

Practising the Discipline of Construction Management: Knowledge and Skills

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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 project, or projects. 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.

Given that previously no research relative to the practice of the discipline of construction management had been undertaken in South Africa, two descriptive surveys were 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 paper 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.*

LITERATURE SURVEY

Introduction

The discipline of construction management is vocational in nature, which results in conflict between vocational and academic objectives, educationalists continually being criticised either overtly or implicitly that the content and approach of the undergraduate courses does not meet the needs of practice (McGeorge, 1993). However, Harriss (1996) maintains tertiary educational institutions should be producing graduates who have the initiative, drive and ability to change the industry. Instead “graduates simply blend in and go with the flow”. Harriss (1996) further maintains one should examine the impact of university education on the Australian building industry and asks the question: “Have we added value and produced a healthy industry?” and adds that the Royal Commission in New South Wales would say no.

Given the findings of a preliminary literature survey, the debate surrounding the content of construction management undergraduate courses, and the fact that no research had been undertaken in South Africa, the first ever study was conducted to investigate the practice of the discipline of construction management. The following constitute the objectives of the study:

- to determine the required knowledge areas and their frequency of use, and
- to determine the required skills and their frequency of use.

SKILLS AND KNOWLEDGE

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 1). 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 1: Composite summary rankings of skills identified for construction senior executive through engineers (Dorsey, 1991)

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

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 suggest 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.

Table 2: Top ten skill/knowledge areas for each level of construction manager (adapted from Young & Duff, 1990)

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

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 2).

RESEARCH

The findings of two separate studies will be reported on. The first 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). The objectives of the study were to determine the skills, areas of knowledge and personality characteristics pertinent to, among other, construction managers.

The second study entailed a national postal survey of non-student members of the SAIB. 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.

Study 1

Due to the late announcement of a national forum to discuss critical academic issues pertaining to the built environment and the need for research findings to facilitate discussion, a limited period of time was available for the circulation and return of the questionnaire – 23 calendar days. Nevertheless, a comprehensive six page questionnaire was mailed to 1172 GCs and 670 SAIB members.

39 GCs returned questionnaires, of which 35 were analysed, representing an effective response rate of 3.1%. However, the low level of response may also have been attributable to the length and comprehensive nature of the questionnaire, in that respondents were required to respond relative to five built environment practitioners.

54 SAIB members returned questionnaires, of which 45 were analysed, representing an effective response rate of 6.7%; 8 responses were received too late to be included in the analysis.

42% of GCs completed construction with an annual value of '>R25m', followed by '>R1m ≤ R5m' (34.3%) and '>R10m ≤ R25m' (17.1%). 68.6% of GCs undertook industrial construction, followed by commercial (65.7%), infrastructure (37.1%) and domestic (22.9%). '0 – 2 floors' (40%) predominated among the levels of construction GCs mostly worked at, followed by 'ground' (37.1%) and '0 – 10 floors' (14.3%).

The GCs subcontracted, on average, 6.0% of the value of construction on a 'labour only' basis, and 26.4% on a 'full' basis. The GCs employed on average, a total of 1057 workers: 275.6 skilled; 373.4 semi-skilled, and 408 unskilled.

41.9% of SAIB members were involved with construction with an annual value of '≤R10m', followed by '>R10m≤R25m' (23.3%) and '>R25m≤R50m' (18.6%). On average, 23.2% of SAIB members were involved with commercial construction, followed by domestic (23.3%) and industrial (23.2%). '0 – 2 floors' (43.2%) predominated among the levels of structures/construction SAIB members were mostly involved with, followed by '0 – 10 floors' (27.3%) and 'ground' (20.5%).

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 is 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, decision making joint fifth, and plan reading and written communication, eleventh and twelfth respectively.

Measuring (quantities) is only ranked twenty ninth, estimating twenty-eighth, and costing, twenty-first. It is significant that the only skill with a mean response of less than 66.7%, is that of measuring (quantities).

Table 3: 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
Plan reading	94.3	97.8	96.1	14=	5=	11
Written communication	100.0	91.1	95.6	1=	17	12
Coordinating	97.1	93.3	95.2	10=	14=	13=
Time management	97.1	93.3	95.2	10=	14=	13=
Team building	94.3	95.6	95.0	14=	12=	15
Practical	91.4	97.8	94.6	16=	5=	16=
Report writing	91.4	97.8	94.6	16=	5=	16=
Negotiating	91.4	88.9	90.2	16=	18=	18
Administration	88.6	84.4	86.5	20	20=	19
Initiating	85.7	84.4	85.1	21	20=	20
Costing	91.4	77.8	84.6	16=	23	21
Numerical (maths)	82.9	82.2	82.6	22=	22	22
Surveying (setting out etc.)	68.6	88.9	78.8	27	18=	23
Financial management	74.3	75.6	75.0	24=	24	24
Computer literacy	74.3	73.3	73.8	24=	25	25
Entrepreneurial	82.9	51.1	67.0	22=	28	26
Graphic communication	65.7	66.1	66.2	28	26	27
Estimating	71.4	57.8	64.6	26	27	28
Measuring (quantities)	60.0	44.4	52.2	29	29	29

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 schedule 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 schedule 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 schedule is important.

Study 2

A comprehensive eight-page questionnaire was mailed to 733 SAIB members by the SAIB. 59 questionnaires were returned, which represents a response rate of 8.1%.

Project manager (17.5%) predominated in terms of the respondents' occupations, followed jointly by contracts manager (10.5%), director (10.5%) and managing director (10.5%). 'Other' occupations accounted for the remaining 51%.

44% of respondents were involved with construction with an annual value of 'R0m – R10m', followed by '>R10m ≤ R25m' (22.%), '>R25m ≤ R50m' (13.6%), '>R100m' (13.6%), and '>R50m ≤ R100m' (6.8%).

Table 4 (Part A): 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=
Contract administration	97.1	93.3	95.2	4=	14=	12
Human resources	94.3	93.3	93.8	8=	14=	13
Negotiating	91.4	93.3	92.4	14=	14=	14
Contract documentation	100.0	84.4	92.2	1=	31=	15
Ethics	97.1	86.7	91.9	4=	26=	16
Codes of practice	91.4	91.1	91.3	14=	20=	17=
Languages (English)	91.4	91.1	91.3	14=	20=	17=
Worker participation	88.6	93.3	91.0	22=	14=	19
Specifications	94.3	86.7	90.5	8=	26=	20
Customer service	91.4	88.9	90.2	14=	23=	21=
Management (business)	91.4	88.9	90.2	14=	23=	21=
Project management	85.7	93.3	89.5	26=	14=	23
Law (labour)	82.9	95.6	89.3	29=	12=	24
Cost control	88.6	86.7	87.7	22=	26=	25=
Construction methods (civil)	88.6	86.7	87.7	22=	26=	25=
Procedures	80.0	93.3	86.7	33=	14=	27
Training	85.7	86.7	86.2	26=	26=	28
Mathematics	88.6	82.2	85.4	22=	33=	29
Service installation	74.3	95.6	85.0	42=	12=	30
Industrial psychology	80.0	88.9	84.5	33=	23=	31
Information technology	77.1	91.1	84.1	37=	20=	32
Entrepreneurship	85.7	75.6	80.7	26=	38=	33
Surveying (land)	77.1	82.2	79.7	37=	33=	34
Affirmative action	82.9	75.6	79.3	29=	38=	35=
Financial management	82.9	75.6	79.3	29=	38=	35=
Work study	82.9	75.6	79.3	29=	38=	35=
Estimating	80.0	77.8	78.9	33=	36=	38
Public relations	74.3	82.2	78.3	42=	33=	39
Facilities management	77.1	75.6	76.4	37=	38=	40=
Purchasing	77.1	75.6	76.4	37=	38=	40=
Cash flow forecasting	80.0	68.9	74.5	33=	51=	42
Remuneration	77.1	71.1	74.1	37=	47=	43
Planning (strategic)	74.3	73.3	73.8	42=	45=	44
Environmental issues	74.3	71.1	72.7	42=	47=	45
Benchmarking	68.6	73.3	71.0	50=	45=	46
Structural design	57.1	84.4	70.8	57=	31=	47=
Risk management	71.4	66.7	69.1	48=	53=	47=
Economics	68.6	68.9	68.8	50=	51=	49
Law (commercial)	60.0	75.6	67.8	55=	38=	50
Cost engineering	71.4	62.2	66.8	48=	57=	51
Drawing (engineering/geometric)	65.7	66.7	66.2	52=	53=	52
Languages (African)	54.3	77.8	66.1	63=	36=	53
Law (company)	60.0	71.1	65.6	55=	47=	54
Final accounts	74.3	55.6	65.0	42=	61=	55

Table 4 (Part B): Recommended subject areas for construction managers according to GCs and SAIB members

Subject area	Response per population (%)			Ranking		
	GC	SAIB	Mean	GC	SAIB	Mean
Professional practice	57.1	71.1	64.1	57=	47=	56
Measuring (quantities)	65.7	60.0	62.9	52=	59	57
Reengineering	62.9	62.2	62.6	54	57=	58
Accountancy	57.1	64.4	60.8	57=	55=	59=
Physics	57.1	64.4	60.8	57=	55=	59=
Marketing	74.3	44.4	59.4	42=	68=	61
Value management/engineering	57.1	55.6	56.4	57=	61=	62
Design	54.3	57.8	56.1	63=	60	63
Statistics	57.1	48.9	53.0	57=	65	64
International contracting	51.4	51.1	51.3	65	64	65
Sociology	45.7	44.4	45.1	66=	68=	66
History of building	34.3	53.3	43.8	73	63	67
Research	42.9	42.2	42.6	68=	67	68
Law (property)	37.1	46.7	41.9	72	66	69
Construction methods (marine)	45.7	37.8	41.8	66=	70=	70
Property economics	42.9	35.6	39.3	68=	72	71
Property development	40.0	37.8	38.9	70=	70=	72
Life cycle costing	40.0	31.1	35.6	70=	73	73
Conveyancing	25.7	20.0	22.9	74	74=	74
Languages (European)	22.9	20.0	21.5	75	74=	75

On average, respondents had 4.8 years experience at operational management level, 6.4 years at middle and 6.1 years at top management levels. 55.9% of respondents were currently working at top management level, 32.2% at middle, and 11.9% at operational management levels.

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.

Table 5 (Part A): Importance of skills per level of construction management based on frequency of use

Skill	Level of management							
	Operational		Middle		Top		All	
	I I	Rank	I I	Rank	I I	Rank	I I	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
Costing	1.05	20	1.61	8=	1.69	8	1.45	11
Plan reading	1.32	1	1.61	8=	1.39	25=	1.44	12
Motivating	1.14	15	1.49	16=	1.66	11	1.43	13
Negotiating (subcontractors)	1.24	6=	1.51	14=	1.41	24	1.39	14=
Technical	1.07	17=	1.59	10=	1.51	18	1.39	14=
Team building	1.00	22	1.46	18	1.58	16	1.35	16
Numerical (maths)	1.20	10=	1.49	16=	1.32	27	1.34	17=
Report & writing	1.12	16	1.51	14=	1.39	25=	1.34	17=
Financial	0.85	25=	1.36	22=	1.68	9=	1.30	19
Supervisory	1.20	10=	1.41	19	1.22	33	1.28	20
Initiating	0.85	25=	1.31	25=	1.61	14=	1.26	21
Negotiating (client)	0.64	34	1.36	22=	1.68	9=	1.23	22
Estimating	0.83	29	1.39	20	1.42	22=	1.21	23=

Table 5 (Part B): 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
Measuring (productivity)	1.07	17=	1.31	25=	1.25	31=	1.21	23=
Procedures development	0.86	24	1.31	25=	1.47	19	1.21	23=
Negotiating (material suppliers)	1.00	21	1.29	28	1.25	31=	1.18	26
Computer	0.71	33	1.37	21	1.42	22=	1.17	27
Measuring (quantities)	1.07	17=	1.32	24	1.07	35=	1.15	28
Conflict resolution	0.85	25=	1.10	32	1.44	21	1.13	29
Communicating (graphic)	0.81	30	1.15	30=	1.29	28=	1.08	30
Entrepreneurial	0.59	35	1.02	35	1.56	17	1.06	31
Marketing	0.54	37	1.15	30=	1.46	20	1.05	32
Negotiating (plant hire)	0.97	23	1.08	33=	1.07	35=	1.04	33
Systems development	0.53	38	1.19	29	1.29	28=	1.00	34=
Training	0.78	31	1.08	33=	1.15	34	1.00	34=
Auditing	0.46	39=	0.83	39=	1.29	28=	0.86	36
Design (formwork)	0.85	25=	0.80	41	0.76	40	0.80	37
Research	0.37	41	0.95	36	0.90	39	0.74	38=
Statistical	0.36	42	0.90	37	0.97	37=	0.74	38=
Work study	0.56	36	0.83	39=	0.73	41	0.71	40
Negotiating (unions)	0.46	39=	0.66	42	0.97	37=	0.70	41=
Surveying (land)	0.73	32	0.85	38	0.51	42	0.70	41=

Given the possible range of responses and to enable the skills and subject areas to be ranked in terms of importance relative to frequency, an importance index (I I) with a minimum value of 0 and a maximum value of 3, was computed for each skill and subject area, using the formula:

$$\frac{3n_1 + 2n_2 + 1n_3 + 0n_4}{(n_1 + n_2 + n_3 + n_4)}$$

where

n_1	=	frequently
n_2	=	sometimes
n_3	=	rarely
n_4	=	never

Respondents were required to respond regarding the frequency of use of 42 skills (Table 5). 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.

It is notable that the I Is 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.

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 schedule 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 I Is 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; health and safety, materials, material management, plant and equipment management are unique to operational management; project management is unique to middle management; cash flow forecasting, financial management, business management, negotiating and remuneration are unique to top management.

Table 6 (Part A): 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
Estimating	0.83	20=	1.54	11	1.42	21=	1.26	11=
Materials	1.05	8=	1.44	15=	1.29	28=	1.26	11=
Measuring (quantities)	1.05	8=	1.58	8=	1.14	46	1.26	11=
Negotiating	0.68	31=	1.47	14	1.64	2=	1.26	11=
Ethics	0.83	20=	1.39	18	1.51	15=	1.24	15
Human resources	0.93	13	1.25	24=	1.51	15=	1.23	16
Specifications	0.88	15=	1.53	12	1.22	36=	1.21	17
Final accounts	0.75	25=	1.44	15=	1.42	21=	1.20	18=
Health and safety	0.98	10=	1.25	24=	1.37	24=	1.20	18=
Materials management	1.08	5=	1.34	19=	1.15	42=	1.19	20=
Purchasing	0.88	15=	1.42	17	1.27	31=	1.19	20=
Cash flow forecasting	0.59	38	1.34	19=	1.61	5	1.18	22
Financial management	0.61	37	1.25	24=	1.64	2=	1.17	23
Procedures	0.75	25=	1.32	21=	1.37	24=	1.15	24=
Professional practice	0.76	23=	1.32	21=	1.36	26	1.15	24=
Remuneration	0.69	29=	1.12	36	1.56	10=	1.12	26
Management (business)	0.53	48=	1.25	24=	1.56	10=	1.11	27=
Plant and equipment management	0.98	10=	1.14	35	1.22	36=	1.11	27=
Mathematics	0.88	15=	1.32	21=	1.08	48=	1.09	29=
Total Quality Management (TQM)	0.76	23=	1.25	24=	1.25	33=	1.09	29=
Entrepreneurship	0.64	35	1.15	33=	1.46	18=	1.08	31
Accountancy	0.53	48=	1.15	33=	1.46	18=	1.05	32
Public relations	0.63	36	1.20	30=	1.29	28=	1.04	33
Codes of practice	0.66	33=	1.20	30=	1.22	36=	1.03	34=
Marketing	0.44	55	1.12	36	1.54	12=	1.03	34=
Cost engineering	0.75	25=	1.17	32	1.15	42=	1.02	36=
Planning (strategic)	0.58	39=	1.07	41	1.41	23	1.02	36=
Design	0.69	29=	1.24	29	1.08	48=	1.00	38
Information technology	0.58	39=	1.08	39=	1.29	28=	0.98	39
Construction methods (civil)	0.83	20=	1.10	38	0.98	53	0.97	40
Law (labour)	0.58	39=	1.00	42	1.31	27	0.96	41
Training	0.58	39=	1.08	39=	1.15	42=	0.94	42
Worker participation	0.73	28	0.98	43=	1.07	50	0.93	43
Industrial relations	0.68	31=	0.88	50=	1.19	41	0.92	44
Benchmarking	0.58	39=	0.97	46	1.12	47	0.89	45
Law (commercial)	0.41	56	0.98	43=	1.24	35	0.88	46
Facilities management	0.56	45=	0.86	53=	1.15	42=	0.86	47
Risk management	0.39	57	0.90	48=	1.27	31=	0.85	48
Economics	0.39	57	0.88	50=	1.25	33=	0.84	49
Law (company)	0.34	61	0.90	48=	1.22	36=	0.82	50

Table 6 (Part B): 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
Law (property)	0.36	60	0.83	58	1.20	40	0.80	51
Environmental issues	0.47	51=	0.86	53=	0.95	54	0.76	52=
Structural design	0.49	50	0.98	43=	0.80	60	0.76	52=
Service installation	0.56	45=	0.78	60=	0.90	56	0.75	54
Research	0.27	63=	0.86	53=	1.02	51=	0.72	55=
Value management/engineering	0.47	51=	0.76	62	0.92	55	0.72	55=
Property development	0.22	66	0.88	50=	1.02	51=	0.71	57
Statistics	0.37	59	0.92	47	0.81	58	0.70	58=
Surveying (land)	0.66	33=	0.86	53=	0.59	67	0.70	58=
Physics	0.46	54	0.86	53=	0.71	63	0.68	60
Work study	0.54	47	0.75	63	0.71	63	0.67	61
Reengineering	0.47	51=	0.71	64	0.76	61	0.65	62
Property economics	0.25	65	0.80	59	0.88	57	0.64	63
Drawing (engineering/geometric)	0.58	39=	0.78	60=	0.47	48=	0.61	64
Industrial psychology	0.32	62	0.64	65	0.81	58	0.59	65
Conveyancing	0.17	68=	0.53	67	0.76	61	0.49	66
Life cycle costing	0.17	68=	0.58	66	0.64	65	0.46	67
Sociology	0.27	63=	0.47	68=	0.61	66	0.45	68
International contracting	0.19	67	0.47	68=	0.32	69	0.33	69
Construction methods (marine)	0.03	70	0.17	70	0.14	70	0.11	70

DISCUSSION

Although research referred to in literature and descriptive surveys 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 subskills of other skills (noted in parentheses): decision making (leadership); conflict resolution (organising); interpersonal (communicating) and administrative (communicating).

Table 7: Review of top ten ranked skills for each study

Skill	Dorsey	Young & Duff			Study 1 Mean	Study 2			
		Junior	Middle	Senior		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)

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.

Table 8: Review of top ten subject areas for each study

Skill	Young & Duff			Study 1	Study 2			
	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)

RECOMMENDATIONS

Construction management undergraduate programmes need to focus on management, and more specifically the management of resources within defined parameters e.g. cost, health and safety, productivity, quality, schedule and the environment. 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 i.e. customer service, health and safety, productivity and quality management. These findings correlate with the contention of Harriss (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 abovementioned findings, complementary issues need to be addressed: benchmarking, constructability, partnering, procurement systems, reengineering and value management.

Another contention of Harriss (1996) which deserves attention is that undergraduate construction management programmes are disassembled into discrete subjects with a single focus. This bears no relation to the way graduates use their knowledge. Harriss (1996) in fact maintains “A graduate does not walk over a freshly stripped suspended slab and think now I’m doing ‘Structures 1’, only to return to the site office and do some ‘Contract Administration 1’ or some ‘Estimating 2’.” A further argument of Harriss (1996) is that undergraduate construction management education should aim to educate a ‘general practitioner’ in construction who will become a specialist through post graduate study and working with specialists.

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