

The practice of construction management

Peer reviewed

Abstract

International literature indicates that supervision, communication, motivation and leadership are the top ranked skills required for practicing construction management — the discipline of managing a construction business and/or project(s). Whereas operational and middle management require more skills and knowledge in operational programming, labour forecasting and organisation, top management requires more skills and knowledge in competitive tendering, costing and estimating, and analysis of project risk.

The research reported on in the article constitutes phase two of the study 'The practice of construction management', which follows two previous surveys conducted to determine knowledge areas and skills required, and their frequency of use. The first study determined that all construction managers (CMs) need: to be able to work with people; to integrate the efforts of people, and technical expertise. Other findings include that the top four subject areas are: programming; quality management; productivity, and industrial relations. The second study determined that administration, oral communication, controlling, co-ordinating, decision making and leadership are skills ranked among the top ten for all levels of management. Other findings include that contract administration, contract documentation, cost control, building methods and quality management are subject areas ranked in the top ten positions for all levels of management.

The article concludes that the most frequently used subject areas reflect the focus at the respective levels of management: top — the management of the business of construction; middle — the management of a number of projects and operational — the management of specific projects.

The article concludes that construction management undergraduate programmes need to focus on management, and more specifically, the management of resources within defined parameters, along with the requisite technical expertise.

Keywords: construction management, discipline, knowledge, skills.

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Abstrak

Internasionale literatuur dui daarop dat vaardigheid in toesighouding, kommunikasie, motivering en leierskap die grootste vereiste is vir praktiseer in konstruksiebestuur — die dissipline wat die bestuur van 'n konstruksie besigheid en/of projek(te) behels. Alhoewel operasionele en middelvlak bestuur meer aanleg, kundigheid en kennis benodig in operasionele programmering, arbeids vooruitskatting en organisasie, benodig topbestuur meer aanleg, kundigheid en begrip in die kompeterende tenderproses, kosteberaming en prysberaming en die risiko-analise van projekte.

Die navorsing waarna in hierdie artikel verwys word, word gebaseer op die tweede fase van die studie 'The practice of construction management', wat volg op twee vorige studies wat onderneem is om areas van kundigheid, kennis en aanleg te identifiseer sowel as die frekwensie en/of intervalle van toepassing daarvan. Die eerste studie het bevind dat alle konstruksiebestuurders (KBs) die volgende eienskappe benodig: die gawe/aanvoeling om met mense te werk; om mense se aksies te integreer, en tegniese kundigheid. Verdere bevindinge sluit in dat die top vier vakgebiede behels: programmering; kwaliteitsbestuur; produktiwiteit, en industriële-verhoudings. Die tweede studie het bevind dat administrasie, verbale kommunikasie, kontrolering, koördinasie, besluitneming en leierskap die aanlegte is wat onder die top tien gelys word vir alle bestuurs dissiplines. Ander bevindinge bewys dat kontrak-administrasie, kontrak-dokumentasie, kostekontrolle, boumetodes en kwaliteitsbestuur die vakareas is wat onder die top tien posisies gelys word in alle vlakke van bestuur.

Die artikel som op dat die vakgebiede wat die meeste toegepas word, die fokus reflekteer aan die verskeie vlakke van bestuur: top — die bestuur van die konstruksiebesigheid; middel — die bestuur van verskeie projekte en operasioneel — die bestuur van spesifieke projekte.

Die artikel bevind dat voorgraadse programme in konstruksiebestuur meer moet fokus op bestuur, en meer spesifiek op die bestuur van hulpbronne binne afgebakende terreine/areas met die vereiste tegniese kundigheid wat daarmee gepaard gaan.

Sleutelwoorde: konstruksiebestuur, dissipline, kennis, kundigheid/aanleg

1. Introduction

Ducker (1955) states the three jobs of management as: managing a business; managing managers, and managing worker and work. He contends that although the three jobs can be analysed separately, studied separately, appraised separately, and despite each having a present and a future dimension, management cannot separate them nor can it separate decisions on present from decisions on future. Clearly, management is concerned with the business environment and work per se, and furthermore, it is concerned with planning — decisions regarding the future.

According to Fellows, Langford, Newcombe & Urry (2002), construction management can be viewed in two dimensions, the management of the business of construction, and of projects per se. They emphasise that in practice, the two dimensions are interdependent. Lavender (1996) emphasises that the differences between managing the business of construction and projects should not be overstated, but that they should be noted. Whereas the former is ongoing, projects are unique, of a temporary nature, entail a series of deadlines and targets, and the establishment of a project team.

Frederick W Taylor, while working in the steel industry during the early 1900s identified the need for a systematic and scientific approach to industrial management. He proposed that managers realise order and system to their work in the form of 'scientific management', and suggested that managers should condense the great mass of traditional knowledge to a science by classifying, tabulating, and reducing it to rules, laws, and formulae. He recommended that managers plan the work of the people reporting to them and devise means of coordination and control. His plan called for managers to motivate their people by selecting, teaching, and developing the workers and 'heartily cooperating with them'. Effectively, he identified the need to systematise management, analyse the work to be done, measure it, and assign portions thereof to the people best able to execute it (Allen, 1958). Allen (1958) contends that although Taylor did not provide the whole answer to "What is a manager?" he enabled us to take a long stride forward.

Henri Fayol's book *General and Industrial Management* published in 1916 in French is regarded as the first attempt to derive general principles of management (Lavender, 1996). He identified six key activities that take place in an industrial organisation: technical such as pro-

duction; commercial such as purchasing and selling; financial such as obtaining long-term and working capital; security in the form of taking care of the organisation's property; accounting such as compiling and maintaining financial information, and managerial. Fayol then identified five processes relative to the managerial activities: forecasting and planning; organizing; commanding; coordinating, and controlling (Lavender, 1996).

Allen (1973) subdivides the order of management work into functions — planning, organizing, leading, and controlling, and suggests a fifth in the form of coordination. Allen (1958) elaborates on management as an art, science, and profession in his book *The Management Profession*. Based upon his interpretation of the term 'management', Allen (1983) evolves a succinct definition for a professional manager: "A management leader who specialises in the work of planning, organising, leading and controlling through the systematic use of classified knowledge, concepts, principles and a common vocabulary, and who subscribes to the standards of practice and a code of ethics established by a recognised body."

The nine recognised functions in an organisation provide further insight relative to the knowledge and skills required by construction managers: general management; production; procurement; marketing; financial; human resources; public relations; legal, and administration and information technology. Generally, the organisation structures of contracting and related organisations, dependent upon size, are structured according to these functions. Successful management of the business of construction, which includes managing projects, is dependent upon effective integration of these functions. Furthermore, although the production function mostly takes place on projects, it is merely one of the functions and is dependent on the others, and *vice versa*.

Given that the environment within which construction management is practiced changes, the debate surrounding the content of construction management undergraduate courses, and a pending scoping exercise by the Building Construction Standards Generating Body, the study 'The practice of construction management Phase 2' was initiated to investigate the frequency of use of knowledge areas and skills.

2. Review of the literature

2.1 Functions and activities of management work

Allen (1973) identifies two classes of work — mechanical and human. He then subdivides the class of human work into the orders of management work and technical work. Technical work entails physical and mental effort by the person doing the work. Management work also entails physical and mental effort, but by a person in a leadership position to realise results through other people. He then subdivides the order of management work into functions — planning, organising, leading, and controlling, and suggests a fifth in the form of coordination. The functions of management work are then subdivided into activities:

- Planning: forecasting; developing objectives; programming; scheduling; budgeting; developing procedures, and developing policies;
- Organising: developing organisation structure; delegating, and developing relationships;
- Leading: decision making; communicating; motivating; selecting people, and developing people, and
- Controlling: developing performance standards; measuring performance; evaluating performance, and correcting performance.

Certain activities are subdivided into segments:

- Developing objectives: establishing key, critical, and specific objectives, and
- Developing organisation structure: establishing functional and divisionalised organisation structure.

2.2 Competencies

Singh (2004) states that the criteria of performance are superior performance and effective performance, the issue being that only some competencies can predict performance. Thus competencies are divided into two categories: threshold or surface, which are required to be minimally effective, and differentiating or core, which distinguish superior from average performers.

The threshold or surface competencies are:

- Knowledge — information regarding content, and
- Skills — ability to perform a task.

The differentiating or core competencies are:

- Self-concept — values, aptitude, attitude, and self-image;
- Traits — self-confidence, team player, and handles ambiguity, and
- Motives — focus on client success, and preserves organisation / personal integrity.

2.3 Project parameters

Table 1 indicates the importance attached to eleven traditional and non-traditional project parameters to project management practices in terms of percentages relative to importance on a scale of 1 (not) to 5 (very), and a ranking based upon an importance index (II) value, ranging between a minimum of 0.00 and 4.00 (Smallwood & Venter, 2002). Given that all the project parameters have II values above the midpoint value of 2.0, the parameters can be deemed to be important to practices. It is notable that four of the five project parameters have II values $> 3.2 \leq 4.00$, which indicates that they are perceived to be between more than important to very important / very important. It is notable that the three traditional project parameters (quality, cost, and time) achieved rankings in the top four. Client satisfaction, which was ranked first, is a function of general performance; certainly cost, quality, and time, but increasingly, project H&S, public H&S, and environment (natural).

Given the importance of the eleven project parameters, construction managers need to manage and optimise performance relative thereto, which in turn requires that they have the requisite knowledge and skills.

Table 1: Importance of various project parameters to project management practices

Parameter	Response (%)					II	Rank
	Not Very						
	1	2	3	4	5		
Client satisfaction	0.0	0.0	0.0	23.3	76.7	3.77	1
Project quality	0.0	0.0	3.3	23.3	73.3	3.70	2
Project cost	0.0	0.0	6.7	23.3	70.0	3.63	3
Project time	0.0	0.0	6.7	33.3	60.0	3.53	4
Project health and safety	0.0	3.3	16.7	20.0	60.0	3.37	5
Public health and safety	0.0	6.7	30.0	6.7	56.7	3.13	6
Labour productivity	0.0	10.0	13.3	40.0	36.7	3.03	7
Environment (natural)	0.0	10.0	23.3	23.3	40.0	2.97	8
Worker satisfaction	0.0	13.3	23.3	43.3	20.0	2.70	9
Designer satisfaction	0.0	13.3	26.7	40.0	20.0	2.67	10
Contractor satisfaction	0.0	13.3	33.3	36.7	16.7	2.56	11

2.4 Knowledge and skills

Research conducted in the United States of America by Dorsey (1991) resulted in the composite summary ranking of skills identified for the positions / functions which require college level certification, senior executive through field engineer (Table 2). According to Dorsey although it may be arguable that the rankings can be adjusted by one notch in either direction, the key point is that the first five skills had strong support among respondents.

Table 2: Composite summary rankings of skills identified for construction senior executive through engineers

Skill	Ranking
Numerical	1
Written communication	2
Oral communication	3
Graphic communication	4
Financial management	5
Planning and control	6
Ethical decision making	7
Leadership	8
Personnel	9
Manual	10

Source: Dorsey 1991

Cecere (1987) conducted research among members of the Associated General Contractors of America (AGC) to determine what is important in two-year college construction curricula. The findings sug-

gest that a strong foundation in communication, mathematics and physics, as well as a basic computer science should be included as part of general educational courses. Emphasis in construction subject areas is important along with basic and applied engineering courses in drafting, surveying and plan reading.

Young & Duff (1990) conducted research among three small, six medium and two large United Kingdom building and / or civil engineering contractors to establish an appropriate body of skills and knowledge for three levels of construction management, directors and senior managers with regional or divisional responsibility constitute level one. Middle managers who essentially co-ordinate between head office and site constitute level two. Level three consists of site personnel. Fifty-six skills and knowledge dimensions were ranked.

Supervision, motivation, leadership and communication i.e. the interpersonal skills are ranked in the top four positions for all levels of construction management (Table 2). Junior and middle managers indicate that skills and knowledge in operational programming, labour forecasting and organisation, and managing of other resources are the next two most frequently required. They also need to be knowledgeable in the management of quality. Health and safety law is a concern for all levels of management. Senior management places more emphasis on competitive tendering, budgetary control, costing and estimating, and analysis of project risk. Financial control is also recognised as part of the middle and junior manager duties.

Table 3: Top ten skill / knowledge areas for each level of a construction manager

Skill / Knowledge	Ranking		
	Junior	Middle	Senior
Supervision	1	2=	1=
Communication	2	1	1=
Motivation	3	2=	1=
Leadership	4	2=	4
Organisation (site)	5	6	44
Health and safety law	6	13	9
Programming	7	5	10
Maintenance	8	7	24
Quality assurance	9	8=	-
Human resource planning	10	10=	20
Budgetary control	13	8=	6=
Competitive tendering	42	23	5
Costing and estimating	20	18	6=
Analysis of project risk	24	16	8

Source: adapted from Young & Duff 1990

According to Fryer (2004) in 1971 Robert Katz identified three broad classes of skills: human; technical, and conceptual. Human skill is the manager's ability to work as a group member and build cooperative effort in the team, communicate and persuade. Technical skill includes proficiency in some aspect of the organisation's work, analytical abilities, and specialised knowledge and techniques. Conceptual skill is the ability to adopt a holistic perspective relative to the organisation. Katz argued that human skill is important at all levels of management, but especially at operational level as such managers have wide-ranging and frequent contact with people. Operational management also relies heavily on technical skill, but this is less important for top management, who depend more on conceptual skill. Katz further argued that many management tasks require the use of several skills — for example, resolving a technical problem may require more than technical skill as it may affect people.

Fryer (2004) focuses on interpersonal, informational, and decisional skills due to Mintzberg's contention that managers perform an intricate set of overlapping roles, namely interpersonal, informational, and decisional. In terms of interpersonal skills, construction managers ranked human skills highest during a study conducted by Fryer (2004) in 1977 to investigate the development of managers in the construction industry. Relative to social skills, site managers and contracts managers stressed the need for keeping people informed, getting them involved in tasks, fostering cooperation and teamwork, communicating clearly, dealing with people as individuals, and showing an interest in people.

The first of two South African studies investigated the skills, areas of knowledge and personality characteristics pertinent to, among other, construction managers (Smallwood, 2000). The study entailed a national postal survey of, among other, general contractor (GC) members of the Building Industries Federation South Africa (BIFSA) and the South African Federation of Civil Engineering Contractors (SAFCEC), and non-student members of the South African Institute of Building (SAIB).

Respondents were requested to identify which of 29 skills construction managers should possess (Table 3). Based upon the mean level of response, the skills were then ranked in order of perceived importance. It is significant that four of the five functions of management work, namely, planning, organising, leading and controlling appear within the top ten ranked skills — coordinating was ranked joint thirteenth. It is also significant that four of the top six ranked skills entail working with people. It is notable that technical expertise is ranked fourth, and decision making joint fifth.

Table 4: Recommended skill areas for construction managers according to GCs and SAIB members

Skill	Response per population (%)			Ranking		
	GC	SAIB	Mean	GC	SAIB	Mean
Conflict resolution	100.0	100.0	100.0	1=	1=	1=
Leadership	100.0	100.0	100.0	1=	1=	1=
Personnel management	100.0	100.0	100.0	1=	1=	1=
Technical expertise	100.0	100.0	100.0	1=	1=	1=
Decision making	100.0	97.8	98.9	1=	5=	5=
Oral communication	100.0	97.8	98.9	1=	5=	5=
Planning	100.0	95.6	97.8	1=	12=	7
Interpersonal	97.1	97.8	97.5	10=	5=	8=
Organising	97.1	97.8	97.5	10=	5=	8=
Controlling	100.0	93.3	96.7	1=	14=	10

Source: Smallwood 2000

Respondents were also requested to identify which of 75 subject areas construction managers should be familiar with (Table 4). It is significant that planning (programming) and quality management, which are ranked joint first, are directly related to two of the three traditional project parameters, namely time and quality. Similarly, productivity, which is ranked third, is indirectly related to schedule and the third project parameter of cost. Industrial relations, ranked fourth, reinforces the importance of skills related to working with people. Health and safety, which impacts on cost, quality and time performance is ranked joint fifth. The contribution of subcontractors to the construction process is acknowledged through the joint fifth ranking of subcontractor management. The joint fifth ranking of TQM amplifies the importance of process improvement. It is notable that materials, construction methods (building), and plant and equipment management are jointly ranked ninth.

The first twelve rankings and the thirteenth ranked human resources, indicate that the management of the resources of labour, materials, plant and subcontractors, within the project parameters of cost, health and safety, quality and time is important.

Table 5: Recommended subject areas for construction managers according to GCs and SAIB members

Subject area	Response per population (%)			Ranking		
	GC	SAIB	Mean	GC	SAIB	Mean
Planning (programming)	100.0	97.8	98.9	1=	8=	1=
Quality management	100.0	97.8	98.9	1=	8=	1=
Productivity	97.1	100.0	98.6	4=	1=	3
Industrial relations	97.1	97.8	97.5	4=	8=	4
Health and safety	94.3	100.0	97.2	8=	1=	5=
Subcontractor management	94.3	100.0	97.2	8=	1=	5=
Total Quality Management (TQM)	94.3	100.0	97.2	8=	1=	5=
Materials management	94.3	97.8	96.1	8=	8=	8
Materials	91.4	100.0	95.7	14=	1=	9=
Construction methods (building)	91.4	100.0	95.7	14=	1=	9=
Plant and equipment management	91.4	100.0	95.7	14=	1=	9=

Source: Smallwood 2000

The second study, 'The practice of construction management Phase 1' entailed a national postal survey of non-student members of the SAIB (Smallwood, 2000). The objectives of the study were to determine, based on frequency of use, the importance of skills and areas of knowledge per level of construction management. Respondents were asked to identify the frequency at which skills and knowledge pertaining to subject areas is required, using the range of responses: frequently, sometimes, rarely or never.

It is significant that all five functions of management work are represented in the top ten ranked skills of operational, middle and 'all' levels of management: controlling; coordinating; planning; leadership, and organising. Planning and organising are not included in the top ten ranked skills of top management (Table 5). It is notable that the IIs for the top eight ranked skills for all levels of management are above the midpoint value of 1.50 indicating prevalence in terms of use. Effectively, costing is more important to top and middle management, whereas interpersonal, organising, planning and plan reading skills are more important to operational and middle management.

Table 6: Importance of skills per level of construction management based on frequency of use

Skill	Level of management							
	Operational		Middle		Top		All	
	II	Rank	II	Rank	II	Rank	II	Rank
Communicating (oral)	1.29	2	1.69	3	1.80	1=	1.59	1
Controlling	1.27	3=	1.71	1=	1.76	3	1.58	2=
Decision making	1.22	8=	1.71	1=	1.80	1=	1.58	2=
Coordinating	1.24	6=	1.63	6=	1.75	4=	1.54	4
Administrative	1.22	8=	1.63	6=	1.75	4=	1.53	5=
Planning	1.27	3=	1.68	4	1.63	13	1.53	5=
Leadership	1.20	10=	1.59	10=	1.73	7	1.51	7=
Organising	1.25	5	1.64	5	1.64	12	1.51	7=
Communicating (written)	1.15	14	1.58	13	1.75	4=	1.49	9
Interpersonal	1.20	10=	1.59	10=	1.61	14=	1.47	10

Source: Smallwood 2000

Respondents were also required to respond regarding the importance of subject areas based on the frequency of use of related knowledge (Table 6). Given that cost, quality and time are the traditional project performance measures and parameters, it is significant that cost control, quality management and planning (programming) are ranked in the top ten subject areas for the operational, middle and top levels of management; with the exception of planning (programming) for top management. It is notable, that relative to the 'all' levels of management there are only two subject areas for which the IIs are above the midpoint value of 1.50, namely construction methods (building) and cost control.

Contract administration, contract documentation, cost control, construction methods (building) and quality management are in the top ten ranked subject areas for operational, middle and top levels of management. Customer service is only common to middle and top management; measuring quantities, programming and subcontractor management is common to operational and middle management.

Table 7: Importance of subject area per level of construction management based on frequency of use of knowledge

Subject area	Level of management							
	Operational		Middle		Top		All	
	II	Rank	II	Rank	II	Rank	II	Rank
Construction methods (building)	1.22	1	1.80	1	1.59	6=	1.54	1
Cost control	1.15	3	1.75	2	1.64	2=	1.51	2
Quality management	1.14	4	1.63	6	1.59	6=	1.45	3
Contract administration	1.08	5=	1.66	3=	1.58	9	1.44	4=
Subcontractor management	1.19	2	1.58	8=	1.54	12=	1.44	4=
Contract documentation	0.98	10=	1.66	3=	1.59	6=	1.41	6
Planning (programming)	1.07	7	1.61	7	1.47	17	1.38	7
Customer service	0.85	19	1.56	10	1.71	1	1.37	8
Project management	0.86	18	1.66	3=	1.54	12=	1.35	9
Productivity	0.90	14	1.53	12	1.46	18=	1.30	10

Source: Smallwood 2000

Although the research cited in the literature did not investigate the exact same skills and subject areas, and in cases consolidated skills and subject areas, a number of skills and subject areas are clearly critical to the practice of construction management. Table 7 provides an overview of the importance of skills by consolidating each of the top ten skills according to the studies referred to in the survey of the literature and the research reported on in this paper. Certain skills are essentially related or sub-skills of other skills (noted in parentheses): decision making (leadership); conflict resolution (organising); interpersonal (communicating), and administrative (communicating).

Table 8: Review of top ten ranked skills for each study

Skill	Dorsey	Young & Duff			Study 1	Study 2 (Phase 1)			
		Junior	Middle	Senior	Mean	Operational	Middle	Top	All
Administrative	-	-	-	-	18	8=	6=	4=	5=
Communicating	2 3 4	2	1	1=	5=	2	3	1= 4=	1 9
Conflict resolution	-	-	-	-	1=	25=	32	21	29
Controlling	6	-	-	-	10	3=	1=	3	2=
Coordinating	-	-	-	-	13=	6=	6=	4=	4
Decision making	-	-	-	-	5=	8=	1=	1=	2=
Financial management	5	13	8=	6=	23	25=	22=	9=	19
Interpersonal	-	-	-	-	8=	10=	10=	14=	10
Leadership	8	4	2=	4	1=	10=	10=	7	7=
Motivation	-	3	2=	1=	-	15	16=	11	13
Organising	-	5	6	44	8=	5	5	12	7=
Personnel	9	-	-	-	1=	-	-	-	-
Programming	6	7	5	10	7	3=	4	13	5=
Supervision	-	1	2=	1=	-	10=	19	33	20
Technical expertise	10	-	-	-	1=	17	10	18	14=

- (not specifically addressed)

Source: Smallwood 2000

Communicating, controlling, leadership, programming, decision making, interpersonal, administrative, coordinating, and to a lesser extent, technical expertise, motivating, organising and supervisory, are critical skills. Although certain studies identify personnel management in general, conflict resolution (related to interpersonal) and financial management to be important skills, not all studies do.

Table 8 provides an overview of the importance of subject areas by consolidating each of the top ten subject areas according to the studies referred to in the paper. Dorsey only addressed skills, and Young & Duff did not differentiate between skills and subject areas.

Most studies indicate building construction, contract administration, contract documentation, cost control, programming, quality management, and subcontractor management to be critical subject areas across all levels of management. Health and safety was identified to a lesser extent. Materials, materials management, and plant and equipment management are important with respect to operational management. Customer service, productivity, project management and to a lesser extent, TQM are subject areas which should be afforded attention.

A recent study conducted by Chileshe, Fester & Haupt (2005) investigated desirable construction management skills relative to Universities of Technology graduates using the Construction Management Skills and Attributes-Subject Performance Index Model. The model includes 37 skills / attributes and 8 subject streams. The findings of the study conducted primarily among GCs, subcontractors, and academics, are presented in Tables 9 and 10.

Given that skills and attributes were consolidated, it is not possible to readily compare the findings with those emanating from other studies. However, relative to other studies reported on, the following are notable: decision making and communicating skills are ranked substantially lower, and planning and interpersonal are ranked similarly.

Table 9: Review of top ten subject areas for each study

Skill	Young & Duff			Study 1	Study 2 (Phase 1)			
	Junior	Middle	Senior	Mean	Operational	Middle	Top	All
Administration	-	-	-	-	-	-	-	-
Building construction	-	-	-	9=	1	1	6=	1
Contract administration	-	-	-	12	5=	3=	9	4=
Contract documentation	-	-	-	15	10=	3=	6=	6
Cost control	-	-	-	24	3	2	2=	2
Customer service	-	-	-	20=	19	10	1	8
Health and safety	6	13	9	5=	10=	24=	24=	18=
Industrial relations	-	-	-	4	31=	50=	41	44
Materials	-	-	-	9=	8=	15=	28=	11=
Materials management	-	-	-	8	5=	19=	42=	20=
Plant and equipment management	-	-	-	9=	10=	35	36=	27=
Productivity	-	-	-	3	14	12	18=	10
Programming	7	5	10	1=	7	7	17	7
Project management	-	-	-	22	18	3=	12=	9
Quality management	9	8	31=	1=	4	6	6=	3
Subcontractor management	-	-	-	5=	2	8=	12=	4=
Total Quality Management (TQM)	-	-	-	5=	23=	24=	33=	29=

- (not specifically addressed)

Source: Smallwood 2000

Table 10: Top ten skills / attributes required of University of Technology graduates.

<i>Skill</i>	<i>Ranking</i>
Trust and honesty	1
Acceptance of responsibility	2
Problem solving skills	3
Worker H&S awareness	4
Time management	5
Decision making	6
Communicating (Oral and Written)	7
Planning scheduling and controlling	8
Practical building knowledge	9
Interpersonal	10

Given that the relevancy of knowledge was presented in terms of streams, it is not possible to readily compare the findings with those emanating from other studies. However, relative to other studies reported on, the following are notable — project management is ranked substantially higher, and building construction is equally.

Table 11: Relevancy of subject streams relative to University of Technology graduates.

<i>Subject stream</i>	<i>Ranking</i>
Project management	1
Construction technology	2
Management theory	3
Construction law	4
Business of construction	5
Construction economics	6
Construction science	7
Research methodology	8

3. Research

3.1 Sample stratum and methodology

A survey 'The practice of construction management Phase 2' was conducted among non-student members of the Chartered Institute of Building (CIOB) (Southern Africa) to determine the frequency at which 78 knowledge areas and 45 skills are used relative to the three levels of management. The primary objective of the survey was to provide 'current' data for reference to by the Building Construction Standards Generating Body (SGB) during a management scoping exercise.

A questionnaire was mailed to members, and also circulated electronically to those members with e-mail addresses. Ninety-one responses were included in the analysis of the data from a net sample frame of six hundred and forty eight, which represents a response rate of 14 %

[91 / (656 — 8)].

3.2 Analysis and presentation of the data

Given that respondents were required to respond in terms of a frequency range: never; monthly; fortnightly; weekly, and daily, it was necessary to compute an importance index (II) to enable a collective comparison of responses to and a ranking of the respective subject areas and skills. The II is calculated as follows:

$$II = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4}{n_0 + n_1 + n_2 + n_3 + n_4}$$

Where n_0 = Unsure / Never, n_1 = Monthly, n_2 = Fortnightly, n_3 = Weekly, n_4 = Daily

The skills and subject areas are presented in and ranked in terms of descending frequency of use. The bold lines inserted across the mean II and rank columns indicate the five ranges of II values, which indicates that the skills and subject areas can be deemed to be used between (range):

- weekly to daily / daily ($> 3.2 \leq 4.0$);
- fortnightly to weekly / weekly ($> 2.4 \leq 3.2$);
- monthly to fortnightly / fortnightly ($> 1.6 \leq 2.4$);

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- never to monthly / monthly ($> 0.8 \leq 1.6$), and
- never to monthly ($> 0.0 \leq 0.8$).

3.3 Findings

Respondents were involved with the following types of construction: commercial (73.6%); industrial (51.6%); domestic (42.9%), and infrastructure (23.1%).

The 0 — 2 floors (67%) height category predominated in terms of the level of structures respondents were involved with, followed by ground (49.5%), below ground (27.5%), 0 — 10 floors (25.3%), and 0 — 20 floors (12.1%).

The average number of years worked in the respective levels of management by respondents increased with the seniority of the level: operational (4.3); middle (6.7), and top (9.3). 65.9% of respondents are currently working at top management level, and 25.3% and 5.5% at middle and operational level respectively.

Tables 11 and 12 indicate the mean frequency of use of skills and subject areas for all levels of management in terms of IIs only, respectively.

Oral and written communicating predominate among skills in terms of the mean for all levels of management, followed by decision-making, organising, administrative, leadership, coordinating, planning, numerical (maths), plan reading, interpersonal, motivating, and controlling (II values $> 3.2 \leq 4.0$) (Table 11). However, it should be noted that leadership and controlling are more important at top management, plan reading is substantially more important at operational and middle management, and interpersonal and motivating are more important at middle and top management.

Other frequently used skills are: supervisory; computer; technical; negotiating with subcontractors, and costing (II values $> 2.4 \leq 3.2$). However, it should be noted that computer skills are substantially more important at middle and top management, and negotiating with subcontractors is substantially more important at operational and middle management.

Other important differences include: measuring quantities is more important at operational management; team building, estimating, and procedures development are more important at middle and

top management, and financial, marketing, and entrepreneurial are more important at top management.

There is only one skill that is never used by the majority of all levels, namely negotiating with unions at operational management.

Mathematics predominates among subject areas in terms of the mean for all levels of management, followed by building methods (construction), materials, customer service, subcontractor management, cost control, quality management, contract administration, productivity, ethics, and materials management (II values $> 2.4 \leq 3.2$) (Table 10). However, it should be noted that: building methods (construction), materials, subcontractor management, cost control, quality management and materials management are more important at operational and middle management; customer service and ethics are more important at top management, and productivity is more important at operational management. Other notable differences include the importance of measuring (quantities) and surveying (land) at operational management, and negotiating, management (business), financial management, public relations, property economics, marketing, entrepreneurship, accountancy, cash flow forecasting, economics, company law, property development, property law, and tax at top management.

There are eleven subject areas that are never used by the majority at operational management, two at middle management, and two at top management.

Table 12: Mean frequency of use of skills for all levels of management in terms of IIs.

Skill	Levels of management							
	Operational		Middle		Top		Mean	
	II	Rank	II	Rank	II	Rank	II	Rank
Communicating (Oral)	3.84	1	3.87	1	3.89	1=	3.86	1
Communicating (Written)	3.65	2	3.65	2	3.75	4	3.68	2
Decision making	3.24	8	3.48	4=	3.83	3	3.51	3
Organising	3.33	6	3.48	4=	3.63	6=	3.48	4
Administrative	3.28	7	3.44	8	3.66	5	3.46	5=
Leadership	3.16	11	3.33	10	3.89	1=	3.46	5=
Coordinating	3.44	4	3.32	11	3.59	8	3.45	7
Planning	3.21	9	3.48	4=	3.49	11	3.39	8
Numerical (Maths)	3.40	5	3.47	7	3.28	13	3.38	9
Plan reading	3.58	3	3.51	3	2.85	19	3.31	10
Interpersonal	3.02	13	3.38	9	3.52	9	3.30	11
Motivating	2.98	14	3.22	12	3.63	6=	3.27	12
Controlling	3.20	10	3.00	15	3.51	10	3.23	13
Supervisory	3.04	12	3.03	13	2.74	21	2.93	14
Computer	2.14	24	3.02	14	3.46	12	2.87	15
Technical	2.81	17	2.80	17	2.78	20	2.79	16
Negotiating with subcontractors	2.90	16	2.90	16	2.37	24	2.72	17
Costing	2.46	19	2.57	18	2.52	23	2.51	18
Measuring (Quantities)	2.92	15	2.33	22	1.90	32	2.38	19
Team building	2.00	25	2.49	19	2.66	22	2.38	20
Initiating	1.53	29	2.30	24	3.23	15=	2.35	21
Negotiating with project managers	2.18	22	2.46	20	2.31	26	2.31	22
Measuring (Productivity)	2.48	18	2.35	21	2.02	30=	2.28	23
Communicating (Graphic)	2.15	23	2.29	25	2.27	28	2.23	24
Financial	1.37	31	2.18	26	3.10	17	2.21	25
Negotiating with material suppliers	2.23	21	2.32	23	2.02	30=	2.19	26
Conflict resolution	1.92	26	2.08	27	2.29	27	2.09	27
Negotiating with clients	1.04	36	2.07	28	3.08	18	2.06	28
Estimating	1.36	32	2.00	29	2.36	25	1.90	29=
Marketing	0.69	41	1.75	34	3.27	14	1.90	29=
Entrepreneurial	0.72	39	1.61	35	3.23	15=	1.85	31
Report writing	1.77	27	1.97	30	1.71	33	1.81	32
Negotiating with plant hire	2.27	20	1.86	33	1.25	38	1.79	33
Procedures development	1.22	33	1.88	32	2.12	29	1.74	34
Training	1.61	28	1.89	31	1.70	34	1.73	35
Systems development	0.71	40	1.32	36	1.68	35	1.23	36
Design (Temporary works)	1.19	34	1.26	38	1.08	41	1.17	37
Design management	0.54	43	1.27	37	1.52	36	1.11	38
Work study	1.07	35	1.18	39=	0.90	43	1.05	39
Negotiating with community	0.77	37	1.18	39=	0.98	42	0.97	40
Statistical	0.76	38	1.00	42	1.13	40	0.96	41
Research	0.64	42	0.92	44	1.18	39	0.91	42
Auditing	0.49	44	1.02	41	1.44	37	0.89	43
Surveying (Land)	1.49	30	0.71	45	0.32	45	0.84	44
Negotiating with unions	0.48	45	0.95	43	0.71	44	0.71	45

Table 13: Mean frequency of use of subject areas for all levels of management (Part A).

Subject area	Levels of management							
	Operational		Middle		Top		Mean	
		Rank		Rank		Rank		Rank
Mathematics	3.28	1=	3.07	1	3.24	1	3.19	1
Building Methods (Construction)	3.28	1=	2.98	2	2.58	9=	2.94	2
Materials	3.08	3	2.65	5	2.28	19	2.67	3
Customer service	1.92	21	2.53	7=	3.21	2	2.55	4
Subcontractor management	2.96	4	2.63	6	2.03	25	2.54	5
Cost control	2.52	9	2.73	4	2.36	15	2.53	6=
Quality management	2.79	8	2.53	7=	2.27	20	2.53	6=
Contract administration	2.14	16	2.77	3	2.48	12	2.46	8
Productivity	2.91	5	2.34	14=	2.08	23=	2.44	9
Ethics	1.93	20	2.44	10=	2.91	5	2.42	10=
Materials management	2.85	6	2.42	12	2.00	27	2.42	10=
Programming planning	2.49	10=	2.32	16=	2.32	17	2.37	12
Measuring (Quantities)	2.81	7	2.31	18	1.80	34	2.30	13
Management systems e.g. Quality	1.96	19	2.32	16=	2.49	11	2.25	14
Contract documentation	2.06	18	2.48	9	2.16	22	2.23	15
Negotiating	1.55	31	2.26	19	2.87	7	2.22	16=
Purchasing	2.18	14	2.41	13	2.08	23=	2.22	16=
Health and safety	2.49	10=	2.07	22	2.02	26	2.19	18
Information technology	1.62	24	2.34	14=	2.44	13	2.13	19
Project management	1.57	27=	2.44	10=	2.36	16	2.12	20
Estimating	1.47	33	2.25	20	2.38	14	2.03	21
Human resources	1.71	23	1.93	25	2.30	18	1.98	22
Civil Methods (Construction)	2.20	13	2.05	23	1.50	46=	1.91	23
Management (Business)	0.91	49=	1.67	32	3.11	3	1.89	24
Specifications	2.29	12	2.08	21	1.92	31=	1.85	25
Plant and equipment management	2.17	15	1.88	26	1.43	52	1.82	26=
Procedures	1.76	22	1.98	24	1.74	36	1.82	26=
Financial management	0.89	51	1.86	27	2.70	8	1.81	28
Public relations	1.18	38	1.66	33=	2.58	9=	1.80	29
Property economics	0.27	70=	0.79	71	1.30	59	1.78	30
Total Quality Management (TQM)	1.60	25=	1.74	29	1.95	30	1.76	31
Marketing	0.72	55	1.60	36=	2.88	6	1.73	32
Codes of practice	1.60	25=	1.69	30	1.78	35	1.69	33=
Worker participation	2.13	17	1.62	35	1.34	56	1.69	33=
Entrepreneurship	0.57	65=	1.27	51=	3.07	4	1.63	35
Environment	1.30	35	1.60	36=	1.98	28=	1.62	36
Cost engineering	1.51	32	1.81	28	1.49	48=	1.60	37
Dispute resolution	1.57	27=	1.50	42	1.60	42	1.55	38
Professional practice	1.05	43	1.55	40	1.98	28=	1.52	39
Strategic planning	1.02	45=	1.60	36=	1.92	31=	1.51	40
Accountancy	0.70	56	1.60	36=	2.17	21	1.49	41
Training	1.38	34	1.68	31	1.32	57	1.46	42
Procurement systems	1.09	41	1.66	33=	1.50	46=	1.41	43
Remuneration	0.91	49=	1.53	41	1.72	37	1.38	44
Risk management	1.07	42	1.33	46=	1.66	39	1.35	45

Industrial relations	1.23	36	1.31	48	1.39	54	1.31	46
Environmental issues	1.04	44	1.29	50	1.56	43	1.29	47
Cash flow forecasting	0.60	63	1.35	44	1.81	33	1.25	48=

Table 13: Mean frequency of use of subject areas and for all levels of management (Part B).

Subject area	Levels of management							
	Operational		Middle		Top		Mean	
		Rank		Rank		Rank		Rank
Final accounts	0.85	52	1.39	43	1.53	45	1.25	48=
Labour law	1.11	40	1.24	54=	1.40	53	1.25	48=
Statistics	1.02	45=	1.30	49	1.31	58	1.21	51
Drawing (Engineering / Geometric)	1.57	27=	1.14	58	0.89	68	1.20	52
Commercial law	0.66	59	1.23	56	1.66	38	1.18	53
Benchmarking	0.73	54	1.27	51=	1.49	48=	1.16	54=
Service management	0.69	57=	1.34	45	1.46	50	1.16	54=
Structural principles / design	1.17	39	1.33	46=	0.91	67	1.13	56
Economics	0.57	65=	1.16	57	1.64	40	1.12	57=
Insurance	0.69	57=	1.24	54=	1.45	51	1.12	57=
Facilities management	0.57	65=	1.25	53	1.35	55	1.05	59
Design (Temporary works)	1.19	37	1.07	62	0.75	72	1.00	60=
Design management	0.59	64	1.12	60	1.29	60=	1.00	60=
Industrial psychology	0.80	53	0.95	65	1.21	63	0.98	62
Physics	1.02	45=	1.09	61	0.72	73	0.94	63=
Value management/engineering	0.64	62	1.13	59	1.05	64	0.94	63=
Company law	0.27	70=	0.90	68	1.62	41	0.93	65
Surveying (Land)	1.57	27=	0.80	69=	0.31	77	0.89	66
Work study	1.00	48	0.93	66	0.71	74	0.88	67
Property development	0.20	75	0.88	69=	1.54	44	0.87	68
Valuing	0.65	60=	1.00	63=	0.93	66	0.86	69
Re-engineering	0.65	60=	0.92	67	0.84	69	0.80	70=
Research	0.44	68	1.00	63=	0.97	65	0.80	70=
Property law	0.23	73=	0.77	72	1.29	60=	0.76	72
Tax	0.12	76	0.67	73	1.25	62	0.68	73
Life cycle costing	0.33	69	0.66	74	0.82	70	0.60	74
Sociology	0.24	72	0.58	75	0.64	76	0.48	75
International contracting	0.05	78	0.36	77	0.76	71	0.39	76
Conveyancing	0.07	77	0.44	76	0.65	75	0.38	77
Marine Methods (Construction)	0.23	73=	0.17	78	0.23	78	0.21	78

4. Summary

Tables 13 and 14 provide a summary of the top ten skills and subject areas for all levels of management in terms of ranks for the phase 1 and 2 practice of construction management studies reported on in the review of the literature and the research sections above, respectively.

Table 13 indicates that relative to skills, sixty-five of the eighty ranks (81.3%) presented are within the top ten of their respective studies — there is limited discordance between the findings of the two studies. Although the II values have not been presented due to the use of different scales, it should be noted that the differences between the highest and lowest ranked mean skill II values are:

- Phase 1: 0.15 on an II ranging from 0.00 to 3.00 (5%), and
- Phase 2: 0.63 on an II ranging from 0.00 to 4.00 (15.8%).

The ranking of communicating (oral), communicating (written), decision making, administrative, leadership, and interpersonal, in particular the two communicating skills, amplifies the importance of the management function of leading. Furthermore, it is notable that the other four functions of management work are ranked within the top ten: organising; coordinating, planning, and controlling.

Table 14: Mean frequency of use of skills for all levels of management for Phases 1 and 2 in terms of ranks.

Skill	Levels of management							
	Operational		Middle		Top		Mean	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Communicating (Oral)	2	1	3	1	1=	1=	1	1
Communicating (Written)	14	2	13	2	4=	4	9	2
Decision making	8=	8	1=	4=	1=	3	2=	3
Organising	5	6	5	4=	12	6=	7=	4
Administrative	8=	7	6=	8	4=	5	5=	5=
Leadership	10=	11	10=	10	7	1=	7=	5=
Coordinating	6=	4	6=	11	4=	8	4	7
Planning	3=	9	4	4=	13	11	5=	8
Interpersonal	10=	13	10=	9	14=	9	10	11
Controlling	3=	10	1=	15	3	10	2=	13

Table 14 indicates that relative to knowledge areas, fifty-two of the eighty ranks (65%) presented are within the top ten of their respective studies — there is a degree of discordance between the findings of the two studies. The differences between the highest and lowest ranked mean knowledge area II values are:

- Phase 1: 0.32 on an II ranging from 0.00 to 3.00 (10.7%), and
- Phase 2: 0.82 on an II ranging from 0.00 to 4.00 (20.5%).

The ranking of construction methods (building) indicates the importance of technical knowledge. The ranking of cost control, quality management, planning (programming), and productivity reflect the status of the traditional three project parameters: cost; quality, and time. The ranking of customer service reflects the status of client satisfaction — client satisfaction was ranked first among eleven project parameters during a study conducted among project managers (Smallwood and Venter, 2002). Furthermore, client satisfaction is essentially a function of performance relative to the traditional project parameters of cost, quality, and time. The relevance of the other subject areas is as follows. Construction management includes the management of projects and therefore contract administration and contract documentation are important. Furthermore, both require communicating. The greater percentage of all projects is undertaken by subcontractors, and construction managers invariably interact with project managers.

5. Conclusions

Construction managers, certainly members of the CIOB (Southern Africa), spend a limited number of years at operational management level, and more at both middle and top management level.

The most frequently used subject areas reflect the focus at the respective levels of management: top — the management of the business of construction; middle — the management of a number of projects, and operational — the management of specific projects.

Based upon their frequency of use and current tertiary education, the question arises as to the extent to which tertiary institutions and continuing professional development (CPD) address a number of skills and subject areas. The skills are: interpersonal; entrepreneurial; initiating; team building; conflict resolution; procedures development; systems development; design management; research; design

(temporary works), and negotiating with the community. The subject areas are: customer service; entrepreneurship; ethics; management systems; procedures; total quality management; risk management; procurement systems; dispute resolution; benchmarking; service management; facilities management; design management; design (temporary works); research; worker participation, and reengineering.

Table 15: Mean frequency of use of knowledge for all levels of management for Phases 1 and 2 in terms of ranks.

Knowledge area	Levels of management							
	Operational		Middle		Top		Mean	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Construction methods (building)	1	1=	1	2	6=	9=	1	2
Cost control	3	9	2	4	2=	15	2	6=
Quality management	4	8	6	7=	6=	20	3	6=
Contract administration	5=	16	3=	3	9	12	4=	8
Subcontractor management	2	4	8=	6	12=	25	4=	5
Contract documentation	10=	18	3=	9	6=	22	6	15
Planning (programming)	7	10=	7	16=	17	17	7	12
Customer service	19	21	10	7=	1	2	8	4
Project management	18	27=	3=	10=	12=	16	9	20
Productivity	14	5	12	14=	18=	23=	10	9

6. Recommendations

Construction management undergraduate programmes need to focus on management and more specifically the management of resources within defined parameters such as cost, environment, health and safety, productivity, quality, and time. However, to be able to manage resources within defined parameters requires technical expertise relative to the construction process. The findings clearly indicate the need to empower graduates to improve the construction process — customer service, health and safety, productivity and quality management. These findings correlate with the con-

ention of Harris (1996) that the Royal Commission in New South Wales would say that undergraduate construction management education has not added value and produced a healthy industry in Australia. Given the aforementioned findings, complementary issues need to be addressed: benchmarking; constructability; partnering; procurement systems; reengineering, and value management. Furthermore, given that construction managers spend a limited number of years at operational management level, and more at both middle and top management level and those construction managers in small and medium sized organisations need to fulfil a range of functions, construction management programmes need to empower graduates to manage the business of construction.

Councils should benchmark tertiary education programmes in terms of skills and subject areas and assess applicants applying for registration accordingly. Institutes should follow suit and engender the delivery of appropriate education and training by the providers thereof, to assure that applicants applying to upgrade their membership, and non-applicants applying for membership, will complement the discipline, practice, and profession of construction management. Furthermore, institutes should evolve the requisite CPD where inadequacies in education and training have been identified, or where changes in the construction environment require such CPD. Practitioners should objectively assess their current 'basket' of skills and level of knowledge relative to subject areas. Tertiary institutions should assess whether they address the subject areas, and the development of the skills, and if so, the extent to which they do.

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