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The awareness and practice of value management by South African consulting engineers: Preliminary research survey findings

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Abstract

The awareness of value management (VM) and the nature and extent of its practice by professional civil, electrical and mechanical engineers in the South African construction industry are investigated using a web-based, online questionnaire survey as the first part of a more extensive investigation. A primary objective of the early study is to test the UK-based assertion of Kelly et al. [Kelly, J., Male, S., Graham, D., 2004. Value Management of Construction Projects. Blackwell, Oxford] that VM is an established service with commonly understood tools, techniques and styles. The survey findings suggest that, while *awareness* of VM is reasonably prevalent among South African engineers, its *practice* is considerably less extensive. Where VM is undertaken, almost no attempt is made to benchmark VM activities against international standards nor does its use appear to conform to any standard methodology. Engineers prefer other ways of delivering value to projects, and do not generally employ VM to facilitate the client briefing process. The findings are important given the increasing globalization of construction services, especially given the international ties between designers, project managers and other professionals. Professional engineering associations in South Africa should adopt a proactive role in promoting the use of VM by engineers, possibly through continuing professional development programmes.

Keywords: Value management; Construction industry; Professional engineers; South Africa

1. Introduction

This paper reports on part of a larger study examining and comparing the practice of value management (VM) in the South African manufacturing and construction industries. The first phase of the project has focused on current VM awareness and practice by built environment professionals in South Africa. Other papers reporting on this phase have documented the VM practices of professional quantity surveyors and architects (Bowen et al., submitted for publication, accepted for publication-a). In this paper, the VM practices of professional consulting engineers are examined. The purpose of the paper is not to add to theories of value management *per se*; rather, it is to report on an empirical study of the awareness and practice of value management by South African consulting engineers; essentially constituting a 'temperature-check' of current practice. According to Kelly et al. (2004: p. 48), VM in the UK construction industry has evolved to become '*an established service with commonly understood tools, techniques and styles*'. Ellis et al. (2005: p. 484) describe VM as '*widely accepted as an important tool in the management of projects*'. While this may be so for construction industries in developed countries, the situation is by no means so clear for a developing nation such as South Africa. Given the major role of engineers in design and management in the SA construction industry, establishing the extent to which they are aware of VM, and the nature and extent of their VM practice, became an important first stage of the wider VM investigation. While the survey findings are obviously of greatest relevance to built

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environment professionals in South Africa, the increasing globalization of construction services – especially the growth in international ties between designers, project managers and other professionals – creates a wider audience for the paper.

The engineering profession in South Africa is regulated in terms of the Engineering Profession Act (No. 46 of 2000) (RSA, 2000) by the Engineering Council of South Africa (ECSA). In terms of this statute, only persons registered with ECSA as professional engineers are entitled to undertake work reserved for engineers and use the designation 'Pr.Eng'. Requirements for registration typically entail possessing a 4-year degree in engineering and 3-year's practical experience under the mentorship of a Pr.Eng.

Using a web-based, online survey questionnaire, data were collected from 78 consulting civil, mechanical and electrical engineers (Pr.Eng) practicing in the construction industry in South Africa. In this context, 'construction' includes both the building and civil engineering (infrastructure) sectors. In the South African context it is also important to note that, in addition to the conventional understanding of "building" (housing, social, commercial, etc.) and "civil engineering" (roads, railways, bridges, dams, etc.), construction work involved in minerals exploration and mining, and offshore oil/gas exploration and production, are also part of the engineering profession's contribution to the national economy. Registered engineers for whom email addresses were on record with ECSA were emailed, requested to participate in the survey, and provided with a link to a URL where the questionnaire could be completed.

The paper commences with a background review of VM research relating to the construction industry and explores documented VM practice by engineers. This is followed by a description of the survey design and administration. The survey findings are then presented and discussed. Finally, conclusions are drawn and recommendations are made.

2. Value management and its application to the construction industry

Value management (VM), as a technique for improving client value in projects, products, processes and systems, has been internationally recognized for almost forty years (Kelly et al., 2004). Its links with engineering go back even further, through value engineering (VE), to the 1940s. Kelly and Male (1988) report that the VE concept evolved from the work of Lawrence Miles who, in the 1940s was a purchasing engineer with General Electric Company (GEC). At that time, the manufacturing industry in the USA was running at maximum capacity to supply armaments to the Allies. GEC were particularly interested in increasing production of turbo-superchargers which required scarce materials. When these materials were not available. Miles obtained alternatives that fulfilled the same including construction, in the 1960s. *Other countries adopted its application in the 1970s* (Kelly et al., 2004) [emphasis added].

For construction projects, VM uses group-based facilitated workshops as the essential driver in a systematic approach to achieve better value, usually on behalf of the project proponent (the client) (Male et al., 1998a). Ideally this objective is usually framed in terms of "functional value" i.e. a delivered function that is measurable and expressed in terms of the cost of delivering that function. Other forms of value improvement are not thereby excluded however; such as improving project aesthetics to enhance potential selling price or marketability; or reducing delivery time and thus bringing the project sooner to its operational phase. Contemporary arguments for using VM flexibly are persuasive (Green and Liu, 2007).

The variables in construction clients' value systems were found by Kelly (2007) to include nine, high order, non-correlated performance variables comprising: capital expenditure (CAPEX); operating expenditure (OPEX); time (duration of the project); esteem (the prestige and benefits to the client that stem from the project); environment (the anticipated effect that the project will have on the surrounding eco-system; e.g. carbon footprint); exchange (the project net worth to the client expressed in one of the acceptable measures of financial performance); politics/community (issues relating to the project's impact on the surrounding community as well as political considerations); and flexibility and comfort (the flexibility offered by the project in terms of how easily it may be configured to meet different requirements. The 'comfort' factor relates to the usability of the project in terms of convenience and comfort). The generation of value is thus susceptible to multiple criteria.

The workshop approach used for VM aims to exploit the synergistic benefits derived from gathering relevant project stakeholders together as a group. It is typically based upon the methodology proposed by SAVE International (SAVE International, 2007) involving: pre-study activity (choosing the VM team; establishing the scope of the study; information gathering; determining evaluation criteria); value study (information phase; speculation phase; evaluation phase; development phase; presentation); and post-study activities (plan, implement and monitor change decisions).

Some flexibility in approach is often found desirable in practice (Kelly et al., 2004). While the central value study should be conducted in a group-based workshop environment, the pre-study and post-study activities can be undertaken separately under suitably qualified administrative guidance (e.g. by the VM/VE facilitator). Parts of the value study itself can also be performed outside of the workshop. For example, much of the information and functional analysis phases of VM could be carried out as pre-study activities and the outputs given as an "information kit" to

to the post-study activities, especially since the requirements of the development phase (detailed costing of alternative ideas) might be beyond the immediate resource capacity of the workshop participants. This flexibility means that the duration of the value study (workshop) itself is not necessarily restricted to a particular number of hours, and may vary from 3–4 h, upto 40 h or more (Kelly and Male, 1993).

Team dynamics (see Fong et al., 2001; Leung et al., 2003; Yu et al., 2007) have an important influence on the effectiveness of the VM process, particularly in relation to the conduct of the central workshop-based elements of the value study (Kelly et al., 2002).

The process of VM is founded on a structured methodology or framework. Male et al. (1998a) provide a 'good practice' VM framework based on results emanating from an international benchmarking study (Male et al., 1998b). Other good-practice standards or guides include the *SAVE International Value Standard* (SAVE International, 2007), the Department of Trade and Industry's *Value Management* guide (DTI, 1997), the *Australian Standard: Value Management* (Standards Australia, 2007), and the Defence Estates Organization's Value Planning and Management guide (DEO, 1998).

There has been considerable research into the application of VM within the construction industry over the last three decades. This research has addressed issues such as promoting the use of value management in construction (Dell'Isola, 1982; Kelly and Male, 1993; Connaughton and Green, 1996; Kelly et al., 2004); the analysis of building components (Asif et al., 2005); best practice VM and benchmarking (HM Treasury, 1996; Male et al., 1998a,b); VM for managing the project briefing and design processes (Fang and Rogerson, 1999; Kelly et al., 2005; Yu et al., 2005); adoption rates, inhibitors and success factors for the adoption of VM in the construction industries of individual countries (Palmer et al., 1996; Fong and Shen, 2000; Shen and Liu, 2003; Liu and Shen, 2005; Cha and O'Connor, 2006); VM methodologies and techniques (Pasquire and Maruo, 2001; Spaulding et al., 2005); VM performance measures (Lin and Shen, 2007); the relationship between VM and quantity surveying (Kelly and Male 1988; Ellis et al., 2005); the integration of risk and value management (Green, 2001; Dallas, 2006); group decision support systems (Shen and Chung, 2002); group dynamics in VM (Leung et al., 2002, 2003); the use of VM to enhance value on public sector projects (Fong, 1999; Hunter and Kelly, 2006); managing value as a management style (Male et al., 2007); client value systems (Kelly, 2007); and hard versus soft VM (Green and Liu, 2007).

3. Consulting engineers and value management

The literature relating to the awareness and practice of VM by engineers is limited. What does exist focuses primarily on VM drivers/inhibitors (see, for example, Bowen et al. (1997, 1999), Fong and Shen (2000), Liu and Shen (2005), Spaulding et al. (2005) and Mbachu and Nkado (2006). Of these, only Bowen et al. (1997, 1999) and Mbachu and Nkado (2006) relate to South Africa.

Bowen et al. (1997, 1999), in a survey of clients, engineers and other design team professionals, found that little attempt is made to match client objectives with the characteristics of different procurement systems. Moreover, despite the fact that clients were perceived by respondents to require assistance in establishing their project needs, formal brief elicitation was found to be conducted infrequently at best. Fong and Shen (2000) examined the readiness of the Hong Kong construction industry for the adoption of VM. Their survey of consultants (including engineers), real estate developers and contractors revealed that the adoption of VM in Hong Kong had been very slow, exacerbated by lack of awareness of VM, misperceptions, a pre-occupation with cost rather than value, a strict distinction between the design and construction phases, and the 'traditionalist' mindset of clients and the construction industry.

Liu and Shen (2005) surveyed a sample of chief engineers in China to establish the state of VM practice in the manufacturing and construction industries, as well as to identify challenges and opportunities to its future development. They found that the manufacturing industry utilized VM to a greater extent than the construction industry, and identified three challenges to implementation, namely, a lack of national VM standards, VM knowledge, and qualified VM facilitators.

Employing a survey of construction professionals, Spaulding et al. (2005) examined the use of functional analysis (FA) as the basis of value management in the Australian construction industry, concluding that FA is not always used in the VM process. Rather, they found a positive association between the use of FA and the knowledge participants have of the VM method, and an inverse relationship between use and difficulties associated with implementing FA. A lack of expert facilitators was also identified as being problematic.

Mbachu and Nkado (2006) developed a conceptual framework for the assessment of client needs and satisfaction during the building development process. With regard to engineering consultancy services, safety and economy in design were priority expectations of clients. This was perceived to be the '*most critical area for improvement given the relatively low performance of engineers in this respect*' (Mbachu and Nkado, 2006: p. 40).

None of the above studies focused exclusively on the nature and extent of value management practice by the engineering profession. It was decided to remedy this lack of focus by conducting an opinion survey of consulting engineers in South Africa. An objective was to explore the UK-based assertion of Kelly et al. (2004), namely, that

of the engineering profession in South Africa. The opinion survey was planned as the first stage (the 'temperature-check') of more extensive research into VM practice in South Africa.

4. Questionnaire design

Based on the work of Palmer et al. (1996), Fong and Shen (2000), Fong (2004) and Spaulding et al. (2005), a sectioned questionnaire was employed utilizing a mixture of closed ended, open ended, scaled and matrix questions. The survey questionnaire contains four sections. Section A deals with demographic information about respondents such as age and experience, membership of value management associations, position within the respondent's organization and characteristics of that organization. Section B establishes respondents' awareness of VM. The questions in Section C examine the use of VM within the respondents' organizations, covering factors such as usage of VM, the focus of VM activities, perceived usefulness of VM, and whether VM activities are predominantly handled internally to the organization or externally. Section D focuses on the nature and extent of VM usage on projects, including reasons for the adoption of VM, extent of VM use on projects; factors influencing the use of VM; the relative importance of client value system factors such as capital costs and running costs; benefits perceived to be derived from using VM; VM methods employed on projects; international VM benchmarks or standards employed; and metrics for measuring VM effectiveness on construction projects. The range of issues included within the survey instrument is drawn from the literature (see Palmer et al. (1996), Fong (1998), Kelly et al. (2004), Ellis et al. (2005), Spaulding et al. (2005) and Male et al. (2007)).

5. Method of data collection

Data were collected from professional civil, mechanical and electrical engineers (Pr.Eng.) registered with the Engineering Council of South Africa (ECSA). A web-based, online questionnaire survey was utilized for data capture. This method of data collection facilitated easy (and inexpensive) national coverage of every civil, mechanical and electrical engineer. The survey instrument study was pilot-tested and found satisfactory. The full survey was launched in July 2008. ECSA, assisted where necessary by the voluntary associations,[1] emailed engineers for whom email addresses were on record, requested their participation in the survey, and provided a link to a URL where the questionnaire could be completed online.

An unresolved issue arises with online surveys of this nature: the inability to determine exact response rates. Since the invitation to participate was issued by the professional registration body and the respective voluntary associations by email, there is no guarantee that each invitation message reached its intended destination; nor that it was actually opened by the recipient. This problem was exacerbated because ECSA was unable to provide registration figures for the different engineer sub-groups, the voluntary associations were unable to identify those engineers operating mainly in the conventional construction industry, and SAIMechE was restricted to emailing registered firms rather than individual engineers. While this is not considered to be a serious problem for the *validity* of the survey, it does show that sample selection for online surveys can present difficulties. The survey response of 78 engineers is therefore indicative and considered suitable for preliminary findings.

Further, it is conceded that the survey respondents constitute a self-selecting sample that may hold strong views (one way or the other) about VM and thus have the potential to be not completely representative of all relevant civil, mechanical and electrical engineers in South Africa. This potential weakness in the survey will be addressed in future research using qualitative case study research methods as a means of triangulating the primary data and providing the opportunity to explore relevant issues at greater depth.

The response rate and representativeness issues are not thought sufficiently serious to invalidate the survey data, and further qualitative research is intended to overcome them by permitting triangulation of data.

6. Analysis of the data

The survey data were analysed using SPSS (Statistical Package for the Social Sciences) Version 16.0 for Mac statistical application software, delivering mainly descriptive statistics. Unless otherwise stated, percentages given below relate to the responses to individual questions. Where applicable, cross-tabulation was undertaken (using the Pearson's Chi-Square test) to establish degrees of association between responses for category variables and/or between civil and mechanical/electrical engineering respondents. Discussion of the results follows in the next section after the analysis presented here.

6.1. Sample profile

A total of 78 engineers completed a questionnaire, comprising civil engineers (47%; $n = 37$) and mechanical and electrical engineers (53%; $n = 41$). The majority of respondents are employed in the private sector (80%) and within consulting engineering practices (98%). Minorities are employed in project management (11%) and construction contracting (4%). Membership of value management orga-

[1] Non-statutory voluntary associations such as Consulting Engineers SA (CESA), the SA Institute of Electrical Engineers (SAIEE), the SA Institute

respondents. A minority (26%) of respondents is also registered with the South African Council for Project and Construction Management. Most respondents are older than 45 years (67%), with 78% over 40 years. The mechanical and electrical engineer respondents are significantly older than their civil engineering counterparts ($p = 0.04$). Sixty-two percent of respondents claim to have sixteen or more years experience in the industry, and 58% have been with the same organization for six or more years. Most respondents (53%) report working for organizations consisting of ten or less engineers, although 31% work for firms employing more than thirty professionals (bi-modal distribution). A majority of respondents' practices (54%) enjoy a gross turnover in building project value of up to ZAR200 m per annum[2]; while a large minority (36%) report a turnover in excess of ZAR500 m per year. The respondent sample may generally be described as older, experienced engineers in private practice, and delivering a substantial volume of professional engineering services on projects in South Africa.

6.2. Awareness and use of value management

Fifty-three percent of participants claim to be *familiar* with VM, with significantly more mechanical and electrical engineers than civil engineers reporting this ($p = 0.04$). Of the respondents aware of VM, 31% derived this from within their own organization; 27% from an academic institution or from attending a VM course; 13% from their professional institution (13%); 7% via the internet; and 22% through 'Other' means including fellow professionals in the industry, clients, and via in-house project development and evaluation processes.

Actual *usage* of VM as a process is *low* among engineer survey respondents, being reported by only 38% ($n = 29$). Differences between discipline groups are not significant.

According to respondents, VM is used for value optimization (20%), least cost determination (26%), and both of these objectives (54%). Respondents' reasons for not using VM include: the company is not familiar with VM (55%); the company has another system in place (17%); a view within the organization that VM is ineffective (6%); and 'Other' (22%) including 'the application of engineering judgement', 'clients focus mainly on costs', experience, part of the normal quality management system, and normal 'assessments of lifespan against cost against functionality'.

Opinions regarding the *usefulness* of VM vary. The most widespread respondent view (62%) ($n = 37$) is that VM is very useful, and that it should be used on most projects. Less pervasive views are that VM is indispensible and should be used on all projects (22%), and on the other hand that VM is occasionally useful and should be used on a few selected projects (10%). Only 7% of respondents think that VM is not at all useful. Significantly more mechanical/electrical engineers than civil engineers attest to the usefulness of VM ($p = 0.01$). Reasons cited in support of these contentions are that the use of VM depends upon the nature and size of the project, and upon client requirements.

Questioned about whether VM activities are predominantly handled internally within the organization, external to the firm, or via a combination of both, respondents report as follows: VM handled internally (67%); externally (13%); and a combination of both internal and external (20%). Reasons cited for internal or external application of VM include the size of the project (38%), discretion of senior management (35%), organizational policy (33%), the availability of in-house expertise (12%), and 'Other' (19%) including the instructions of the client and the specific requirements of the project.

6.3. Nature and use of value management

This section reports on the nature and use of VM within consulting engineering practices. Given the low reported usage (38%; $n = 29$, of all engineer survey respondents) of VM as a formal process within engineering practices, the percentage responses given here represent minority views. Of those respondents confirming that VM is used within their organizations, 33% state that VM is used on most projects. A clear minority (25%) report that VM is used on all projects, whilst 19% report VM usage in only rare cases. Of those respondents who utilize VM, 71% state that the adoption of a VM philosophy is part of the organizational culture of their practices.

6.3.1. Reasons why VM is used

Reasons cited for using VM are that the technique has become an organizational ('select box') internal requirement (6%), and that it optimizes value (61%); clarifies the project brief (35%); facilitates the achievement of functionality (38%); is effective in reducing costs (41%); emanates from requests from clients (31%); and results from pressure from management (6%). 'Other' views (17%) are that 'optimization in line with the client's brief is the primary responsibility of an engineer', positive experiences of VM by senior management, and that achieving value for a client is part of a normal professional service.

Survey respondents report that, where VM is used within their organization, such use is primarily promoted by senior management (58%) and project managers (52%). Promotion of VM usage by quantity surveyors (9%), in-house VM practitioners (3%) or by an in-house VM department (20%) is seen to be minimal. The main reason cited for the *initial* adoption of VM by the organization is requests from project sponsors and clients (29%); while 'keeping abreast of local competition that makes use of the practice' (18%) and 'links with international organizations or overseas parent companies' (18%) are less strong

'produce better projects for our clients', for marketing purposes, because clients (oil companies specifically mentioned here) benchmark themselves against competitors, VM is part of the quality management system, and VM is inherent in design optimization.

6.3.2. Importance of client value system variables

Engineer survey participants were asked to indicate on a scale of 1–5 (1 = completely unimportant; 5 = extremely important) their opinion as to the relative importance of the client value system variable factors noted by Kelly (2007). The results are depicted in Table 1.

The engineers responding to this survey question perceive CAPEX to be the most important factor in determining project success for a construction client, with 86% stating that capital expenditure is at least a very important consideration (this variable displays the highest mean rating score with the lowest standard error and standard deviation). Operating expenditure and 'time' are considered the next most important variables determining project success for clients, followed by environmental considerations. Exchange, esteem and design flexibility are considered by engineer respondents to be the least important factors for clients in terms of value. Differences between the engineer respondent sub-groups with regard to client value system variables are not significant.

6.3.3. Client objectives for VM

Survey participants were presented with a list of VM objectives or goals and asked to indicate which of those factors had been the focus (objective) of VM studies with which they had personally been involved. The results are shown in Table 2.

According to the survey respondents, VM practice within the SA construction industry focuses primarily on the potential for reducing the capital cost of projects (64%), optimizing the value of the project over its life (58%), reducing operating costs (53%), enhancing project functionality (53%), and enhancing project worth (50%). Other *foci* for VM acknowledged by respondents, but receiving less support, include achieving shorter project duration (42%), minimizing the environmental impact of the project (33%), the realization of project execution efficiencies (31%), and clarification of the project brief (31%). Enhanced project flexibility (28%) and usability (28%) are thought to be less important objectives for VM studies, and 18% of the respondents to this question claim that no formal goals at all are defined to guide the VM process.

Table 1
Engineer survey respondents' ranking of high order performance variables in clients' value systems ($n = 35$).

Value system factor	Mean	Std. error	Std. deviation	Rank
Time	3.83	0.186	1.098	3
Comfort	3.62	0.179	1.045	5
Flexibility	3.44	0.185	1.078	9
CAPEX	4.49	0.126	0.742	1
Environment	3.74	0.166	0.980	4
Esteem	3.47	0.170	0.992	7
OPEX	4.17	0.166	0.985	2

Table 2
Ranking of engineers' survey responses for objectives/goals defined for VM studies ($n = 36$).

VM study objective	% Response	Rank
Reduced project capital costs	64	1
Enhanced project functionality	53	3
Clarification of the brief and/or effective brief management	31	9
Enhanced project worth	50	6
Optimisation of value over the life of the project	58	2
Minimisation of environmental impact	33	8
Enhanced project usability in terms of convenience and comfort	28	11
Greater flexibility offered by the project	28	11
Effective risk management	51	5
Shorter project duration	42	7
Realisation of project execution efficiencies	31	9
Reduced project operating costs	53	3
Other	6	13

6.3.4. Outcomes of VM

The use of VM is claimed to, *inter alia*, result in cost savings, improvements in functionality, or a combination of both. Of the survey respondents confirming use of VM, 23% report that savings of up to 5% of project cost are typical. Twenty-seven percent indicate savings up to 10%; while another 27% suggest typical savings up to 15%. Two engineer respondents actually claim typical project cost savings in excess of 25%. Similar opinions occur regarding improvements in project functionality and quality, with improvements of up to 5% reported by 23%; another 32% indicate improvements of up to 10%; while 10% of the respondents to this question suggest that up to 15% improvement is typical. Quite a large number in this group (36%; $n = 11$) actually claim that improvement in project functionality in excess of 15% is typically achievable through the use of VM.

Questioned about the desired outcomes expected to flow from VM studies on projects, respondents select a range of deliverables including a VM action plan; workshop report; project development model; cost analysis of the project; analysis of project functionality; and a formal presentation to the project client/sponsor. The results are shown in Table 3. The engineer respondents display a clear preference for cost-based outcomes, favouring a detailed presentation to the client (60%) and a detailed cost analysis (57%) above all others. The remaining outputs do not enjoy majority support (≤40%). Under 'Other', respondents

Table 3
Ranked responses of engineer survey respondents for desired outputs flowing from the VM process ($n = 35$).

Desired VM process output/outcome	% Response	Rank
VM action plan	40	3
Workshop report	23	6
Project development model	31	5
Cost analysis	57	2
Analysis of project functionality	34	4
Formal presentation to project client/sponsor	60	1

6.3.5. VM team dynamics

The survey instrument presented several factors relating to VM team dynamics (e.g. team size, definition of roles, external versus internal VM team) and participants were asked to rate their importance in terms of influencing the success of the VM study (1 = completely unimportant; 5 = extremely important). The results are depicted in Table 4.

Participants rate team leadership and the clear definition of roles and responsibilities jointly highest in terms of their potential to influence the effectiveness of a VM study. Other influential factors include group goal-setting, composition of the team, external environmental factors (such as the VM workshop location), team cohesion and size (number) of the VM team. Whether the VM team is internal to the project or appointed as an external team is seen by respondents as the least influential factor affecting the success of a VM study.

6.3.6. VM methods and tools

Survey participants were asked to choose, from a given list, the VM methods they use. The results are given in Table 5. The most widely adopted VM methods are reported to be the value engineering audit (44%), job plan (36%), and the orientation meeting (31%). The remaining techniques enjoy minimal support (<20%). The two respondents providing information under 'Other' (6%) report the use of 'experience, intelligence and common sense', as well as 'post review and comment from users'. It is unclear how the latter responses fit the context of VM methods.

Table 4
Engineer survey respondent rating of the importance of team dynamic factors in influencing the success of VM studies ($n = 37$).

Team dynamics factor	Mean	Std. error	Std. deviation	Ranking
Team size	3.16	0.211	1.280	7
Definition of roles and responsibilities	4.03	0.162	0.986	1
Team composition	3.73	0.204	1.239	4
Team leadership	4.03	0.131	0.799	1
Team cohesion	3.62	0.179	1.089	5
Group goal-setting	3.95	0.164	0.998	3
External environmental factors	3.31	0.168	1.009	6

Table 5
Engineer survey responses for usage of VM methods ($n = 36$).

VM method	% Responses
Job plan	36
Charette method	3
40 h Workshop	3
Value engineering audit	44
Contractor's change proposal	17
Shortened study	3
Concurrent study	14
Orientation meeting	31
'Other'	6

The usage of VM tools varies considerably amongst respondents (see Table 6). For those who answered this question ($n = 30$), a clear preference exists for tools associated with traditional practice, namely, life cycle costing (57%), time, cost and quality management (47%), and value analysis (43%). Comparatively few respondents (⩽20%) report using the tools normally associated with VM in the literature. Under 'Other' methods (10%), participants report applying normal quality management systems.

The use of VM is promoted as a vehicle for clarifying the project brief (Kelly et al., 1993; Yu et al., 2005). To examine the nature and extent of this use in practice, survey participants were asked to indicate the VM methods used for brief clarification and the extent to which such methods are used. Of those who answered this question ($n = 34$; just under half of all engineer respondents), 62% indicate that VM methods for briefing purposes are used in most if not all projects. However, 21% claim VM usage for briefing at most only in rare instances. Questioned about which VM methods are used for briefing purposes, the responses ($n = 27$) indicate that the job plan (48%) is the most widely used technique. Methods also enjoying support include the value engineering audit (41%) and the orientation meeting (29%). However, the method typically associated with project briefing (the Charette) is not cited by any respondents. The Charette, typically conducted over a short period of time, is a specific VM intervention that '*seeks to rationalize the client's brief through the identification of the function of key elements and the spaces provided*' (Kelly et al., 2004: p. 20).

Table 6
Engineer survey responses for usage of VM tools ($n = 30$).

VM tool	% Response
Functional analysis systems technique (FAST)	17
Simple multi-attribute rating technique (SMART)	10
Kano model	0
Lever of value	0
Quality function deployment technique	7
REDReSS	0
Spatial adjacency programming	0
Time, cost and quality triangle	47
Value analysis	43

6.3.7. Benchmarking VM

VM 'good practice' standards or benchmark guides include the Australian Value Standard AS 4183-2007 (Standards Australia, 2007), the British/European VM Value Standard BS/EN 12973:2000 (British Standards Institution, 2000), and the SAVE International Value Standard (SAVE International, 2007). Presented with ten benchmarks/standards for VM, and asked to indicate which (if any) they follow, engineer survey respondents indicate scarcely any involvement with such benchmarking. The responses are shown in Table 7.

Clearly, use of international VM benchmark standards is virtually non-existent among the survey respondents. Standards listed under 'Other' options include in-house quality management systems (but no mention is made of ISO 9000).

6.3.8. Integrating VM with risk and quality management

Ellis et al. (2005) point to the integration of VM and risk management (RM) in practice, reinforcing the findings of Hiley and Paliokostas (2001) that '*practice is ahead of theory in this respect*' (Ellis et al., 2005: p.491). This is confirmed by 72% of the respondent engineers who report that VM and RM are integrated and generally managed together as part of the management system (14% state that they are independently managed). The results are shown in Table 8.

Finally, survey participants were questioned regarding the extent to which VM is integrated with quality assurance procedures such as TQM and Six Sigma. The results are depicted in Table 9. Integration is fairly widespread, but 32% report integration at most only in rare instances, and only 26% claim *complete* integration.

7. Discussion of the results

The response demographics present a survey sample comprising professional civil, mechanical and electrical services engineers in South Africa who are mature, appropriately qualified and well-experienced. They work mainly in private practice, in organizations almost evenly spread between large and small firms. However, only slightly more than half of them claim to be *aware* of, and *familiar with* VM. Their knowledge of VM is gained from various sources, but about a half of the respondents suggest that it is derived in-house or from attendance at a VM course. Since the former may have a limited catchment capacity (colleagues may be too busy to keep abreast of current VM developments), and the latter may be biased towards traditional techniques, there is always the danger that the engineers' knowledge of VM is not fully contemporaneous, particularly since none belong to a dedicated VM association. Use of internal VM teams is the preferred option, a result in keeping with the findings of Fong and Shen (2000).

Despite a relatively low indicated *use* in practice of VM (38%), respondents do have a high regard for its usefulness. A clear majority of responding engineers believe that VM should be used on most projects. This seeming mis-match is difficult to explain, but cited reasons for non-use of VM include lack of familiarity with the technique within the organization (but how would they then know whether VM was useful or not?), and the adoption of surrogate systems such as the application of quality assurance to professional engineering processes. This suggests that, while engineers are aware of VM and its potential effectiveness, there is little or no culture of VM adoption in their organizations and other management systems are adapted to fulfill its objectives, at least in part. Whilst these findings align with those of Fong and Shen (2000) in Hong Kong, they are in direct contradiction with the assertion of Kelly

Table 7
Engineer survey responses for adoption or use of VM benchmarks/standards ($n = 24$).

VM benchmark/standard	% Response
SAVE International Value Standard SAVE International (2007)	4 ($n = 1$)
The Value Management Benchmark Male et al. (1998a)	4 ($n = 1$)
HM Treasury Central Unit on Procurement Guidance No. 54 – Value Management HM Treasury (1996)	0
BRE Value Management Standard BRE (2000)	4 ($n = 1$)
ICE Creating Value from Engineering ICE (1996))	0
BSRIA Value Engineering of Building Services – Application Guide 15/96 BSRIA (1996)	0
UK Department of Trade and Industry Value Management Guide DTI (1997)	0
Defense Estates Organization – Value Planning and Management DEO (1998)	0
Australian Value Standard AS 4183:2007 Standards Australia (2007)	4 ($n = 1$)
British/European VM Value Standard BS/EN 12973:2000	4 ($n = 1$)

Table 8
Engineer survey responses for extent to which VM and RM processes are integrated ($n = 29$).

Extent of integration	% Response
VM and RM are generally managed together using the same procedures	72
VM and RM are sometimes managed together using the same procedures	14
VM and RM are independently managed using distinctly different procedures	14

Table 9
Engineer survey responses for extent to which VM and quality assurance processes are integrated ($n = 31$).

VM benchmark/standard	% Response
Completely integrated	26
Predominantly integrated	29
Partially integrated	13
Not generally integrated (only in rare cases)	22
Not integrated; managed as distinctly different processes	10

Where the use of VM is promoted, responding engineers indicate that this is most often at the instigation of the *project client*, concurring with the findings of Fong and Shen (2000). Value management is sometimes adopted as a counter to the services offered by competing firms. These findings reinforce the conclusion that an intrinsic VM culture is not common in professional engineering organizations in South Africa.

Survey respondents clearly appreciate the importance of capital and operating costs in clients' value systems (Table 1), and believe that their minimization is the main objective of VM, so as to optimize project value over its life cycle (Table 2). The engineers are also very aware of concerns for the environment, rating this highly (fourth: Table 1) in clients' value criteria, but give this factor far less prominence as an objective for a VM study (eighth: Table 2). This suggests that engineers may not be aware of how VM can be used in this context (Bowen et al., accepted for publication-b). Instead, engineers display a more traditional grasp of VM and preferences for its outcomes: cost-based objectives and deliverables (Tables 2 and 3). This is also reflected in the engineers' preferences for VM methods and tools (value engineering audit: Table 5; time/cost/quality triangle, value analysis, life cycle costing: Table 6). These findings align with those of Fong (1999), Fong and Shen (2000) and Mbachu and Nkado (2006). Usage of techniques such as FAST is not widespread (Table 6), a finding corroborating at least in part that reported by Ellis et al. (2005) and Spaulding et al. (2005).

In several ways these findings about VM and its use reflect a limited and dated view, and go against contemporary understandings. Nowadays, VM is postulated as a technique to be applied as early as possible in the project procurement process (Yu et al., 2005) with subsequent iterations as necessary (Kelly et al., 2005), with a focus on confirming client objectives; clarifying the project brief; determining functional requirements; and establishing indicators for success. Contemporary arguments for using VM flexibly are persuasive (Green and Liu, 2007).

The importance of role and responsibility definition, team leadership, and group goal-setting (Table 4) as factors influencing the success of VM studies is reinforced by the survey findings. This accords with the earlier work of Leung et al. (2003) who concluded that participation is an essential element of the process, and reinforces the findings of Bowen and Edwards (1996) who stress the importance of effective interpersonal communication within *multi-discipline* design teams. This result aligns with the emphasis placed by Green and Liu (2007) on the 'softer' aspects of VM.

Where VM is applied, the results appear to be favourably regarded by engineers, with cost savings and improvements in project functionality of up to 15% reported as not un-typical (and even better for some respondents). Indeed, the survey revealed solid support for improvements of (Fong, 1999). Since there can be few project management techniques capable of delivering benefits of this magnitude, it raises the question as to why use of VM is not far greater among engineers in South Africa?

Notwithstanding the role of engineers in the briefing process (especially on infrastructure projects), the *ad-hoc* nature of the briefing, and the association between effective briefing and client satisfaction with the product (Bowen et al., 1999), where engineer respondents do report use of VM for the purpose of clarifying the project brief this does not appear to happen consistently and the Charette method is not adopted.

A clear majority of respondents claim that, where VM is employed, it is integrated with risk management and that they are generally managed together using the same procedures (Table 8). This adds support to the finding of Ellis et al. (2005) with respect to UK cost consultants. Most respondent engineers appear to appreciate the risk management dimensions inherent in VM. In contrast (but concurring with the findings of Fong (1999)), there is a lack of integration of VM and quality management systems (Table 9).

Few respondent engineers (who have undertaken VM) report having used any of the best practice guides available to assist VM practitioners (Table 7). This finding is noteworthy given practice elsewhere (see Male et al., 1998b), is possibly indicative of an unstructured approach to VM, and supports the view that South Africa engineers' knowledge of VM is not fully contemporaneous.

8. Conclusions

This paper reports the findings of a web-based, online questionnaire survey into the nature and extent of value management (VM) practice by professional civil, mechanical and electrical engineers in South Africa. The survey explores practitioners' familiarity with, and understanding of, VM and the nature and extent of the use of VM techniques within their organizations.

The findings indicate that, *contrary* to the UK-based findings of Kelly et al. (2004: p. 48) that VM has evolved to become '*an established service with commonly understood tools, techniques and styles*', the concept of VM is not *widely* understood and practiced by engineers in the SA construction industry. Of those who do recognize its potential and practice VM, such practice is not usually benchmarked against international standards nor undertaken in accordance with the traditional standard methodology. South African engineers appear to prefer other methods of delivering value to projects.

Value management is seen as capable of delivering significant savings in cost and improvements in functionality. Given this, why is VM use not more widespread amongst South African engineers? Respondent engineers see the minimization of capital and operating costs as a primary objective of VM and this is reflected in their preferences

widespread. Despite the importance of the client briefing process, VM is not used to any great extent for the purpose of clarifying the brief. Whilst most engineer respondents see the benefits to be gained from integrating VM and risk management, the same cannot be said about integrating VM with quality management systems.

Given the increasing globalization of construction services – especially the growth in international ties between designers, project managers and other professionals – these findings serve as a cautionary note to South Africa consulting engineers. Active membership of dedicated VM organizations, although currently non-existent among the survey respondents, holds considerable potential for developing and refreshing respondents' VM skills. It is recommended that voluntary associations in the engineering professions in South Africa initiate comprehensive programmes of continuing professional development activities designed to promote greater awareness and practice of VM. This exploratory study informs an agenda for the development of such VM expertise.

The findings of the survey research raise almost as many new questions as answers about value management and its practice in South Africa. These issues will be addressed through further investigation, using a detailed case study approach with relevant stakeholders including professional associations. Particular attention will be paid to client value systems and VM practice in South Africa against a rich background of the language, cultural and commercial differences of stakeholders in that country.

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