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CONSTRUCTION, ENGINEERING & PUBLIC WORKS INSPECTION 2012 CONFERENCE

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QUALITY MANAGEMENT IN CONSTRUCTION

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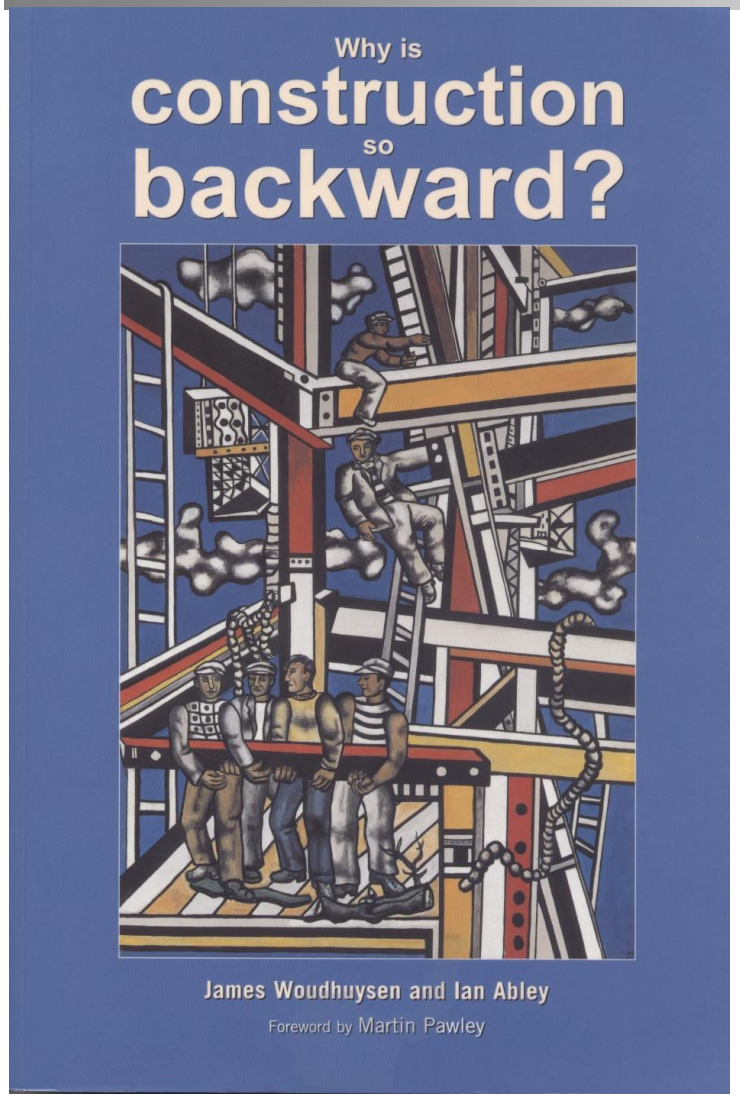
Why is construction so backward?



(Woudhysen and Abley, 2004)

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Absolutes of quality

Crosby (1984):

- **Definition: Conformance to requirements**
- **Performance standard: Zero defect**
- **System: Prevention**
- **Measurement: Price of non-conformance**

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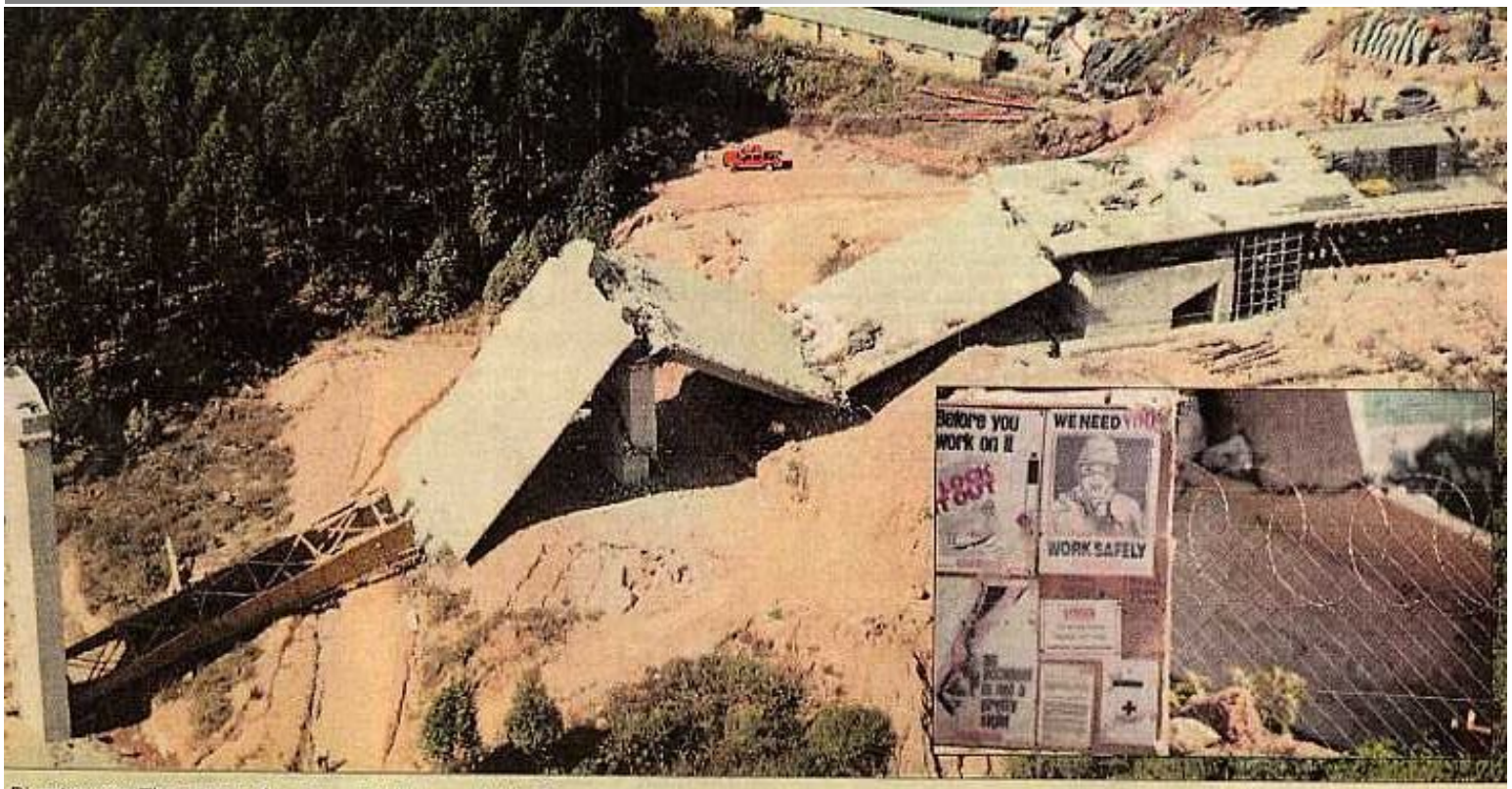
Injaka Bridge collapse (1)



Disaster area: The construction of a road bridge near Injaka Dam turned into disaster when it collapsed, instantly killing 12 people and injuring 15. Two of the injured died later. Insert - A reminder to workers of the dangers of working on a construction site. Full update on page 2. **Photographs by Raymond Travers.**

Injaka Bridge collapse, Mpumalanga, July, 1998 (Travers, 1998)

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Injaka Bridge collapse (2)

- **Causes (Department of Labour, 2002):**
  - The slide path was not under the webs
  - The placing of the sliding pads between the deck and temporary bearings was not as specified
  - Insufficient reinforcement in the deck section, especially the bottom slab
  - The failure to fully appreciate the implications of the early cracks
  - The acceptance and approval of a launching nose which was substantially less stiff than that prescribed in the project specification
  - The deviation from the project specification regarding the automatic pier deflection monitoring at pier 2
  - The deviation from the project specification regarding the height tolerances of the temporary bearings on pier 3
  - The use of design and construction personnel, at decision-making level, without appropriate qualification and experience in incremental launched bridges

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Injaka Bridge collapse (3)

- No independent design reviews were conducted of either the temporary or permanent works
- **Contributory causes (Department of Labour, 2002):**
  - The lack of experience on the part of design personnel in incremental launching techniques resulted in poor communications between the parties to clarify understandings and interpretations regarding the slide path position
  - The lack of clear instructions in the project specification and clear indications on the consulting engineers design drawings as to the position of the sliding path, resulted in incorrect interpretations being made

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Pretoria North shopping centre collapse

Pretoria North Shopping Centre slab collapse, October, 1996 (Davis, 1996)

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Coega Bridge collapse (1)

Coega Bridge collapse, Port Elizabeth, November, 2003 (Markman, 2003)

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Coega Bridge collapse (2)

Coega Bridge collapse, Port Elizabeth, November, 2003 (Markman, 2003)

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Coega Bridge collapse (3)

Coega Bridge collapse, Port Elizabeth, November, 2003 (Markman, 2003)

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Investec Office Complex scaffolding collapse

Investec Office Complex scaffolding collapse, Sandton, August, 1997 (Prinsloo, 1997)

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Macro construction environment

Construction quality is subject to a macro environment:

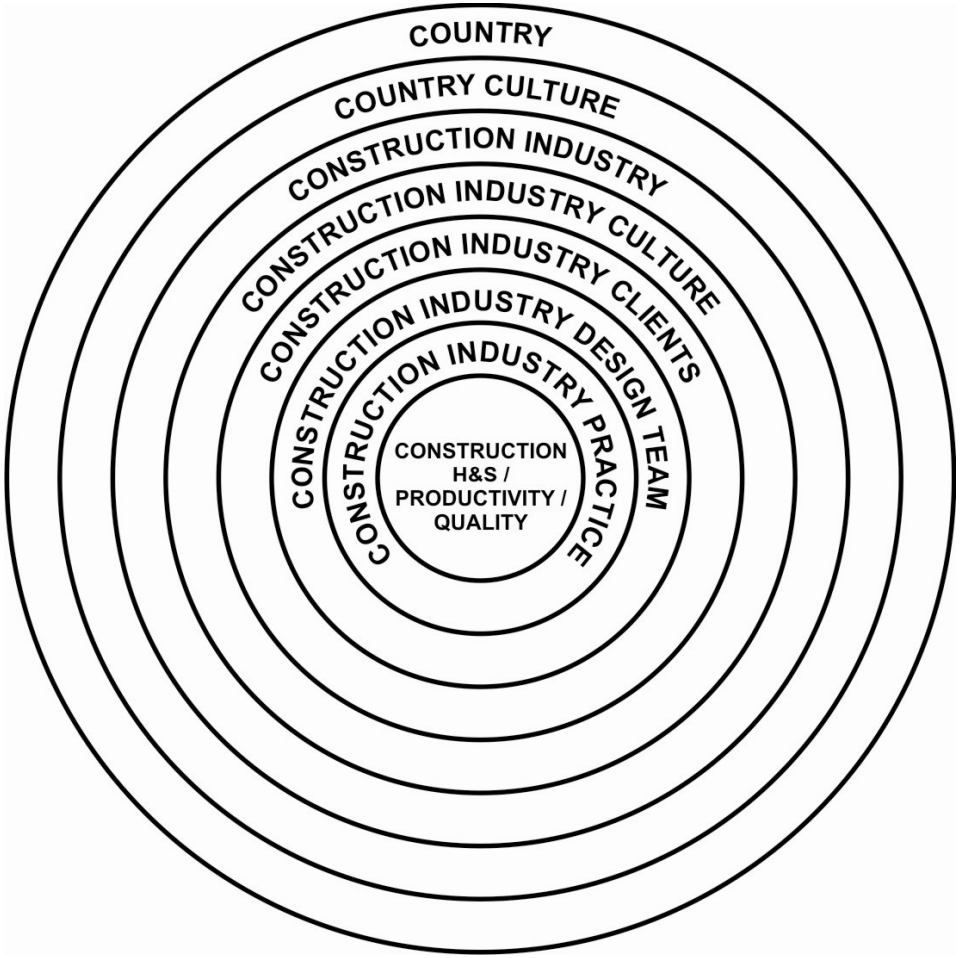

Figure 1: Construction H&S / Productivity / Quality – the macro environment (Smallwood, 2000)

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Challenges relative to construction

- Neanderlithic – 'little pieces of burnt clay glued together'
- Project phases: project initiation and briefing → concept and feasibility → design development → tender documentation and procurement → construction documentation and management → project close out
- Separation of design and construction
- Industry structure
- Fragmented contributions
- Focus on cost and time
- Client driven industry
- Procurement – competitive tendering
- No barriers to entry
- De-skilling
- Poor culture

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Shoddy low-cost housing construction costs State R50bn (1)

Odendaal (2012):

- **"Rectification of substandard construction work on many of the low-cost housing projects throughout South Africa has left the State with a bill of about R50-billion, said Human Settlements Minister Tokyo Sexwale on Thursday."**
- **"Speaking at a construction sector breakfast, Sexwale said he was hesitant to spend any of the R25-billion set aside in his budget for housing projects until the issue of substandard work was resolved and he received certain assurances from the sector."**
- **"Inexperienced, less-than-credible 'shovel, wheelbarrow and bakkie brigade' construction groups involved in the tenders for government's housing programmes were delivering 'shoddy' workmanship and many of their constructions were falling apart."**

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Shoddy low-cost housing construction costs State R50bn (2)

- **“Black economic-empowerment was not a licence to deliver substandard or poor-quality work, he said.”**
- **“Sexwale reported that there were about 2 000 people at national level which were believed to be involved in corruption and the awarding of tenders before many had a chance to bid. But it did take two to tango, he noted, adding that this was something the department was looking into.”**
- **“Others commented on a number of issues in the industry, including unclear building specifications, the lack of sufficient and competent inspectors for large contracts, lack of partnerships, the need for training centres and skills transfer, poor-quality material, and continued lack of implementation of ever-mounting policies and regulations.”**

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Research findings

- The research findings reported on in Tables 1 to 20 emanate from the empirical surveys conducted relative to the cidb report *CONSTRUCTION QUALITY IN SOUTH AFRICA: A client perspective* (www.cidb.org.za)
- The findings are the unexpurgated version i.e. detailed
- Stakeholders surveyed included: clients; project managers; designers; cidb Grade 2-4 contractors; cidb Grade 5-9 contractors; employer associations, and tertiary built environment education
- Mean score (MS): 1.00 – 5.00:
  - 1.00: Strongly disagree / Not important / Very poor / Minor extent / Minor contribution
  - 5.00: Strongly agree / Very important / Very good / Major extent / Major contribution

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Definitions of quality

Definition	Mean Score								Rank
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Tert BE Edu.	Mean	
Doing things right in every part and level of the organisation	3.69	4.44	3.83	4.44	4.32	3.25	4.63	4.09	1
Excellence	4.07	4.00	4.20	4.28	4.23	3.00	4.00	3.97	2
Conformance to requirements	3.77	3.56	3.83	4.24	4.50	3.50	3.63	3.86	3
Best practice	4.08	4.22	3.17	4.12	4.09	3.00	4.00	3.81	4
Durability	3.77	3.89	3.67	4.25	4.27	2.75	3.75	3.76	5
Conformance to customer requirements	3.85	3.33	2.83	4.32	4.27	3.63	3.88	3.73	6
Customer satisfaction	3.62	3.78	2.50	4.48	4.23	2.75	3.75	3.59	7

Table 1: Extent of agreement with definitions of quality

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Importance of parameters (1)

Parameter	Mean Score							Rank
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean	
Quality	4.29	4.67	4.33	4.92	4.64	4.56	4.57	1
Cost	4.36	4.44	4.67	4.44	4.68	4.22	4.47	2
Time	4.21	3.89	4.67	4.76	4.64	4.22	4.40	3
Health and safety (H&S)	4.43	4.22	3.67	4.80	4.68	4.33	4.36	4
Environment	4.21	4.22	3.17	4.24	4.23	4.56	4.11	5

Table 2: Importance of parameters to respondents' organisations

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Importance of parameters (2)

Parameter	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Cost	4.71	4.44	5.00	4.56	4.56	4.65	1
Time	4.71	4.11	4.50	4.75	4.22	4.46	2
Quality	4.57	3.78	4.00	4.75	3.44	4.11	3
Health and safety (H&S)	4.64	3.44	3.67	4.63	3.67	4.01	4
Environment	4.50	3.11	3.67	4.47	3.00	3.75	5

Table 3: Importance of parameters to built environment practitioners and stakeholders

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Importance of parameters (3)

Practitioner / Stakeholder	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Architects	4.14	4.56	4.67	4.30	3.67	4.27	1
Civil Engineering designers	4.36	4.44	3.80	4.50	4.00	4.22	2
Mechanical Engineering designers	4.07	4.33	4.20	4.42	3.86	4.18	3
Structural Engineering designers	4.21	4.33	4.33	4.42	3.57	4.17	4
Project managers	4.57	3.33	4.50	4.53	3.71	4.13	5
Electrical Engineering designers	4.29	4.00	3.60	4.33	3.57	3.96	6
Quantity surveyors	3.86	3.67	3.33	4.19	3.14	3.64	7
Grade 5-9 contractors	3.79	3.13	3.33	4.59	2.75	3.52	8
Materials manufacturers	3.71	3.14	3.50	3.82	3.14	3.46	9
Trade contractors	3.07	2.44	2.83	4.14	2.43	2.98	10
Grade 2-4 contractors	3.21	2.78	3.00	3.54	2.25	2.96	11
Labour only contractors	3.07	1.89	2.00	3.53	2.14	2.53	12

Table 4: Importance of quality to built environment practitioners and stakeholders

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Rating of practitioners / stakeholders in terms of performance relative to quality

Practitioner / Stakeholder	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Structural engineering designers	4.21	3.67	4.17	3.87	3.17	3.82	1
Civil engineering designers	4.36	3.67	3.67	3.89	3.33	3.78	2
Project managers	4.31	2.89	4.17	3.83	3.50	3.74	3
Mechanical engineering designers	4.14	3.56	3.67	3.79	3.33	3.70	4
Architects	3.71	3.67	3.83	3.79	3.29	3.66	5
Electrical engineering designers	4.14	3.33	3.67	3.93	3.00	3.61	6
Materials manufacturers	3.57	3.00	3.50	3.94	3.43	3.49	7
Quantity surveyors	3.64	3.22	3.50	3.63	3.00	3.40	8
Grade 5-9 contractors	3.29	2.89	3.50	3.63	2.33	3.13	9
Grade 2-4 contractors	2.86	2.78	3.33	2.94	2.17	2.82	10
Trade contractors	2.79	2.25	2.50	3.53	2.00	2.61	11
Labour only contractors	2.71	2.00	2.00	2.71	1.80	2.24	12

Table 5: Rating of built environment practitioners / stakeholders in terms of their performance relative to quality

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Rating of South African construction quality

Mean Score						
Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean
3.00	2.75	3.33	3.48	3.45	2.71	3.12

Table 6: Rating of South African construction quality

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Rating of South African construction quality

Sector	Mean Score							Rank
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean	
Upper-income residential	4.23	3.50	4.00	4.00	3.76	3.11	3.77	1
Industrial residential	3.60	2.75	3.60	3.78	3.71	3.17	3.44	2
Commercial	3.50	3.13	3.67	3.87	3.50	2.78	3.41	3
Infrastructure	3.57	3.00	3.33	3.04	3.47	2.75	3.19	4
Middle-income residential	3.29	2.38	2.83	2.96	2.82	2.67	2.83	5
Low-income residential	2.43	1.38	1.50	1.96	2.06	1.22	1.76	6

Table 7: Rating of South African construction quality

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Importance of interventions / systems relative to the achievement of quality

Intervention / System	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Total quality management	4.23	4.44	4.20	4.43	4.43	4.35	1
Quality management system	4.29	4.11	4.20	4.43	4.29	4.26	2
Quality control	4.43	4.33	4.33	4.64	3.43	4.23	3
Quality improvement	4.38	4.43	4.17	4.19	3.71	4.18	4
Quality assurance	4.36	3.63	4.00	4.55	3.43	3.99	5

Table 8: Importance of interventions / systems relative to the achievement of quality

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Importance of interventions / systems relative to the achievement of quality

Intervention / System	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Total quality management	4.23	4.44	4.20	4.43	4.43	4.35	1
Quality management system	4.29	4.11	4.20	4.43	4.29	4.26	2
Quality control	4.43	4.33	4.33	4.64	3.43	4.23	3
Quality improvement	4.38	4.43	4.17	4.19	3.71	4.18	4
Quality assurance	4.36	3.63	4.00	4.55	3.43	3.99	5

Table 8: Importance of interventions / systems relative to the achievement of quality

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Importance of interventions / systems relative to the achievement of quality (1)

Driver	Mean Score					Rank
	Client	Design-er	PM	Grade 5-9	Mean	
Management commitment and involvement	3.85	4.25	3.17	4.15	3.86	1
Customer expectations	3.92	3.88	3.33	4.19	3.83	2
Recorded outcomes and achievements i.t.o. quality	3.77	3.43	3.60	4.00	3.70	3
Benchmarking	4.08	3.38	3.40	3.84	3.68	4
Desirable results	3.85	3.38	3.20	3.95	3.60	5
Work improvement teams	3.82	3.50	3.00	3.58	3.48	6
Quality circles	3.92	3.14	3.20	3.61	3.47	7
Recorded outcomes and achievements i.t.o. reward systems / incentives	3.33	3.43	3.60	3.38	3.44	8
Recorded outcomes and achievements i.t.o. training	3.46	3.75	3.20	3.29	3.43	9

Table 9: Importance of interventions / systems relative to the achievement of quality (Part A)

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Importance of interventions / systems relative to the achievement of quality (2)

Driver	Mean Score					Rank
	Client	Design-er	PM	Grade 5-9	Mean	
Data and information	3.58	3.50	3.00	3.55	3.41	10
Recorded outcomes and achievements i.t.o. procurement of equipment and material	3.83	3.25	3.00	3.55	3.41	11
Allocation, use and control of operational resources	3.71	3.43	2.67	3.68	3.37	12
Levels of output or productivity	3.77	3.00	3.00	3.59	3.34	13
Profitability	3.15	3.63	2.67	3.90	3.34	14
Mission statement, vision and values	3.50	3.50	2.33	3.85	3.30	15
Short-term view	3.36	3.00	3.33	3.35	3.26	16
Recorded outcomes and achievements i.t.o. volume / output	3.38	2.83	2.83	3.50	3.14	17
Innovation and creativity	3.46	3.25	2.17	3.40	3.07	18
Probable outcomes	3.15	2.88	2.75	3.47	3.06	19

Table 9: Importance of interventions / systems relative to the achievement of quality (Part B)

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Prevalence of documented QMSs (1)

Category	Yes (%)
Client	42.9
Designers	37.5
PM	33.3
Grade 2-4 contractors	50.0
Grade 5-9 contractors	68.2
Mean	46.4

Table 10: Prevalence of documented QMSs in respondents' organisations

Category	Yes (%)
Client	16.7
Designers	0.0
PM	40.0
Grade 5-9 contractors	35.0
Mean	23.0

Table 11: Prevalence of ISO 9000 certification in organisations that have documented QMSs

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Prevalence of documented QMSs (2)

Category	Yes (%)
Client	8.3
Designers	0.0
PM	0.0
Grade 5-9 contractors	37.5
Mean	11.5

Table 12: If not ISO 9000 certified does your organisation intend to pursue ISO 9000 certification?

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Achieving quality on projects (1)

Practice / System	Mean Score					Rank
	Client	Design-er	PM	Grade 5-9	Mean	
Inspections / Visual checks	4.21	4.67	4.17	4.43	4.37	1
Coordination meetings	3.93	4.44	4.00	4.29	4.17	2
Client briefing	3.93	4.25	3.33	4.05	3.89	3
Samples / References	3.21	4.00	3.50	4.43	3.79	4
Checklists	3.79	4.11	3.50	3.71	3.78	5
Close out report	3.79	3.71	3.17	4.05	3.68	6
Tests	4.07	3.56	3.33	3.35	3.58	7
Value management	3.14	3.50	2.80	4.38	3.46	8
Constructability reviews	3.21	3.38	3.17	3.95	3.43	9
Documented Quality Management System	3.31	3.22	3.00	4.00	3.38	10

Table 13: Extent to which practices / systems are used to achieve quality on projects

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Achieving quality on projects (2)

Perspective / Practice / Situation	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Management commitment (Project)	4.36	4.63	4.33	4.59	4.00	4.38	1
Management commitment (Top)	4.08	4.78	4.00	4.64	3.89	4.28	2
Constructability of design	4.36	4.56	4.33	4.14	3.78	4.23	3
Experienced project supervision (project manager)	4.07	4.33	4.17	4.55	3.78	4.18	4
Appropriate details	4.21	4.44	4.00	4.10	4.11	4.17	5
Management commitment (Middle)	3.93	4.86	4.00	4.36	3.44	4.12	6
Appropriate specifications	4.14	4.22	3.83	4.05	4.22	4.09	7
Thorough understanding of quality	3.71	4.11	3.83	4.41	3.56	3.92	8
Conformance to standards	4.00	4.11	3.50	4.29	3.67	3.91	9
Adequate supervision	3.79	4.22	3.83	4.27	3.33	3.89	10
Appropriate design fee	3.50	3.89	3.67	4.30	4.00	3.87	11
Adequate planning in general	3.79	3.89	3.83	4.23	3.56	3.86	12
Adequate project manager skills	3.79	3.78	4.00	4.05	3.67	3.86	13
Adequate project duration	3.86	3.50	3.83	4.00	4.00	3.84	14
Appropriate selection of design team	3.64	4.13	4.00	4.05	3.11	3.79	15

Table 14: Extent to which perspectives / practices / situations contribute to the achievement of quality in respondents' organisations / respondents' organisations relative to projects, and on projects (Part A)

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Achieving quality on projects (3)

Perspective / Practice / Situation	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Holistic understanding of the role of quality	3.62	3.89	3.50	4.19	3.67	3.77	16
Appropriate rates paid to consultants	3.71	3.50	3.67	4.24	3.63	3.75	17
Wish to improve work processes	3.64	3.78	3.50	4.32	3.44	3.74	18
Focus on assurance to achieve quality	3.64	3.57	3.50	4.45	3.33	3.70	19
Optimum quality assurance	3.64	4.00	3.40	4.09	3.25	3.68	20
Adequate work organisation	3.50	3.89	3.50	4.27	3.22	3.68	21
Commitment to certification	3.86	3.88	3.17	4.30	3.13	3.67	22
Adequate resources	3.29	3.67	4.00	4.00	3.33	3.66	23
Limited variations	3.50	3.67	3.83	3.76	3.38	3.63	24
Completion of paper work	3.43	4.13	3.50	4.05	3.00	3.62	25
Consideration for health and safety (construction)	3.85	3.50	2.67	4.05	3.67	3.55	26
Adequate quality training	3.57	3.71	2.60	4.23	3.44	3.51	27
Reporting on non-conformances	3.50	3.63	2.50	4.14	3.44	3.44	28
Adequate generic training	3.36	3.43	2.60	4.00	3.22	3.32	29
Optimum weather	3.21	3.00	2.67	3.55	2.38	2.96	30

Table 14: Extent to which perspectives / practices / situations contribute to the achievement of quality in respondents' organisations / respondents' organisations relative to projects, and on projects (Part B)

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Achieving quality on projects (4)

Perspective / Practice / Situation	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Management commitment (all stakeholders)	4.50	4.63	4.17	4.14	4.63	4.41	1
Training in quality	4.36	4.56	4.17	3.86	4.11	4.21	2
Specification (Appropriate)	4.54	4.56	3.83	4.15	3.89	4.19	3
Quality prequalification	4.36	4.57	3.83	4.10	3.75	4.12	4
Organisation culture	4.00	4.22	4.40	3.76	4.22	4.12	5
Education in quality	4.43	4.44	3.83	3.86	3.89	4.09	6
Contractor project quality plans	4.14	4.67	3.50	4.15	3.88	4.07	7
Worker participation	4.29	4.00	3.50	4.23	4.13	4.03	8
Goal setting	4.21	4.50	3.83	3.91	3.67	4.02	9
Contractor Quality Management Systems	4.54	4.11	3.33	4.14	4.00	4.02	10
Details (Appropriate)	4.23	4.44	3.67	4.15	3.56	4.01	11
Optimum project duration	4.07	4.00	4.17	4.21	3.56	4.00	12
Measurement - Outcome e.g. No. of defects, cost of rework	4.21	4.00	4.00	4.14	3.44	3.96	13
Design (Appropriate)	4.23	4.33	3.67	4.10	3.44	3.95	14
Standard operating procedures (SOPs)	4.21	4.00	4.00	3.86	3.25	3.86	15

Table 15: Extent to which perspectives / practices / situations could improve or contribute to an improvement in quality in South African construction (Part A)

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Achieving quality on projects (5)

Perspective / Practice / Situation	Mean Score						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Benchmarking	4.14	4.00	3.83	3.82	3.50	3.86	16
Measurement - Performance e.g. percentage of workers trained in quality	4.07	4.33	3.40	3.73	3.50	3.81	17
Quality improvement processes	4.36	3.88	3.33	3.95	3.50	3.80	18
Client actions	3.93	3.78	3.50	3.81	3.75	3.75	19
Designer Quality Management Systems	4.08	3.67	3.80	4.05	3.11	3.74	20
Integration of design and construction	4.00	3.89	3.50	3.90	3.33	3.72	21
Contract documentation	4.07	4.00	3.33	3.81	3.11	3.66	22
Safe work procedures (SWPs)	4.21	3.75	3.33	3.91	3.11	3.66	23
Reengineering	3.69	3.67	3.40	4.00	3.29	3.61	24
Contractor ISO 9000 series certification	4.33	3.14	3.25	3.83	3.11	3.53	25
Partnering	3.86	4.00	3.50	3.28	3.00	3.53	26
Quality circles / forums	4.23	3.43	3.20	3.53	3.25	3.53	26
Designer ISO 9000 series certification	4.00	2.50	2.80	4.00	2.89	3.24	28
Union prioritisation	3.58	2.75	2.50	2.79	3.00	2.92	29

Table 15: Extent to which perspectives / practices / situations could improve or contribute to an improvement in quality in South African construction (Part B)

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Barriers to achieving quality on projects (1)

Intervention / Situation	Mean Score							Rank
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean	
Poor site management (planning, organising, leading, controlling, and coordinating)	4.36	4.56	4.33	4.68	4.00	4.22	4.36	1
Lack of contractor quality expertise	4.57	4.56	4.17		4.19	4.00	4.30	2
Corruption	3.71	4.11	4.50	4.85	4.21	4.22	4.27	3
Inadequate resourcing by contractors	4.00	4.11	4.33		4.05	4.13	4.12	4
Lack of understanding of quality	4.00	4.44	3.83	4.58	3.73	4.11	4.12	5
Level of subcontracting	4.00	3.88	4.17	4.62	3.71	3.88	4.04	6
Focus on cost by contractors	4.29	4.11	3.83	3.84	4.05	4.00	4.02	7
Inadequate information	3.64	4.00	4.33	4.50	4.00	3.63	4.02	8
Inadequate skills quality training	4.21	4.11	3.83		3.73	4.11	4.00	9
Focus on time by contractors	4.14	4.11	3.67	4.04	3.95	3.67	3.93	10
Lack of insight relative to the role of quality	4.00	4.33	3.83		3.67	3.78	3.92	11
Lack of minimum requirement to contract	4.21	4.43	3.20		3.85	3.88	3.91	12
Detail	3.79	4.38	4.33		3.71	3.25	3.89	13
Lack of worker participation	4.00	3.57	3.50	4.16	4.09	4.00	3.89	14
Focus on cost by clients	4.00	4.22	3.50		3.76	3.89	3.87	15

Table 16: Extent to which interventions / situations are a barrier to achieving quality on projects (A)

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Barriers to achieving quality on projects (2)

Intervention / Situation	Mean Score							Rank
	Client	Design - er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean	
Poor constructability	3.79	4.22	4.17		3.79	3.38	3.87	16
Inappropriate project durations	3.85	3.67	4.00	4.29	3.90	3.50	3.87	17
Focus on time by clients	3.71	4.11	3.83		3.76	3.89	3.86	18
Lack of 'design team' management commitment	3.57	4.22	4.33		3.64	3.50	3.85	19
Lack of 'construction' management commitment	4.21	4.22	2.83		3.70	4.29	3.85	20
Lack of quality improvement processes	4.07	3.88	3.17	4.27	3.71	4.00	3.85	21
Inadequate generic skills training	4.07	4.00	3.67		3.67	3.78	3.84	22
Lack of pre-qualification on quality	4.00	4.00	3.83		3.64	3.63	3.82	23
Inadequate production skills	4.07	4.00	3.50		3.50	4.00	3.81	24
Specification	3.93	4.11	4.00		3.76	2.89	3.74	25
Lack of Quality Management Systems in construction	4.14	3.78	3.20		3.65	3.89	3.73	26
Inadequate quality related tertiary education (Construction manager)	3.86	4.11	3.40		4.00	3.22	3.72	27
Inadequate quality related tertiary education (Project manager)	4.00	4.13	3.00		3.95	3.29	3.67	28

Table 16: Extent to which interventions / situations are a barrier to achieving quality on projects (B)

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Barriers to achieving quality on projects (3)

Intervention / Situation	Mean Score							Rank
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean	
Lack of designer quality expertise	3.86	3.89	3.83		3.76	2.88	3.64	29
Reliance on inspections	4.00	3.44	3.50		3.55	3.63	3.62	30
Ineffective contractor registration	4.23	3.71	2.40	4.50	3.90	3.00	3.62	31
Cyclical industry	3.20	4.13	4.00		3.63	3.13	3.62	32
Lack of QMSs in design	3.86	3.56	3.67		3.62	3.33	3.61	33
Inadequate quality related tertiary education (Engineer)	4.00	3.33	3.83		3.95	2.88	3.60	34
Design	3.86	4.25	3.83		3.38	2.50	3.56	35
Variations	3.83	3.33	3.67	3.79	3.37	3.25	3.54	36
Focus on quality control	3.86	3.38	2.83		3.64	3.88	3.52	37
Inadequate quality related tertiary education (Architect)	3.92	3.33	3.50		3.84	3.00	3.52	37
Contract documentation	3.43	4.00	3.33		3.41	3.38	3.51	39
Competitive tendering	3.64	2.89	3.33	3.92	3.90	3.22	3.48	40
Archaic processes (design and construction)	3.69	3.44	3.67		3.21	3.00	3.40	41
Separation of design and construction	3.42	3.25	3.33		3.10	2.89	3.20	42
Inadequate quality related tertiary education (Quantity surveyor)	3.43	3.22	2.50		3.80	3.00	3.19	43
Lack of partnering	3.38	3.38	3.00		2.50	2.29	2.91	44

Table 16: Extent to which interventions / situations are a barrier to achieving quality on projects (C)

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Quality related measures used

Measure	Yes (%)					
	Client	Design-er	PM	Grade 2-4	Grade 5-9	Mean
No. of defects	50.0	50.0	50.0	96.0	90.0	67.2
No. of test failures	71.4	28.6	50.0	92.0	90.0	66.4
Cost of rework	64.3	37.5	33.3	-	85.7	55.2

Table 17: Quality related measures respondents' organisations undertake / request

- Rework constitutes (cidb 5-9 Contractors):
  - 6% of Project cost
  - 9.9% of Project value
- Rework constitutes 13% of project value (Smallwood, 1997)

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Knowledge of quality

Mean Score						
Client	Design-er	PM	Grade 2-4	Grade 5-9	Assoc.	Mean
3.85	3.78	3.67	4.31	4.09	3.50	3.87

Table 18: Respondents' self rating of their knowledge of quality

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Sources of quality knowledge

Source	Mean Scores						Rank
	Client	Design-er	PM	Grade 5-9	Assoc.	Mean	
Experience	4.54	4.67	4.17	4.18	4.00	4.31	1
In-house training	4.23	3.67	3.33	3.82	4.00	3.81	2
University / University of Technology / College education	4.31	4.22	3.50	3.45	3.00	3.70	3
Post-graduate qualifications	3.62	4.14	3.50	3.38	2.88	3.50	4
External training	4.08	3.14	3.33	3.64	3.25	3.49	5
Practice notes	3.54	3.44	3.00	3.09	3.43	3.30	6
Workshops	4.00	2.86	2.67	3.05	3.13	3.14	7
Short courses	4.23	2.83	2.67	2.82	3.00	3.11	8
Magazine articles	3.08	3.11	2.83	2.82	2.89	2.95	9
CPD seminars / workshops	3.54	3.44	2.17	2.71	2.78	2.93	10
Journal papers	2.92	2.89	2.20	2.68	2.25	2.59	11
Conference papers	3.08	2.89	2.00	2.43	2.50	2.58	12

Table 20: Degree of contribution of sources of knowledge to respondents' quality knowledge

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Designing for quality (1)

Plank and hollow-block composite slab, Plettenberg Bay (Hamp-Adams, 1994)

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Designing for quality (2)

Pre-cast pre-stressed hollow core slab section (SA Builder Bouer, 2004a)

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Designing for quality (3)

Pre-cast pre-stressed hollow core slab section (SA Builder Bouer, 2004b)

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Designing for quality (4)

Precast concrete stair flights, Port Elizabeth (Smallwood)

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Designing for quality (5)

Precast concrete stair flights, Port Elizabeth (Smallwood)

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Conclusions (1)

- There is not a uniform understanding of quality (definition)
- Cost and time are more important than the other parameters
- The importance of quality varies according to the role stakeholders play
- The pre-occupation with cost and time marginalises quality
- This pre-occupation affects contractors' quality related performance (rating)
- South African construction quality can be substantially improved (overall rating)
- Quality performance is influenced by the sector in which construction is undertaken and the contributors
- An improvement process is important in terms of achieving quality (TQM)
- A range of interventions / systems are important relative to the achievement of quality

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Conclusions (2)

- An informal approach is adopted relative to the achievement of quality (prevalence of documented QMSs)
- A range of perspectives / practices / situations contribute to the achievement of quality – management commitment is critical!
- A range of perspectives / practices / situations could improve or contribute to an improvement in quality – management commitment is critical
- A range of interventions / situations are a barrier to achieving quality – poor site management!
- The level of quality knowledge is inadequate
- The sources of quality knowledge are predominantly informal

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