of improving ‘how organisations working together’ overcome complexities and deliver value to stakeholders.

Keywords: Content analysis, lean construction, performance, research trends, supply chain management

Abstrak

Die vordering van projekte in terme van objektiewe was altyd ‘n sensitiewe onderwerp in die konstruksie-industrie. Konstante aspekte wat normaalweg ter sprake is, is die onbevoegdheid van specifieke projekte om voorafbepaalde afleveringsmylpale te behaal. Om hierdie onbevoegdheede teen te werk, is prestasieverbeteringshulpmiddels soos voorsieningsketting kennisbestuur in die praktiek voorgestel.

Die sentrale tema van hierdie aspekte is dus gemoeid met die behoefte om prestasie-verbetering in konstruksie deur middel van die eksploratie (uitbuiting) van die konsepte inherent in prestasieverbeteringshulpmiddels uit die perspektiewe van lean konstruksie navorsers, soos gedokumenteer in die jaarlike International Group for Lean Construction (IGLC)-konferensies, te

Dr Fidelis A. Emuze, Research Associate, Built Environment Research Centre (BERC), School of the Built Environment, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth 6031, South Africa. Phone: +27 41 504 2399, Fax: +27 41 504 2345, email: <Fidelis.Emuze2@nmmu.ac.za>
bevorderder. Die metode wat gevolg is, was kwalitatief van aard aangesien die nuutste literaturnavorsing bekikbaar op die IGLC-webportaal kwalitatief van aard was.

Die navorsingsuitkoms van hierdie studie, wat implikasies vir die Suid-Afrikaanse konstruksie-industrie inhou, het gepoog om sekere oplossings aan te bied wat prestasie georiënteerde aspekte van projekbestuur en/of voorsieningsketting kennisbestuur probleme teen kan werk en om alle betrokkenes behulpsaam te kan wees om saam te werk met die doel om afleveringsmylpale te behaal.

**Sleutelwoorde:** Konteksanalise, lean konstruksie, prestasie, bevoegdheid, navorsingspatrone, voorsieningsketting kennisbestuur

1. **Introduction**

Construction management research (CMR) findings reveal that construction is in need of improvement as many problems can be observed in the sector. Analysis of these problems has shown that a major part of them are supply chain problems, originating at the interfaces of different parties and functions (Vrijhoef, Koskela & Howell, 2001: 2). However, despite the attention that supply chain management (SCM) has attracted among researchers, the translation of its concepts and techniques into the construction industry is still a challenging issue (Isatto & Formoso, 2011: 1).

Vrijhoef & London (2009: 1) suggest that construction SCM is thus an emerging area of practice that is more concerned with the coordination of discrete quantities of materials and related specialist services delivered to specific construction projects. According to them, reasons for the adoption of SCM in construction include among others:

- The organisation and sourcing of materials is becoming increasingly complex across the global construction industry;
- Global sourcing of materials and assemblies provided by advances in transportation technologies as well as a shortage of craft labour that force increasing amount of value-added work to be conducted off-site deep in the supply chain;
- Construction clients are demanding faster, more responsive construction processes, and higher quality facilities, and
- There is mounting evidence of improvement in project performance through taking a supply chain perspective.

In this sense, poor performance exemplified in current and past Construction Industry Development Board (cidb) Construction Industry Indicators (CII) reports amplifies the need for improvement in South African construction that is reportedly dominated by small and medium-size enterprises (SMEs) in the form of subcontractors
(Shakantu, Tookey, Muya & Bowen, 2007: 97). The proliferation of the number of such organisations in the industry calls for a holistic way of managing the construction process (Shakantu et al., 2007: 97). In addition, given the reported advantages that horizontal SCM offers SMEs in construction in terms of business survival and competitiveness, industry stakeholders cannot afford not to exploit the potentials of SCM in South Africa.

For instance, Bjørnfot, Torjussen & Erikshammar (2011: 687) observed that an analysis of the economic data from the development of the national Swedish timber industry during the 2008-2010 economic crisis indicates that the amount of bankruptcies of SMEs in the northern Swedish timber industry has been fewer than the national average. They contend that, even though there may be other reasons for this, horizontal supply chain collaboration among the SMEs was a key reason for the improved business survival rate. According to them, horizontal supply chain alliance provides a flexible business climate that leads to improved competitiveness and survivability in a volatile market (Bjørnfot et al., 2011: 687). In addition, it is notable that because, unlike certain other industrial contexts, construction supply chains are subject not only to sequential but also to pooled and reciprocal interdependencies, and to interdependence owing to the need for synchronising a range of supply chains to each and every construction site, there appears to be a major hindrance to the development of appropriate SCM models and efficient supply chain practices in construction (Bankvall, Bygballe, Dubois & Jahre, 2010: 391).

2. Literature review

2.1 Supply chain

A supply chain is complex, dynamic and involves the constant flow of information (forecast, orders, schedules), material (components, end products), and funds between different and independent stages in a project life cycle (Azambuja & O’Brien, 2009: 3). According to Azambuja & O’Brien (2009: 3), understanding of customers’ expectations and supply chain uncertainty in terms of demand and supply that a firm faces is essential for developing the right capabilities or abilities to serve its market. In other words, a supply chain may need to emphasise its efficiency capabilities that depend on a set of final product characteristics and expected performance. For example, a responsive supply chain is able to address a wide range of quantities demanded, meet short lead
times, handle a large variety of products, meet a very high service level, and handle supply uncertainty.

Thus, while SCM may be practised on a single project, its greatest benefits materialise when it is practised across all projects in a firm; involves multiple organisations, and is applied consistently over time (Tommelein, Ballard & Kamisky, 2009: 107). Managing the supply chain in construction is therefore important because contracts themselves tend to be broad commitments. For example, as uncertainty and complexity rise, project managers find it increasingly difficult to coordinate the project supply chain by managing contracts, which will, in turn, result in delegating a larger share of the coordination process to other stakeholders at operational levels (Isatto & Formoso, 2011: 15). In addition, as individuals or firms are awarded more autonomy, the overall coordination burden grows, demanding organisational structures that are able to manage commitment loops in terms of project completion (Azambuja & O’Brien, 2009: 12; Isatto & Formoso, 2011: 16).

The importance of the study is centred on the need to address the detrimental effects that inadequate management of the supply chain that always manifest as cost and time overruns, rework, and in worse cases, accidents is having on project performance. As a result of increased investments in the industry in the future, the management of subcontractors and suppliers by principal general contractors (GCs) is vital to the quest for the delivery of enhanced value to both clients of the industry and the end users of construction products in South Africa.

Moreover, the problem statement proposed for the study suggests that the lacklustre management of supply chains, in particular the supply chains of GCs, limits the extent of performance improvement in construction. The overall aim of this article is thus to highlight the utility of SCM for performance improvement, especially from the lean construction perspective. The article is structured as follows. In the next section a literature review focusing on lean construction research outputs and their focus area is presented, followed by a description of the research method. The actual qualitative content analysis and the findings are then presented in addition to a discussion of the findings. This is followed by the conclusions and recommendations.
2.2 Lean construction

Lean management principles can be regarded as fundamental prerequisites for continuous improvement activities (Meiling, Backlund & Johnsson, 2012: 152). Lean in the construction context entails the understanding of what the client wants in terms of cost, quality and time (value); identifying the hierarchy of processes required to deliver what the client wants, and recognising that individual steps may or may not add value (value stream); examining the steps holistically, understanding dependencies, balancing resources and planning work to avoid delays or rework at interfaces (flow); recognising that each step is not just an end in itself, but an input to the next stage that needs to be delivered at the right time, quantity and quality (pull), and continuously striving to be better (perfection) (Terry & Smith, 2011: 8). Eriksson (2010: 395-396) noted that the core elements of lean construction can be assumed to be waste reduction, process focus in production planning and control, end customer focus, continuous improvements, cooperative relationships, and systems perspective.

These descriptions of what lean construction entails are supported by quantitative analysis of contents sourced through articles delivered at IGLC conferences. Two articles “Review of lean research studies and relationships to the Toyota Production Research Framework” (authored by Jacobs, 2011) and “Lean construction – 2000 to 2006” (authored by Alves & Tsao, 2007) indicated the main research themes that have engaged the attention of lean construction researchers since 1996.

Content analysis (quantitative) was chosen as the research methodology for analysing 592 IGLC research studies from 1996 to 2009 against the Toyota Production System (TPS) framework (Jacobs, 2011: 3). The analysis revealed that lean research in construction did not align exclusively around the TPS framework. From the 592 studies analysed, 241 (40%) were classified within the four overarching TPS categories having the TPS principles, and 351 (60%) were classified outside the TPS framework as fitting in one of 15 lean-related proxy categories that were created during the course of the study by merging themes during the analysis process (Jacobs, 2011: 8). As indicated in Table 1, the TPS framework includes 4 categories of long-term philosophy, the right process, invest in people and partners, and continuous problem-solving, while the 15 lean-related proxy categories include theory, benchmarking, information technology, sustainability, organisational change, game simulation, design management, literature review, waste control, outside lean
focus, prefabrication, models and feedback, safety, and logistics. Out of these categories, process, people and partners, design management, waste control, prefabrication, and logistics suggest that a segment of lean research outputs addressed issues central to performance improvement by enhancing the interface and/or relationships between construction supply chain members.

Table 1: Clarification of categories of lean research outputs from 1996 to 2009

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term philosophy</td>
<td>Toyota Production System</td>
</tr>
<tr>
<td>The right process</td>
<td>Toyota Production System</td>
</tr>
<tr>
<td>Invest in people and partners</td>
<td>Toyota Production System</td>
</tr>
<tr>
<td>Continuous problem-solving</td>
<td>Toyota Production System</td>
</tr>
<tr>
<td>Theory</td>
<td>Theory development research associated with lean construction</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Compared construction processes and performances with those of other industries</td>
</tr>
<tr>
<td>Information technology</td>
<td>Use of computers and telecommunication in construction</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Architectural property which allows continued viability in construction</td>
</tr>
<tr>
<td>Organisational change</td>
<td>Undergone internal transformations with organisations</td>
</tr>
<tr>
<td>Game simulation</td>
<td>Various activities in ‘real life’ in the form of games</td>
</tr>
<tr>
<td>Design management</td>
<td>Integration of construction design into management</td>
</tr>
<tr>
<td>Finance</td>
<td>Construction activities concerned with providing capital</td>
</tr>
<tr>
<td>Literature review</td>
<td>Body of lean text that reviewed critical points of lean construction</td>
</tr>
<tr>
<td>Waste control</td>
<td>Measures of wastes in construction</td>
</tr>
<tr>
<td>Outside lean focus</td>
<td>No relevance to other 18 categories in lean construction</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>Manufacturing of sections of a building at a factory off-site</td>
</tr>
<tr>
<td>Models and feedback</td>
<td>Lean production models and feedback on applied applications in construction</td>
</tr>
<tr>
<td>Safety</td>
<td>Safety systems in construction</td>
</tr>
<tr>
<td>Logistics</td>
<td>Handling of operations in construction</td>
</tr>
</tbody>
</table>

Adapted from Jacobs (2011: 6)
The second quantitative content analysis publication was based on IGLC papers from 2000 to 2006. Alves & Tsao (2007: 50) analysed abstracts and keywords of all 357 papers presented at 7 IGLC conferences from 2000 to 2006. They collected a total of 1,710 keywords from 329 papers (92.2% of all IGLC papers from 2000 to 2006). They grouped major keywords with their related terms into keyword clusters, and then gathered clusters with 10 or more keywords appearances as indicated in Table 2. This effort accounted for a total of 810 keywords, which suggest that the analysis covers 47.4% of all IGLC keywords from 2000 to 2006. The exercise was embarked upon based on the assumed hypothesis that postulates that a keyword analysis combined with a review of IGLC papers is sufficient to reveal the primary research areas in the IGLC community from 2000 to 2006 (Alves & Tsao, 2007: 58).

Alves & Tsao (2007: 53) observed that, in the group of papers analysed, the papers on SCM are in most cases theoretical or descriptions of how organisations work within their supply chains. The papers addressed theoretical models and analysis with the intention of providing explanations related to how construction supply chains work, their peculiarities, and what should be done to effectively implement SCM in construction. Alves & Tsao (2007: 54) further noted that some papers described how specific supply chains work concerning how actors in a specific supply chain interact, how the supply chain operates and what its main problems are, opportunities for improvement, and good practices that can be replicated to other supply chains in construction. However, it was observed that papers related to cases about the implementation of SCM concepts across 4 or more organisations were lacking among the examined IGLC papers. The authors suggest that this may be due to the fact that the construction industry may be learning slowly about the need to manage not only their firms, but also their supply chains (Alves & Tsao, 2007: 54). Thus, despite the high frequency of SCM keywords in the papers analysed (Table 2), the IGLC community has a long way to go in terms of the implementation of SCM in construction.

Table 2: Frequency of keywords and related keywords in 2000 to 2006 IGLC papers

<table>
<thead>
<tr>
<th>Keyword cluster</th>
<th>Keyword instances</th>
<th>Related keywords</th>
<th>Total keywords</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean construction</td>
<td>94</td>
<td>0</td>
<td>94</td>
<td>5.5</td>
</tr>
<tr>
<td>Design management</td>
<td>10</td>
<td>61</td>
<td>71</td>
<td>4.2</td>
</tr>
<tr>
<td>Culture and human aspects</td>
<td>5</td>
<td>55</td>
<td>60</td>
<td>3.5</td>
</tr>
</tbody>
</table>
The linkage of the lean and agile paradigms to the engineered-to-order (ETO) sector (such as construction) focus on the proposition that lean and agile strategies can be mapped onto supply chain structures in order to assist the determination of their applicability in the sector (Gosling & Naim, 2009a: 751). To be succinct, the articles based on content analysis evidently show that the lean construction studies have addressed SCM, albeit at varying degrees. While these studies were conducted with quantitative content analysis method, the next section will present findings and discussions that arose from a qualitative content analysis effort.
3. Research

This study can be considered an empirical research undertaking that emphasises deductive coding. Though qualitative content analysis can take the form of either inductive or deductive reasoning, deductive content analysis is often used in cases where the researcher intends to cast existing data in a new context (Elo & Kyngas, 2008: 111; Zhang & Wildemuth, 2009: 310). This may involve testing categories and concepts based on earlier research findings documented as models, mind maps and literature review (Zhang & Wildemuth, 2009: 310).

Categories and a coding scheme can thus be derived from previous related studies and theories. Two basic steps put forward by Elo & Kyngas (2008: 111) in terms of deductive content analysis entail the development of a categorisation matrix and coding of the data according to the categories. After a categorisation matrix has been developed, all the data are reviewed for content and coded for correspondence with identified categories.

3.1 Research methods

The findings reported and discussed in this article relate to SCM from the lean construction perspective. These primary data were generated through a qualitative analysis of content. Qualitative content analysis was chosen because it emphasises an integrated view of speech/texts and their specific contexts; goes beyond merely counting words or extracting objective content from texts to examine meanings, themes and patterns that may be manifest or latent in a particular text, and allows researchers to understand social reality in a subjective but scientific manner (Zhang & Wildemuth, 2009: 308). In brief, a total of 8 IGLC research studies, from 2007 to 2010, were analysed for emergent themes related to SCM through process analysis.

The dates were chosen in order to unearth meanings of recent SCM-related findings documented in the IGLC proceedings. The 2011 papers were excluded, because they were not readily available on the IGLC web portal during data mining. The number of papers was arrived at by focusing on articles that were published under the IGLC conference theme “Supply Chain Management” from 2007 to 2010. In addition, only papers that have SCM as a keyword were chosen for analysis. Figure 1 presents the research steps taken in this study. The scale on which the research project took place required the utilisation of a qualitative data analysis software package. Atlas.ti was used for analysing the papers that were downloaded from
the IGLC website. Figure 2 illustrates the Atlas.ti interface used while analysing the papers. Basically, all the 8 files (in ‘pdf’ format) were assigned to Atlas.ti, and each research study was then viewed electronically during analysis, as illustrated by Figure 2.

Figure 1: Representation of the research steps

Figure 2: Display of Atlas.ti interface
4. Results

As one would expect from SCM-related papers delivered at IGLC conferences, the term 'supply chains' tops the list of codes (Table 3). The use of open coding method (descriptive) led to the compilation of a total of 62 quotations. Descriptive coding relates to a word or short phrase, which is the basic topic of a passage of text. The table indicates that codes such as supply chains, logistics management, and integration of functions, lean thinking, inventory management, and coordination of flow gathered 64.6% of the quotations, which suggest that these issues dominate the findings presented in the analysed IGLC papers.

In line with the qualitative analysis procedure documented in the literature (Elo & Kyngas, 2007: 109-112), the categories presented in Table 4 were derived from the data through deductive content analysis. The deductive approach is based on previous findings, and therefore it moves from the general to the specific concerning the emergent theme indicated in Table 4. The identified categories, namely construction logistics, flow coordination, merger of supply chains, and complexity and value-related discourse suggest that the principal theme among the analysed IGLC papers is ‘how to ensure project success based on supply chain decisions’. These decisions could be made by an upstream or downstream actor in the network as long as it eliminates non-value-adding activities (wastes) and delivers value to the client.

Table 3: Codes used for qualitative content analysis

<table>
<thead>
<tr>
<th>Code</th>
<th>Number of quotations</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply chains</td>
<td>10</td>
<td>16.1</td>
</tr>
<tr>
<td>Logistics management</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>Integration of functions</td>
<td>6</td>
<td>9.7</td>
</tr>
<tr>
<td>Lean thinking</td>
<td>6</td>
<td>9.7</td>
</tr>
<tr>
<td>Inventory management</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Coordination of flows</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>information technology</td>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>Coordination complexity</td>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>Value delivered to client</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Production activities</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Coordinate actions</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Material tracking</td>
<td>1</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Among the quotations that led to the emergence of construction logistics as a distinct category, the use of logistics centres (preferably for large projects), reduction of inventory cost through material aggregation, just-in-time (JIT) delivery of materials, tracking of materials in transit (on-site and off-site), reliable location and delivery of on-site items as well as the ability to make equipment requisitions with ease when they are needed, were cited as benefits of lean SCM concerning logistics. Among others, the elimination of warehouse management problems, creation of instant and consistent visual communication networks, integration of activities across firms, and increased production planning and control were advantages of flow coordination that were empirically discovered by the IGLC researchers.

Concerning the need to merge supply chain functions among project partners, the lean construction researchers are of the opinion that reduction of individual organisational risks, elimination of unnecessary efforts (duplication), coordination of activities and processes, and managing processes beyond the focal company justify the call for the adoption of SCM concepts in construction. Value-driven processes and the use of lean thinking methods both at the strategy and operational levels were also cited as reasons why SCM may be useful in the industry in terms of project complexity and value creation.
### Table 4: Coding of the primary data into the categorisation matrix

<table>
<thead>
<tr>
<th>Theme</th>
<th>How to ensure project success based on supply chain decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Construction logistics</td>
</tr>
<tr>
<td>A case for the use of logistics centres</td>
<td>Eliminates warehouse management problems</td>
</tr>
<tr>
<td>Reduction of inventory cost through material aggregation</td>
<td>Creates instant and consistent visual communication networks</td>
</tr>
<tr>
<td>Just-in-Time delivery of materials</td>
<td>Brings high levels of accountability</td>
</tr>
<tr>
<td>Tracking of materials in transit</td>
<td>Improves production planning and control</td>
</tr>
<tr>
<td>Reliable on-site location and delivery of items</td>
<td>Integrates activities across firms</td>
</tr>
<tr>
<td>Ability to make equipment requisitions with ease</td>
<td>May prevent managerial problems including lack of cooperation and insufficient role definition of the SC agents</td>
</tr>
</tbody>
</table>

### 5. Discussion

Given that the majority of the active contractors on the cidb register of contractors are located between grades 1 and 5 (Emuze & Smallwood, 2011: 112), which indicated limited contracting capacities, it can be argued that concepts inherent in SCM may be beneficial to contractors in South Africa. Not only will the contractors become more competitive, the client satisfaction levels could also improve further as increased value is delivered to them.
The need to improve performance through proper coordination of multilayer subcontracting is not particular to South Africa. For example, the data collected from Hong Kong construction industry demonstrated that improper work practice among subcontractors contributes to poor quality; long communication chain contributes to poor time management; increased abortive and remedial work from them leads to increased cost overruns, and information sharing errors lead to poor coordination of processes (Tam, Shen & Kong, 2011: 115). The case for the SCM implementation from the lean construction perspective is equally reinforced by the perception that lean in construction projects entails (Eriksson, 2010: 401):

- Safe work environment;
- Good site cleaning;
- High comfortableness (fun to work);
- Commitment and participation;
- Good communication and feedback;
- High trust among participants;
- Good collaboration;
- Focus on continuous improvement;
- Focus on reducing waste;
- Focus on function and life cycle costs, and
- Fast decisions about design changes.

Furthermore, ETO or BTO (build-to-order) has emerged as a major operation strategy for improving organisational competitiveness (Gunasekaran & Ngai, 2005: 447). Although both lean and agile strategies have been proposed in the literature as strategies for the ETO and the BTO sector, some of these studies suggest that agility may be more suited to ETO supply chain, while leanness may be well suited to a ship-to-stock (STS) supply chain (Gosling & Naim, 2009a: 752). However, the findings of this particular study reiterate the potential that lean offers the construction industry. Even pertaining to the ETO sector, Gosling & Naim (2009a: 751) suggest that certain strategies could enact performance improvement.

Such strategies include shift between supply chain structures, supply chain integration, information management, business systems engineering, flexibility, time compression, and the development of new product process improvement. As an illustration, the need to understand risk and uncertainties pertaining to construction SCM shows that ‘flexibility’ could be a significant competitive factor in
the construction industry (Gosling & Naim, 2009b: 821). The study conducted by Gosling & Naim (2009b: 818-821) shows that sources of supply chain uncertainties relate to control, demand, process, and supply. For example, they revealed that deliveries that are unable to access site, the speed of construction and the volatility of workflow required the most flexibility types concerning process uncertainties. In this context, process flexibility is the ability to structure the project process so that it can accommodate late changes in design criteria and intermediate schedule milestones (Gosling & Naim, 2009b: 817).

Gosling, Naim & Towill (2012: 11) went further to develop a four-step framework that provides a structured route map for organisations operating in the construction industry to consider the uncertainties in their supply chains and the types of flexibilities required to mitigate them. The framework includes classify the supply chain; identify and analyse uncertainties; optimise pipelines, and develop strategic flexibility. The strength of the framework is that it emphasises the bringing together of organisations to collectively consider uncertainties and flexibilities in the supply chain, and then encourages them to make use of a collaborative approach for problem identification and solution.

6. Conclusions and recommendations

This article started off by identifying the need to adopt concepts inherent in SCM for the purpose of improving performance at both the strategic and operational level of project implementation. The proliferation of subcontracting businesses and the number of contractors with limited contracting capacities that necessitate the use of joint ventures and short- or long-term relationships with larger firms amplified the need for lean SCM in South Africa.

The qualitative analysis of content conducted with the 8 SCM-based papers accessed through the IGLC website indicates that a number of benefits could be harnessed through the adoption of SCM concepts from the lean perspective. Based on the findings of the study, it can be advised that project stakeholders should embrace lean construction, especially the theme that is related to SCM, because the examined papers demonstrate or promote how to ensure project success based on supply chain decisions. These supply chain decisions could allow benefits related to construction logistics, coordination of the flow of products and services, integration of functions, and value creation to accrue to project stakeholders. The ability to evolve flexibilities that could mitigate a
range of risks and uncertainties inherent in processes and supplies associated with construction activities supports this argument.

Meanwhile, future research projects should analyse the veracity of each category in Table 4 in the South African context. This should boost the quest for lean construction maturity in the industry. Through case study research endeavours, the application of lean SCM principles and practices should be observed, mapped, analysed and improved in South Africa.

Acknowledgement
The author is deeply grateful to the NMMU-cidb Centre of Excellence, hosted by the Built Environment Research Centre (BERC), for supporting this research project.

References list


Nyameka Zunguzane, John Smallwood & Fidelis Emuze

Perceptions of the quality of low-income houses in South Africa: Defects and their causes

Peer reviewed

Abstract

A number of low-income houses recently built in South Africa are reportedly defective. The sheer number of low-income houses that failed to conform to quality expectations, especially in certain provinces, has become a source of concern for the national Department of Human Settlements (DHS) and other construction industry stakeholders.

This article assesses issues related to non-conformance to quality requirements in low-income houses from the perspective of both owners and contractors. A quantitative survey was conducted among housing beneficiaries in a post-1994 township in Port Elizabeth in the Eastern Cape. The initial findings were further complemented with the perceptions of contractors registered with the National Home Builders Registration Council (NHBRC).

Selected findings suggest that the principal causes of defects in low-income houses is perceived to be related to the use of emerging contractors who are presumably not experienced enough, and to the use of unskilled labour by the contractors. By implication, the respondents were of the opinion that poor workmanship could be the primary cause of defects in low-income houses. It can, therefore, be argued that, apart from adequate monitoring and inspection of projects, stakeholders in the form of emerging contractors and their labour should endeavour to improve their competencies pertaining to quality.

Keywords: Construction, contractors, low-income housing, owners, quality

Abstrak

‘n Aantal lae-koste huise in Suid-Afrika wat onlangs gebou is, het verskeie foute. Die groot aantal lae-koste huise wat nie aan die kwaliteitsverwagtinge voldoen nie, raak ‘n kommer vir die nasionale Departement van Behuising en ander aandeelhouers in die konstruksiebedryf.

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Hierdie artikel wys aspekte aan, uit die perspektief van die huiseienaars asook die kontrakteurs/aannemers, wat nie aan die kwaliteitsvereistes vir lae-koste huise voldoen nie. ’n Kwantitatiewe opname is gedoen onder huiseienaars in ’n na-1994 woonbuurt in Port Elizabeth in die Oos-Kaap. Die finale bevindinge is ook verkry uit die persepsies van kontrakteurs wat by die Nasionale Huisbouers Registrasie Raad (NHRR) geregistreer is.

Bevindinge wys daarop dat die hoofoorsaak van foute in lae-koste huise te wyte is aan die gebruik van onervare opkomende kontrakteurs wat onopgeleide arbeiders in diens neem. Die respondente het swak vakmanskap uitgewys as die hoofoorsaak van foute in lae-koste huise. Daar kan aanbeveel word dat opkomende kontrakteurs hul vaardighede/bekwaamheid in projekinspeksies asook arbeidskwaliteit behoort te verhoog.

Sleutelwoorde: Konstruksie, kontrakteurs, lae-koste huise, eienaars, kwaliteit

1. Introduction

Quality is a fundamental term in the construction industry. The non-achievement of such a crucial aspect of construction can result in the failure of a construction project and in the dissatisfaction of clients and/or building occupants. Furthermore, the non-achievement of quality can result in delays in building projects and the need for rework, which can result in a significant financial loss. Quality focuses on eliminating defects and variations and seeks to avoid waste of time, materials, and financial resources due to rework (Love, Edward & Smith, 2005: 197).

In the case of low-income houses, Carmona, Carmona & Gallent (2003: 3) contend that poor-quality housing, whether poorly planned in the wider sense, or badly designed, has been the hallmark of a commodity culture whereby housing is viewed as merely a ‘demand good’ to be thrown up wherever the price is right. According to Carmona et al. (2003: 7), quality should be provided with the end-user in mind in order to create a healthy and safe living environment. However, the features of inadequate housing quality include:

- Overcrowding;
- Relatively small sizes of houses;
- Poor building standards in terms of inadequate sound attenuation or heat insulation, and
- Lack of basic urban design amenities, and inadequate supply of services (Carmona et al., 2003: 7).

In brief, research studies indicate that the quality in the building of low-income houses is one of the reasons for dissatisfaction expressed by occupants. For instance, a case study investigation conducted in Pelindaba, Bloemfontein, revealed that in general
74% of the respondents recorded negative perceptions about the quality of their public sector-built low-income houses (Mehlomakulu & Marais, 1999). The respondents observed prevalence of cracks in their houses (78%), roof leakages (58%) and, in general, they were not satisfied with the physical structure of the houses.

Similarly, the study conducted by Madzidzela (2008) at Nyandeni Local Municipality discovered that 85% of the respondents experienced problems with the low-income houses they are occupying. Reported problems include flooding (27.5%), lack of water (25%), lack of electricity (12.5%), and drainage-related issues (35%). Therefore, as state-delivered subsidy or low-income houses will continue to dominate the South African landscape in terms of housing provision for lower income households (Landman & Napier, 2010), it is imperative to address the quality issue in low-income housing with a view to finding a practical solution. Hence, the issue examined in this article concerns the non-attainment of quality in low-income housing, which has exacerbated wastage in financial resources and contributed to an increase in the housing backlog in the country. Perhaps, according to anecdotal evidence, the occurrence of rework, defects, and increases in the housing backlog may be responsible for the perception that low-income houses seldom conform to the National Building Regulations (NBR). For instance, the Minister of Human Settlements, Tokyo Sexwale, explained that a total of 40 000 houses must either be rectified or completely demolished countrywide as a direct consequence of poor workmanship (Dalgish, 2009: 4). The minister further states that two of such houses have claimed the lives of two people - a woman and a boy.

1.1 The research objective

In this context, the primary objective of this article is to determine the underlying factors that have seemingly engendered the production of poor-quality low-income houses in South Africa. Doing this could provide additional insights related to the problem and lead to the identification of interventions that can be considered to be useful in South Africa. The assumed research problem, therefore, states that ‘non-achievement of quality constitutes a significant barrier to the delivery of low-income houses in South Africa’.

The importance of the article is underpinned by the need to examine why there are excessive numbers of defects in low-income houses in South Africa, because failure to conform to quality requirements
usually has negative consequences related to money in terms of budgetary control either in client or contractor organisations.

2. Quality issues in construction management corpus

According to research conducted by the Building Research Establishment (BRE) (Egbru, Ellis & Gorse, 2004: 308), 90% of building failures are due to problems arising in the design and construction stages. These problems include poor communication; inadequate information or failure to check information; inadequate checks and controls; lack of technical expertise and skills, and inadequate feedback leading to recurring errors. Egbru et al. (2004: 308) note that most of these problems are mainly 'people'-related problems. A great number of the defects in low-income houses occurred during the construction stage and were mostly due to poor communication and inadequate checks and controls (Sommerville, 2007: 395). As an illustration, Alink (2003: 18) states that failures have resulted from incorrect building procedures and poor on-site supervision and workmanship. This is in accord with the contention of Egbru et al. (2004: 308). According to Alink (2003: 18), factors contributing to the lack of success and the non-achievement of quality in the low-income housing sector include:

- Lack of sufficient finance;
- Use of unskilled labour;
- Use of emerging contractors;
- Lack of contribution by the private sector;
- Lack of management commitment toward quality achievement, and
- Substandard quality of workmanship.

2.1 Challenges related to low-income houses in South Africa

Despite the considerable modifications and revisions to the housing policy over the years, concerns related to quality, efficiency, effectiveness and sustainability of housing programmes still define and frame discussions (Khan & Thring, 2003: 18). The challenges usually dominating the low-income housing sector include poor design of houses; houses that are environmentally unsound; houses that are not suitable to the local climate, and houses that entail high maintenance costs. According to Goebel (2007: 292), other problems associated with low-income housing processes include:
New houses and townships continue placing poor and low-income blacks in ‘ghettos’ on urban peripheries, far from jobs and services;

New houses and infrastructure such as sewerage services are of poor quality, are rapidly deteriorating and require maintenance;

People dislike the model of housing used, and would prefer larger houses – the main model was changed in 1998 when the DHS increased the minimum size of new houses to 30m², and

Because of these problems, people often sell or rent out their subsidised low-income houses bought through the subsidy, and move back to squatter or other informal settlements closer to their economic activities.

### 2.2 Defects in low income houses in South Africa

According to Khumalo (2010: 2), one of the reasons for violent demonstrations and riots in South Africa is the lack of housing and the fact that available housing is likely to be badly constructed low-income houses with cracks. This is a problem that affects most provinces in South Africa. Media reports reveal that a contractor at Kumani and MP Stream villages in Bushbuckridge in Mpumalanga was stopped by residents after building ten (10) subsidised (otherwise called RDP) houses using bricks laid upright (Magagula & Mnisi, 2010: 2). The holes in the bricks were such that one could see right through to the next room and were not filled with mortar. The contractor had not built any foundations to save on bricks and cement.

Kota (2010: 26) also observed that government-subsidised houses in Vukani in Grahamstown were falling down, because of poor workmanship and inferior quality. Weak bricks, leaking water pipes, roofs, drains and toilets were some of the problems encountered in houses. Residents claim that they have been given black plastic by the municipality to cover the leaking areas when they complained about the leakages in the houses and that government-subsidised housing in that area is characterised by fraud, mismanagement and corruption (Kota, 2010: 26). Some defects in low-income houses, as stated by Zincume (2010: 7), include unstable door frames; usage of weak cement mortar, and some houses were without roofs. Similarly, the media reports that some of the issues in the N2 gateway project in the Western Cape, cited in Mtyala (2010: 4), included the delay to install electricity in other areas of the project. In the case of low-income houses in the communities of Boipatong and
Tshepiso, 75 houses in Boipatong and 35 houses in Tshepiso have to be demolished due to quality problems (Kunene, 2010: 11). In the Eastern Cape, Gibbon (2010: 5) states that 30 000 houses that were built since 1994 have “constructional defects”. Most of these houses were in a state where they have to be demolished and completely rebuilt and, according to Gibbon (2010: 5), in a schedule of 80 building contractors who were allocated contracts in the province, 42% have disappeared, leaving behind unfinished units.

2.3 Causes of defects in low-income houses in South Africa

According to Gibbon (2010: 5), poor workmanship in housing construction, and poor management and control of building contractors have contributed to the housing problem. Poor workmanship often leads to delays in projects. Lubisi & Rampedi (2010: 2) contend that the primary causes of delays are related to the perception that emerging subcontractors with capacity challenges were always appointed to execute projects. Another media report noted that the use of alternative building technologies by less experienced contractors has also contributed to the housing problem. In a study conducted in Limpopo, Mpumalanga, the Western Cape, Eastern Cape and Gauteng, which investigated the use of alternative building technologies such as compressed earth, interlocking blocks, shutters and concrete, and eco-frame, it was found that there is little knowledge or awareness on the part of beneficiaries of low-income housing with regard to building systems approval requirements, and whether the building method used carried an Agrément certificate (Mgiba, 2007: 16).

The study also showed that 4 of the 5 developers who were part of the study had used construction methods that were not certified. Advantages found in the study were that these alternative construction methods were cost-effective on the part of developers, enhanced speedy delivery, and some construction methods were found to be easy to maintain. The disadvantages were the inability of the houses to resist extreme weather conditions, structural defects such as cracks that are not easy to repair with some materials, poor workmanship, and structures that are not compatible to future extensions (Mgiba, 2007: 16).

3. Research methodology

The study, which was quantitative in nature, addressed quality in low-income housing projects in terms of causes of defects in low-income houses; the quality of built low-income houses; challenges
experienced by housing beneficiaries/occupants; selection of materials used in low-income housing projects; selection of workers for projects; construction methods used in projects, and the means or ways that could promote conformance to the NBR among contractors (home builders).

The sample strata consist of housing beneficiaries from Wentzel Park in Alexandria and housing contractors identifiable through the NHBRC database. The Wentzel Park township in Alexandria was chosen because of accessibility for the primary investigator. Table 1 summarises the response rate. Forty-five (45) out of the fifty (50) questionnaires delivered by hand to housing beneficiaries were collected, which constitutes a 90.0% response rate. From the sample extracted from the NHBRC database, only twenty-nine (29) of eighty-eight (88) low-income housing contractors completed and returned questionnaires. This constitutes a 33.0% response rate.

Table 1: Summary of the response rate

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sent</th>
<th>Returned</th>
<th>Not returned</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing beneficiaries</td>
<td>50</td>
<td>45</td>
<td>5</td>
<td>90.0</td>
</tr>
<tr>
<td>Contractors</td>
<td>88</td>
<td>29</td>
<td>59</td>
<td>33.0</td>
</tr>
</tbody>
</table>

3.1 The data

The survey instruments posed questions that provided answers to the research problem. The questions were designed to be easily understood and to be answered in minimal time to optimise the response rate. The questionnaires consisted of predominantly close-ended five-point Likert scale-type questions, and open-ended questions. Open-ended questions were included so that participants could express and explain their views in order to reveal issues not captured in the literature reviewed.

The questions for housing beneficiaries were compiled in Xhosa and English to accommodate people who can only speak one of these languages. The questionnaires were also short and to the point in order to avoid reducing the interest of the participants. The questions were designed in such a way that respondents were not required to reveal confidential information of any kind. The questionnaires were accompanied by a covering letter which explained the purpose of the study. It assured confidential treatment of responses and anonymity of respondents. In brief, the instrument related to housing
beneficiaries was delivered by hand, while the instrument meant for contractors was posted and e-mailed to them individually.

### 3.2 Results: Housing beneficiaries (owners)

The beneficiaries who participated in the study formed part of a sample extracted from the community of Wentzel Park in Alexandria in the Eastern Cape. 55.6% of the respondents confirmed that they are the legal owners of their respective houses. The majority of the houses have either 2 (20.0%), 3 (22.2%), or 5 (17.8%) occupants. In addition, the majority of the respondents took over the ownership of their houses in 2000 (11.1%), 2002 (15.6%), 2004 (15.6%), and 2009 (11.1%). 53.4% of the respondents mentioned that they have occupied their low-income houses for more than eight (8) years.

As indicated in Table 2, when asked about the state of their low-income houses in terms of percentage responses to a scale of 1 (strongly disagree) to 5 (strongly agree), nearly half of the respondents strongly agreed that they have used their personal income to enhance the quality of their houses (46.2%). However, 65.4% were unsure as to whether their houses were inspected and approved before occupation; only 25.0% and 12.5% agreed or strongly agreed that the quality of their houses was of acceptable standard, and with 2.8% for neutral, 16.7% for disagree, and 30.6% for strongly disagree, it can be observed that the majority of the respondents were not very satisfied with the house allocated to them.

**Table 2: Perceptions of the occupants of low-income houses related to the state of their houses**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you ever had to use your own money to maintain your house?</td>
<td>2.6 0.0 2.6 0.0 48.7 46.2</td>
<td>4.38</td>
<td>1.92</td>
<td>1</td>
</tr>
<tr>
<td>Do you know if your house was inspected and approved?</td>
<td>65.4 3.8 0.0 0.0 15.4 15.4</td>
<td>3.38</td>
<td>2.02</td>
<td>2</td>
</tr>
</tbody>
</table>
Given this level of dissatisfaction, the respondents were asked to rate problems that they may have encountered with their low-income houses on a scale of 1 (minor) to 5 (major), as indicated in Table 3. It is notable that accidents or injuries due to defects in the house are rated the most by respondents. In fact, 71.4% of the respondents perceive that accidents or injuries due to defects in the house constitute a major problem. Similarly, the respondents perceived that leaking water pipes (29.2%), problems associated with stability (27.3), cracks in the walls (32.5%), inability of the house to resist extreme weather conditions and water penetration through the walls (23.5%) constitute major problems experienced in their low-income houses.

Table 3: Problems experienced by housing beneficiaries

<table>
<thead>
<tr>
<th>Problem</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents or injuries due to defects in the house</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minor......</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Major........</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>U</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaking water pipes</td>
<td>0.0</td>
<td>14.3</td>
<td>14.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Problems associated with stability</td>
<td>0.0</td>
<td>29.2</td>
<td>16.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Cracks in the walls</td>
<td>0.0</td>
<td>35.0</td>
<td>25.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Inability of the house to resist extreme weather</td>
<td>10.0</td>
<td>38.2</td>
<td>2.9</td>
<td>2.9</td>
</tr>
</tbody>
</table>

27
### Table 3: Problems Observed in Low-Income Houses

<table>
<thead>
<tr>
<th>Problem</th>
<th>Minor.........................</th>
<th>Major</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water penetration through the walls</td>
<td>0.0</td>
<td>35.3</td>
<td>17.6</td>
<td>11.8</td>
<td>5.9</td>
</tr>
<tr>
<td>Roof leaks</td>
<td>0.0</td>
<td>35.5</td>
<td>19.4</td>
<td>9.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Roofs which make noise or even blow off when windy</td>
<td>0.0</td>
<td>42.9</td>
<td>10.7</td>
<td>10.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Incomplete house</td>
<td>0.0</td>
<td>40.0</td>
<td>3.3</td>
<td>0.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Dampness</td>
<td>0.0</td>
<td>51.4</td>
<td>8.6</td>
<td>5.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Door frames which shake and faulty doors</td>
<td>0.0</td>
<td>40.5</td>
<td>27.0</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Water penetration through window frames</td>
<td>0.0</td>
<td>43.2</td>
<td>24.3</td>
<td>8.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Leaking drains and toilets</td>
<td>0.0</td>
<td>57.7</td>
<td>11.5</td>
<td>0.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Collapsing of walls</td>
<td>0.0</td>
<td>50.0</td>
<td>25.0</td>
<td>0.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Water penetration through the floor</td>
<td>0.0</td>
<td>50.0</td>
<td>15.6</td>
<td>6.3</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Apart from the problems listed in Table 3, the respondents also observed that “having to fix the house all the time; unplastered walls; unfinished houses; house not painted; leakage from the ceiling; rusty window frames; ceiling not fitted correctly; unstable roofs in windy situations, and door without proper locks” constitute the plethora of problems they have experienced while living in their low-income houses. When asked about what the reasons could be for the defects they have observed in their low-income houses, the housing beneficiaries answered as indicated in Table 4. Table 4 indicates that 32.6% agreed and 34.9% strongly agreed that the use of emerging contractors results in defects in low-income houses. A further 45.2% also strongly agreed that the use of unskilled labour can cause defects in low-income houses. In general, other causes identified by the owners include:

- “Contractors always underpay local labour and claim that government does not provide sufficient funding for housing projects”;
- “Contractors tend to employ their friends and relatives”, and
“Some of the houses are not durable and do not last long because they have been built by inexperienced people.”

Table 4: Beneficiaries’ perceptions related to the causes of defects

<table>
<thead>
<tr>
<th>Causes</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of emerging contractors</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>4.7</td>
<td>11.6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Strongly agree</td>
<td>11.6</td>
<td>0.0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>16.3</td>
<td>32.6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>32.6</td>
<td>34.9</td>
<td>3.68</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>34.9</td>
<td>32.6</td>
<td>1.75</td>
<td>5</td>
</tr>
<tr>
<td>Use of unskilled labour</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>9.5</td>
<td>19.0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Strongly agree</td>
<td>19.0</td>
<td>2.4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>7.1</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>16.7</td>
<td>45.2</td>
<td>3.67</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>45.2</td>
<td>3.3</td>
<td>2.13</td>
<td>5</td>
</tr>
<tr>
<td>Insufficient building funds from the government</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly disagree</td>
<td>35.9</td>
<td>7.7</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Strongly agree</td>
<td>7.7</td>
<td>2.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.6</td>
<td>17.9</td>
<td>15.4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>17.9</td>
<td>20.5</td>
<td>1.92</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>20.5</td>
<td>2.21</td>
<td>2.21</td>
<td>5</td>
</tr>
</tbody>
</table>

3.3 Results: Contractors

Given that low-income housing beneficiaries have established that they were not overtly satisfied with the quality of their houses, a further survey was conducted among contractors in order to shed more light on the issue. In terms of background checks, 86.2% of the contractors confirmed that they are registered with the NHBRC. Based on the perceptions of the contractors, Table 5 indicates the causes of defects in low-income housing in terms of percentage responses to a scale of 1 (minor) to 5 (major), and a mean score (MS) between 1.00 and 5.00. It is notable that seventeen (17) of the twenty MSs are above the midpoint of 3.0. The three causes that have MS below 3.0 include the lack of involvement of professional designers; inadequate information, and incorrect designs issued by the architect or engineer. From these results, it can be argued that, in general, the respondents were of the opinion that these causes can be deemed to be minor causes of defects in low-income housing. However, poor workmanship that is ranked first can be considered to be the main cause of defects in low-income housing. This is followed by workers not being committed to the implementation of quality standards, trying to save more than necessary on materials, focusing more on production and less on quality, contractors not understanding the National Building Regulations (NBR), and poor on-site supervision.
Table 5: Contractors’ perceptions of the causes of defects in low-income houses

<table>
<thead>
<tr>
<th>Cause</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Poor workmanship</td>
<td>0.0</td>
<td>0.0</td>
<td>6.9</td>
<td>10.3</td>
</tr>
<tr>
<td>Workers are not committed to the implementation of quality standards</td>
<td>0.0</td>
<td>3.5</td>
<td>6.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Trying to save more than necessary on materials</td>
<td>0.0</td>
<td>3.5</td>
<td>3.5</td>
<td>10.3</td>
</tr>
<tr>
<td>More focus on production and less on quality</td>
<td>0.0</td>
<td>3.5</td>
<td>6.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Contractors do not understand the National Building Regulations</td>
<td>10.3</td>
<td>0.0</td>
<td>6.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Poor on-site supervision</td>
<td>0.0</td>
<td>0.0</td>
<td>6.9</td>
<td>27.6</td>
</tr>
<tr>
<td>Use of unskilled labour</td>
<td>0.0</td>
<td>0.0</td>
<td>13.8</td>
<td>17.2</td>
</tr>
<tr>
<td>Use of inappropriate, unsuitable alternatives or cheap materials</td>
<td>0.0</td>
<td>3.5</td>
<td>13.8</td>
<td>20.7</td>
</tr>
<tr>
<td>Use of emerging contractors</td>
<td>3.5</td>
<td>6.9</td>
<td>6.9</td>
<td>20.7</td>
</tr>
<tr>
<td>Faulty construction (incorrect building procedures)</td>
<td>0.0</td>
<td>10.3</td>
<td>6.9</td>
<td>20.7</td>
</tr>
<tr>
<td>Insufficient or no inspections of work in progress</td>
<td>0.0</td>
<td>3.5</td>
<td>10.3</td>
<td>27.6</td>
</tr>
<tr>
<td>Inadequate checks and controls</td>
<td>6.9</td>
<td>6.9</td>
<td>13.8</td>
<td>20.7</td>
</tr>
<tr>
<td>Management is not committed to quality management</td>
<td>0.0</td>
<td>6.9</td>
<td>17.2</td>
<td>17.2</td>
</tr>
<tr>
<td>Poor communication</td>
<td>3.5</td>
<td>3.5</td>
<td>20.7</td>
<td>17.2</td>
</tr>
<tr>
<td>Inadequate feedback</td>
<td>13.8</td>
<td>6.9</td>
<td>10.3</td>
<td>27.6</td>
</tr>
<tr>
<td>Lack of sufficient finances</td>
<td>3.5</td>
<td>13.8</td>
<td>13.8</td>
<td>27.6</td>
</tr>
<tr>
<td>Cause</td>
<td>Response (%)</td>
<td>MS</td>
<td>Std. Dev</td>
<td>Rank</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>--------------</td>
<td>-----</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Failure to check information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cause</td>
<td>U</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>MS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of involvement of professional designers (architects and engineers)</td>
<td>6.9</td>
<td>27.6</td>
<td>27.6</td>
<td>17.2</td>
</tr>
<tr>
<td>Inadequate information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorrect designs issued by the architect or engineer</td>
<td>6.9</td>
<td>37.9</td>
<td>27.6</td>
<td>6.9</td>
</tr>
</tbody>
</table>

What is notable with respect to the findings in Table 5 is the level of unsure responses, which can be deemed minimal. This suggests that the contractors who responded to the questions could be assumed to be sure of their responses pertaining to the causes of defects in low-income housing. In response to a further open-ended question, the contractors contend that other causes include:

- “Use of unskilled labour which has been recommended by the initiating municipality”;
- “Lack of involvement of building professionals such as land surveyors to check contours and engineers to inspect stormwater systems in the planning phase of housing projects”;
- “The main reason is that the ‘quantum’ (grant from government) currently at R66 000 is not sufficient to build the top structure to the required quality. The government should increase the quantum by approximately R20 000 and contractors should refrain from tendering for low-income housing jobs until the quantum has been increased. Who builds at a loss over and above the risks associated with low-income housing? Contractors are forced to cheat on materials and quality due to a lack of work”;
- “Contractors should be evaluated before being awarded tenders to prevent unqualified contractors from being awarded tenders. Political awarding of tenders should cease, because it does not benefit the process”;
- “The allocation of projects to unqualified and unmotivated contractors remains an issue”;
• “Lack of training of workers and sense of responsibility or ownership”;
• “Theft of materials, especially cement, by the very community for whom the houses are being built. The concrete and mortar end up being weaker and the house cracks as a result, because the cement content has been reduced”, and
• “The Department of Human Settlements and its authorised persons are involved in bribery and incorrect tender processes.”

Table 6 indicates the degree of concurrence with statements pertaining to quality by contractors in terms of percentage responses to a scale of 1 (strongly disagree) to 5 (strongly agree), and a mean score between 1.00 and 5.00. The table suggests that 35.7% of the respondents strongly agreed that most defects in low-income houses occur during the construction stage, and that a large number of houses have to be fixed due to the non-achievement of quality standards. In addition, 21.4% of the respondents equally strongly agreed that the majority of low-income houses do not conform to NBR requirements, and that the neglect of health and safety (H&S) negatively affects the quality of houses built. When asked who is responsible for carrying out inspections on projects in order to prevent defects, the respondents mentioned government engineers, project managers, architects, municipal officials, and provincial authorities as external inspectors. Although 78.6% of the respondents confirmed that they use quality standards when constructing low-income houses, the type of standard to which the individual contractor adheres differs. Some of them mentioned that they adhere to design specifications provided to them by engineers, whereas others listed ISO 9001, NHBRC standards, and SABS as the standard to which they adhere.

Table 6: Extent of agreement with statements pertaining to quality by contractors

<table>
<thead>
<tr>
<th>Statement</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most defects in low-income houses occur during the construction stage</td>
<td>0.0 7.1 17.9 0.0 39.3 35.7</td>
<td>3.79</td>
<td>1.32</td>
<td>1</td>
</tr>
</tbody>
</table>
A large number of houses have to be fixed due to the non-achievement of quality standards 3.6 14.2 3.6 7.1 35.7 35.7 3.78 1.40 2

The majority of low-income houses do not conform to the National Building Regulations 0.0 14.3 14.3 7.1 42.9 21.4 3.43 1.37 3

Neglecting health and safety negatively affects the quality of houses built 3.6 10.7 17.9 32.1 14.3 21.4 3.19 1.30 4

Fast-tracking building projects result in the non-achievement of quality standards 0.0 14.8 22.2 22.2 25.9 14.8 3.04 1.32 5

The high demand for RDP houses causes contractors to work fast and ignore quality standards 0.0 10.7 39.3 21.4 21.4 7.1 2.75 1.14 6

Quality is an obstacle to productivity and is associated with high costs 0.0 39.3 17.9 21.4 14.3 7.1 2.32 1.33 7

However, pertaining to the need to adhere to principles identified in the NBR, the contractors were asked “How can conformance to NBR be promoted among contractors?”. As indicated in Table 7, 74.1% of the respondents strongly agreed that regular inspections and performance audits can promote conformance to the NBR. A further 73.1% also strongly agreed that training and education related to low-income house building standards can promote conformance to the NBR. In addition to these interventions, the selection of materials for building purposes was investigated, as poor material selection and usage could potentially result in defects and/or non-achievement of quality. Table 8 suggests that 46.4% of the respondents strongly agreed that materials should be selected based on either design specifications or compliance to building regulations. As indicated in Table 8, 35.7% of the respondents also agreed that affordability and availability of financial resources could influence material selection. Although 7.1% of the respondents were unsure about the contribution of availability of material, the mere fact that 39.3% of them agreed or strongly agreed with the statements suggests that material availability can affect material selection, which could determine the level of defects in low-income houses.
Acta Structilia 2012: 19(1)

Table 7: Contractors’ perceptions related to how to promote conformance to the NBR

<table>
<thead>
<tr>
<th>Statement</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree ........ Strongly agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Regular inspections and performance audits</td>
<td>0.0</td>
<td>3.7</td>
<td>3.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Training and education on low-income house building standards</td>
<td>0.0</td>
<td>3.9</td>
<td>3.9</td>
<td>11.5</td>
</tr>
<tr>
<td>Workshops and seminars</td>
<td>0.0</td>
<td>3.7</td>
<td>14.8</td>
<td>22.2</td>
</tr>
<tr>
<td>Ensure registration with a quality assurance body</td>
<td>0.0</td>
<td>7.4</td>
<td>14.8</td>
<td>14.8</td>
</tr>
</tbody>
</table>

Table 8: Contractors’ perception related to the selection of materials

<table>
<thead>
<tr>
<th>Factor</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree ........ Strongly agree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Material specified by the designer or developer</td>
<td>0.0</td>
<td>0.0</td>
<td>7.1</td>
<td>25.0</td>
</tr>
<tr>
<td>Suitable material according to building regulations</td>
<td>0.0</td>
<td>3.6</td>
<td>7.1</td>
<td>25.0</td>
</tr>
<tr>
<td>Affordability of material</td>
<td>0.0</td>
<td>10.7</td>
<td>14.3</td>
<td>10.7</td>
</tr>
<tr>
<td>Available financial resources</td>
<td>0.0</td>
<td>17.9</td>
<td>14.3</td>
<td>10.7</td>
</tr>
<tr>
<td>Availability of material</td>
<td>7.1</td>
<td>21.4</td>
<td>10.7</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Table 9, which indicates respondents’ perceptions pertaining to the criteria used for the selection of workers in low-income housing projects in terms of percentage responses ranging from 1 (strongly disagree) to 5 (strongly agree), suggests that 57.1% and 32.1% strongly agreed that contract requirements as well as the level of
skills and training possessed by workers could affect the selection of workers for low-income housing projects.

Table 9: Contractors’ perception related to the selection of workers for low-income housing projects

<table>
<thead>
<tr>
<th>Factor</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract requirements, e.g. the use of local labour</td>
<td>Strongly disagree... Strongly agree</td>
<td>3.6</td>
<td>17.9</td>
<td>57.1</td>
</tr>
<tr>
<td>Skills and training which the worker has</td>
<td>Strongly disagree... Strongly agree</td>
<td>0.0</td>
<td>32.1</td>
<td>32.1</td>
</tr>
<tr>
<td>Available financial resources</td>
<td>Strongly disagree... Strongly agree</td>
<td>0.0</td>
<td>34.2</td>
<td>21.4</td>
</tr>
<tr>
<td>Community empowerment such as using beneficiaries to build their own houses</td>
<td>Strongly disagree... Strongly agree</td>
<td>0.0</td>
<td>28.6</td>
<td>28.6</td>
</tr>
</tbody>
</table>

Table 10 indicates that 50.0% of the contractors strongly disagreed with the notion that acceptable methods according to building regulations affect the preferred construction method used for low-income housing projects. A further 35.7% and 33.3% also strongly disagreed that less time-consuming methods and less expensive methods influence the choice of construction methods used for low-income housing projects. In fact, only a minority (3.7%-10.7%) strongly agreed with the statements tabulated in Table 10.

Table 10: Construction methods used when building low-income houses

<table>
<thead>
<tr>
<th>Factor</th>
<th>Response (%)</th>
<th>MS</th>
<th>Std. Dev</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable methods according to building regulations</td>
<td>Strongly disagree... Strongly agree</td>
<td>0.0</td>
<td>17.9</td>
<td>14.3</td>
</tr>
</tbody>
</table>
4. **Conclusions and recommendations**

The provision of low-income housing to the poor in South Africa is performing below expectations due to a number of factors. There are major problems in all aspects related to the provision of low-income houses. Starting at governmental departments, such as municipalities that award and oversee low-income housing projects, to the contractors who build the houses, problems seem to abound.

The study revealed that there is a major problem in terms of defective houses in the low-income housing sector. It was confirmed that the major cause of defects is poor workmanship. Poor workmanship, as cited in the literature reviewed, was confirmed by the results of the conducted survey. In fact, poor workmanship was ranked first and confirmed as the main cause of defects in low-income housing by the respondents to the survey.

In addition, the majority of the contractors who participated in the survey agreed that the use of unskilled labour and faulty construction methods are among the causes of defects in low-income houses. As a result, recommendations arising from the study include:

- Project monitoring and inspections during the construction phase should be ensured by project stakeholders such as municipal inspectors and NHBRC officials;
- There should be a set of uniform standards to be adhered to by all contractors involved in the provision of low-income houses;
- Low-income housing projects should be awarded to competent contractors: contractors’ experience and capabilities should be evaluated before contract award;
- Formal training requirements in the built environment disciplines should be promoted among emerging contractors, especially in terms of construction materials and methods;
- Training and education related to low-income housing building standards should be provided through workshops and seminars at regular intervals;
All contractors involved in low-income housing projects should be encouraged to register with a quality assurance body in order to facilitate performance audits, and

There is a need to engender a culture of excellence related to quality in the industry.

References list


Magagula, T. & Mnisi, O. 2010. This is the house built of...holes. Daily Sun, 19 March, p. 2.


Mtyala, Q. 2010. Would-be homeowner insists house is hers as handover turns sour. Cape Times, 22 April, p. 4.


A linear regression modelling of the relationship between initial estimated and final achieved construction time in South Africa

Peer reviewed

Abstract

The estimation of contract completion time has always been inaccurate despite there being a need for certainty regarding the completion of projects. This article reports on an investigation of the relationship between initial and final contract time with the aim of developing an equation for reasonably estimating project period. Data for the study was secured from a total of eighty-eight questionnaires and sixty-five projects. The sample population consisted of architects, contractors, quantity surveyors, structural engineers and clients. Five metropolitan cities in the provinces of the Eastern Cape, Free State, Gauteng, KwaZulu-Natal, and the Western Cape, namely Bloemfontein, Cape Town, Durban, Johannesburg and Port Elizabeth, constitute the geographical area in which the study was conducted. Inferential statistical analysis, including regression analysis, was used to evolve, inter alia, a model and linear equations for estimating building construction time. The equations involved in the respective phases of the study are \( Y = 9.9 + 1.0586x \) for phase one, and \( Y = 13.1159 + 1.1341x \) for phase two. During phase two of the study, it was determined that 35.3% additional time needs to be added to the amount of the initial contract period in order to estimate final contract time. It is recommended that either the equation \( Y = 13.1159 + 1.1341x \) be used, or that 35.3% additional time be added to the amount of initial contract time to estimate the final contract time.

Keywords: Relationship, initial & final construction time, project delivery

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Abstrak
Die skatting van die konktrakvoltooiingstydperke was altyd inkorrek ten spyte daarvan dat daar ‘n behoefte is vir sekerheid betreffende die voltooiing van projekte. Hierdie artikel doen verslag oor ‘n ondersoek na die verhouding tussen aanvanklike en finale kontraktydperke met die doel om ‘n berekening vir redelike geskatte projekperiodes te ontwikkel. Data vir die studie is verkry uit ‘n totaal van agt en tagtig vraelyste en ses en vyftig projekte. Die steekproefpopulasie het bestaan uit argitekte, kontrakteurs, bourekenaars,strukturele ingenieurs en kliënte. Vyf metropoolstede, in die provinsies van die Oos-Kaap, Vrystaat, Gauteng, KwaZulu-Natal en Wes-Kaap, naamlik Bloemfontein, Kaapstad, Durban, Johannesburg en Port Elizabeth, het die geografiese gebied gevorm waarin die studie gedoen is. Inferensiële statistiese analise, insluitende regressive analise is gebruik om, onder andere, ‘n model en lineêre vergelykings om boukonstruksie tydperke te skat, te ontwikkel. Die vergelykings wat ontwikkel is in die onderskeie fases van die studie is Y = 9.9 + 1.0586x vir fase een, en Y = 13.1159 + 1.1341x vir fase twee. Gedurende fase twee van die studie, is dit vasgestel dat 35.3% addisionele tyd tot die aanvanklike kontrakperiode bygevoeg behoort te word om die finale kontraktydperk te kan skat.
Daar word aanbeveel dat die vergelyking Y = 13.1159 + 1.1341x eerder gebruik word, of dat 35.3% addisionele tyd tot die getal van die aanvanklike kontraktydperk bygevoeg word om sodoende die finale kontraktydperk te kan skat.

Sleutelwoorde: Verhouding, aanvanklike en finale kontraktydperke, projek levering

1. Introduction
Success with respect to delivery of a building project could be referred to as the completion of a building within specified time, budget limits, quality standards, and void of accidents. This indicates the level of management control on the project and a measure of competence. Observation has revealed that peculiar problems concerning project management still exist (Jha & Iyer, 2005: 314). There are many means of control in the delivery of projects: activity planning, labour, materials, and plant and equipment planning, as well as supervision of work in the form of allocation of daily tasks, specification of work direction and guidance, the designing of temporary works, and the sequencing of activities. These require firm control in order to deliver the project as designed. Various stakeholders on a project, namely clients, contractor, and designers, as well as external influences contribute to the process of delivery of a project. The objective of this article is to determine the relationship between these factors and the delivery dates achieved on projects.
2. Project delivery time

Based on the aforementioned, the influences on project delivery time were identified from previous studies conducted by Sambasivan & Soon (2007: 522), Assaf & Al-Hejji (2006: 352-353), and Faridi & El-Sayegh (2006: 1171-1172). Seventy-six factors were identified (sub-problems), which were then grouped into twelve categories (problem category). Table 1 indicates these groups and the number of factors associated with each group. These form the theoretical framework of the study.

Table 1: Problem categories which influence project delivery time

<table>
<thead>
<tr>
<th>S/No</th>
<th>Problem category</th>
<th>Sub-problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Client understanding of the design, procurement and</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>construction processes</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Quality of management during design</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Quality of management during construction</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Motivation of staff</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Site ground conditions</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Site access</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Constructability of design</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Management style</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>Management techniques used for planning and control</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Physical environmental conditions</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>Economic policy</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Socio-political conditions</td>
<td>3</td>
</tr>
</tbody>
</table>

Each of these problem categories will now be discussed:

- Clients’ understanding of the design and construction processes means the level of their contributions to the design and construction teams, and the ability to quickly make authoritative decisions regarding the progress of the project;
- Quality of management during design – this refers to the extent of competence of engineers and architects regarding building design. The ease of construction depends on the level of freeness from ambiguity relative to design. Factors for consideration include dimensional accuracy; revision of drawings; conflicting design information; missing information, and expediting shop drawings;
Quality of management during construction implies the various efforts put into the construction stage of the project, such as analysis of construction methods and resource; work sequencing to adhere to and maintain workflow, and monitoring and updating of plans to appropriately reflect work status;

Motivation of staff – the degree of labour performance depends largely on motivation. Motivation is defined as inducement given to enhance productivity. These are: job security; a sense of belonging; recognition of contribution made; opportunity to improve skills, and career advancement;

Site ground conditions – an indication of the nature of the site soil, and related factors. Frimpong, Oluwoye & Crawford (2003: 325) state that ground problems such as extent of ground contamination and archaeological finds; the height of the water table, and underground services impact on the speed of delivery of a project;

Site access reflects the ease of traffic ingress and egress, both vehicular and people. Factors for consideration include congestion at ingress and egress points, and road conditions;

Constructability of design – this is the ease at which a design can be constructed. Constructability requirements are major factors necessitating the integration of construction experience into building designs. Oyedele & Tham (2006: 2093) schedule factors that could be used to assess constructability, inter alia: flexibility of design to changes; dimensional coordination of elements; scope and complexity of off-site fabrication; appropriateness of design tolerance, and working space;

Management style – machines and systems are operated by people, but generally the nature of people tends towards not wanting to work, except being coerced. Griffith & Watson (2004: 57) identify three main types of management style, namely autocratic, democratic, and laissez-faire;

Management techniques used for planning and control. These are the various scheduling tools available and employed in activity sequencing and executing them. These include critical path method; bar chart; line of balance; horse blanket, and s-curves;

Physical environmental conditions – this refers to the influence of weather and natural occurrences, which negatively impact on the speed of construction. They are: natural hazard/fire;
flood; adverse local weather – rainfall and temperature differences; adverse light, and noise;

- Economic policy – this refers to government policies such as restriction on importation of building materials; interest rates, and inflation which may negatively affect construction period (Koushki & Kartam, 2004: 127-128), and

- Socio-political conditions. These are government policies and its effects on projects and individuals. Factors include civil strife or riots; influence of civil action groups, and disruption due to environmental concerns.

3. **Previous predictive studies on construction duration**

Table 2 presents the results of previous predictive studies undertaken by several researchers in different parts of the world.

**Table 2: Predictive model equations**

<table>
<thead>
<tr>
<th>Study</th>
<th>Country of study</th>
<th>Predictive Equation</th>
<th>Where</th>
<th>Model/Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ogunsemi &amp; Jagboro (2006: 257)</td>
<td>Nigeria</td>
<td>$T = 118.563 - 0.401c \ (c &gt; 408) or T = 603.427 \times 0.610c \ (c &gt;408)$</td>
<td>$R^2 = 0.765$ (high predictive power)</td>
<td>$T$ = completion time; $c$ is in millions of naira.</td>
</tr>
<tr>
<td>Love, Tse &amp; Edwards (2005: 192)</td>
<td>Australia</td>
<td>$\log (t) = 3017.8 + 0.274 \log \ (GFA) + 0.142 \log \ (floor)$</td>
<td></td>
<td>$t$ = completion time; $GFA$ = gross floor area, and $floor$ = number of floors.</td>
</tr>
<tr>
<td>Moselhi, Assam &amp; El-Rayes (2005: 356)</td>
<td>Canada and USA</td>
<td>$TP_i = HCO_i/PH_i$</td>
<td></td>
<td>$TP_i$ = time impact of change or a period, $HCO_i$ = actual change order hours during period $i$, $PH_i$ = planned hours during period $i$, and $i = 1-5$.</td>
</tr>
<tr>
<td>Al-Moumani (2000: 55)</td>
<td>Jordan</td>
<td>$Y = 82.87 + 1.0016x$</td>
<td></td>
<td>$Y$ = number of days of actual construction, and $X$ = number of days specified in the contract.</td>
</tr>
</tbody>
</table>
**Chan (2001: 226)**  
**Country of study:** Malaysia  
**Model equation:** \( Y = 269C^{0.32} \)  
**Where:** \( T = \) time of completion, and \( C = \) project estimated cost.

**Stoy, Dreier & Schacher (2007: 79)**  
**Country of study:** Germany  
**Model equation:**  
\[
\ln(y) = 4.753 + 0.0002x_1 - 0.001x_2
\]  
**Where:** \( y = \) construction speed (m\(^2\) gross external floor area/month); \( x_1 = \) absolute size (m\(^2\) gross external floor area), and \( x_2 = \) project standard (building construction cost/m\(^2\) gross external floor area).

**Ling, Chan, Chong & Ee (2004: 180)**  
**Country of study:** Singapore  
**Predictive model:**  
\[
Y = 145 + 0.017 \text{ Gross floor area} + 133 \text{ Contractors design capability (1)} R^2 = 0.93 \text{ (very high predictive power)} \\
Y = 3.462 + 0.024 \text{ gross floor area} - 464 \text{ Project scope definition completion when bids are invited} - 443 \text{ Extent to which the contract period is allowed to vary during bid evaluation} - 180 \text{ Design completion when budget is fixed (2)} R^2 = 0.90 \text{ (very high predictive power)}.
\]

**Xiao & Proverb (2003: 326)**  
**Country of study:** Japan; UK, and USA  
**Model equation:**  
\[
Y = 5.458 + (-6.403E - 02) \text{DELAYEDT} + 0.489 \text{LIFEEMP2} + 0.172 \text{CSTIME} + 0.415 \text{PSUBCON2} + (-2003E - 03) \text{DCARATI} R^2 = 0.52 \text{ (good predictive power)}
\]  
**Where:** DELAYEDT represents the typical delay on similar projects as percentage of the original contract time; LIFEEMP2 is a dummy variable for a commitment towards lifetime employment (one for “yes” and zero for “no”); CSTIME represents the importance contractors allocate to construction time to satisfy clients (on a scale of one to ten, where one represents totally unimportant and ten very important); PSUBCON2 is a dummy variable for the partnering with subcontractors (one for “yes” and zero for “no”), and DVARATI represents the typical number of design variations during construction.

**Proverbs & Holt (2000: 663)**  
**Country of study:** UK  
**Model equation:**  
\[
Y = 14.439 = 13.377 \text{ (“concrete pump” transportation method)} - 4.125 \text{ (“property” types of formwork)} + 3.609 \text{ (productivity of erecting formwork to floor slabs)} + 1.690 \text{ (number of supervisions)} R^2 = 0.473 \text{ (average predictive power)}.
\]

It is observed from Table 2 that researchers in each country have a distinctive predictive model for the estimation of final completion time of projects. This cannot be separated from the following: the
construction business environment for each country differs; socio-political conditions and policy of each country differ; the prevailing weather and geo-physical conditions of regions differ, and the technological developments of countries are different. These key construction performance factors have associated subfactors that influence each main factor, with a consequential result on project delivery time. As a result, a particular model developed in a country cannot be used for the estimation of project completion time in other countries based on the foregoing argument. Therefore, this study was embarked on to establish a model for the estimation of final project delivery time in South Africa.

4. Methodology

Both the quantitative and qualitative research approaches were used in this study. Probability sampling techniques were employed in the selection of the sample for the study – proportional stratified, simple random, and systemic sampling.

The concept of these sampling techniques is to allow each sample equal opportunity of occurrence. Relative to the proportional stratified samples, details of respondents were documented alphabetically from A to Z. These constitute layers from which sample sizes of each layer were calculated before drawing from each layer, in a box, the required number of samples. Systemic sampling is that process that allows samples to be picked at regular interval.

The geographical areas included in the study are the three most active areas of South Africa in terms of construction, namely Gauteng, KwaZulu-Natal, and the Western Cape. The Eastern Cape was used as a proxy. Respondents to the study included architects, contractors, clients, structural engineers, and quantity surveyors. These were drawn from the South African Institute of Architects (SAIA), the Association of South African Quantity Surveyors (ASAQS), the South African Property Owners Association (SAPOA), Civil Engineers of South Africa (CESA), and Master Builders Associations (MBAs).

The questionnaire was based on the twelve problems categorised, which formed the framework for the study, and the associated sub-problems evolved from the survey of the literature which initially identified seventy-six factors. These were crystallised and developed into questions that addressed the issue of delays in the delivery of projects.
The statistical tools used for the analysis of data include descriptive and inferential statistical tools. Cronbach's alpha; Cohen's d, and factor analysis loading were used to test for reliability and consistency of data.

The data for the study was collected in three phases using questionnaires. Relative to Phase 1, the primary survey of the study, eighty-eight questionnaires were analysed, representing a response rate of 6.1%. Relative to Phase 2, the historical survey (in this phase, data relative to causes of delay on projects were obtained and the extent of delay in weeks), twenty-four questionnaires were analysed (the number of projects handled previously were considered, in this case, and data from a total of fifty-six (56) were obtained and analysed), representing a response rate of 33.5%. The Phase 3 survey is not applicable to this article.

In order to test the reliability of the data, a Cronbach's coefficient test was conducted and found that values for all the categories of factors were > .70, which is regarded as adequate proof of internal consistency of the factors. Factor analysis loading for sample sizes of 88-99 is 0.60. Most factors have a loading greater than 0.60. This is an indication that factors adequately describe the constructs.

Respondents over the age of thirty years and above predominate (76.5%) in the sample investigated. The most common academic qualifications of respondents are Bachelors (25%), Honours (23%), and B.Tech (17%), totalling 65%. Managing directors/Managing members/Principal (35%), senior staff (20%) and managers (17%) predominate in terms of respondents' status. The mean number of years of experience of respondents is 17. The type of facility with which respondents were involved include residential; commercial offices, and institutional facilities in the form of education, health, and others. The mean value of projects with which respondents have been involved is R866.63 million.

4.1 Linear regression

A linear regression test was conducted to determine the relationship between the start and the finish times of contracts. The conditions relative to the data and the tests are discussed as follows. It should be noted that, in terms of the study, working days and not weekdays represent a week. The start date was when a contractor started work on site, and the end date was the date of handing over of a site to the client or his/her representative. The specified duration and actual duration are not inclusive of the retention period. Actual duration provided by respondents was accurate, because
data was obtained from archives of past projects. Relative to the reasons for delay in project delivery, a closed ended questionnaire was used to access the amount of delay experienced on each project. A space was provided in the questionnaire for respondents to specify, in their own opinion and relative to the projects handled, the causes of delay in project delivery, which is not included in this article, because the focus of this article is the relationship between initial and final contract duration. Changes to the contract in the form of design, additional work, and so on have being taken care of among the seventy-six factors identified and categorised into the twelve problem categories for this study. The results are presented in Figures 1 to 4.

Regression analysis was conducted to determine the kind of relationship between the initial and actual or final contract duration. The scatter plot (Figure 1) indicates a good fit, the correlation coefficient $r = 0.82$ suggests a strong linear relationship between the factors, and $r^2 = 0.68$ indicates that the predictive ability of the equation found is high. A relationship in the form of $Y = 9.9 + 1.0586x$ was obtained, where $Y$ = actual completion duration and $X$ = initial contract duration.
4.1.1 Phase 2 questionnaire: Regression analysis

Linear regression analysis was conducted to determine the relationships between:

- Initial contract duration and final contract duration for the public and private sectors;
- Initial contract duration and final contract duration for the public sector, and
- Initial contract duration and final contract duration for the private sector.

Figure 2 shows the initial contract duration and final contract duration for the public and private sectors.

It should be noted that in all the tests that were conducted α is set at 5%.

![Figure 2: Scatter plot for initial and final contract duration (public and private)](image)

Based upon the correlation coefficient $r = 0.86$, the relationship between initial and final contract duration can be deemed to be strong and statistically significant, because the p value is $< 0.05$ (Figure 2). The predictive ability $r^2 = 0.77$ is high. Therefore, the
equation $Y = 13.1159 + 1.1341x$ can be used to predict final contract duration of projects, where $Y$ is final project duration and $X$ is initial project duration.

Figure 3 shows the initial contract duration and final contract duration for the public sector.

The correlation coefficient $r = 0.89$, presented in the scatter plot in Figure 3, indicates that a strong linear relationship exists between the initial and the final contract duration and is statistically significant as a result of the $p$ value being < 0.05. The predictive ability $r^2 = 0.79$ is high. Therefore, the equation $Y = 16.7912 + 1.0778x$ can be used to predict final contract duration, where $Y$ is final contract duration and $X$ is initial contract duration.

Figure 4 shows the initial contract duration and final contract duration for the private sector.
Figure 4 presents the result of the linear regression analysis for the private sector. The value for $r = 0.90$, which indicates that a strong linear relationship exists between the initial and final contract duration. Given that the p value is $< 0.05$, a statistically significant relationship exists between both times. The predictive ability $r^2 = 0.82$ is high. Therefore, the equation $Y = 16.7912 + 1.0778X$ can be used to predict the final completion time of a project, where $Y$ is project final contract duration and $X$ is initial contract duration.

When comparing the results of the linear regressions analysis for the private and public sector it will be observed that the results obtained from the private sector have greater predictive ability. Therefore, the combined result is recommended for use.

Respondents were asked to indicate the number of weeks from one to eight and over relative to the twelve problem categories identified as contributors to delay, that were experienced in the delivery of contract or projects during the first phase of the study. Note that this is the opinion of the respondents. Table 3 presents the result.
Table 3: Percentage delay on project delivery time

<table>
<thead>
<tr>
<th>Problem category</th>
<th>Frequency of respondents</th>
<th>Standard deviation</th>
<th>Percentage mean (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of management during construction</td>
<td>12</td>
<td>10.63</td>
<td>4.9</td>
</tr>
<tr>
<td>Physical environmental considerations</td>
<td>12</td>
<td>10.02</td>
<td>4.8</td>
</tr>
<tr>
<td>Client understanding of design, procurement and construction processes</td>
<td>9</td>
<td>6.39</td>
<td>3.4</td>
</tr>
<tr>
<td>Economic policy</td>
<td>8</td>
<td>7.91</td>
<td>3.2</td>
</tr>
<tr>
<td>Site ground conditions</td>
<td>8</td>
<td>5.54</td>
<td>3.0</td>
</tr>
<tr>
<td>Constructability of design</td>
<td>7</td>
<td>6.42</td>
<td>3.0</td>
</tr>
<tr>
<td>Quality of management during design</td>
<td>7</td>
<td>5.30</td>
<td>2.9</td>
</tr>
<tr>
<td>Management techniques used for planning and control</td>
<td>6</td>
<td>4.04</td>
<td>2.4</td>
</tr>
<tr>
<td>Management style</td>
<td>5</td>
<td>4.23</td>
<td>2.2</td>
</tr>
<tr>
<td>Socio-political conditions</td>
<td>5</td>
<td>4.91</td>
<td>2.2</td>
</tr>
<tr>
<td>Motivation of staff</td>
<td>5</td>
<td>3.46</td>
<td>1.8</td>
</tr>
<tr>
<td>Site access</td>
<td>4</td>
<td>3.28</td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td></td>
<td>35.3</td>
</tr>
</tbody>
</table>

The percentage mean was computed for the delays caused by factors in various categories. Respondents were asked to indicate the actual delay experienced on the project in terms of days or weeks with reference to the problem category. The percentage delays were calculated relative to the specified project durations. These were then added up to obtain the percentage contribution of the problem categories to delay. The standard deviation was included to enable the ranking of the problem categories. It was found that the factors identified in the research could cause 35.3% addition of time, which is the delay with respect to the initial contract duration.

5. Conclusions

Based on the regression analysis conducted in Phases 1 and 2, the equation for predicting the actual contract duration based on the initial contract duration is given as:
• For the Phase 1 study:
  \[ Y = 9.9 + 1.0586x \]
• For the Phase 2 study:
  \[ Y = 13.1159 + 1.1341x \]

The difference between the two equations is not statistically significant. Therefore, the equation from the Phase 2 survey is suggested for use. The quality of management during construction such as the level of supervision, activity sequencing and ineffective coordination of resources negatively affects the completion time of projects. Physical environmental conditions such as rainfall and high and low temperatures negatively affect delivery time of projects.

6. Recommendations

It is recommended that the regression equation \[ Y = 13.1159 + 1.1341x \] be used for the estimation of final contract duration of projects in the South African construction industry.

Based on the minimum percentage of delay, the twelve problem categories of the study could contribute 35.3%, i.e. additional time to the contract duration. The difference in these two results is insignificant, that will be obtained, when using the regression equation, and adding a percentage to initial contract duration for computing final contract duration. Therefore, both are recommended for use, depending on the initiative of the user.

Clients should evaluate the quality performance of contractors before awarding contracts. This will reduce the incidence of delay on projects. Yasamis, Arditi & Mohammadi (2002: 221) propose a model for evaluating contractors’ quality performance (Figure 5). This model is recommended for evaluating contractors’ quality performance in South Africa. Note that the actions to be taken at each stage are specified in the various boxes. The benefit of this is a motivation for contractors to improve and document their quality management approach in order to be competitive and maintain a continuous flow of business.
Figure 5: Contractor quality performance (CQP) evaluation model
Source: Yasamis et al., 2002: 221

Figure 5 documents processes to follow in the selection of quality-conscious contractors. First, obtain the data of the contractor. Secondly, set out the criteria for evaluating contractors, including prequalification, corporate level quality standards, and project level quality standards. Thirdly, decide on acceptable standards relative to the foregoing, and select quality-conscious contractors, which will constitute the schedule of bidders.
One major advantage of the CQP evaluation model is that it moves existing contractor evaluation methods to a new baseline that includes the evaluation of contractor quality performance. This is expected to allow the owner to select a quality-oriented contractor and consequently avoid some of the problems related to construction quality (rework resulting in delay) and client satisfaction. Based on these, a reasonable delivery date of projects could be calculated with no delay experienced, and the result of the model for the calculation of completion duration will be accurate when used.

Contractors’ technical and financial performance should be evaluated. This will result in a better understanding of the contractors’ overall capabilities.

The hiring of a materials manager to independently supervise and monitor the progress of the construction work will contribute significantly to on-time delivery of materials to sites.

The construction industry should provide quality management guidelines to be enforced by consultants on projects. Stakeholders should be committed to quality management, designers included. Designers' quality management should focus on the following:

- Commitment to providing a quality service;
- Production of correct and complete drawings and specifications;
- Coordinating and checking of design documentation;
- Conducting design verification through design analysis reviews;
- Conducting constructability reviews, and
- Off-site prefabrication should be encouraged in areas susceptible to heavy rainfall.

References list


Frank Berry & Basie Verster

’n Model vir die meting van die bourekenaar se kommunikasievolwassenheid

Peer reviewed

Abstrak
Die doel van hierdie artikel is om die identifisering en meting van die determinante van ‘n kommunikasievolwassenheidsmodel wat die bourekenaar se kommunikasievermoë meet, te beskryf.

Die ondersoek is gedoen onder praktiserende bourekenaars, argitekte, ingenieurs, kliente en aannemers, gekies uit al 9 provinsies van Suid-Afrika. Die vraelys is in 2010 uitgestuur en is ook in dieselfde jaar terug ontvang. Die vraelys is per e-pos gesirkuleer met die doel om die belangrikheid van die determinante van die voorgestelde model volgens die die standaard gestel deur bourekenaars te meet. Sienings is ook in gewin ten opsigte van die bourekenaarstandaard van volwassenheid volgens die gekose determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar in die konstruksiebedryf vorm.

Die navorsingsresultate het die volgende determinante aangewys as belangrik om die kommunikasievolwassenheidsmodel te vorm: mondelinge kommunikasie, skriftelike kommunikasie, kontraktuele kommunikasie, inligtingstegnologiese kommunikasie, leierskapkommunikasie en kommunikasie deur instrumente. Die siening van die respondente betreffende die bourekenaarstandaard van die determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar vorm, toon dat die determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar bepaal positief ervaar is en die determinant ‘Kontraktuele kommunikasie’ het die hoogste waarderingsuitslag behaal. Die determinant ‘Mondelinge kommunikasie’ is relatief tot die ander determinante uitgesonder as ’n gebied wat verdere ontwikkeling benodig.

Sleutelwoorde: Kommunikasievolwassenheidsmodel, kommunikasievermoë, bourekenaar, Suid-Afrika

Abstract
The aim of this article is to describe the identification and measurement of the determinants important for a communication maturity model leading to the development of a communication maturity model to measure the communication capabilities of the quantity surveyor.

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The survey has been conducted amongst practising quantity surveyors, architects, engineers, clients and contractors chosen from all 9 provinces in South Africa. The questionnaire which was distributed and returned by respondents by email in 2010, was aimed at measuring the importance of the determinants according to the quantity surveying standard. Views on the quantity surveying standard of maturity in communication based on the chosen determinants which forms the communication maturity model for the quantity surveyor in the construction industry were also collected.

The results of the survey indicated that respondents identified the following determinants as important elements of the communication maturity model: verbal communication, written communication, contractual communication, information technology communication, leadership communication and instruments communication. The views of respondents regarding the quantity surveying standard in maturity from the chosen determinants which form the communication maturity model, showed that all determinants were positively experienced and that the determinant ‘Contractual communication’ showed the highest valuation result. The determinant ‘Verbal communication’ is in relation to other determinants identified as an area that should be developed.

Keywords: Communication maturity model, communication capabilities, quantity surveyor, South Africa

1. Inleiding

Volgens die literatuur wat geraadpleeg is betreffende die bydrae van die bourekenaarsprofessie tot kommunikasie, is daar tans ‘n gebrek aan die bewustheid binne die areas van die determinante van kommunikasievolwassenheid in die bourekenaarsprofessie (Verster, Hauptfleisch & Kotzé, 2008: 23).

Gruber (2004) konstateer dat volwassenheid groei oor tyd impliseer, sowel as die insig welke faktore tot die sukses bygedra het, om sodoende weê vir moontlike regstellings te vind of maniere voor te stel om probleme te voorkom.

‘n Standaard van volwassenheid kan omskryf word as die mededinging na beste praktyk tussen mededingers en nie-mededingers wat tot ‘n organisasie se superieure prestasie aanleiding gee. Die vergelyking van huidige en vorige resultate deur bestuurders kan problematies wees aangesien die huidige prestasie met ‘n swak vorige prestasie vergelyk mag word. Indien die huidige prestasie egter met die volwassenheidstandaard van ‘n industrie vergelyk word, mag die resultate ‘n ander uitkoms gee (Smith & Cronje, 2002: 121).

Die veronderstelling dat ‘n volwassenheidsmodel ‘n bydrae tot die ontwikkeling van die bourekenaarsprofessie mag lewer, impliseer noodwendig dat die definisie dit konstateer. Gruber (2004: powerpoint slides) defineer ‘n ‘volwassenheidsmodel’ soos volg:
"A maturity model is a framework describing a process whereby something desirable can be developed or achieved."

'n Volwassenheidsmodel is 'n instrument om prosesse van organisasies te ontwikkel en te verfyn; 'n gestructureerde versameling elemente wat karaktereierskaapte van effektiewe prosesse beskryf en wat voorsiening maak vir:

- 'n Vertrekpunt;
- Die nut van 'n gemeenskap se vorige ondervindings;
- 'n Gemeenskaplike grond en 'n gedeelde visie;
- 'n Raamwerk vir prioritisering van aksies; en
- 'n Wyse om te bepaal wat verbeteringe vir die organisasie beteken (Wikipedia, [n.d.]: Internet).

Die projekbestuurvolwassenheid van projekgeoriënteerde maatskappye, organisasies en lande kan gemeet word deur volwassenheidsmodelle toe te pas en met die norm wat geld te vergelyk (Gareis, 2005: 584).

Die belangrikheid en invloed van 'n volwassenheidsmodel as instrument om die volwassenheid van bourekenkundige kommunikasie te meet sal waarskynlik 'n bydrae tot die professie se ontwikkeling lever (Berry, 2012: 18).

Berry (2008: 147) stel voor dat die voorgestelde kommunikasievolwassenheidsmodel as 'n meetinstrument dien om leemtes uit te wys wat, indien daaraan aandag gegee word, tot voordeel van die professie mag streek.

2. Terminologie

Vir doeleindes van hierdie artikel is dit belangrik om die volgende terme te verduidelik:

**Instrumente:** Die bepalende faktore wat die determinant 'kommunikasie deur instrumente' verteenwoordig en 'n direkte invloed op die determinant betreffende bourekenkundige kommunikasie uitoefen (Berry, 2012: 4).

**Kommunikasie deur instrumente (Professie):** bourekenkundige kommunikasie-instrumente wat onderskeidelik in die konstruksiebedryf deur die professie se amptelike liggame self vir die bourekenaar se gebruik opgestel word, soos byvoorbeeld die: Elementale kostebromigisdokument, Standaardselseldokument,
Kontrakkooreenkomisdokument, Voorbereidselsdokument, Modelvoorskrifte vir Ambagte en Modelhoeveelheidslyste-dokument (Berry, 2012: 250).

**Kommunikasie deur instrumente (Bourekenaar):** instrumente wat die bourekenaar normaalweg op projekte in die konstruksiebedryf gebruik en self opstel, soos byvoorbeeld die: Kosteraming, Gangbaarheidstudie, Kosteplan, Betalingsadvies, Kosteverslag, Boukoste-eskalasie-berekenings-voorleggings, Finale rekening en Hoeveelheidslyste (Berry, 2012: 256).

**Kommunikasie deur instrumente (Duidelikheid) Professie:** die verstaanbaarheid van bourekenkundige kommunikasie-instrumente, wat deur die professie self opgestel word soos byvoorbeeld die: Elementale kostebramigsdokument, Standaardselseldokument, Kontrakkooreenkomisdokument, Voorbereidselsdokument, Modelvoorskrifte vir Ambagte en Modelhoeveelheidslyste-dokument (Berry, 2012: 251).

**Kommunikasie deur instrumente (Ondersteunend) Professie:** die ondersteunende waarde van kommunikasie-instrumente wat deur die professie self opgestel word soos byvoorbeeld die: Elementale kostebramigsdokument, Standaardselseldokument, Kontrakkooreenkomisdokument, Voorbereidselsdokument, Modelvoorskrifte vir Ambagte en Modelhoeveelheidslyste-dokument (Berry, 2012: 261).

**Kommunikasie deur instrumente (Duidelikheid) Bourekenaar:** die verstaanbaarheid van bourekenkundige kommunikasie-instrumente, wat deur die bourekenaar self opgestel word soos byvoorbeeld die: Kosteraming, Gangbaarheidstudie, Kosteplan, Betalingsadvies, Kosteverslag, Boukoste-eskalasie-berekenings-voorleggings, Finale rekening en Hoeveelheidslyste (Berry, 2012: 256).

**Kommunikasie deur instrumente (Ondersteunend) Bourekenaar:** die ondersteunende waarde van kommunikasie-instrumente wat deur die bourekenaar self opgestel word soos byvoorbeeld die: Kosteraming, Gangbaarheidstudie, Kosteplan, Betalingsadvies, Kosteverslag, Boukoste-eskalasie-berekenings-voorleggings, Finale rekening en Hoeveelheidslyste (Berry, 2012: 266)

**Model:** Voorbeeld en ontwerp. ’n Teoretiese raamwerk of wetenskaplike voorstelling waarbinne die werklikheid bedryf word (Verster, 1994: 5).
Volwassenheid: Professionele ontwikkeling oor 'n tydperk, asook begrip waarom suksesvolle uitkomste behaal word (Gruber, 2004: powerpoint slides).

Voortgesette professionele ontwikkeling (VPO): is 'n verpligte voortgesette professionele ontwikkelingsprogram vir die duur van 'n loopbaan (Verster, Kotze en Hauptfleisch, 2008: powerpoint slides)

3. Navorsing

'n Vraelys is in 2010 aan geselekteerde praktiserende bourekenaars, argitekte, ingenieurs, kliënte en aannemers per e-pos gesirkuleer met die doel om sienings ten opsigte van die volwassenheid van bourekenkundige kommunikasie in die konstruksiebedryf in te win. Die geselekteerde groep is uit al 9 provinsies van Suid-Afrika gekies en die respondente het 'n redelike verspreiding verteenwoordig. Die werkservaring van 77.0% van die respondente is 10 jaar en meer in die konstruksiebedryf, terwyl 52.6% van hierdie persentasie 'n werkservaring van 20 jaar of meer het. Die repondente het dus bewese werkservaring en hulle siening kan derhalwe as verteenwoordigend en geloofwaardig beskou word (sien Tabel 1).

<table>
<thead>
<tr>
<th>Tabel 1: Werkservaring van respondente</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondente groepe</td>
</tr>
<tr>
<td>Ingenieurs</td>
</tr>
<tr>
<td>Aannemers</td>
</tr>
<tr>
<td>Kliënte</td>
</tr>
<tr>
<td>Argitekte</td>
</tr>
<tr>
<td>Bourekenaars</td>
</tr>
<tr>
<td>TOTAAL</td>
</tr>
</tbody>
</table>

Die respondente met 'n kliënte- en bourekenaarsagtergrond se terugvoer was positief in vergelyking met die ander respondente en onderskeidelik 40.91% en 43.21% van diégene wat vraelyste ontvang het, het voltooide vraelyste teruggestuur. Die argitekte, ingenieurs en kontrakteurs het minder positief gereageer en die respons op die vraelyste uitgestuur was onderskeidelik 18.18%, 18.46% en 30.30%. Die respons word in Tabel 1 getoon.
### Tabel 2: Respons op vraeyste

<table>
<thead>
<tr>
<th>Respondente groep</th>
<th>Vraeyste uitgestuur</th>
<th>Vraeyste terugontvang</th>
<th>Persentasie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingenieurs</td>
<td>65</td>
<td>12</td>
<td>18.46%</td>
</tr>
<tr>
<td>Aannemers</td>
<td>33</td>
<td>10</td>
<td>30.30%</td>
</tr>
<tr>
<td>Kliënte</td>
<td>22</td>
<td>9</td>
<td>40.91%</td>
</tr>
<tr>
<td>Argitekte</td>
<td>66</td>
<td>12</td>
<td>18.18%</td>
</tr>
<tr>
<td>Bourekenaars</td>
<td>81</td>
<td>35</td>
<td>43.21%</td>
</tr>
<tr>
<td>TOTAAL</td>
<td>267</td>
<td>78</td>
<td>29.21%</td>
</tr>
</tbody>
</table>

Die totale reaksie was 29.21% en word vir doeleindes van hierdie artikel as verteenwoordigend beskou.

Die kolomme in die tabelle het die volgende betekenis:

- **Determinant:** Die kommunikasie determinante wat die volwassenheid van die bourekenkundige kommunikasie bepaal.
- **GBS:** Gemiddeld van bourekenaarstandaard (gebasseer op die opinies van respondente oor wat die vlak van bourekenaarstandaard in die bourekenaarsprofessie in Suid-Afrika behoort te wees gemee te teen hul siening van wêreldklasstandaard [Soos reeds genoem beskik meer as die helfte van die respondente oor ‘n werkservaring van meer as 20 jaar in die konstruksiebedryf en word hulle siening as geloofwaardig beskou]).
- **Belangrikheid persentasie in terme van determinant:** Illustreer wat die respondente se siening is oor wat die belangrikheid van die vlak van volwassenheid is ten opsigte van elke determinant.

Belangrikheid persentasie in terme van determinant: Illustreer wat die respondente se siening is oor wat die belangrikheid van die vlak van volwassenheid is ten opsigte van elke determinant.

Die skaal vir die waarde-etiket word alternatiewelik as ‘laag’ = (1), ‘gemiddeld’ = (5), ‘hoog’ = (10) aangedui.

Die siening van die respondente, is gebruik om die belangrikheid van determinante van die volwassenheid van bourekenkundige kommunikasie te bepaal.

### 4. Resultate en bespreking

Die resultaat van die respondente se siening ten opsigte van die belangrikheid van die determinante van die volwassenheid van die bourekenaar om effektiewe kommunikasie in die uitvoering van projekte te handhaaf, word in Tabel 3 verstrek.
### Tabel 3: Belangrikheid van die determinante van die kommunikasievolwassenheidsmodel

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Bourekenaar-Standaard GBS</th>
<th>Belangrikheid (%) in terme van determinant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kontraktuele kommunikasie</td>
<td>8.54</td>
<td>94%</td>
</tr>
<tr>
<td>Kennis</td>
<td>8.31</td>
<td>89%</td>
</tr>
<tr>
<td>Inligtingstegnologiese kommunikasie</td>
<td>8.08</td>
<td>85%</td>
</tr>
<tr>
<td>Kommunikasie deur instrumente (Duidelikheid): Bourekenaar</td>
<td>8.04</td>
<td>87%</td>
</tr>
<tr>
<td>Kommunikasie deur instrumente (Duidelikheid): Professie</td>
<td>8.03</td>
<td>85%</td>
</tr>
<tr>
<td>Skriftelike kommunikasie</td>
<td>8.00</td>
<td>89%</td>
</tr>
<tr>
<td>Kommunikasie deur instrumente (Ondersteunend): Professie</td>
<td>7.96</td>
<td>85%</td>
</tr>
<tr>
<td>Kommunikasie deur instrumente (Ondersteunend): Bourekenaar</td>
<td>7.94</td>
<td>85%</td>
</tr>
<tr>
<td>Leierskapkommunikasie</td>
<td>7.80</td>
<td>85%</td>
</tr>
<tr>
<td>Mondelinge kommunikasie</td>
<td>7.54</td>
<td>84%</td>
</tr>
</tbody>
</table>

Die siening van die respondente betreffende die **bourekenaarstandaard** van die determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar vorm, het in dalende volgorde die volgende waarderingsuitslag vir die betrokke determinante aangedui: ‘Kontraktuele kommunikasie’ (8.54), ‘Kennis’ (8.31), ‘Inligtingstegnologiese kommunikasie’ (8.08), ‘Kommunikasie deur instrumente (Duidelikheid): Bourekenaar’ (8.04), ‘Kommunikasie deur instrumente (Duidelikheid): Professie’ (8.03), ‘Skriftelike kommunikasie’ (8.00), ‘Kommunikasie deur instrumente (Ondersteunend): Professie’ (7.96), ‘Kommunikasie deur instrumente (Ondersteunend): Bourekenaar’ (7.94), ‘Leierskapkommunikasie’ (7.80) en ‘Mondelinge kommunikasie’ (7.54). Die determinant ‘Kontraktuele kommunikasie’ (8.54) het die mees positiewe en ‘Mondelinge kommunikasie’ (7.54) die mins positiewe waarderingsuitslag betreffende die standaard van die bourekenaar se kommunikasievolwassenheid aangeteken.

Die siening van die respondente het in dalende volgorde betreffende die **belangrikheid van die determinante** van die kommunikasievolwassenheidsmodel, die volgende waarderingsuitslag vir die betrokke determinante aangedui: ‘Kontraktuele kommunikasie’ (94%), ‘Kennis’ (89%), ‘Skriftelike kommunikasie’ (89%), ‘Kommunikasie deur instrumente (Duidelikheid): Bourekenaar’ (87%), ‘Kommunikasie deur instrumente (Duidelikheid): Professie’ (85%), ‘Kommunikasie deur instrumente (Ondersteunend): Professie’ (85%), ‘Kommunikasie deur instrumente (Ondersteunend): Bourekenaar’ (85%), ‘Leierskapkommunikasie’ (85%) en ‘Mondelinge kommunikasie’ (84%).
(87%), ‘Inligtingstegnologiese kommunikasie’ (85%), ‘Kommunikasie deur instrumente (Duidelijkheid): Professie’ (85%), ‘Kommunikasie deur instrumente (Ondersteunend): Professie’ (85%), ‘Kommunikasie deur instrumente (Ondersteunend): Bourekenaar’ (85%), ‘Leierskap-kommunikasie’ (85%) en ‘Mondelinge kommunikasie’ (84%). Die determinant ‘Kontraktuele kommunikasie’ (94%) word as die belangrikste determinant en ‘Mondelinge kommunikasie’ (84%) die mins belangrike determinant in terme van die determinant ‘Kommunikasievolwassenheidsmodel’ uitgewys.

Die bourekenaar se mondelinge, skrifelike, kontraktuele, inligtingstegnologiese en leierskap kommunikasie word positief in die konstruksiebedryf ervaar en word almal as belangrike determinant beskou om deel van ‘n bourekenkundige kommunikasievolwassenheidsmodel te vorm.

Die bourekenaar se ‘kommunikasie deur instrumente’ is ten opsigte van duidelikheid/verstaanbaarheid en ondersteunende waarde beskou, asook afsonderlik vir dokumentasie wat deur die professie self en deur die bourekenaar opgestel, hanteer. ‘Kommunikasie deur instrumente’ is ook positief ten opsigte van bagemelde fasette ervaar en word dus as een determinant saamgevoeg en word as sodanig as ‘n belangrike determinant beskou om deel van ‘n bourekenkundige kommunikasievolwassenheidsmodel te vorm.

Die resultaat van die respondente se siening ten opsigte van die determinante wat die voorgestelde kommunikasie-volwassenheidsmodel vorm, word in Tabel 4 voorgestel.

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Bourekenaarstandaard GBS</th>
<th>Belangrikheid (%) in terme van determinant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kontraktuele kommunikasie</td>
<td>8.16</td>
<td>91%</td>
</tr>
<tr>
<td>Kommunikasie deur instrumente</td>
<td>8.13</td>
<td>88%</td>
</tr>
<tr>
<td>Inligtingstegnologiese kommunikasie</td>
<td>7.95</td>
<td>85%</td>
</tr>
<tr>
<td>Skrifelike kommunikasie</td>
<td>7.85</td>
<td>86%</td>
</tr>
<tr>
<td>Mondelinge kommunikasie</td>
<td>7.66</td>
<td>82%</td>
</tr>
<tr>
<td>Leierskapkommunikasie</td>
<td>7.58</td>
<td>85%</td>
</tr>
</tbody>
</table>

Die siening van die respondente betreffende die bourekenaarstandaard van volwassenheid van die gekose determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar

Die siening van die respondente betreffende die belangrikheid van die gekose determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar vorm, het in dalende volgorde die volgende waarderingsuitslag aangedui: ‘Kontraktuele kommunikasie’ (91%), ‘Kommunikasie deur instrumente’ (88%), ‘Skriftelike kommunikasie’ (86%), ‘Inligtingstegnologiese kommunikasie’ (85%), ‘Leierskapkommunikasie’ (85%) en ‘Mondelinge kommunikasie’ (82%) aangeteken.

Die determinante wat die kommunikasievolwassenheidsmodel van die bourekenaar bepaal is positief ervaar en die determinaat ‘Kontraktuele kommunikasie’ het die hoogste waarderingsuitslag behaal.

Die geïdentifiseerde determinante is as belangrik beskou om die bourekenkundige kommunikasievolwassenheidsmodel te vorm en die bourekenaar se bydrae in kommunikasie is positief deur die roolspelers aangeslaan.

5. Bourekenkundige kommunikasievolwassenheidsmodel

Die ontwikkeling van ’n nuwe meetinstrument, gebaseer op die resultate uit Tabel 4, en die bydrae van die artikel, ‘om bourekenkundige kommunikasievolwassenheid te meet’ is uniek in die sin dat daar nie vorige navorsing direk hieroor gedoen is nie.

Figuur 1 toon ’n voorgestelde bourekenkundige kommunikasievolwassenheidsmodel. Dit word voorgestel dat die model saamgestel word uit ses geïdentifiseerde determinante soos verkry uit die siening van die respondente wat in kwadrante onderverdeel is en op die buitesirkel getoon word. Die determinante word deur elemente, instrumente, rekenaarprogrammatuur, karakterskappe, en/of projekbestuursgebiede verteenwoordig.

Die belang van kennis waarop die kern van kommunikasie gefundeer is, word in die kern van die model getoon en word deur dimensies verteenwoordig.

Die pyltjies toon die moontlike direkte of indirekte wisselwerking tussen die onderskeie geïdentifiseerde determinante en/of die kennisdimensies aan.
Die komponente waaruit die kommunikasievolwassenheidsmodel saamgestel is, word soos volg voorgestel:

- Kennis: 'rooi';
- Mondelinge kommunikasie: 'oranje';
- Skriflike kommunikasie: 'geel';
- Kontraktuele kommunikasie: 'groen';
- Kommunikasie deur instrumente: 'blou';
- Inligtingstegnologiese kommunikasie: 'indigo';
- Leierskapkommunikasie: 'violet'.

---

**Figuur 1: Bourekenkundige kommunikasievolwassenheidsmodel**
Die rasional om kennis in die kern van die bourekenkundige kommunikasievolwassenheidsmodel te plaas, dui daarop dat kennis fundamenteel tot effektiewe kommunikasie beskou word en as ’t ware die voedingsbron vir kommunikasie is. Die vyf kennisdimensies (onderrig, opleiding, mentorskap, VPO en navorsing) is belangrik vir ’n professie om as ’n geleerde gemeenskap te ontwikkel tot vlakke wat met wêreldklasprofessies vergelyk kan word en eweneens om volwassenheid in kommunikasie te bereik (Verster, Kotzé & Hauptfleisch, 2008: 5-10). Die volwassenheidsvlak van kennis waaroor ’n persoon beskik is derhalwe direk afhanklik van die effektiwiteit van die kennisdimensie, wat daarop dui dat die ontwikkeling van die kennisdimensie tot effektiewe kommunikasie in die konstruksiebedryf kan bydra.

Die interafhanklikheid van die determinante word in die bourekenkundige kommunikasievolwassenheidsmodel beklemtoon deur die pyltjie wat vanaf die kennisdimensies na die determinant vloei, maar ook weer terug na die kennisdimensies, wat op kruisbestuiwing dui en noodwendig ontwikkeling verseker. Dit beteken dat die ontwikkeling van enige determinant ook ’n direkte of indirekte invloed op die ontwikkeling van die ander determinante het.

Die determinant ‘Mondelinge kommunikasie’ word verteenwoordig deur die volgende elemente: kundigheid, taalvermoë, geloofwaardigheid, oorredingsvermoë, selfvertroue, dinamiese/uitgaande gedrag, integriteit, algemene indruk en voorkoms. Deur hierdie elemente te meet volgens die bourekenkundige kommunikasievolwassenheidsmodel kan bourekenaarfirmas moontlike ontwikkelingsgebiede identifiseer wat ontwikkel behoort te word.

Die determinant ‘Skriflike kommunikasie’ word verteenwoordig deur die elemente: professionaliteit, taalgebruik, wetenskaplikheid, gehalte en doelgerigte opdraggewing wat gemeet in terme van die bourekenkundige kommunikasievolwassenheidsmodel vir bourekenaarfirmas ‘n aanduiding mag gee van moontlike ontwikkelingsgebiede.

Kontraktueelbindend, billikheid, effektiwiteit en afdwingbaarheid asook ondubbelsinnigheid vorm die elemente vir die determinant ‘Kontraktuele kommunikasie’, wat gemeet volgens die bourekenkundige kommunikasievolwassenheidsmodel, vir bourekenaarfirmas moontlike ontwikkelingsgebiede kan uiltig.

Die determinant ‘Kommunikasie deur instrumente’ word gekenmerk deur twee afdelings naamlik, die kommunikasiinstrumente vir die bourekenaar en kommunikasie-instrumente
vir die professie. Die gebruik van die kommunikasie-instrumente kosteraming, gangbaarheidstudie, kosteplan, betalingsadvies, kosteverslag, boukoste-eskalasieberekenings voorlegging, finale rekening en hoeveelheidslyste is belangrik vir die bourekenaar. Die Standaardstelsel, kontrakoooreenkoms, voorbereidsels, model voorskrifte vir ambagte en modelhoeveelheidslyste is belangrike kommunikasie instrumente wat deur die professie gebruik word. Bourekenaarfirmas en die professie kan onderskeidelik moontlike ontwikkelingsgebiede identifiseer wanneer hierdie instrumente gemeet word in terme van die bourekenkundige kommunikasievolwassenheidsmodel.

Die determinant ‘Inligtingtegnologiese kommunikasie' se elemente sluit in: Woordprocesseringsprogramme, spreivelprogramme, voorleggingprogramme, hoeveelheidslysteteknisieprogramme, ontwerpprogramme vir meetdoeleindes, e-posdienste, projekbestuursprogramme en internetdienste. Moontlike ontwikkelingsgebiede kan identifiseer word indien hierdie elemente gemeet word volgens die bourekenkundige kommunikasievolwassenheidsmodel vir bourekenaars.

Die determinant ‘Leierskapkommunikasie' sluit die volgende in: Karaktereienskappe – visie in besluitneming, moed in besluitneming, beoordeling van totale prentjie, orden inligting en die hantering van spanning vorm die karakteienskappe wat indien gemeet, volgens die bourekenkundige kommunikasievolwassenheidsmodel vir bourekenaars, moontlike ontwikkelingsgebiede mag uitwys.

Projekbestuurareas – koste, finansiering, omvang, eise, tyd, gesondheid en veiligheid, gehalte, omgewingsbewaring, risiko, integrasie, kommunikasie, menslike hulpronne en kontrakverkryging vorm die projekbestuurareas wat, indien gemeet, volgens die bourekenkundige kommunikasievolwassenheidsmodel vir bourekenaars, moontlike ontwikkelingsgebiede mag uitwys.

Die determinante word verteenwoordig deur die belangrike elemente en/of instrumente en/of rekenaarprogrammatuur en/ of leierskapkaraktereienskappe of projekbestuurgebiede wat direk beïnvloed word deur die kennisdimensies en tot effektiewe kommunikasie aanleiding mag gee.

6. Aanbevelings

Die bourekenkundige kommunikasievolwassenheidsmodel behoort as 'n strategiese model gebruik te word om sodoende 'n bydrae tot die ontwikkeling van die bourekenaar te maak.
Die professie kan die bourekenkundige kommunikasie-volwassenheidsmodel gebruik deur ’n waardetoekenning aan die belangrike elemente of instrumente of rekenaarprogrammatuur of leierskapkaraktereienskappe of projekbestuursgebiede te maak om sodoende die waarderingsuitslag van elke determinant te bepaal om ’n aanduiding van die bourekenaar se kommunikasievermoë te verkry en moontlike ontwikkelingsbiede te identifiseer.

Die bourekenkundige professie het ’n bydrae in die wêreld te lever en behoort die uitdagings en geleenthede aan te gryp en verder te ontwikkel om te verseker dat die professie se rol in die konstruksiebedryf ononderhandelbaar is.

Verwysingslys


WIKIPEDIA: the Free Encyclopaedia. (s.n.) [Internet]. Beskikbaar by: <http://en.wikipedia.org/wiki/Main_Page> [Besoek 7 Maart 2007].
Innocent Musonda, Jan-Harm Pretorius & Theo Haupt

Assuring health and safety performance on construction projects: Clients’ role and influence

Peer reviewed

Abstract
This article presents findings from an investigation conducted in Botswana and South Africa on how construction clients could influence health and safety (H&S) performance on construction projects.

The continued poor state of construction H&S and the inability of designers and contractors to influence an industry-wide H&S culture change motivated the article. It was also recognised that one of the reasons the construction industry continued to lag in H&S performance was the way in which H&S implementation and management was organised. The article proposes a client-centred model for H&S performance improvement.

The conceptual model and its factors were developed from both literature and a Delphi survey. Structural equation modelling was applied to data collected from a questionnaire survey to design a best fit model.

The key finding was that, generally, client H&S culture impacted on project H&S performance. The influence of clients was found to be statistically significant when commitment, communication and H&S procedures were evident. This finding was encouraging as it specifically shows how clients could influence performance. However, it remains to be seen whether these results could be replicated in other datasets. If indeed that is the case, then this article contributes significantly to the body of knowledge.

Keywords: Botswana, construction, culture, health and safety, improvement, influence, performance, South Africa

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Abstrak
Hierdie artikel gee bevindinge weer van ‘n ondersoek wat in Botswana en Suid-Afrika gedoen is oor hoe konstruksie-kliënte ‘n invloed kan hê op die uitvoering van beroepsgesondheid en veiligheid in konstruksieprojekte.

Die aanhoudende swak toestand waarin konstruksie beroepsgesondheid en veiligheid verkeer asook die onvermoë van ontwerpers en kontrakteurs om die beroepsgesondheid en veiligheidskultuurverandering industriewyd te beïnvloed, het die ondersoek in hierdie artikel gemotiveer. Dit is ook erken dat een van die redes vir die konstruksie-industrie se gebrek aan beroepsgesondheid en veiligheid optrede is die manier waarop beroepsgesondheid en veiligheidsimplimentering en bestuur georganiseer word. Die artikel stel ‘n klientgesentreerde model voor om beroepsgesondheid en veiligheidsoptrede te verbeter.

Die konsepmodel en die faktore is ontwikkel uit literatuur asook ‘n Delphi-opname. Gestrukturereerde vergelykingsmodelleering is toegelaat om data uit ‘n vraelysoopname te versamel om sodoende ‘n model te ontwerp wat die beste pas.

Die sleutelbevindinge was dat kliënt beroepsgesondheid en veiligheid ‘n impak het op projek beroepsgesondheid en veiligheid. Die invloed van kliënte het duidelik uitgestaan ten opsigte van toevertroue, kommunikasie en beroepsgesondheid en veiligheidsprosedures. Hierdie bevinding wys waar kliënte optrede mag beïnvloed. Nietemin, dit moet nog gesien word of hierdie resultate gerealiseer kan word in ander datastelle. Indien wel, lever hierdie artikel ‘n beduidende bydrae tot die liggaam van kennis.

Sleutelwoorde: Botswana, konstruksie, kultuur, beroepsgesondheid en veiligheid, verbetering, invloed, optrede, Suid-Afrika

1. Introduction

The construction industry has for a long time been considered the most hazardous industry (Bomel, 2001: 0.5; CIOB, 2009: 6; McDonald, Lipscomb, Bondy & Glazner, 2009: 53). Accidents cost national economies nearly 4% of gross domestic product (GDP) and there is consequently a dire need for improvement in terms of health and safety (H&S) performance (ILO, 2003: 15). Construction workers are more at risk of an accident, ill health and/or even a fatality at work than other manufacturing-based industries (Loughborough & UMIST, 2003: Vii; Hoonakker, Loushine, Carayon, Kallman, Kapp & Smith, 2005: 461). Generally, construction sites are still one of the most dangerous workplaces, because of the high incidence of accidents (Hoonakker et al., 2005: 461; Teo, Ling & Chong, 2005: 329; Kines, Spangenberg & Dyreborg, 2007: 53).

The risk of a fatality in construction is at least five times more likely than in other manufacturing-based industries (Sawacha, Naum & Fong, 1999: 309; Loughborough & UMIST, 2003: Vii). According to Bomel (2001: 0.5), the construction industry is a hazardous environment where workers have direct exposure to heights, forces, and power. Workers face these risks every day of their working lives.
Of great concern, therefore, is the exposure of workers to hazards in construction projects.

The nature and organisation of the construction industry have partly compounded the problem. H&S performance improvement in the construction industry has been made difficult as a result. The construction sector is a complex industry (Teo et al., 2005: 329), and the complexity is compounded by the extensive use of sophisticated plant, equipment, methods of construction, as well as multidisciplinary and multitasked project work force. It is this complex nature that shapes the industry’s way of functioning and performance (Sawacha et al., 1999: 309; Dubois & Gadde, 2001: 2).

Furthermore, the construction industry has the following unique characteristics that contribute to its complexity and pose a challenge to performance improvement:

• An industry that offers temporary employment (Pellicer & Molenaar, 2009: 44);
• Work locations for any group of workers often changing (Riley & Brown, 2001: 150; McDonald et al., 2009: 53);
• Temporary work sites where workers are employed by different employers but work alongside each other (Chan & Chan, 2004: 203; Pellicer & Molenaar, 2009: 44; Misnan, Mohammed, Mahmood, Mahmud & Abdullah, 2008: 1902);
• An industry comprised mostly of small employers (Pellicer & Molenaar, 2009: 44). For example, in the United Kingdom, 98% of the registered companies employ 24 workers or less in their companies (Dainty, Briscoe & Millet, 2001: 163);
• Large numbers of people are employed in this industry and have to combine a diverse range of skills to complete a project (Bomel, 2001: 2.4; Dainty et al., 2001: 163; Riley & Brown, 2001: 150; Pellicer & Molenaar, 2009: 44);
• A large number of subcontractors (Bomel, 2001: 2.4; Riley & Brown, 2001: 158; Pellicer & Molenaar, 2009: 44);
• Construction projects with short periods (Bomel, 2001: 2.4; Dainty et al., 2001: 163; Riley & Brown, 2001: 150);
• Sites evolving as construction proceeds, resulting in changing the hazards that workers face weekly (Bomel, 2001: 2.3; Riley & Brown, 2001: 150);
• A fragmented industry (Egan, 1998: 8; Chan & Chan, 2004: 203). Dainty et al., (2001: 163) argue that the proliferation in
subcontracting has further complicated the situation, causing further fragmentation of the production process;

- An industry subjected to cyclical economic downturns (Egan, 1998: 9; Dainty et al., 2001: 163), and
- An industry with a low and unreliable rate of profitability (Egan, 1998: 7; Pellicer & Molenaar, 2009: 44).

In addition, Winch (2000: 142) observed that the construction industry is largely operationalised through a professional system which requires that designs be fully specified at tender stage. Yet the assumptions regarding the competence of designers in the technical details of a wide range of construction technologies and the ability of the client to keep requirements fixed over a period of time compromise the effectiveness of the professional system. The fact is that designs are rarely fully specified (Winch, 2000: 145). This system has also contributed to the industry’s lack of cooperation and integration. Egan (1998: 13) observed that the construction industry was basically an industry typically dealing with the project process as a series of sequential and largely separate operations undertaken by individual designers, contractors and suppliers who have no stake in the long-term success of the project and therefore do not have any commitment to it. Therefore, changing this culture is fundamental if performance improvement is to be realised.

Consequently, the culture of clients could offer an opportunity for addressing the problem of H&S performance (Bomel, 2001: 5.5). The impetus for change lies with the clients of construction projects, because clients can influence contractors’ H&S performance (Smallwood, 1998: 182; Bomel, 2001: 9.7; Lingard, Blisma, Cooke & Cooper, 2009: 132). The client has been overlooked in most studies with emphasis placed on the contractor or the construction process. H&S during the construction process is conventionally considered to be the contractor’s responsibility. When construction accidents occur, perceived factors of causation are mostly associated with management failures on the part of the contractor or failures of site operatives to control unsafe site conditions or unsafe actions (Abdelhamid & Everett, 2000: 55; Suraji, Sulaiman, Mahyuddin & Mohamed, 2006: 49). The general perception is that construction H&S is a matter of construction management rather than the management on the part of clients and other participants in the construction process. Studies concentrating on factors that relate to the contractor create the impression that the main problem lies with contractors and, therefore, H&S performance improvement can only be achieved by addressing contractor issues. It is, however,
unlikely that H&S performance improvement can be achieved in the industry by only focusing on the construction stage and the contractor specifically. This is partly due to the difficult conditions in which contractors operate, including constraints and actions of designers and clients (Suraji et al., 2006: 59).

The current study investigated the influence of clients on construction project H&S performance. The following hypothesis is to be tested: The H&S culture of clients defined by leadership, involvement, procedures, commitment, communication and competence impacts on project H&S performance.

Client-centred H&S performance improvement has not been investigated in sufficient detail (Lingard et al., 2009: 132). The study by Huang & Hinze (2006) in the U.S.A. investigated the influence of owners or clients on construction H&S performance by using the number of accidents to measure performance. To the contrary, the current study used leading indicators which better reflect H&S performance and are proactive (Carder & Ragan, 2003: 163; Jafri, Ahmad & Kamsah, 2005: 703; Cameron & Duff, 2007: 870) to characterise H&S performance. Examples are the use of indicators such as evidence of H&S inspections and audits to define performance. In addition, this study was not restricted to projects with good H&S performance only, but included other construction projects within South Africa and Botswana. In addition, the study investigated specifically the influence of the H&S culture of clients on H&S performance.

Therefore, the current study builds on Huang & Hinze’s (2006) study and uses an alternative method to model the influence of client H&S culture on project H&S performance. This method involved a Delphi study and a field questionnaire survey. In addition, structural equation modelling (SEM) (Kline, 2005: 83) was used to reliably model how clients could influence project H&S performance.

2. Research

The study was conducted using both qualitative and quantitative data-collection methods. For the qualitative part, a Delphi technique was used, whereas a field questionnaire survey was used for the quantitative part. The Delphi survey was conducted with 11 H&S experts drawn from different parts of the world. The output from the Delphi technique was a conceptual model and the factors of client H&S culture. As for the quantitative approach, a questionnaire survey was conducted among construction professionals based in
Botswana and South Africa on the practice of H&S in the construction industry.

The analysis of the quantitative data was done using a structural equation modelling (SEM) software, Mplus version 6.0. The conceptual model analysed in the current study evolved as an output from both the literature review and the Delphi process. The conceptual model was thereafter tested using SEM of the questionnaire survey results. The SEM process was therefore undertaken as a confirmatory factor analysis (CFA) of the conceptual model.

2.1 Delphi study

The Delphi study involved 11 invited panellists who had been identified from three sources. The first source was the CIB W099 register of members on the CIB W099 website. The CIB W099 is a working commission, an international forum of researchers working on construction H&S. The second source was CIB W099 conference proceedings from 2005 to 2009. Individuals who had frequently appeared as authors or keynote speakers were identified as potential participants in the study. The third source was identifying individuals working in the area of H&S in the Southern African construction industry.

The Delphi panel consisted of two members from South Africa, three each from the United States of America (USA) and the United Kingdom (UK), and one each from Singapore, Hong Kong and Sweden. Of these, one of the panellists had a Doctor of Science (DSC) degree, six had Doctor of Philosophy (PhD) degrees, two had Master of Science (MSc) degrees, one had a Bachelor of Science (BSc.) degree, and one had a Diploma in Safety Management. All the panellists specialised in construction H&S. In terms of their current occupation, three of the panellists were employed by contracting organisations, one by a consulting organisation, and six by universities. All panellists held very senior positions in their organisations and were involved in community service.

The panel had a cumulative total of 243 years of experience. The lowest number of years of experience for an individual was seven and the highest was 45 years. The median number of years of experience was 15 years. Experience was an important factor in determining who an expert was and, therefore, the minimum number of years was set to be five. In terms of publications, 10 of the panellists had published in peer-reviewed journals, conference proceedings and books. Between them, they had published 57 books and monographs, 19 chapters in books, 187 peer-reviewed
academic journals, 345 recent conference papers and 341 other publications comprising articles in professional journals, technical reports, policy papers, expert witness documentation and keynote addresses (Table 1). In addition, the panel had led and managed 108 funded research projects. Three panellists served on the editorial boards of 43 peer-reviewed journals and conference proceedings.

Table 1: Panellists’ publications

<table>
<thead>
<tr>
<th>Panel publications</th>
<th>No. of publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books and monographs</td>
<td>57</td>
</tr>
<tr>
<td>Chapters in books</td>
<td>19</td>
</tr>
<tr>
<td>Peer-reviewed journals</td>
<td>187</td>
</tr>
<tr>
<td>Peer-reviewed conference proceedings</td>
<td>345</td>
</tr>
<tr>
<td>Funded research</td>
<td>108</td>
</tr>
<tr>
<td>Other publications</td>
<td>341</td>
</tr>
<tr>
<td>Editorial board membership</td>
<td>43</td>
</tr>
<tr>
<td>Referee for journals</td>
<td>22</td>
</tr>
<tr>
<td>Referee for conference proceedings</td>
<td>30</td>
</tr>
</tbody>
</table>

2.1.1 Delphi process

A questionnaire was developed from literature and distributed electronically to all panel members. The questions related to the importance of the various factors of client H&S culture and the significance of client influence. The panel was asked to rate the importance of these factors on contractor and designer H&S performance. The importance of each factor was based on a 10-point rating scale ranging from 0 representing 0% or negligible or low impact to 10 representing 100% or very high impact.

The panel also rated the likelihood that contractor H&S performance would improve if the identified client culture H&S factors were evident. The likelihood or probability scale ranged from 1 to 10, representing 0% to 100%. The impact significance of each factor was thereafter obtained as a product of the rated likelihood and severity, as illustrated in equation 1.

Impact Significance = Likelihood factor x Severity factor

Equation 1
The Delphi process involved three iterative rounds to achieve consensus between the panel members regarding the extent of the client’s influence on both contractor and designer H&S performance.

Apart from the panel rating the likelihood and severity of various factors, they were also requested to make comments on their ratings, especially if the ratings differed from those of other panel members. Comments were also made about what other factors or issues needed to be included or omitted from the theorised model.

2.1.2 Delphi findings

The average impact significance of all factors of client H&S culture on contractor H&S performance was found to be 6.60 while that on designer H&S performance was determined to be 6.45 (Figure 1). The significance of the impact of various factors associated with the client was categorised as being either critical, major, moderate, minor or low. A rating of one and below was considered to be low while that of seven to ten was considered to be critical (Table 2). According to the rating scale, the value of 6.60 indicated that the level of clients’ impact and influence on contractors’ H&S performance was of ‘major impact significance’. Similarly, a rating of 6.45 on designers H&S performance was determined to be ‘major’. All the factors of client H&S culture had an impact significance of more than 5.0, with client involvement being rated higher for designer H&S performance. The rating of 7.31 was considered to be ‘critical impact significance’.

Table 2: Impact significance and severity rating scale

<table>
<thead>
<tr>
<th></th>
<th>0&gt;1</th>
<th>1&gt;3</th>
<th>3&gt;5</th>
<th>5&gt;7</th>
<th>7&gt;10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low/ negligible</td>
<td>Minor</td>
<td>Moderate</td>
<td>Major</td>
<td>Critical</td>
<td></td>
</tr>
</tbody>
</table>

On the other hand, client leadership had major impact significance on contractor H&S performance (Figure 1). Client competence had the least impact significance on contractor H&S performance, with a rating of 6.20. Similarly, client competence was also considered to have lower impact on designer H&S performance. The impact significance of client competence on designer H&S performance was determined to be 5.20. However, the rating of client competence was deemed to be of ‘major impact’ significance although, in comparison to other factors, client competence was considered to be the least significant (Table 2).
The mean likelihood of contractors and designers implementing various H&S elements due to client influence was 83% and 78%, respectively (Figure 2). This finding suggested that the implementation of H&S elements by contractors was ‘very likely to occur’ with client influence whereas that of designers was considered to be ‘likely to occur’.

The Delphi study findings indicated that clients could significantly influence both contractor and designer H&S performance, given that contractors and designers were more likely to implement H&S elements with client influence. In addition, when the client H&S culture was evident in a project, a major impact on contractor and designer H&S performance was likely. Other aspects of H&S culture such as H&S programmes, goals, policies, rules and communication were important and would have a significant impact on both contractor and designer H&S performance.

Considering these findings, it was conceptualised that client H&S culture impacted on overall project H&S performance. In addition, aspects of client H&S culture such as leadership (CLLP), involvement (CLIP), procedures (CLPP), communication (CLNP), commitment (CLTP) and competence (CLCE) had to be evident in client
organisations for the client to have a significant influence on project H&S performance.

![Graph showing likelihood of elements being implemented by contractor and designer](image)

**Figure 2:** Likelihood of contractors and designers implementing H&S elements due to client influence

### 2.1.3 Conceptual model of client H&S influence on project H&S performance

The conceptual model in Figure 3 depicts the relationships between client H&S culture, contractor, designer, and overall project H&S performance. The postulated relationships in the conceptualised model were that:

- **H1** client H&S culture has a direct positive influence on contractor H&S performance;
- **H2** client H&S culture has a direct positive influence on designer H&S performance;
- **H3** client H&S culture has a direct positive influence on project H&S performance;
- **H4** contractor H&S performance has a direct positive influence on project H&S performance, and
H5 designer H&S performance has a direct positive influence on project H&S performance

The second stage of model development entailed testing or validating this conceptualised model by means of a field questionnaire survey and analysing the data using SEM in order to achieve a desirable level of both internal and external validity.

2.2 Field questionnaire survey

A questionnaire survey was conducted among 281 construction professionals in South Africa and Botswana. Raw data from the questionnaire survey was analysed using structural equation modelling (SEM) with EQS and MPlus software packages. The measurement model was analysed using EQS version 6.1, while the full structural model was analysed using MPlus version 6.0. According to Kline (2005: 15), a sample size of 281 is classified as large. A small sample of less than 100 cases tended to be problematic when it came to SEM analysis (Kline, 2005: 5).
The pre-analysis statistics of the data revealed that there were some missing values and the distribution characteristics indicated non-normality. The values of Mardia’s coefficient, as shown in Table 3, for all constructs were found to be high. Table 3 shows that Mardia’s coefficient for client culture was the highest with 443.7814, while that of contractor H&S performance was the lowest with 41.029. Consequently, a more robust analysis method, the robust maximum likelihood (RML), was selected for the analysis of the data. The RML gives several robust fit indices that take care of the distribution characteristics of the data (Bartholomew, Loukas, Jowers & Allua, 2006: 72). According to Byrne (2006: 22), one of the outputs from the RML estimation method is the robust chi-square statistic ($\chi^2$), referred to as the Satorra-Bentler scaled statistic ($S - B \chi^2$), and the robust standard errors which are corrected for non-normality in large samples. SEM is based on the assumption that the data is normal.
3. Questionnaire survey results

3.1 Structural model pre-analysis results

Results from the analysis of the measurement models indicated that all measurement models worked well and satisfied the requirement that the models should be over-identified. It is also a requirement for SEM analysis that the conditions of model identification are met. Boomsma (2000: 486) argues that it is the duty of a researcher to examine whether a model is theoretically identified or not. Kline (2005: 105) explains that a model is said to be identified if it is theoretically possible to derive a unique estimate of each parameter. Consequently, it is desirable to have an over-identified model. Byrne (2006: 31) explains that an over-identified model is one in which the number of parameters to be estimated is less than the number of data variances and covariances of the observed variables, resulting in a positive degree of freedom.

The significance of model over-identification is that it allows for a model to be rejected, rendering it of scientific value (Byrne, 2006: 31). A just-identified model cannot be rejected and it is impossible to obtain a solution for an under-identified model.

Examination of the results in Table 3 indicated that the lowest value for the degree of freedom was 24 and the highest was 137. These values were indicative of a positive value of degree of freedom and suggestive of an over-identified model.

Table 3: Measurement model statistics on distribution and fit

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mardia’s coefficient</th>
<th>$S – Bx^2$</th>
<th>Df</th>
<th>CFI</th>
<th>SRMR</th>
<th>RMSEA</th>
<th>RMSEA 90% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client culture</td>
<td>443.7814</td>
<td>219.323</td>
<td>137</td>
<td>0.979</td>
<td>0.025</td>
<td>0.047</td>
<td>0.035: 0.058</td>
</tr>
<tr>
<td>Contractor H&amp;S performance</td>
<td>41.0290</td>
<td>25.0664</td>
<td>24</td>
<td>0.999</td>
<td>0.009</td>
<td>0.013</td>
<td>0.000: 0.051</td>
</tr>
<tr>
<td>Designer H&amp;S performance</td>
<td>225.6381</td>
<td>35.6033</td>
<td>24</td>
<td>0.994</td>
<td>0.010</td>
<td>0.042</td>
<td>0.000: 0.070</td>
</tr>
<tr>
<td>Project H&amp;S performance</td>
<td>179.4860</td>
<td>294.515</td>
<td>119</td>
<td>0.923</td>
<td>0.048</td>
<td>0.075</td>
<td>0.064: 0.086</td>
</tr>
</tbody>
</table>

In addition, the results revealed that there were no convergence problems in the analysis, because all parameter estimates for client H&S culture, designer H&S performance, contractor H&S performance and project H&S performance constructs stabilised.
in fewer than 10 iterations each. The desired circumstance is the situation whereby only a few iterations are needed to reach convergence and these should not exceed the value of 30 (Byrne, 2006: 102). According to Byrne (2006: 102), the number of iterations exceeding 30 results in non-convergence and the output may not be trusted.

The measurement model specifications were also found to be adequate. Fit indices presented in Table 3 indicated that the measurement models worked well. All the fit indices fell within the acceptable limits for a good fit. The minimum comparative fit index (CFI) was 0.923 for the project H&S performance construct. A value greater than 0.900 is acceptable and a value greater than 0.950 is described as being good fit (Bartholomew et al., 2006: 73; Schreiber, Stage & King, 2006: 330; Dion, 2008: 367). The CFI values for client culture, contractor and designer H&S performance constructs were all above 0.95 (see Table 3). Similarly, the root mean square error of approximation (RMSEA) values for all constructs fell within the acceptable limits. A good fit model has RMSEA values of less than 0.050, while values of less than 0.080 indicate an acceptable model fit (Hu & Bentler, 1999: 27; Kline, 2005: 139; Bartholomew et al., 2006: 73; Dion, 2008: 367). The ranges for RMSEA with 90% confidence interval were also not large, indicating acceptable approximations. In addition, the standardised root mean squared residual (SRMR) values were all less than 0.050 and, therefore, the models were considered to be of good fit (Kline, 2005: 141; Schreiber et al., 2006: 330).

It was necessary to ensure that the measurement models worked well before the structural model could be analysed. Therefore, having been satisfied that the pre-analysis test of SEM assumptions result did not reveal any significant problems, the full structural model was analysed.

3.2 Structural model’s goodness-of-fit statistics

The structural model, as presented in Figure 4, was analysed using MPlus software. The indicator variables for the client H&S culture, contractor and designer H&S performance were analysed in parcels, while those of project H&S performance were analysed as individual indicator variables. From a total sample of 281 responses, 259 cases were analysed. The number of cases that were skipped was 22, because they had missing variables. Only complete cases were analysed for the model. The model was analysed using the robust maximum likelihood method. The covariance matrix was analysed as opposed to the correlation matrix.
As shown in Table 4, the sample data yielded a chi-square statistic ($\chi^2$) of 2,966.661 with 1,342 degrees of freedom. The associated p-value was determined to be 0.000. From these values, the normed chi-square value was determined to be 2.211. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended. Therefore, since the value of 2.211 obtained for the postulated model was lower than 3.0, the result suggested an acceptable fit of the model. However, the chi-square statistic is only indicative of fit and, therefore, other goodness-of-fit indices were reviewed.

Table 4 presents the fit indices for the postulated model. The root mean square error of approximation (RMSEA) with 90% confidence interval was found to be 0.068 (lower bound value = 0.065 and upper bound value = 0.072). The RMSEA index was just above the upper limit value of 0.050 for the model to be described as having a good fit. However, a value of 0.068 was indicative of an adequate fit. A model with RMSEA values of up to 0.080 is considered to be acceptable (Hu & Bentler, 1999: 27; Kline, 2005: 139; Bartholomew et al., 2006: 73; Dion, 2008: 367). In addition, the upper confidence interval of 0.072 did not exceed the upper acceptable value of 0.08, as recommended by Hu & Bentler (1999: 27).

In addition, the standardised root mean square residual (SRMR) was found to be 0.045. The SRMR of 0.045 was much lower than the cut-off value of 0.05. Therefore, the SRMR value also indicated that the postulated model had a good fit. On the other hand, the comparative fit index (CFI) yielded a value that was close to the lower limit value of 0.90 at 0.88. The CFI index was not greater than 0.90 which is the lower limit value for model acceptance if the CFI is considered in the combination rules. However, in the current study, a two statistic model fit evaluation strategy, as proposed by Hu & Bentler (1999: 16), was followed. The decision on model fit was, therefore, based on the SRMR and the RMSEA fit indices.

An evaluation of the SRMR, RMSEA and the CFI fit indices indicated that the postulated model reasonably fits the sample data. Therefore, having been satisfied with the model fit to the sample data, it was feasible to evaluate the statistical significance of the hypothesised relationships between the factors of client H&S culture and the overall project H&S performance. The results are presented in Table 4.
Table 4: Robust fit indices for the postulated model

<table>
<thead>
<tr>
<th>Fit index</th>
<th>Cut-off value</th>
<th>Model 1.0</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi^2$</td>
<td></td>
<td>2966.661</td>
<td></td>
</tr>
<tr>
<td>Df</td>
<td>0</td>
<td>1342</td>
<td>Acceptable</td>
</tr>
<tr>
<td>CFI</td>
<td>0.9 acceptable</td>
<td>0.88</td>
<td>Barely acceptable</td>
</tr>
<tr>
<td></td>
<td>0.95 good fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRMR</td>
<td>0.08 acceptable</td>
<td>0.045</td>
<td>Good fit</td>
</tr>
<tr>
<td></td>
<td>0.05 good fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.08 acceptable</td>
<td>0.068</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>0.05 good fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMSEA 90% CI</td>
<td>0.08</td>
<td>0.065:0.072</td>
<td>Acceptable range</td>
</tr>
</tbody>
</table>

3.3 Hypotheses testing

Rejection of the hypotheses depended on how reasonable the parameter estimates were in terms of their magnitude, signs and statistical significance. In addition, if in the output there were estimates that had correlation values greater than 1.00, had negative variances and the correlation or covariances were not definitely positive, they were said to be exhibiting unreasonable estimates (Byrne, 2006: 103). In addition, the test statistic had to be greater than 1.96 based on the $p$-value of $> 0.005$ before the hypothesis could be rejected (Byrne, 2006: 103). The test statistic reported in this study was the parameter estimate divided by its standard error and, therefore, it functioned as a $Z$-statistic to test that the estimate was statistically different from zero. The significance test was used to evaluate the general hypotheses H1 to H5.

3.3.1 Testing the direct influence of client H&S culture on contractor H&S performance

It was generally hypothesised that client H&S culture had a direct positive influence on contractor H&S performance. Specifically, the hypotheses, which collectively formed hypothesis H1, were:

- **H1a** leadership, had a direct positive influence on contractor H&S performance;
- **H1b** Involvement, had a direct positive influence on contractor H&S performance;
- **H1c** procedures, had a direct positive influence on contractor H&S performance;
Musonda et al. • Assuring health and safety performance

H1d commitment, had a direct positive influence on contractor H&S performance;
H1e communication, had a direct positive influence on contractor H&S performance, and
H1f competence, had a direct positive influence on contractor H&S performance.

Results from the confirmatory factor analysis of the full structural model, presented in Table 5, yielded support for hypothesis $H1_c$ (procedures) and $H1_d$ (commitment) but did not support the hypothesis $H1_a$ (leadership), $H1_b$ (Involvement), $H1_e$ (communication) and $H1_f$. (competence). The relationship between the factor, procedures, and contractor H&S performance was found to be significant at the probability level of 5% ($\lambda = 0.494$, $Z = 4.407$ and $P = 0.000$). Similarly, the hypothesised relationship between the factor, commitment, and contractor H&S performance was found to be statistically significant. That relationship yielded significant parameter estimates at 5% probability level with $\lambda = 0.616$ (parameter estimate), $Z = 2.393$ and $P = 0.017$.

On the other hand, although the hypothesised relationship between the factor involvement and contractor H&S performance was significant at 5% probability level ($\lambda = -0.663$, $Z = -2.402$, $P = 0.016$), the direction was not positive definite. The result seemed to indicate that, with the increase in client H&S involvement, contractor H&S performance decreased by 0.663 units. This result was interesting, because it was expected that, with an increase in client involvement, there would be an increase in contractor performance. However, the measurement model on client H&S culture revealed high collinearity between commitment and involvement factors of client H&S culture. The high collinearity may probably explain the unreasonable parameter estimate exhibited for hypothesis $H1_b$, (involvement).

The influence of other factors, namely client leadership, communication and competence, on contractor H&S performance was found to be evident despite these relationships not being statistically significant. The parameter estimates for these relationships were found to be as follows: between the client competence factor and contractor H&S performance ($\lambda = 0.081$, $Z = 0.675$ and $P = 0.500$), leadership factor and contractor H&S performance ($\lambda = 0.204$, $Z = 1.720$, $P = 0.086$), and communication factor and contractor H&S performance ($\lambda = 0.026$, $Z = 0.212$, $P = 0.832$). Therefore, although the relationships between these client factors and contractor H&S
performance were evident, they were found to be not statistically significant and consequently meant that the postulated specific hypotheses for these relationships were not supported. However, since influence from these factors was evident, the relationship was considered to be practically significant.

Therefore, the general hypothesis \( H_1 \), which postulated that client H&S culture had a direct positive influence on contractor H&S performance, could not be rejected, because two of the six specific hypotheses were found to be statistically significant and were positive. In addition, the other specific hypotheses were found to be practically significant, because the influence was evident albeit not statistically significant.

3.3.2 Testing the direct influence of client H&S culture on designer H&S performance

The second general hypothesis was that client H&S culture had a direct positive influence on designer H&S performance. Specifically, the hypotheses were that the factors of client H&S culture, namely:

\[ H_{2a} \] leadership, had a direct positive influence on designer H&S performance;
\[ H_{2b} \] involvement, had a direct positive influence on designer H&S performance;
\[ H_{2c} \] procedures, had a direct positive influence on designer H&S performance;
\[ H_{2d} \] commitment, had a direct positive influence on designer H&S performance;
\[ H_{2e} \] communication, had a direct positive influence on designer H&S performance, and
\[ H_{2f} \] competence, had a direct positive influence on designer H&S performance.

Results from the confirmatory factor analysis of the full structural model, presented in Table 5, yielded support for \( H_{2c} \) (procedures) and \( H_{2e} \) (communication), but did not support the hypothesis \( H_{2a} \) (leadership), \( H_{2b} \) (involvement), \( H_{2d} \) (commitment) and \( H_{2f} \) (competence). The relationship between the procedures factor and designer H&S performance was found to be significant at 5% probability level with \( \lambda = 0.439 \) (factor loading), \( Z = 3.009 \) and \( P = 0.003 \). Similarly, the hypothesised relationship between the communication factor and designer H&S performance was found to be statistically
significant. This relationship yielded significant estimates at the 5% probability level of $\lambda = 0.348$, $Z = 3.346$ and $P = 0.001$. The parameter estimates for the two factors of client H&S culture, namely procedures and communication, indicated that, with an increase of one unit in procedures, designer H&S performance increased by about 0.439. Similarly, an improvement of one unit in client communication caused an improvement of 0.348 in designer H&S performance.

The insignificant relationships were found to be those between the competence factor and designer H&S performance ($\lambda = -0.196$, $Z = -1.747$, $P = 0.081$), the leadership factor and designer H&S performance ($\lambda = 0.182$, $Z = 1.618$, $P = 0.106$), and the commitment factor and designer H&S performance ($\lambda = 0.188$, $Z = 0.681$, $P = 0.496$). The strength of these relationships was not statistically significant, although the findings revealed that there was evidence of relationship. In addition, the factors competence and involvement were found to have a negative relationship with designer H&S performance. This result was surprising, because it was expected that an increase in client competence and involvement would result in an increase in designer H&S performance.

Nonetheless, the general hypothesis H2, which postulated that client H&S culture had a positive direct influence on designer H&S performance, could not be rejected, because two of the six specific hypotheses were found to be statistically significant. In addition, the four other specific hypotheses were found to be practically significant, because the influence was evident albeit not statistically significant.

### 3.3.3 Testing the direct influence of contractor H&S performance on project H&S performance

Results of the SEM analysis yielded support for the hypothesis that contractor H&S performance had a direct positive influence on project H&S performance. The test statistics were found to be significantly different from zero ($\lambda = 0.546$, $Z = 8.02$, $P = 0.000$). Given these results, the hypothesis H4 could not be rejected, because contractor H&S performance had a direct positive influence on project H&S performance. The parameter estimate between contractor H&S performance and project H&S performance indicated that, for every unit improvement in contractor H&S performance, project H&S performance would improve by 0.546 units. The contractor in this case referred to upper management.
Table 5: Parameter estimates and test statistic for model 2.0

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Parameter</th>
<th>Un-standardised</th>
<th>Standardised estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Estimate (λ)</td>
<td>Z-statistic</td>
</tr>
<tr>
<td>H1a</td>
<td>CLLP→ CONT H&amp;S PERFORMANCE</td>
<td>0.228</td>
<td>1.738</td>
</tr>
<tr>
<td>H1b</td>
<td>CLIP→ CONT H&amp;S PERFORMANCE</td>
<td>-0.608</td>
<td>-2.348</td>
</tr>
<tr>
<td>H1c</td>
<td>CLPP→ CONT H&amp;S PERFORMANCE</td>
<td>0.474</td>
<td>4.282</td>
</tr>
<tr>
<td>H1d</td>
<td>CLTP→ CONT H&amp;S PERFORMANCE</td>
<td>0.618</td>
<td>2.324</td>
</tr>
<tr>
<td>H1e</td>
<td>CLNP→ CONT H&amp;S PERFORMANCE</td>
<td>0.024</td>
<td>0.212</td>
</tr>
<tr>
<td>H1f</td>
<td>CLCP→ CONT H&amp;S PERFORMANCE</td>
<td>0.090</td>
<td>0.675</td>
</tr>
<tr>
<td>H2a</td>
<td>CLLP→ DESG H&amp;S PERFORMANCE</td>
<td>0.188</td>
<td>1.665</td>
</tr>
<tr>
<td>H2b</td>
<td>CLIP→ DESG H&amp;S PERFORMANCE</td>
<td>-0.132</td>
<td>-0.538</td>
</tr>
<tr>
<td>H2c</td>
<td>CLPP→ DESG H&amp;S PERFORMANCE</td>
<td>0.388</td>
<td>2.744</td>
</tr>
<tr>
<td>H2d</td>
<td>CLTP→ DESG H&amp;S PERFORMANCE</td>
<td>0.175</td>
<td>0.674</td>
</tr>
<tr>
<td>H2e</td>
<td>CLNP→ DESG H&amp;S PERFORMANCE</td>
<td>0.298</td>
<td>3.299</td>
</tr>
<tr>
<td>H2f</td>
<td>CLCP→ DESG H&amp;S PERFORMANCE</td>
<td>-0.202</td>
<td>-1.750</td>
</tr>
<tr>
<td>H3a</td>
<td>CLLP→ PROJ H&amp;S PERFORMANCE</td>
<td>0.018</td>
<td>0.270</td>
</tr>
<tr>
<td>H3b</td>
<td>CLIP→ PROJ H&amp;S PERFORMANCE</td>
<td>-0.137</td>
<td>-0.968</td>
</tr>
<tr>
<td>H3c</td>
<td>CLPP→ PROJ H&amp;S PERFORMANCE</td>
<td>0.127</td>
<td>1.359</td>
</tr>
<tr>
<td>H3d</td>
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<td>0.219</td>
<td>1.481</td>
</tr>
<tr>
<td>H3e</td>
<td>CLNP→ PROJ H&amp;S PERFORMANCE</td>
<td>0.033</td>
<td>0.442</td>
</tr>
<tr>
<td>H3f</td>
<td>CLCP→ PROJ H&amp;S PERFORMANCE</td>
<td>0.095</td>
<td>1.122</td>
</tr>
<tr>
<td>H4</td>
<td>CONT→ PROJ H&amp;S PERFORMANCE</td>
<td>0.518</td>
<td>7.124</td>
</tr>
<tr>
<td>H5</td>
<td>DESG→ PROJ H&amp;S PERFORMANCE</td>
<td>0.163</td>
<td>2.636</td>
</tr>
</tbody>
</table>

(Robust statistical significance at 5% level)
3.3.4 Testing the direct influence of designer H&S performance on project H&S performance

The results from the SEM analysis yielded support for the hypothesis that designer H&S performance had a direct positive influence on project H&S performance. The test statistics were found to be significantly different from zero ($\lambda = 0.159$, $Z = 2.582$, $P = 0.010$). Therefore, the hypothesis H5 could not be rejected, given these parameter estimates. The parameter estimate between designer H&S performance and project H&S performance indicated that, for every unit improvement in designer H&S performance, project H&S performance would improve by 0.159. This coefficient was, however, lower than the desired 0.400. Nonetheless, the relationship was found to be significantly different from zero, indicating that designer H&S performance had a significant influence on project H&S performance.

3.3.5 Testing the direct influence of client H&S culture on project H&S performance

The general hypothesis was that client H&S culture had a direct positive influence on construction project H&S performance. Specifically, the hypotheses, which collectively formed the hypothesis H3, were that the factors of client H&S culture, namely:

- H3a leadership, had a direct positive influence on project H&S performance;
- H3b involvement, had a direct positive influence on project H&S performance;
- H3c involvement, had a direct positive influence on project H&S performance;
- H3d commitment, had a direct positive influence on project H&S performance;
- H3e communication, had a direct positive influence on project H&S performance, and
- H3f competence, had a direct positive influence on project H&S performance.

The results for these specific hypotheses, presented in Table 6, did not yield support for all hypothesised direct relationships between the factors of client H&S culture and project H&S performance. The test statistics revealed that the direct relationships between the factor leadership and project H&S performance had a parameter
coefficient $\lambda = 0.016$ and the test statistic $Z = 0.270$. The probability $P$ was found to be 0.787 for this relationship. The relationship between the factor involvement and project H&S performance yielded $\lambda = -0.158$, $Z = -0.965$ and $P = 0.334$. On the other hand, parameter estimates for the relationship between the factor procedures and project H&S performance were $\lambda = 0.139$, $Z = 1.371$ and $P = 0.171$. The relationships between the factor commitment and project H&S performance ($\lambda = 0.231$, $Z = 1.502$, $P = 0.133$) and between communication and project H&S performance ($\lambda = 0.038$, $Z = 0.445$, $P = 0.656$) were also not significantly different from zero or the null hypothesis. Therefore, the general hypothesis (H3) that client H&S culture had a direct positive influence on project H&S performance was rejected.

### 3.3.6 Testing indirect influence of client H&S culture on project H&S performance

An indirect relationship is said to exist between two variables if the direct relationship between the two is completely insignificant or tends to diminish in the face of an increased indirect significance. The direct relationship between client H&S culture and project H&S performance was found to be insignificant (Table 6). However, the direct relationship between client H&S culture and contractor H&S performance was found to be significant. Similarly, the relationship between client H&S culture and designer H&S performance was also significant. In addition, the direct influences of contractor and designer H&S performance on project H&S performance were found to be significant (Table 6).

The indirect effects on project H&S performance by three factors of client H&S culture, namely involvement, procedures and commitment, mediated by contractor H&S performance, were found to be significant at 5% probability level. The standardised indirect effects of the involvement factor yielded parameter estimates $\lambda = -0.362$, $Z = -2.335$ and $P = 0.020$. As for the factor procedures, the estimates were $\lambda = 0.270$, $Z = 3.877$ and $P = 0.000$, indicating that the effect was significant. The specific standardised indirect effects of the commitment factor on project H&S performance, mediated by contractor H&S performance, yielded parameter estimates $\lambda = 0.337$, $Z = 2.303$ and $P = 0.021$. These estimates indicated a significant effect. The effects of three factors of client H&S culture, namely communication, leadership and competence, were found to be statistically insignificant when client influence on project H&S performance was mediated by contractor H&S performance (Table 6).
Further examination of the indirect influence of client H&S culture on project H&S performance, mediated by designers, revealed that two relationships were significant. The indirect effect of the factor communication on project H&S performance, mediated by designer H&S performance, was found to be significant. The standardised parameter estimates of the indirect relationship were $\lambda = 0.055$, $Z = 1.977$ and $P = 0.048$. The indirect effect of the procedures factor had un-standardised parameter estimates of $\lambda = 0.063$, $Z = 1.968$ and $P = 0.049$. However, the standardised estimates for the factor procedures were found to be insignificant (Table 6).

The sum of indirect effects of client H&S culture on project H&S performance revealed that two factors, namely procedures and commitment, had a statistically significant total indirect effect on project H&S performance. This indirect effect was mediated by both contractor and designer H&S performance. The standardised...
estimates for the total indirect effect were found to be $\lambda = 0.340$, $Z = 4.619$ and $P = 0.000$ for the procedures factor. The standardised estimates of the total indirect effect of the commitment factor were found to be $\lambda = 0.366$, $Z = 2.052$ and $P = 0.040$.

The finding on the indirect effect of client H&S culture on project H&S performance confirmed the mediatory role that contractor and designer H&S performance played in the postulated model. In addition, the findings also confirmed that, although the client H&S culture did not exhibit a direct positive influence on project H&S performance, its indirect influence on project H&S performance was significant.

Therefore, the hypothesis that client H&S culture generally had an indirect positive influence on project H&S performance, mediated by contractor and designer H&S performance, could not be rejected. Specifically, the influence of the procedures and commitment factors was found to be statistically significant at 5% probability level and the indirect influence of the other factors was found to be evident.

Table 6: Specific indirect effects of client H&S culture on project H&S performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Un-standardised</th>
<th>Standardised estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indirect effect ((\lambda))</td>
<td>Z-statistic</td>
</tr>
<tr>
<td>CLLP→ CONT → PROJ. H&amp;S</td>
<td>0.118</td>
<td>1.738</td>
</tr>
<tr>
<td>CLIP→ CONT → PROJ. H&amp;S</td>
<td>-0.315</td>
<td>-2.258</td>
</tr>
<tr>
<td>CLPP→ CONT → PROJ. H&amp;S</td>
<td>0.245</td>
<td>3.748</td>
</tr>
<tr>
<td>CLTP→ CONT → PROJ. H&amp;S</td>
<td>0.320</td>
<td>2.216</td>
</tr>
<tr>
<td>CLNP→ CONT → PROJ. H&amp;S</td>
<td>0.012</td>
<td>0.211</td>
</tr>
<tr>
<td>CLCE→ CONT → PROJ. H&amp;S</td>
<td>0.047</td>
<td>0.667</td>
</tr>
<tr>
<td>CLLP→ DESG → PROJ. H&amp;S</td>
<td>0.031</td>
<td>1.412</td>
</tr>
<tr>
<td>CLIP→ DESG → PROJ. H&amp;S</td>
<td>-0.021</td>
<td>-0.533</td>
</tr>
<tr>
<td>CLPP→ DESG → PROJ. H&amp;S</td>
<td>0.043</td>
<td>1.968</td>
</tr>
<tr>
<td>CLTP→ DESG → PROJ. H&amp;S</td>
<td>0.028</td>
<td>0.662</td>
</tr>
<tr>
<td>CLNP→ DESG → PROJ. H&amp;S</td>
<td>0.049</td>
<td>1.999</td>
</tr>
<tr>
<td>CLCE→ DESG → PROJ. H&amp;S</td>
<td>-0.033</td>
<td>-1.488</td>
</tr>
</tbody>
</table>
4. Discussion

4.1 Influence of client H&S culture on contractor H&S performance

The findings suggested that client H&S culture had an influence on the H&S performance of the upper management of contractors. Two of the six specific hypotheses, which collectively formed the hypothesis that client H&S culture had a direct positive influence on contractor H&S performance, were found to be statistically significant. The two hypotheses related to the influence of client H&S culture, namely procedures and commitment. The indicator variables for the factor procedures were for the client to:

- have programmes to monitor and analyse H&S implementation;
- have clear project H&S goals;
- schedule H&S as a key contract prequalification criterion for all parties to be involved in a project;
- schedule H&S in all contracts;
- conduct regular H&S performance measurement;
- have their own H&S committee, and
- conduct hazard identification and risk assessments (HIRAs).

The study found the influence of the procedures factor of client H&S culture on contractor H&S performance to be statistically significant. This finding supports those of the study by Huang & Hinze (2006: 171) who observed that projects where owners or clients tracked the individual H&S performances of each contractor on their project site had significantly better H&S performances.

Although Huang & Hinze (2006: 171) only referred to one indicator variable, namely performance measurement, their study supports the current study finding that clients needed to have clear procedures if they were to influence contractor H&S performance. The indicator variables for the commitment factor were for the client to:

- demonstrate a positive H&S attitude;
- actively promote H&S;
- provide adequate resources for H&S implementation;
- put in effort to routinely evaluate H&S in all work schedules;
- set up incentives for good H&S behaviour;
- set H&S as a major agenda item in project meetings;
actively monitor H&S programmes;
always attend H&S meetings on the construction site;
conduct H&S inspections and audits, and
be involved always in accident or incident investigations.

The commitment factor of client H&S culture had a statistically significant influence on contractor H&S performance. The findings of this study support the observations made by Toellner (2001: 47), Wiegmann, Zhang, Thaden, Sharma & Mitchell (2002: 11), Mohamed (2003: 82), Ng, Cheng & Skitmore (2005: 6), Cameron & Duff (2007: 870), and Choudry, Fang & Mohamed (2009: 209) who found that management commitment was key to H&S performance and culture. To date there have been few studies on evaluating the effect of client commitment on contractor H&S performance.

The influence of leadership, involvement, communication and competence were found to be statistically insignificant. This finding was surprising, because these factors were expected to have an influence on contractor H&S performance. In addition, the Delphi panel found them to have high impact significance. However, since statistical significance can be greatly affected by the sample size and the type of population that is sampled, it would be useful to learn whether the results would be different in another study with a different sample type and size. Notwithstanding this, the influence of these factors was found to be evident and therefore practically significant.

Client involvement was found to have a negative relationship with contractor H&S performance. Client involvement was defined by the following indicator variables which required the client to:

personally be active in critical project H&S activities;
always be present in project H&S meetings;
contribute to H&S training;
actively oversee H&S on critical operations;
constantly stay in touch on H&S issues;
always communicate information on H&S to all parties, and
conduct regular audits and inspections.

The study found that, if clients increased their involvement in activities that defined client involvement, the H&S performance of contractors deteriorated. However, it was realised during the study that there was a thin differentiating line between the factors involvement and commitment. The current study reported high collinearity between
these two factors. The involvement factor had a correlation value higher than 0.9 with the commitment factor. Therefore, it was speculated that the unreasonable result where client involvement caused deterioration in contractor H&S performance may probably have been a result of the high collinearity between the two factors. This may, in fact, be the reason why some authors use and refer to the two factors as being one factor, namely commitment and involvement (Mohamed, 2003: 82).

The findings relative to the hypothesis that client H&S culture had a direct positive influence on contractor H&S performance entailed that the minimum that the client could do in order to significantly influence contractor H&S performance was to have procedures in place and to be committed to H&S performance.

The findings offer a minimum requirement that could be used by clients seeking to influence contractor H&S performance. A checklist of items defining the factors of procedures and commitment could ensure that clients satisfied the basic required criteria to influence contractor H&S performance.

4.2 Influence of client H&S culture on designer H&S performance

Client H&S culture was found to have an influence on designer H&S performance. Two of the six specific hypotheses, which collectively formed the hypothesis that client H&S culture had a direct positive influence on designer H&S performance, were found to be statistically significant. The two specific hypotheses were that the procedures and communication factors had direct positive influence on designer H&S performance.

The finding in the current study validated a proposal by Bomel (2004: 149) that designers could design for H&S with the mobilisation of client influence. It would appear that, if clients had clear programmes on H&S, it would be easier for designers to perform their H&S obligations.

The communication factor was defined by the client having to:

- have formal reporting system of incidents and accidents;
- involve all parties in planning for H&S on the project;
- involve all parties to review H&S;
- provide timely feedback on reported accidents and incidents;
- communicate risk findings to all parties on the project;
- have clearly outlined H&S roles and responsibilities;
• have clearly communicated expected performance on H&S to all, and
• provide information on H&S risk control to all parties.

The effect on designer H&S performance by the client communicating was found to be statistically significant. The findings relative to the hypothesis that client H&S culture had a direct positive influence on designer H&S performance entailed that the minimum that the client could do in order to significantly influence designer H&S performance was to have procedures in place and to provide effective communication on H&S. However, although the influence of leadership, involvement, commitment and competence factors was not statistically significant, their influence was evident and therefore practically significant.

The findings only offer a minimum requirement that could be used by clients seeking to influence designers’ H&S performance. A checklist of items defining the factors, procedures and communication, could ensure that clients satisfied the basic required criteria to influence designer H&S performance. Designer H&S performance, especially designing for H&S, was critical to the overall project H&S performance (Bomel, 2004: X).

4.3 Influence of client H&S culture on project H&S performance

Client H&S culture was found to have an indirect positive influence on project H&S performance. This influence was mediated by contractor and designer H&S performance. The effects on project H&S performance of procedures and commitment were found to be statistically significant. However, the direct positive influence of client H&S culture on project H&S performance was found to be statistically insignificant. None of leadership, involvement, procedures, commitment, communication and competence factors had a statistically significant direct positive influence on project H&S performance.

The study found that client H&S culture was important to project H&S performance, particularly procedures and commitment. The finding that client H&S culture had an indirect positive influence on project H&S performance validated an observation made by Bomel (2004: 102) that clients’ culture offered an opportunity upon which H&S performance could be improved on construction projects. The findings also suggested that project H&S performance and improvement may not be achieved by focusing only on one party such as the contractor, or designer, or indeed the client. However,
the findings seemed to suggest that the participation of all parties was critical to achieving the desired H&S performance. The influence of client H&S culture on project H&S performance was found to be an indirect one and was mediated by both designer and contractor H&S performance.

In addition, although the direct influence of designers and contractors was found to be significant, the results suggested that these two factors also needed influence from client H&S culture. In order to continuously achieve or improve project H&S performance, client H&S culture was found to be necessary.

The importance of having conducted a structural equation modelling analysis to determine the influence of client H&S culture on the contractor, designer and project H&S performance was that it was possible to identify specifically which factors of client H&S culture had a statistical significant causal effect and direction of that effect as opposed to a general blanket statement that client H&S culture had an influence on project H&S performance. With this analysis, it was easier to operationalise in terms of what the client needed to do in order to assure project H&S performance.

4.4 Influence of contractor and designer H&S performance on project H&S performance

Contractor H&S performance in terms of upper management had a direct positive influence on project H&S performance. This finding was consistent with the Lin & Mills (2001: 135) study which found that, when contractors scored highly in management responsibility and H&S system elements, their total H&S standards tended to be higher. The study findings highlighted the role of contractors to influence overall project H&S performance. It also highlighted that it was beneficial for H&S performance improvement to commence with the involvement and commitment of the upper management of contractors as opposed to concentrating on factors found during the construction stage only. This significance was also highlighted by Jaselkis, Anderson & Russell (1996: 69) who argued that management characteristics, H&S meetings and budget allocations improved H&S performance. These aspects had to do with upper management.

Designer H&S performance had a direct positive influence on project H&S performance. This finding was consistent with that of Behm (2006: 7) and Gambatese, Behm & Hinze (2005: 1035) who found a link between the design and construction site injury and fatality incidents and concluded that designing for H&S was a viable intervention in the construction industry.
The current study highlighted the role of designers to influence overall project H&S performance. This finding confirmed a typical lack of understanding by some designers as to the extent of their influence on H&S performance (Gambatese, 1997: 32; Toole, 2005: 206). Therefore, the finding that designers have a significant influence on project H&S performance was noteworthy in that it provides designers with the knowledge that they had an influence on H&S performance.

For clients, who were employers of designers, designer H&S performance could constitute a checklist of activities to supervise designers to ensure project H&S performance. Similarly for designers, they could know which activities needed to be implemented or engaged with by them to ensure project H&S performance. These activities could also constitute leading indicators for all stakeholders involved in a project.

5. Conclusions

A model was developed based on findings from a review of literature and the Delphi study. The conceptual model postulated that client H&S culture had an influence on construction project H&S performance. The model further postulated that client H&S culture had an influence on contractor and designer H&S performance.

The postulated model was analysed using EQS version 6.1 and Mplus version 6.0 SEM software packages. The fit statistics for the measurement and structural models had an adequate fit to the sample data. The final model, presented in Figure 5, showed that client H&S culture had an influence on contractor, designer and project H&S performance. Specifically, the factors of procedures and commitment were found to have a statistically significant influence on contractor H&S performance, while the factors of procedures and communication had a statistically significant influence on designers. Client H&S culture was found to have an indirect influence on project H&S performance. This influence was mediated by contractor and designer H&S performance. Procedures and commitment had a statistically significant influence on project H&S performance.

The findings had theoretical value, because respondents were drawn from client, contractor, designer and subcontractor organisations. Respondents had working knowledge of the projects on which they were reporting. In addition, the questionnaire survey, whose results were modelled using the SEM, validated the conceptual model
developed from synthesised theories established from literature and, more importantly, from the Delphi study. The current study was supported by other studies that had used other research methods on the influence of clients on project H&S performance. However, the current study utilised a robust modelling method of SEM to specifically identify client H&S factors with significant influence.

The study found that better project H&S performance was possible when the factors of client H&S culture were evident. The influence of client H&S culture assured contractor, designer and project H&S performance. It would seem that project H&S performance would be assured by ensuring that the client H&S culture remained positive and that all the factors of client H&S were evident.

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Solly Seeletse & Watson Ladzani

Project cost estimation techniques used by most emerging building contractors of South Africa

Peer reviewed and revised

Abstract
This article investigates newly emerging building contractors of South Africa who are expected to survive by projects obtained mainly through tendering. Some of these contractors fail even before obtaining the first tender while many fail in the first three years of their formation.

The research population used was restricted to formally registered businesses found at the time in the register of the Construction Industry Development Board (cidb). The population of 792 businesses, registered as Grade 5 class, consisted of five distinct types of contractors, general builders, civil engineers, electricians, mechanical builders and other sundry players. A sample of 160 was used which is approximately 20% of the population. The literature was reviewed on tendering and related aspects: competitive bidding, estimating activities, pricing a tender, and evaluating a tender. The research tool used was a questionnaire, which investigated biographical and company information, proposal management and estimation, programming and scheduling, estimating strategies, understanding of basic cost concepts, project risk management, pre-tender internal price evaluation, and tender submission.

Findings of this research revealed that South African emerging contractors showed inadequacies and variations in cost concepts, scheduling tools, risk management and tender price estimation. They also lacked essential resources and skills for competing for tenders. Emerging contractors are advised to use consultants to assist them and/or subcontract to established contractors with a reputable history. They should use these opportunities to learn superior estimation methods (which are also more complex) and apply them to improve their own tendering practices.

Keywords: Cost estimation, estimation methods, emerging contractors, tender

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Abstrak
Hierdie artikel ondersoek nuutontluikende boukontrakteurs van Suid-Afrika wat moet oorleef op projekte wat hoofsaaklik deur tenders verkry word. Sommige van hierdie kontrakteurs raak bankrot nog voordat hulle die eerste tender gekry het, terwyl baie bankrot speel binne die eerste drie jaar van hul ontstaan.

Die navorsingspopulasie wat gebruik is, was beperk tot formeelgeregistreerde besighede wat toe gevind kon word in die register van die Konstruksie Industrie Ontwikkelingsraad (Construction Industry Development Board). Die populasie het bestaan uit 792 besighede, geregistreer as graad 5-klas, bestaande uit vyf afsonderlike tipes kontrakteurs, algemene bouers, siviele ingenieurs, elektriese, mecaniese bouers en diverse rolspekers. ‘n Monster van 160 is gebruik, wat ongeveer 20% van die populasie is. Die literatuur is nagegaan oor om vir iets te tender en verwante aspekte: mededingende bie, voorleggingsbestuur, beramingsaktiwiteite, risikobestuur, prys van ‘n tender en evaluering van ‘n tender. Die navorsingsinstrument wat gebruik is, was ‘n vraelys wat die biografiese en maatskappyinligting ondersoek het, naamlik voorleggingsbestuur en beraming, programmering en skedulering, beramingstrategieë, begrip van basiese kostekonsepte, projek risikobestuur, voor-tender interne prysvaluasie en tendervoorlegging.

Bevindinge van hierdie navorsing het getoon dat Suid-Afrika se ontlukende kontrakteurs ontoereikendhede en variasies in kostebegrippe, skedulerings-instrumente, risikobestuur en in tenderpryssskatting toon. Hulle het ook ‘n gebrek aan nodsaaklike hulpmiddele en die vermoëns om mee te ding vir tenders. Daar word aanbeveel dat ontlukende kontrakteurs konsultante moet gebruik om hulle by te staan en/of dat hulle moet subkontrakteer by gevestigde kontrakteurs wat ‘n hoog aangeskrewe reputasie het. Hulle moet hierdie geleenthede gebruik om uitmuntende beramingsmetodes (wat meer ingewikkeld is) te leer en toe te pas om hul eie tenderpraktyke te verbeter.

Sleutelwoorde: Kosteberaming, beramingsmetodes, opkomende kontrakteurs, tender

1. Introduction

South Africa’s emerging construction enterprises seem to deviate from global trends in costing projects, and differ according to provinces. The Western Cape, Gauteng and KwaZulu-Natal provinces are more advanced and more urban compared to the other six provinces (Eastern Cape, Free State, North-West, Northern Cape, Limpopo, and Mpumalanga) by virtue of having more urban than rural areas and being richer (Bond, 1999; Gumede, 2010). Emerging contractors in the various provinces seem to suffer from the way they develop project proposals, mainly in terms of costing. Thus, when tendering for large projects there are discrepancies with regard to the way in which the contractors in the different areas cost their projects, which seems to disadvantage some of them. Large and experienced contractors, on the other hand, do not experience this problem. They have survived time while emerging ones seem to fail quickly and in large numbers.
The South African construction outlook is published by the Construction Industry Development Board (CIDB, 2007). The CIDB (2007) reveals an oversubscription of emerging contractors who contribute about 80% of the registered contractors. One advantage of the emerging contractors is that the developed contractors need them to secure large projects. Emerging contractors can find and secure a partner who can empower them through exposure, skills transfer and revenue while collaborating on large projects. The trend, however, seems to be that many emerging contractors prefer to compete against large contractors instead of opting to partner with them. In some cases, they compete with limited knowledge. The CIDB is available to help contractors, but contractors should take the initiative to apply to be assisted with their needs. Emerging contractors are the main target of the CIDB support. Despite the preferential procurement policy by government and the CIDB, the contractors fulfilling composition conditions do not necessarily win tenders for large projects if they cannot convince the prospective client that they can perform the tasks required. No company would award large projects to contractors who ‘obviously do not understand the magnitude of the task’. The deficiencies of the emerging contractors include the lack of experience in large projects, project proposals lacking the breakdown of tasks, and poor project costing. Besides the prices that deviate far from the reasonable limits, emerging contractors seem to be using outdated project costing methods (i.e. methods no longer used by emerging contractors of developed worlds and large contractors) in business. This article explores the project costing methods used by South African emerging contractors (Nkado, Akintoye, Bowen & Pearl, 1999). The principal aim is to analyse project cost estimation practices, methods and processes utilised by the emerging construction sector in South Africa; identify deficiencies requiring remedial action through development programmes established for emerging contractors, and ultimately establish techniques used by the majority of emerging contractors when estimating tender prices.

2. Estimation

Estimation is the engineering art of developing an informed (or scientific) prediction about the cost and delivery date, and establishing all the resources required by the project (Kemp, 2004: 328; Steyn, Basson, Carruthers, Du Plessis, Prozesky-Kuscke, Kruger, Van Eck & Visser, 2006: 173). Cost estimates are used to evaluate the economic feasibility of projects, evaluate project alternatives, and establish the budget and cost control mechanism (Scott &
Amos, 2007: 9). Clark & Lorenzoni (1997: 11) cite a definition of cost engineering by the American Association of Cost Engineers (AACE) as the area of engineering practice where engineering judgement and experiences are used in the application of scientific principles and techniques to the problems of cost estimation, cost control and profitability. Therefore, estimation is a prediction of the quantity of resources needed to accomplish an activity or create an asset.

There is consensus (Clark & Lorenzoni, 1997; Kemp, 2004; Steyn et al., 2006; Scott & Amos, 2007) that a sound estimate depends on the following building blocks:

- a well-defined scope (what we are trying to estimate);
- a cost element structure (how information is organised), and
- historical cost data (data from cost accounting records and/or experience of knowledgeable people).

Heinze (1996: 225) also mentions the four categories of estimates used based on work scope and/or available information as:

- the quickie (guesstimate, back of a match-box, while on the phone);
- the concept (preliminary, study, order-of-magnitude, factored);
- the budget (official, the approval), and
- the definitive (final, control, firm, detailed, hard bid, take-off, and so on).

The choice of estimating method depends on several factors including the end-use of the estimate, the amount of time and money available to prepare the estimate, estimating tools and data available, the level of project definition, design information available, and the timing or phase of the project.

Clough & Sears (1999: 27) explain that several persons are involved in the initial and ultimate pricing stages as the term ‘estimator’ refers to all persons involved with the estimating function. An estimate is valid only if the basis for preparing it is also valid (Heinze, 1996: 226; Scott & Amos, 2007; Kul & Uppal, 2008: 1). Thus, the validity and reliability of the estimate depends on the knowledge and experience of the estimator together with a good performance record that inculcates confidence in the estimate. Fuller & Kahn (2003: 147) state that the estimators use the same basic skills, but that actual methods and job descriptions vary widely according to contractors. The estimator’s roles and responsibilities are perceived to be planning and review of specifications; compiling data for operations; researching potential
jobs; site study; negotiations; meetings with field team, and value engineering.

2.1 Project cost estimation

The project cost process considers the different project life cycle phases until the final design is completed and the Bill of Quantities (BoQ) is produced (Clough & Sears, 1999: 19). The BoQ is necessary to start cost estimation. Cost estimates are done for initial estimation to determine the feasibility of a project. Estimates are based on a system of gross unit costing. The unit costs are based on previous work of a similar type and magnitude extrapolated forward in time to reflect the current market conditions, project location and the peculiar character of the envisaged project (Lowe & Skitmore, 1994).

Clough & Sears (1999: 25) list common methods used to determine the order of magnitude costing as:

- cost per function estimates based on expenditure per unit of use;
- square metre cost estimates based on gross floor area;
- index number estimates based on the national price indices;
- cost estimates based on cubic metres per volume capacity;
- parameter costing based on different building components and systems, and
- partial take-off estimates using quantities of major work elements from partially completed designs.

3. Tendering

Nokes & Kelly (2007: 295) define tendering (also known as bidding) as the action of confirming a price offer for specified tasks/activities of a project in the prescribed method to the client and the client appreciates it as a procurement process to acquire products and services from outside the project team. Pricing tools for tendering include pricing strategies, sales and revenues, return on investment (ROI), return on sales (ROS), break-even analysis, and so on. Scott & Amos (2007) conceptualise the pricing process using an input-conversion-output model by defining (and thus replacing) pricing as the tools and techniques. The approach indicates that analytical tools are applied on the inputs to produce usable information at the start, during execution and on completion of the project.
Tender evaluation is explained in terms of:

Validation of estimates: An estimate is a prediction of the expected final cost of a proposed project for a given work scope. Thus, by its nature, an estimate involves assumptions and uncertainties, and is associated with some level of error. This level of error can be correlated to probabilities of over-running or under-running the predicted cost. Consequently, an estimate should be reviewed and validated for any errors prior to it being used for tendering purposes (Clemons, Barnett & Lanier, 2005).

Adjusting estimate: Tendering is done within certain time limits. However, some instances take longer to evaluate the tender, and tender conditions may change in the process. Scott & Amos (2007: 72-78) state that changes in project costs occur for a number of economic reasons. Common cost change concepts include inflation, deflation, escalation, taxation, and currency variation if construction takes place in a globalised environment (the global context excludes the emerging sector due to the small size of projects undertaken by the sector). In addition, a project may be funded, designed and governed by a legal jurisdiction in various countries other than the one in which the project is assembled and delivered.

Estimate accuracy: Cheung, Wong & Skitmore (2008: 349) studied clients’ and estimators’ tolerance to estimating errors. They found that clients and estimators stressed the importance of giving accurate cost estimates, are risk-averse and tolerate overestimates more than underestimates. Heinze (1996: 226) provided a set of descriptive and qualitative terms according to which an estimate can be assessed, namely terms such as credibility; accuracy; exactness; precision; reliability; tolerance; materiality, and validity.

Tender submission: The end result of the decision to tender is to submit the tender to the client’s premises. After effecting the necessary adjustment of the tender price according to the pricing strategies of the contractor, a competitive tender is ready for submission in the prescribed format. The prescribed format to submit tenders is usually found in the invitation to tender (ITT) which normally contains the following details:

- the targeted cidb registration status (grade) of contractors;
- availability of documents and contact details of personnel responsible for receiving tender enquiries;
- the date and venue of pre-tender meeting (briefing session) and whether it is compulsory or not;
manner of tender submission, i.e. original tender documents, returnable schedules and whether electronic or other forms of submission are acceptable;
- the closing date and the place of submission, and
- the tender validity period from the closing date.

If these requirements are not complied with, the tender may be disqualified.

Negotiating tender contract: As a starting point, negotiations would typically be centred on the offer made by the contractor and counteroffers by the client and are an iterative process until consensus is reached. Acceptance following an offer is an unqualified declaration of intent made by the client, approving the offer without reservation. A typical construction industry contract contains contract clauses relating to general terms and conditions, warranties or guarantees, breach of contract, remedies, payment valuations certificates and progress payments, contract duration, dispute resolution mechanisms, and specific requirements depending on the form of contract selected by the parties. The preceding discussion implies that negotiators need to have strong commitment to mutual gain, have strong focus on the problem, and generally be clear in communicating the negotiator’s viewpoints.

3. Research methodology

A semi-structured questionnaire consisting of six questions, each with several subquestions, was the main research instrument. The questions referred to estimating techniques used by emerging contractors. The questionnaire was distributed to a sample of 161 emerging contractors such as builder, civil, electrical, mechanical and miscellaneous other contractors. The respective sample sizes of each strata were 54 (36.0%), 68 (39.8%), 19 (11.8%), 11 (6.8%) and nine (6.6%).

3.1 Population and sampling

The study population were emerging cidb-registered contractors registered for work up to R5m. The cidb’s Contractor Register included 792 such contractors (cidb, 2009). These contractors were further categorised into contractor types or strata: general builders, civil, electrical, mechanical, and others. These strata enabled stratified sampling (Curwin & Slater, 2002). Simple random samples were selected from each stratum. Simple random sampling is a sampling method where items in the research population are uniform and
have an equal probability of being included in the sample (Bless & Kathuria, 1993). To increase accuracy, a 20% sampling ratio was used based on the 10% minimum required, thus targeting 160 (20% = 158.4) of these contractors. The proportional sizes were determined for each stratum, and respective samples were generated using a random generator. The cidb’s definition of potentially emerging contractor implies that the contractor organisation is owned mainly by the previously disadvantaged individual/s as a result of the previous government’s discriminatory laws. Bouma (2000: 130) advises that at least 30 individual elements are required in order to provide a pool that is large enough for simple kinds of analyses. The respondents were further categorised into provincial locations.

Table 1 summarises the population, sample, and sampling ratios of the various strata, as well as the total sampling ratio.

Table 1:  Population, sample, and strata

<table>
<thead>
<tr>
<th></th>
<th>General building</th>
<th>Civil</th>
<th>Electrical</th>
<th>Mechanical</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>286</td>
<td>316</td>
<td>94</td>
<td>53</td>
<td>43</td>
<td>792</td>
</tr>
<tr>
<td>Sample (frequency)</td>
<td>58</td>
<td>64</td>
<td>19</td>
<td>11</td>
<td>9</td>
<td>161</td>
</tr>
<tr>
<td>Sample (% of population)</td>
<td>20.28%</td>
<td>20.25%</td>
<td>20.21%</td>
<td>20.75%</td>
<td>20.93%</td>
<td>20.33%</td>
</tr>
</tbody>
</table>

Key: % of population = sample as percentage of category population

From the 792 member population, a stratified sample of 161 respondents (20.3% of the population) participated. Table 2 provides the provincial spread of the contractors.

Table 2:  Provincial spread of respondents

<table>
<thead>
<tr>
<th></th>
<th>GAU</th>
<th>KZN</th>
<th>NW</th>
<th>FS</th>
<th>WC</th>
<th>NC</th>
<th>Mpu</th>
<th>EC</th>
<th>Lim</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘f’</td>
<td>34</td>
<td>29</td>
<td>14</td>
<td>11</td>
<td>16</td>
<td>8</td>
<td>16</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>‘%’</td>
<td>12.1%</td>
<td>18.0%</td>
<td>8.7%</td>
<td>6.8%</td>
<td>9.9%</td>
<td>5.0%</td>
<td>9.9%</td>
<td>8.7%</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

Key: ‘f’ = number/frequency of respondents; ‘%’ = percentage of respondents; GAU = Gauteng; KZN = KwaZulu-Natal; NW = North-West; WC = Western Cape; NC = Northern Cape; Mpu = Mpumalanga; EC = Eastern Cape; Lim = Limpopo
4. Findings

4.1 Proposal management and estimating team

Table 3 presents the emerging contractors’ distribution according to frequencies of responsibility for managing proposal and estimating among the role players (business owner, project manager and consultant) involved when the emerging contractors prepare tender documents.

<table>
<thead>
<tr>
<th></th>
<th>Building</th>
<th>Civil</th>
<th>Electrical</th>
<th>Mechanical</th>
<th>Other forms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business owner</td>
<td>38</td>
<td>23</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>79</td>
</tr>
<tr>
<td>Project manager</td>
<td>7</td>
<td>15</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Consultant</td>
<td>13</td>
<td>26</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>64</td>
<td>19</td>
<td>11</td>
<td>9</td>
<td>161</td>
</tr>
<tr>
<td>%</td>
<td>36.12%</td>
<td>39.75%</td>
<td>11.80%</td>
<td>6.83%</td>
<td>5.59%</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4: Responsibility for estimation

The research sample consisted of 58 (36.0%) general builders, 64 (39.7%) civil engineers, 19 (11.8%) electricians, 11 (6.8%) mechanical engineers, and 9 (5.6%) other/sundry contractors. Business owners, project managers and consultants were responsible for the estimation, at 49.1%, 19.2% and 31.7%, respectively. Interest arises to test whether the responsibility in proposal management and estimation and the contractor type are dependent. The null hypothesis is \( H_0 \): project management responsibility in the emerging contractor sector depends on the type of emerging contractor.
Due to a few observed frequencies, the Yates corrected chi-square (Bless & Kathuria, 1993: 192) is used, namely:

\[ \chi^2 = \sum_{i=1}^{k} \left( \frac{|O_{ij} - e_{ij}| - 0.5}{e_{ij}} \right)^2 \]

where, \( O_{ij} \) are the observed frequencies and \( e_{ij} \) the expected frequencies of the emerging contractors based on the null hypothesis. All the tests were conducted at the 5% level of significance to determine whether the estimation methods used by emerging contractors were due to an existing pattern or occurred randomly.

Table 5: Expected responsibility for proposal management

<table>
<thead>
<tr>
<th></th>
<th>Building</th>
<th>Civil</th>
<th>Electrical</th>
<th>Mechanical</th>
<th>Other forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business owner</td>
<td>28.4596</td>
<td>31.4037</td>
<td>9.3230</td>
<td>5.3975</td>
<td>4.4161</td>
</tr>
<tr>
<td>Project manager</td>
<td>11.1677</td>
<td>12.3230</td>
<td>3.6584</td>
<td>2.1180</td>
<td>1.7329</td>
</tr>
<tr>
<td>Consultant</td>
<td>18.3727</td>
<td>20.2733</td>
<td>6.0186</td>
<td>3.4845</td>
<td>2.8509</td>
</tr>
</tbody>
</table>

Calculation of chi-square statistic gives \( \chi^2 = 11.5252 \). The degrees of freedom (d.f.) for this contingency table is \((\text{rows} - 1)(\text{columns} - 1) = (2)(4) = 8\). At the 5% level of significance the critical value is 16.919. Since the test statistic does not exceed the critical region, the null hypothesis of independence cannot be rejected. Thus, at the 5% level of significance there is no statistical evidence that estimation approach depends on the type of contractor. This means that there is no attachment of proposal management and estimation to a type of role played during estimation when tendering in the emerging contractor sector.

Table 6: Responsibility for proposal management per province: observed

<table>
<thead>
<tr>
<th></th>
<th>GAU</th>
<th>KZN</th>
<th>NW</th>
<th>FS</th>
<th>WC</th>
<th>NC</th>
<th>Mpu</th>
<th>EC</th>
<th>Lim</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>25</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>PM</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>5</td>
<td>12</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>11</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>29</td>
<td>14</td>
<td>11</td>
<td>16</td>
<td>8</td>
<td>16</td>
<td>14</td>
<td>19</td>
<td>161</td>
</tr>
</tbody>
</table>
Table 7: Responsibility for proposal management per province: expected

<table>
<thead>
<tr>
<th></th>
<th>GAU</th>
<th>KZN</th>
<th>NW</th>
<th>FS</th>
<th>WC</th>
<th>NC</th>
<th>Mpu</th>
<th>EC</th>
<th>Lim</th>
</tr>
</thead>
</table>

Chi-square $\chi^2 = 35.2519$ with d.f. = (2)(8) = 16. The critical value is 26.296. The test statistic exceeds this critical value, leading to the rejection of the null hypothesis of independence. Thus, at the 5% significance level there is enough statistical evidence that estimation methods used by emerging contractors depend on the province in which the contractor is located. Therefore, the emerging contractors in the different provinces vary with respect to the estimation methods they use in tendering.

Table 8 displays the distribution of the observed frequencies of the professional backgrounds of the various emerging contractor sector role players.

Table 8: Professional background of estimator versus responsibility: observed

<table>
<thead>
<tr>
<th></th>
<th>Engineer</th>
<th>Quantity surveyor</th>
<th>Architect</th>
<th>Accountant</th>
<th>OD</th>
<th>IP</th>
<th>Stat/ Econ</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>7</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>27</td>
<td>31</td>
<td>4</td>
<td>79</td>
</tr>
<tr>
<td>PM</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>9</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>1</td>
<td>13</td>
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<td>3</td>
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<td>14</td>
<td>7</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>31</td>
<td>8</td>
<td>5</td>
<td>45</td>
<td>54</td>
<td>12</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 9 displays the expected frequencies based on Table 8 with the hypothesis that the professional backgrounds of emerging contractors do not influence the type of role played by emerging contractors in tendering.
Table 9: Professional background of estimator versus responsibility: expected

<table>
<thead>
<tr>
<th></th>
<th>Engineer</th>
<th>Quantity surveyor</th>
<th>Architect</th>
<th>Accountant</th>
<th>OD</th>
<th>IP</th>
<th>Stat/Econ</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>7.3602</td>
<td>15.2112</td>
<td>3.9255</td>
<td>2.4534</td>
<td>22.0807</td>
<td>26.4969</td>
<td>5.8882</td>
</tr>
<tr>
<td>PM</td>
<td>2.8882</td>
<td>5.9689</td>
<td>1.5404</td>
<td>0.9627</td>
<td>8.6646</td>
<td>10.3975</td>
<td>2.3106</td>
</tr>
<tr>
<td>Con</td>
<td>4.7516</td>
<td>9.8199</td>
<td>2.5342</td>
<td>1.5839</td>
<td>14.2547</td>
<td>17.1056</td>
<td>3.8012</td>
</tr>
</tbody>
</table>

Chi-square $\chi^2 = 24.41964$ with d.f. = (2)(6) = 12. The critical value is 21.026. The test statistic exceeds the critical value, resulting in rejecting the null hypothesis of independence. Hence, at the 5% level of significance there is enough statistical evidence that the role players used by the emerging contractors depend on the professional background of the contractor. This means that the professional backgrounds of emerging contractors influence the type of role player involved in estimating when tendering.

4.2 Programming and scheduling techniques

Table 10 displays the distribution of the observed frequencies of programming and scheduling techniques used against the various role players in the emerging contractor sector.

Table 10: Use of programmes versus responsibility for proposal management and estimation: observed

<table>
<thead>
<tr>
<th></th>
<th>CPM</th>
<th>PERT</th>
<th>Charts</th>
<th>WBS</th>
<th>Other forms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>0</td>
<td>3</td>
<td>54</td>
<td>21</td>
<td>1</td>
<td>79</td>
</tr>
<tr>
<td>PM</td>
<td>1</td>
<td>0</td>
<td>19</td>
<td>2</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>1</td>
<td>2</td>
<td>19</td>
<td>19</td>
<td>1</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>5</td>
<td>101</td>
<td>42</td>
<td>11</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 11 displays the expected frequencies based on Table 10 with the hypothesis that the programming and scheduling techniques in the emerging contractor sector do not influence the type of role played by emerging contractors in tendering.
Table 11: Use of programmes vs. responsibility for proposal management and estimation: expected

<table>
<thead>
<tr>
<th></th>
<th>CPM</th>
<th>PERT</th>
<th>Charts</th>
<th>WBS</th>
<th>Other forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>0.9814</td>
<td>2.4534</td>
<td>49.5590</td>
<td>20.6087</td>
<td>5.3975</td>
</tr>
<tr>
<td>PM</td>
<td>0.3851</td>
<td>0.9627</td>
<td>19.4472</td>
<td>8.0870</td>
<td>2.1180</td>
</tr>
<tr>
<td>Con</td>
<td>0.6335</td>
<td>1.5839</td>
<td>31.9938</td>
<td>13.3043</td>
<td>3.4845</td>
</tr>
</tbody>
</table>

Chi-square $\chi^2 = 30.285498$ with d.f. = (2)(4) = 8. The critical value is 26.296, which is lower than the test statistic, leading to rejecting the null hypothesis of independence. Thus, at the 5% significance level there is enough statistical evidence that the use of programming technique in the emerging contractor sector depends on the professional background of the contractor.

4.3 Project risk management

Table 12 displays the distribution of the observed frequencies of project risk management used against the various role players in the emerging contractor sector.

Table 12: Use of project risk management versus responsibility: observed

<table>
<thead>
<tr>
<th></th>
<th>Internal document analysis</th>
<th>Checklist analysis</th>
<th>Assumptions and analysis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>1</td>
<td>4</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>PM</td>
<td>3</td>
<td>13</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>2</td>
<td>8</td>
<td>41</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>25</td>
<td>130</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 13 displays the expected frequencies based on Table 12 with the hypothesis that project risk management in the emerging contractor sector does not influence the type of role played by emerging contractors in tendering.

Table 13: Use of project risk management versus responsibility: expected

<table>
<thead>
<tr>
<th></th>
<th>Internal document analysis</th>
<th>Checklist analysis</th>
<th>Assumptions and analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>2.9441</td>
<td>12.2671</td>
<td>63.7888</td>
</tr>
<tr>
<td>PM</td>
<td>1.1553</td>
<td>4.8137</td>
<td>25.0311</td>
</tr>
<tr>
<td>Con</td>
<td>1.9006</td>
<td>7.9193</td>
<td>41.1801</td>
</tr>
</tbody>
</table>
Chi-square $\chi^2 = 461.7588$ with d.f. = $(2)(2) = 4$. The critical value is 9.488. The test statistic exceeds the critical value, and results in the rejection of the null hypothesis of independence. It is concluded that at the 5% level of significance there is enough statistical evidence that the use of project management risk approach and responsibility for proposal management and estimation in the emerging contractor sector are dependent.

Table 14 displays the distribution of the observed frequencies of risk allocation strategies used against the various role players in the emerging contractor sector.

Table 14: Use of project risk allocation strategies: observed

<table>
<thead>
<tr>
<th></th>
<th>Risk transfer</th>
<th>Risk reduction</th>
<th>Risk retention</th>
<th>Risk elimination</th>
<th>Risk sharing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>7</td>
<td>66</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>79</td>
</tr>
<tr>
<td>PM</td>
<td>7</td>
<td>13</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>17</td>
<td>14</td>
<td>2</td>
<td>4</td>
<td>14</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>93</td>
<td>4</td>
<td>7</td>
<td>26</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 15 displays the expected frequencies based on Table 14 with the hypothesis that risk allocation strategies in the emerging contractor sector do not influence the type of role played by emerging contractors in tendering.

Table 15: Use of project risk allocation strategies: expected

<table>
<thead>
<tr>
<th></th>
<th>Risk transfer</th>
<th>Risk reduction</th>
<th>Risk retention</th>
<th>Risk elimination</th>
<th>Risk sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>15.2112</td>
<td>45.6335</td>
<td>1.9627</td>
<td>3.4348</td>
<td>12.7578</td>
</tr>
<tr>
<td>PM</td>
<td>5.9689</td>
<td>17.9068</td>
<td>0.7702</td>
<td>1.3478</td>
<td>5.0062</td>
</tr>
<tr>
<td>Con</td>
<td>9.8199</td>
<td>29.4596</td>
<td>1.2671</td>
<td>2.2174</td>
<td>8.2360</td>
</tr>
</tbody>
</table>

Chi-square $\chi^2 = 37.87779$ with d.f. = $(2)(4) = 8$. The critical value is 15.507. The test statistic exceeds the critical value, and the null hypothesis of independence is rejected. Thus, at the 5% significance level there is no enough statistical evidence that the use of project risk allocation and responsibility for estimation in the emerging contractor sector are dependent.
4.4 Pre-tender internal price evaluation

Table 16 displays the distribution of the observed frequencies of pre-tender internal price evaluation used against the various role players in the emerging contractor sector. Table 17 displays the expected frequencies based on Table 16 with the hypothesis that pre-tender internal price evaluation in the emerging contractor sector does not influence the type of role play in tendering.

Table 16: Pre-tender internal price evaluation versus responsibility: observed

<table>
<thead>
<tr>
<th></th>
<th>Over-price</th>
<th>Under-price</th>
<th>Balance price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>6</td>
<td>4</td>
<td>69</td>
<td>79</td>
</tr>
<tr>
<td>PM</td>
<td>2</td>
<td>2</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Con</td>
<td>3</td>
<td>11</td>
<td>37</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>17</td>
<td>133</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 17: Pre-tender internal price evaluation versus responsibility: expected

<table>
<thead>
<tr>
<th></th>
<th>Over-price</th>
<th>Under-price</th>
<th>Balance price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BO</td>
<td>5.3975</td>
<td>8.3416</td>
<td>65.2609</td>
</tr>
<tr>
<td>PM</td>
<td>2.1180</td>
<td>3.2733</td>
<td>25.6087</td>
</tr>
<tr>
<td>Con</td>
<td>3.4845</td>
<td>5.3851</td>
<td>42.1304</td>
</tr>
</tbody>
</table>

$\chi^2 = 7.58178$ with d.f. = (2)(2) = 4. The critical value is 9.488. The test statistic does not exceed the critical value. The null hypothesis of independence is therefore not rejected. The conclusion is that at the 5% level of significance there is enough statistical evidence that among the emerging contractors, the use of project management risk approach does not have any bearing on the person responsible for estimating.

5. Results and discussions

This section presents the research results. This is followed by a discussion of the results and the conclusion.
5.1 Proposal management and estimating team

In South Africa’s emerging contractor sector, civil engineers dominated the contractors, followed by general builders, mechanical engineers, electricians and, lastly, a mix of other types of contractors. Proposal management and estimation were dominated by business owners, then project managers and, lastly, consultants. Since estimation approach was found to be dependent on the type of contractor, this implies that different contractors approached estimation differently. It was similarly shown that different contractors approached estimation and proposal management differently according to province. Professional backgrounds of different contractors also influenced the way in which the contractors managed proposals and conducted their estimation of projects.

5.2 Programming and scheduling techniques

The study revealed that programming and scheduling techniques used by the various emerging contractors were associated with the way in which the emerging contractors managed proposals and conducted their estimation of projects.

5.3 Project risk management

The study showed that, in the emerging contractor sector, use of project risk management approach and responsibility for proposal management and estimation are dependent.

5.4 Pre-tender internal price evaluation

The study showed that, in the emerging contractor sector, use of pre-tender internal price evaluation also influenced the responsibility to manage proposal and estimation approaches.

6. Conclusions

This section concludes the research by pointing at three salient findings regarding the main concerns of this research, and provides the recommendations from the study.

6.1 Role playing to estimate tender prices

Through analyses and tests conducted, empirical evidence shows that, in the emerging contractor sector:

- the responsibility of estimating tender prices is linked to and dependent on the principal trading area/s. General building
and electrical contractors prefer to take responsibility for price estimation whereas the combined enterprise formations usually outsource the responsibility to consultants, and

- the majority of emerging contractors have technical skills whereas few of them outsource to persons with quantity surveying skills and even fewer to civil engineers.

6.2 General practices to estimate tender prices

- The majority of emerging contractors make use of the Gantt chart programming and scheduling technique. Fewer use the WBS method. The more complex CPM and PERT methods are virtually not used, i.e., they are used to an insignificant extent relative to the use of other methods. Generally though, relative to the methods applied in the construction industry in South Africa, project costs estimates developed by emerging contractors are questionable.

- Cost drivers such as labour, materials, plant and equipment are highly recognised in the tender compilation.

- The emerging contractor sector seems to have high awareness of risk factors but seems to lack the capability to manage risk.

6.3 Compliance to best practice

Since leading nations use complex methods which the emerging construction sector in South Africa did not use, it is evident that this sector does not meet global best practice standards. There is no doubt that this is caused by the lack of skills and resources necessary to meet global best practice.

7. Recommendations

The estimation practices of not following benchmarked standards and depending on the poor condition (such as lack of skill and knowledge) of the contractors require intervention to remedy the sector’s plight. It is generally recommended that the remedial action should focus on proposal and procurement management, project cost management, and project risk management. Specific recommendations are discussed below.
7.1 Responsibility to estimate tender prices

Emerging contractors mainly lack technical skills and enter the market with limited exposure and resources, whereas consultants seem to be able to improve the emerging business in building and construction. Therefore, in order to enhance their competitiveness and sustainability, it is recommended that:

- they volunteer to work under consultants in order to acquire the skills used by consultants on outsourced work, and that
- emerging contractors who do not have technical skills should never tender as main contractors, but should subcontract or partner with companies that have the skills and resources.

7.2 Practices to estimate tender prices

If the emerging contractors use simpler estimation methods while their established competitors use complex ones, emerging contractors will likely not be perceived as competitive. It is therefore recommended that:

- the emerging contractors should emulate leading local contractors to familiarise themselves with the environment;
- they should be ‘interns’ or subcontractors of established contractors in order to learn to use complex methods quickly and simpler scheduling techniques independently to verify the results of the complex ones. (In this way they ask to be mentored and, in return, give their time.), and that
- they should learn about project risks and methods to manage risks to eliminate or minimise their impact.

7.3 Compliance to best practice

It is recommended that the emerging South African contractors should follow niche business and/or subcontract to established contractors for skills acquisition and avoid direct and immediate competition until they have reached a stage where they can perform at a higher level. When they have acquired the main basic skills to practise methods used by leading competitors to raise their standards to competitive levels, gained experience and established their client base adequately, then they can start participating independently, but rather on a low scale. They should learn the trade during their subcontracts from established contractors. In their early existence they should avoid exerting themselves aggressively and independently against established contractors.
Acknowledgement

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References list


Financial implications for built environment consultants working at risk in South Africa

Abstract
Consultants in the built environment of South Africa are facing financial risks due to clients' expectations of completing certain portions of work at risk. Thus, consultants would complete projects at risk in return for the possibility of remuneration in the long run. A descriptive survey was conducted among various professional consultants working within the built environment in South Africa. The findings include that a large percentage of work was expected to be completed at risk. Once work was completed at risk, a relatively small percentage continued to a stage where the actual consultant received remuneration. As a result of the current global economic climate, the amount of work required to be completed at risk increased and the percentage of work continuing to a stage of remuneration has also decreased. A greater percentage of clients therefore expected more work to be done at risk than the actual amount of work for which consultants are remunerated.

Keywords: Built environment, financial risk, expectations, remuneration, work done at risk

Abstrak
Konsultante in die boubedryf van Suid-Afrika loop finansiële risiko's as gevolg van kliënte se verwagtinge om sekere fases van werk te voltooi teen 'n risiko. Konsultante voltooi dus projekte teen 'n risiko met die hoop op vergoeding in die lang duur. 'n Beskrywende opname is gedoen onder 'n verskeidenheid professionele konsultante wat in die boubedryf van Suid-Afrika werk. Die bevindinge was dat 'n groot persentasie van die werk teen 'n risiko gedoen word. As die werk teen risiko voltooi is, is daar maar 'n relatiewe klein persentasie
wat voortgaan tot ‘n stadium waar die konsultant wel vergoeding ontvang. As gevolg van die wêreld se huidige ekonomiese klimaat het die hoeveelheid werk wat teen risiko gedoen word toegeneem terwyl die stadium waar vergoeding moet geskied, afgeneem het. Meer kliënte verwag dus werk wat teen ‘n risiko gedoen moet word terwyl die eintlike bedrag van vergoeding vir die konsultante afgeneem het.

Sleutelwoorde: Bou-omgewing, finansiële risiko, verwagtinge, vergoeding, werk gedoen op risiko

1. Introduction

The South African construction industry has experienced a decade of considerable growth and success, particularly as a result of the government’s considerable infrastructure spending. According to a report by the Department of Agriculture and Land Reform (2008: 7), the construction industry managed to increase its contribution to South Africa’s Gross Domestic Product by 18% between 2003 and 2008. However, the current global recession has, as in most sectors, put a dampener on growth (Adendorff, Appels & Brink, 2011: 42).

During certain economic cycles, professional consultants in the built environment are forced to work at risk. No current remuneration model for consultants working at risk in South Africa is clearly defined. Professionals are increasingly expected to commit their intellectual property and time at risk. Developers and employers have a tendency to take a certain amount of advantage of this phenomenon (Chinyiou, 2011: 4). Therefore, consultancy firms expected to do work at risk are facing more substantial risks during recessed economic cycles due to an increase in the amount of work required to be completed at risk (Van Zyl, 2011). Consultants are, in turn, expected to do the work, only to receive remuneration in the long run based on the case of the possibility of actual projects continuing. Various researchers argue that clients use the work done by the consultant to some extent, but no payment is, however, made to the consultant in the long run, even though the client has found some form of personal enrichment (Clark, 2012: 4). Consultants and consultancy firms are therefore incurring substantial loss of potential turnover due to work completed at risk never continuing to a stage of remuneration for such consultant or organisation (Griffin, 2012: 1).

2. Literature review

The financial uncertainty as a result of the current economic cycle has negative effects on businesses that trade during these times. A decline in employment opportunities and level of trade, caused by recessionary conditions, is primarily unfavourable for any economic
The contribution of Gross Fixed Capital Formation to Gross Domestic Product in South Africa averaged between 20% and 22% in 2009 and 2010, a marked improvement from an average of 17% in 2005 (Du Plessis & Smit, 2005: 5). From 2006 to 2010 there has been a substantial increase in fixed capital in South Africa brought about by the need to support longer term and sustainable economic growth. Strong investment in fixed capital has therefore provided structural support to the economy (The Consulting Engineers South Africa, 2011: 5). The construction sector in South Africa contributed 49% to Gross Fixed Capital Formation, and increased its contribution to 10.8% of Gross Domestic Product in the 3rd quarter of 2010. Between 2006 and 2010 the construction industry in South Africa was supported by stronger government investment as well as an increase in capital spending by Eskom, ACSA and Transnet, while private sector investment was boosted primarily by residential and retail construction (Consulting Engineers South Africa, 2011: 5; Gordhan, 2012: 1).

Residential buildings completed in South Africa also indicated a steady decline between 2007 and 2010. In an economic downturn owners and prospective owners of buildings may prefer to maintain their existing stock and delay new work, and therefore the number of mortgage approvals has a strong effect on the housing market (Chamberlin, 2009: 24-26).

From 2008 to 2010, the highest value of plans passed in South Africa, but never constructed, totalled R23 731 925 000 in 2008. In the same year, the mortgage rate was the highest, at 15.1%. Comparing the mortgage rate to the value of plans passed, but never constructed, a direct relationship between the mortgage rate and the value of the plans emerged. The negative value for residential buildings in 2009 could arguably be due to the sharp drop in mortgage rates.
from 15.1% in 2008 to 11.7% in 2009, causing investors to carry on with building of plans passed in 2008 and, in turn, create the possibility of inaccuracies in the interpretation of data. To even out the data, a linear trend line has been added to the graph shown in Figure 4, illustrating the relationship between the value of the plans and the mortgage rate. A comparison of the linear trend line of the total value for plans passed, but never constructed, shows consistency against the gradual drop in mortgage rates over the three-year period. The actual value of building plans passed in South Africa in 2010 fell by 7.6 on the year in December (-11.7% y/y previously). The weakness was more pronounced in the non-residential building sector, which included factories, commercial and other office buildings. The real value of buildings actually completed in South Africa fell by 39.7% y/y in December 2010 (-15.4% y/y previously), driven by a contraction in both the residential and non-residential buildings (Radira, 2011: 1). This difference in the fall of plans passed, compared to buildings actually completed, created a situation where building projects were either cancelled or put on hold. This therefore increased the risk for consultants who are involved in those projects of not being remunerated for the work completed (Radira, 2011: 1).
Economic cycles of recession caused uncertainty with regard to the financial feasibility of selected projects within the built environment (Posner, 2009: 25-43). Long-term construction projects may be victims of enormous escalations in cost. If recessions occur during the implementation phase of any project, the chances of cancellation will increase (The Construction Index, 2012: 1; Markstein, 2011: 1). It has been reported that most mega-projects have been put on hold and some cancelled, the reason being the world economic downturn (COBRA, 2010: 20). Two of Murray and Roberts’ projects, a R3.2 billion Donald Trump Tower in Dubai and another in the Middle East, have also subsequently been cancelled (COBRA, 2010: 20). Goup5’s small housing project for a local mining firm, African Copper Mining, has been cancelled due to financial pressures (Business Day, 2012: 1).

Eskom in South Africa also terminated the procurement process of the proposed and much needed multibillion-rand nuclear power station projects due to economic downturn factors (COBRA, 2010: 20). Construction of the much acclaimed Leadenhall building in Johannesburg was temporarily put on hold in 2008 and 2009, due to concerns over future occupancy rates, which were forecasted to be much lower during recessed economic downturns (Chamberlin, 2009: 30). At December 2011, only 13 of 107 planned projects in South Africa had broken ground, and only 10 of these have gone vertical (Lilia, 2009: 42). A decline in private sector investment, particularly in new housing construction, machinery, equipment and transport, contributed to the poor performance in gross fixed investment. Slower growth in non-residential construction resulted in a negative
Conditions for consultants in the built environment industry continued to become more challenging. Fee income fell by 8% compared to the first 6 months, or by 16.9% year-on-year adjusted for inflation (CPI, 2011). The high level of discrepancies between consulting firms indicated that some firms did manage to report an increase in earnings, while most firms reported a decrease (Consulting Engineers South Africa, 2011: 19). The average (un-weighted) net profit (before tax) moderated in the last six months from 18.4% in the first six months of 2009 to 16.4% in the last six months of 2009. Therefore, economists expected profit margins to moderate further in 2010, to an average of between 10% and 13%. Although a larger number of consulting firms were dissatisfied with profit margins, the majority of consulting firms were still of the opinion that the profit margins were between satisfactory and good (Consulting Engineers South Africa, 2011: 10).

An increase in competition was felt due to the plummeting economy (Newcomb, 2009). It is argued that competition generally eased during a time when the availability of work decreased, and intensified during periods of work shortages (Consulting Engineers South Africa, 2010: 13). An easing of competition has generally led to an increase in prices, while price inflation was capped during periods of work shortages, due to the fact that an increasing number of firms tendered on the same projects. The tendering process was regarded as costly and time-consuming, and higher levels of competition significantly increased the risk for consultants in South Africa (Hughes, Hillebrandt, Greenwood & Kwawu, 2006: 140). Respondents indicated that competition was seen to have declined 79% in December 2007 to 78% in December 2009, recovering from what may have been a supported error during the June 2009 survey as part of the research study, 36%. Competition undoubtedly remains fierce in the construction industry in South Africa. It can be argued that competition really escalated in 2008 and subsequently led to an increase in the rates whereby firms discounted fees (Consulting Engineers South Africa, 2010: 14).

The discounting of fees, benchmarked against fee guidelines gazetted by The Engineering Council of South Africa, continued during the 2008 survey period, but moderated, from 19.3% to 16.4% during June 2009. Indications were that 43% of the firms reported a discounting rate of 20% or more, the highest being 45%. Larger firms argued to leverage a discount at an average of 21% during 2009 (compared to 25% and 15% in the previous surveys). Interestingly,
those firms already running at a capacity rate of 100% or more seemed to be offering the highest discounting rates of over 25%. Consulting Engineers South Africa’s labour cost indicator, on the other hand, increased by 10.7% year-on-year December 2009, including a 20.6% increase in June 2009 (Consulting Engineers South Africa, 2011: 25). The increase in engineering consulting costs has, since June 2003, surpassed the increase in the Consumer Price Index, indicating that the real change in fee income has probably been overstated, given the fact that the Consumer Price Index has used a nominal fee income deflator (Consulting Engineers South Africa, 2011: 25). The average unit labour cost in the consulting engineering consulting industry, however, increased by a mammoth 145.0% a month between June 2002 and June 2009, from an average of R75 per hour (based on 160 hours per month) to R185m in June 2009 (Consulting Engineers South Africa, 2010). Average unit costs, on the other hand, increased by an annual rate of 21.7% in 2008, compared to 9.6% in 2007 and 10% in 2006. Unit costs rose 11% in June 2009 compared to December 2008, or by 25.4% compared to that of the June 2008 unit cost survey (Consulting Engineers South Africa, 2011: 25). Changes in the general cost of living (as measured by Statistics South Africa’s Consumer Price Index) have clearly been non-indicative of labour cost changes within the consulting engineering industry (Consulting Engineers South Africa, 2010: 25).

2.1 Working at risk

Consultants are often required to perform work at risk (Consulting Engineers South Africa, 2011: 25). The concept of ‘working at risk’ is defined as when a consultant performs certain work for, or on behalf of a client and payment of the fee for such work is deferred (partially or in full) until a specific agreed event(s) occurs. This event is further defined as ‘success’. If success is not achieved (often by an agreed date), the client has no further liability or obligation to pay the deferred fee. The work required by the client could include items such as presentations, design proposals and draft designs or layouts (eHow, 2012: 1; Saito & Furusaka, 2006: 3).

Reasons for performing work at risk typically fall within the following broad category: A requirement to align the interests of the consultant with those of the client through risk-sharing and a mechanism utilised by clients to manage their own cash flow and risk profiles. Whatever the reason, working at risk is becoming increasingly common (Consulting Engineers South Africa, 2011: 25). While it may be a valuable marketing tool for consultants, it also involves a meaningful role in protecting the interests of clients, but there are some pitfalls
that should be avoided. One of the pitfalls is pricing – if the pricing is wrong for a particular project, either the consultant or the client may thus be prejudiced (Moss, 2000: 1).

Working at risk should however not be confused with a simple deferral of the consultant’s fee (or a portion thereof), which the client has already agreed to pay. In the case of a deferral, payment of the fee is certain, but when working at risk, there is a possibility that the fee never gets paid. It is clear in the case of working at risk that there is a definite transfer of risk to the consultant, but the same does not apply to a simple deferral of the fee. It is also clear from the definition of the concept of working at risk that the definition of success is critical. The event or events making up success should be defined clearly, without any ambiguity, and should be measurable or identifiable (Contractor Community, 2012: 1; New South Wales Government Procurement System for Construction, 2008: 5). An example would be the signing of a specific contract by the client or his agent. Payment of fees in portions or stages, each dependant on individual success events or combinations thereof, may apply (Consumer Build, 2012: 1). It is not necessary for the full fee payable to the consultant to be deferred, but where a portion of the fee is deferred this will still regarded as constituting working at risk (Consulting Engineers South Africa, 2011: 30).

The question to be posed is at whose risk is work to be completed. First, it is argued and assured that the consultant will not be entitled to any fees or compensation for work to be done. From an income point of view, the work is being done at the risk of the consultant, who may never be paid for the services rendered (Ipenz, 2004: 14). It often appears that projects never go ahead, but alternatively, when they do proceed, the original consultant is not re-employed. The client then utilises the work done by the initial consultant on the project at a much later date, leaving the consultant out of pocket (De Vries, 2009: 1; Finch, 2011: 1).

The price of work as regarded by consultants has two components, namely the actual cost of carrying out the works and security which is allowed for profit. The activities involved in the course of work at risk therefore also warrant expenditure. The cost of work thus completed at risk will then usually be regarded to be subsumed in an organisation’s overhead costs (Chinyio, 2011: 13). Determining overhead costs depends to a large extent on collecting accurate data and being able to present this data in a meaningful way. People and resources used to conduct the work at risk are not specifically dedicated to risk projects. However, only determining what resources
are completely consumed during this period is argued to be very difficult to determine. This is further complicated by how individuals and organisations are rewarded and the actual manipulation of data that occurs when people may try to optimise their personal rewards (Dalrymple, Boxtel & Staples, 2006: 72-79). There are two types of overhead costs in professional consulting, namely company overhead costs and project overhead costs (Assaf, Bubshait, Atiyah & Al-Shahri, 2001: 1). The consulting company overheads include salary costs, payroll burdens, travelling expenses, communication expenses, legal services, drafting supplies, printing and copying, all incurred directly due to a certain project (American Society of Civil Engineers, 2003: 26). Project overheads, on the other hand, refer to the costs which cannot be linked directly to a certain project in particular, but are merely required for the survival of the business. These general overheads include items such as office supplies, automobile expenses, administration salaries, etc. (American Society of Civil Engineers, 2003: 26). Company overheads may be one of the main reasons why many professional consultants are unable to realise a profit, or even stay in business (Assaf et al., 2001: 1). The expenditure on overheads varies between firms and trades, but each organisation must endeavour to recoup this as outgoing. This could be done by allowing for overheads either in each item of the Bill of Quantities, in South Africa, or as a lump-sum addition to the net project cost (World Bank, 2012: 1). In best practice, some overheads will be charged along with the preliminaries, and the rest as part of the unit rates pricing of individual items of work. A broad estimation of overheads is to assess the company’s expenditure as a percentage of its turnover (Chinyio, 2011: 13).

Since some overheads are not incurred directly on a product such as construction of consulting materials, they can deceptively be invisible. However, overheads are relevant and expected to support the primary functions of any organisation. The ideal is to minimise, but not to do away with overhead costs. The minimisation must not be regarded as part of the detrimental primary functions of the organisation, but to ensure efficiency therein and to avoid or minimise waste.

3. Research method

In this study a quantitative approach was followed with the aim of gaining recognition of the problem. The case study approach and method was chosen for it allows for collection of rich data and assists in understanding phenomena in their real-life context (Oney-Yazici,
Giritli, Topcu-Oraz & Acar, 2007: 438). Interviews were used as the primary data-gathering method for this study. More specifically, focus interviews were chosen and questions were carefully designed to provide adequate coverage for the purpose of the research. The concepts and topics in the literature reviews were used to elicit information from the respondents.

The sample frame for the survey conducted included a wide spectrum of nine consulting professionals within the South African built environment, including engineers, property developers, project managers, quantity surveyors and architects. The design of the questionnaire was aimed at gathering data relevant to each sub-problem. As the topic being researched was of a technical and possibly personal nature, the questionnaires only addressed the salient aspects in order to be non-problematic. The questionnaire comprised 18 questions and was designed to ensure that the selected sample frame was not discouraged from responding. The questionnaire focused on the following topics as reviewed within the research, namely general information; information about amount of work done; information about remuneration for work done, and work done at risk between 2007 and 2010.

Respondents were given the opportunity to express general comments regarding the sustainability of any current remuneration models for consulting professionals in South Africa working at risk. Due to the increase in demand for the scarce skills of professionals in the professional consulting industry in South Africa, the likelihood existed that potential respondents were experiencing substantial workloads. Leedy & Ormrod (2005: 185) concluded that the use of questionnaires has advantages. However, questionnaires yield a low rate of response. However, based upon previous survey response rates of Crafford (2007) and Rossouw (2007), the eight responses can be deemed adequate for this research. The response rates for these surveys were 14.5% and 29%, respectively.

The following reasons that could have had a negative effect on the response rate were considered: respondents not having an interest in the research topic; the current nature and economic state of the construction/development industry in South Africa; the perception that completing the questionnaires would be time-consuming; non-delivery of questionnaires, and the respondents’ unwillingness to take part in the survey. The number of questions entailed responses in the form of percentages, but due to the fact that it was argued to be very time-consuming for respondents to research exact numbers,
a certain degree of educated freedom was expected from each respondent.

4. The case study

4.1 Interview results: Profile of respondents

What is your highest qualification?

The majority of the respondents identified that the highest qualification they possess is a “B degree”, which includes Bachelor’s as well as Baccalaureus Scientiae degrees, with the second highest number being Baccalaureus Scientiae Honores degrees. Zero respondents possessed only Grade 12 or a National Diploma.

Please indicate which field of consultancy you are involved in.

The choices ranged between engineering, construction management, quantity surveying, project management and other. The majority of the respondents are involved in project management (32%), with construction management and engineering being second (23% each). Quantity surveying possessed the smallest share at only 4%.The responses received for other (18%) include sustainable energy, regional planning and feasibility/business cases for infrastructure, a consultant architect, and a dispute resolution consultant.

Please indicate what type of consulting projects your organisation completed in 2010 (indicate as a percentage totalling 100%)

Respondents were required to choose between commercial, industrial, infrastructure, residential and other. Most of the allocations were for infrastructure (46%), with commercial, industrial, residential and other occupying a considerably lower percentage share on average through the respondent frame. In the event of a percentage allocated to “other”, respondents were required to specify, among others, wind farms, government, museum, sport, offices, education, recycling, space planning, etc. or golf estates.

Please indicate the average contract value range of consulting work done by your organisation (including contracts consulted for at risk where no remuneration was received).

Respondents were required to indicate a range by specifying an amount from and to per industry as their indication in the third question. This question was included to, in conjunction with the turnover; establish the relevant size of the organisation and contracts
which they have completed to work on, as well as to prove the spectrum of respondents surveyed.

What was the turnover for your organisation in 2010?

Options included unsure, will not say, and the South African Rand value for the turnover of the organisation in 2010. This question was included in order to attempt to notice the spectrum of respondents, as well as to equate the actual amount of potential turnover lost by each of the respondents in testing each one of the propositions.

4.2 Interview results: Remuneration of consulting work

In the event of the project continuing, at what stage (indicated as a percentage) into the project will remuneration for the work completed in the beginning be received?

Respondents were required to indicate a percentage per industry as posed in the third question. Comments by many respondents included that the costs of the work done at risk are covered in the budgeted overheads of the organisation, but in many cases are written off from the start. However, respondents also indicated that the overheads were to be recovered from successful projects and will only be fully recovered into the projects once and if projects continue.

4.3 Interview results: Consulting work done “at risk”

What percentage of consulting work completed in 2010 was to be remunerated once the project was confirmed to continue further, or in the event that your organisation is selected for the project (i.e. “at risk”)?

Choices were again between commercial, industrial, infrastructure, residential and other. Other was specified in question 3. Although, in question 3, it was noted that the majority of work conducted at average through the sample frame consists of infrastructure, it is residential (32.73%) and commercial (26.73%) that required the highest amount of work to be completed at risk, with industrial (14%) and infrastructure (14.09%) requiring a considerably lower percentage of total work to be done at risk.

What percentage of consulting work done at risk in 2010 continued to a stage where remuneration was received by your organisation?

Choices were again between commercial, industrial, infrastructure, residential and other. On average only 30% of all commercial work done at risk continued to a point where remuneration was received by the consultant, thereby being the second lowest received score,
after infrastructure. Fifty-two per cent of industrial work continued to the point of remuneration for the consultant. It was specified in previous questions that the majority of work done by consultants consists of work in the infrastructure field, but it became evident that this field requires one of the lowest percentages of work done at risk. This field of infrastructure, however, also has the lowest success rate for projects continuing to a point of remuneration for the involved consultant with only 6.25% of projects continuing to this point for any given professional consulting project. Although it is difficult to specify exactly which type of work specified in “other” caused the high percentage of “at risk work” continuing to an actuality and a point of remuneration for the consultants, “other” scored the highest, and was therefore regarded as the lowest risk factor posed for consultants.

Has the amount of work to be done “at risk” increased since 2007?

Respondents were required to choose between “Yes”, “No”, or “Unsure”. The majority of the respondents noted that the situation of work being required to be completed at risk has in fact deteriorated since 2007 with 55% answering “Yes” to this question. Twenty-seven per cent answered a definite “No”, and 18% were “Unsure”. A large percentage of respondents who answered “No” or “Unsure” indicated that they do almost no work at risk.

If YES in previous question, what percentage of consulting work was done at risk in 2007?

The options were similar to those indicated in the fourth question in order to enable a comparison to be made between 2007 and 2010.

If YES in previous question, what percentage of consulting work done in 2007 continued to the stage where remuneration was received by your organisation?

The options were similar to those indicated in the fifth question in order to enable a comparison to be made between 2007 and 2010.

What is the cost to your organisation of the actual work generally done “at risk” (indicate in the form of percentage of contract value).

Respondents were required to indicate a percentage per particular industry indicated in the third question.

What kind of work has generally been done “at risk” by your organisation (please indicate with an X in all the relevant fields)?

Options included presentations, sketch drawings, working drawings, rough cost estimations, feasibility studies and other. If “other” is
chosen, respondents were required to specify. Specifications for “other” include various types of programmes and reports as well as the general management of the risk phase of the project and development facilitation.

What percentage of clients use the work done “at risk” by your organisation for any form of personal enrichment of any kind (including to establish the feasibility of a project or merely for personal information)?

Respondents were required to indicate a percentage per industry as indicated in this particular third question. In answering this question, it became clear that, in the respondents’ opinion, a much higher percentage of clients utilised the work done at risk, than what consultants got remunerated for.

What were the consulting projects presented generally used for (please check all relevant boxes)?

Options included personal information, feasibility, acquisition of possible investors, seeking funds from financial institutions, presentations, cost estimations and other. If “other” was selected, respondents were required to specify. However, not a single respondent selected “other” in this instance.

To what extent of financial risk did your organisation experience of work done “at risk” (please indicate with X only one option)?

Options included no financial effect on organisation, very small financial risk, small financial risk, average financial risk, large financial loss, and risk of closure.

On a scale of 1 to 5 where 1 (has not) and 5 (has very), how sustainable do you think a current remuneration model was for consultants when working in the following industries?

Respondents were required to indicate per industry, as indicated in the third question. When examining the linear trend lines drawn for each of the industries, it became clear that the majority of the respondents regarded the sustainability of any current remuneration model as unsustainable across most fields.

What percentage of your annual turnover was for work done “at risk”? Respondents were given the choice of either answering “Unsure” or entering a percentage. Two respondents answered 0% and two respondents answered “Unsure”. Out of the rest of the respondents who answered, a percentage of their turnover was, however, from
work procured “at risk”. An average of 49.29% of their turnover procured “at risk” was reported.

Do you have any other comments regarding remuneration models for professional consultants in South Africa completing work at risk?

Comments included: For our company it may be completing work at risk due to some ‘scope creep’. For some respondents, considerable work was done against minimal fees in return for obtaining rezoning and marketing of the proposed schemes. Some projects were being ‘sold on’, and for other respondents the cutting of ‘downstream’ revenue was to flow from the initial projects done at risk. Some respondents regarded this as possibly due to not being astute enough when dealing with certain developers and agents. Considerable and significant wealth has, however, been generated by some respondents requesting a certain portion of proposals for work done at risk. From experience, what was more damaging was the pressure felt to cut consulting fees and the new tendency of required tendering about possible commissions in the industry, which were felt to be damaging to certain design professions and the business environment in general. Adequate fees are required to service a project. Respondents also argued that it is possible to pass off work produced with the minimal input necessitated by tight fees, but this was felt to be very damaging to the profession, its sustainability and society at large. Some respondents also indicated the lack of awareness of what competent design can (and should) contribute towards the appropriate development of South Africa, communities and the well-being of all South Africans. Current tendering for services in South Africa was felt to be not sustainable for it does not promote growth in the industry, training and development of trainees. The tender process was also argued to be wasteful and inefficient as it results in unnecessary cost to companies. The tender process rewards the lowest bidder, which is rarely (if ever) best equipped for the job, and clients in the public sector often lack the skills and knowledge to be able to adjudicate on the most appropriate service provider. The further lack of clarity on the scope of work was also regarded as a critical problem for many tenders. This increase in tender offers by the public sector will in the future change the figures periodically striving towards 100% of tendered appointments.

The review of related literature and the findings emanating from the descriptive survey were used to test the propositions.
4.1.1 Proposition one

Consultancy firms in the South African built environment are facing more substantial risks during recessed economic cycles due to an increase in the amount of work required to be completed at risk.

Comparing the Gross Domestic Product and the contribution by the construction industry in South Africa to the Gross Domestic Product of 2007 and 2010 in South Africa, it became clear that the economy and the South African construction industry was in a worse condition in 2010 than in 2007. Therefore, these two years were compared with regard to the amount of work required to be completed (at risk) as well as the success rate of projects for the consultants involved. It was evident that the amount of work required to be completed in 2010 was considerably higher than that required during 2007 for most industries. The percentage of projects which continued to a stage where the consulting organisation received remuneration dropped from 2007 to 2010. It is therefore argued that the consultants were under more financial pressure during 2010 due to the decline in successful projects within the construction industry in South Africa.

![Graph showing percentage of work required at risk in 2007 versus 2010]

Figure 4: Percentage of work required at risk in 2007 versus 2009
Source: Researcher’s own construction

4.1.2 Proposition two

Consultants were expected to do a certain amount of work, only to receive remuneration in the case of the project continuing.

Results of this survey indicated that large percentages of work were required to be completed by consultants in South Africa working at risk. It became evident that the stages at which certain
organisations were remunerated for work done at risk were often far into the actual project. The cost of such project work done at risk was often written off to overhead costs which were to be believed to be recovered equally over all perceived successful projects.

![Graph showing stage of project remuneration](image)

**Figure 5:** Stage of project as percentage at which remuneration is received for work  
**Source:** Researcher's own construction

### 4.1.3 Proposition three

Clients of the respondents of this survey used the work done by the consultant to some extent, but no payment was made to certain consultants even though the clients had some form of personal enrichment.

Respondents believe that it often happens that the project does not go ahead, but when it does proceed, the original consultant was not re-employed for whatever reason. The client then utilised the work done by the initial consultant on the project at a later stage, leaving the consultant out of remuneration (Consulting Engineers South Africa, 2004).

### 4.1.4 Proposition four

Consultants and consultancy firms are incurring substantial loss of potential turnover because of work completed at risk never continuing to a stage of remuneration.
In order to test the above proposition, the extent of financial loss was calculated per respondent which indicated that his/her organisation did in fact endeavour doing work at risk. In order to calculate the percentage of potential turnover lost by each respondent per industry, data were required regarding the percentage of total work done, the percentage of the particular work completed at risk, as well as the percentage of the latter which continued to the point where the organisation actually received remuneration.
To calculate the percentage of potential turnover lost by each organisation, the following equation was used:

\[ P_{\text{lost}} = (100 \times P_t) \times P_r \times (100 - P_p) \]

where:
- \( P_{\text{lost}} \): Percentage of turnover lost because of work at risk
- \( P_t \): Percentage per industry of total
- \( P_r \): Percentage of \( P_t \) which is completed at risk
- \( P_p \): Percentage of \( P_r \) for which remuneration is received

Respondent one indicated that 60% of work undertaken by his/her organisation was classified as “other”, of which 5% was done at risk. Of this 5%, only 95% continued to a stage where his/her organisation received remuneration. This translated to 0.15% of the respondent’s turnover being lost because of work completed at risk. The respondent did not indicate a turnover; therefore it is not possible to calculate a physical value in South African Rand.

Respondent two indicated that 80% of work undertaken by his/her organisation is classified as “commercial”, of which 90% was done at risk. Of this 90%, only 30% continued to a stage where his/her organisation received remuneration, which meant that 70% of it was lost. This translates to a loss of 50.4% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 75 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 37 800 000.00. Ten per cent of work undertaken by his/her organisation was classified as “industrial”, of which 60% was done at risk. Of this 60%, only 70% continued to a stage where his/her organisation received remuneration. This translates to a loss of 1.8% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 75 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 1 350 000.00. Ten per cent of work undertaken by his/her organisation was classified as “residential”, of which 100% was done at risk. Of this 100%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 9.0% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 75 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 6 750 000.00.

Respondent three indicated that 30% of work undertaken by his/her organisation was classified as “commercial”, of which 100% was done at risk. Of this 100%, only 40% continued to a stage where his/
her organisation received remuneration. This translates to a loss of 18% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 6 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 1 080 000.00. Forty per cent of work undertaken by his/her organisation was classified as “industrial”, of which 60% was done at risk. Of this 60%, only 50% continued to a stage where his/her organisation received remuneration. This translates to a loss of 12% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 6 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 720 000.00. Thirty per cent of work undertaken by his/her organisation was classified as “residential”, of which 100% was done at risk. Of this 100%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 27% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 6 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 1 620 000.00.

Respondent four, however, indicated that 30% of work undertaken by his/her organisation was classified as “industrial”, of which 30% was done at risk. Of this 30%, only 70% continued to a stage where his/her organisation received remuneration. This translates to a loss of 2.7% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 12 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 324 000.00.

Respondent five argued that 5% of work undertaken by his/her organisation was classified as “commercial”, of which 2% was done at risk. Of this 2%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 0.09% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 428 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 385 200.00. Ninety per cent of work undertaken by his/her organisation was classified as “industrial”, of which 2% was done at risk. Of this 2%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 0.09% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 428 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 385 200.00.
by his/her organisation was classified as “infrastructure”, of which 5% was done at risk. Of this 5%, only 5% continued to a stage where his/her organisation received remuneration. This translates to a loss of 4.28% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 428 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 18 297 000.00.

Respondent six indicated that 20% of work undertaken by his/her organisation was classified as “commercial”, of which 100% was done at risk. Of this 100%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 18% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 100 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 18 000 000.00. Eighty per cent of work undertaken by his/her organisation was classified as “infrastructure”, of which 100% was done at risk. Of this 100%, only 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 72% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 100 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 72 000 000.00.

Respondent seven indicated that 20% of work undertaken by his/her organisation was classified as “commercial”, of which 2% was done at risk. Of this 2%, only 60% continued to a stage where his/her organisation received remuneration. This translates to a loss of 0.16% of the respondent’s turnover because of work completed at risk. Twenty per cent of work undertaken by his/her organisation was classified as “industrial”, of which 2% was done at risk. Of this 2%, only 60% continued to a stage where his/her organisation received remuneration. This translates to a loss of 0.16% of the respondent’s turnover because of work completed at risk. Sixty per cent of work undertaken by his/her organisation was classified as “residential”, of which 70% was done at risk. Of this 70%, only 50% continued to a stage where his/her organisation received remuneration. This translates to a loss of 21% of the respondent’s turnover because of work completed at risk.

Respondent eight indicated that 100% of work undertaken by his/her organisation was classified as “infrastructure”, of which 30% was done at risk. Of this 30%, nothing continued to a stage where his/her organisation received remuneration. This translates to a loss of 30% of the respondent’s turnover because of work completed at risk. The
turnover indicated by the respondent for 2010 is ZAR 11 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 3 300 000.00.

Respondent nine indicated that 98% of work undertaken by his/her organisation was classified as “infrastructure”, of which 20% was done at risk. Of this 20%, 10% continued to a stage where his/her organisation received remuneration. This translates to a loss of 17% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 6 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 1 058 400.00. Two per cent of work undertaken by his/her organisation was classified as “residential”, of which 90% was done at risk. Of this 90%, only 60% continued to a stage where his/her organisation received remuneration. This translates to a loss of 0.72% of the respondent’s turnover because of work completed at risk. The turnover indicated by the respondent for 2010 is ZAR 6 000 000.00, which means that the South African Rand value lost because of this factor equates to ZAR 43 200.00. It should be noted that the percentages and amounts of turnover lost are identified as “potential turnover”, which means that it would be the amount gained by each organisation in the event of each project taken on by the organisation at risk continuing to completion for that organisation. Every organisation incurred great losses of potential income because of work started by that organisation at risk not continuing to completion for that organisation.

5. Conclusions and recommendations

The downturn in the current economic condition in South Africa has had a negative effect on the South African built environment which, in turn, affects businesses at all levels of trade. Although the value added to Gross Domestic Product by the South African construction industry has increased from 2006 to 2010, the number of buildings reported as completed in South Africa declined between 2007 and 2010. The uncertainty caused by an economic downturn increased the risk of construction projects not reaching final completion, causing potentially substantial financial loss and/or risk in the South African built environment, architectural engineering and cost estimating.

Consultants are required and expected to perform work such as presentations, design and draft proposals at risk, only to be remunerated for such work at the possibility of the project continuing during a later stage. The cost of any work completed
at risk by a consultant or company is generally covered by the particular company’s overheads. The majority of work completed by the sample of this study consisted of infrastructure. However, residential and commercial projects required the most amount of work expected to be completed at risk. On average, the majority of work in the infrastructure field did not continue to any stage of remuneration for the involved company. The amount of work required to be done at risk also increased from 2007 to 2011, and companies were, therefore, faced with financial risks due to work having to be done at risk.

It was also found during the study that countless resources were wasted by companies and consultants in South Africa annually due to work being completed “at risk” and not continuing to a stage where remuneration was received. Consultants were, in fact, expected to conduct a great amount of work at risk in South Africa, with work in the residential industry requiring the highest average percentage of work done at risk. Work in the industrial sector has had the highest success rate, after “other” for work done at risk to continue to a stage where the consultant received remuneration. Work in the infrastructure sector has had the lowest success rate for remuneration, and it is therefore suggested as the highest risk sector in terms of work continuing. The situation of work required to be completed at risk has also deteriorated between 2007 and 2010 in South Africa. The percentage of work required at risk increased, whereas the success rate of projects continuing for any given consultant decreased.

The actual cost to the consulting organisation of the work done at risk equates to between 1% and 2.5% of the total contract value. It was noted that, on average, more clients use the work done at risk than what they receive remuneration for. An argument raised by one of the respondents in this survey indicated that the professionals in the built environment often do work “for free”, while other professionals such as attorneys, accountants or doctors will invoice clients for their time spent.

6. Further research

The current tender process in South Africa for both contractors and consultants was cause for some concern and should be further investigated. The money that it is costing each consortium (or firm) taking part in a tendering process should be reviewed in South Africa. The proposed methods followed during selection processes should also be investigated, as the possibility exists that, with the
current selection processes, the price of proposals exceeds the factor of whether the bidding company is financially equipped to manage the actual bidding process. One respondent representing a leading engineering consultancy firm indicated that there are serious problems as a result of certain clients “not knowing what they really want”.

References list


INFORMATION FOR AUTHORS

1. An article may be submitted in Afrikaans or English. The desired length for an article is between 4 000 en 12 000 words.

2. Two copies of the typed article must be submitted (authors keep the original) accompanied by a disk AND forwarded via email (see point 23.). The format must be kept as plain as possible for extracting and printing purposes.

3. An edited (proofread) article on any relevant topic, well presented and written in easy understandable style, will be considered for publishing. Diagrams, sketches and photos (jpeg or tif format at 300 dpi) may be included.

4. The editor reserves the right to alter the article(s) where necessary with regard to the style and presentation of the publication. If extensive alterations are advised by adjudicators the article(s) will be returned to the author.

5. Copyright is transferred to Acta Structilia Journal when an article is accepted for publication.

6. Article content must be written in Microsoft Word, Arial, font size 12, single spacing.

7. Titles must be short and concise, but informative. Supply suitable headings and sub-headings where necessary. The title must be in both Afrikaans and English.

8. A short summary, in both Afrikaans and English, must be provided at the beginning of the text.

9. Applicable keywords in Afrikaans and English must be given after the summary.

10. Use Arabic numbers with full stops in between for headings and subheadings, i.e. 1. followed by 1.1 and 1.1.1 up to a maximum of three levels. After that use a) etc.

11. Source references in the text must be in the Harvard style of referencing (Author, date; pages). i.e. (Schleien, 1996: 20-40)

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14. A copy of internet documents cited in the text and listed in the references must accompany the article.

15. Quotations are not in italics and must be written in double inverted commas. Inserts in quotations are placed in block brackets. Quotations longer than three lines are indented and are placed without quotation marks.

16. Avoid uncommon abbreviations and acronyms. Abbreviations should be limited to those in general use. Names of corporations, etc are at first written out in full with the abbreviation in brackets after which the abbreviated form may be used.

17. Italics are preferred for stereotyped Latin terms such as per se and for words in other languages.

18. Use single inverted commas to emphasise words or phrases.

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20. Authors may submit the names and addresses of three scholars (experts) in his field (not members at own place of work) as possible adjudicators.

21. The author(s) will receive two complimentary copies of the relevant issue of Acta Structilia Journal.

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23. Note that a publication fee of R30-00 per page is payable for every article published. An invoice will be sent to the main author.

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1. Acta Structilia Joernaal publiseer artikels in Afrikaans en Engels. Die verlangde lengte vir 'n artikel is tussen 4 000 en 12 000 woorde.
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