SCAFFOLDING HEALTH AND SAFETY: A MULTI-STAKEHOLDER ISSUE

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Historically, scaffolding has been used extensively in the construction industry to enable work at elevated heights. However, in terms of agency, scaffolding contributes substantially to all classes of injury, fatalities included. Literature indicates that scaffolding is a multi-stakeholder issue: clients are required to ensure that principal contractors have made adequate allowance for health and safety (H&S); reducing the amount of work required at elevated heights is one of the principles of designing for construction H&S, and contractors require a range of scaffolding related skills to manage and undertake the processes related to scaffolding. A study conducted among general contractors (GCs) investigated a range of design, procurement, and construction issues relative to scaffolding. Conclusions include: scaffolding is a dynamic process that requires a range of contributions and interventions; scaffolding is a scientific process and does not merely entail assembling and dismantling of components, and procurement, design, education and training, systems and procedures, scaffolding per se, and construction management all influence scaffolding H&S and can prevent scaffolding related accidents. Recommendations to assure healthy and safe scaffolding include inter alia: planning and coordinating in general; awareness; education and training; scientific designs; development and implementation of systems and procedures; safe loading, and inspections.

Keywords: construction, health and safety; multi-stakeholder, scaffolding.

INTRODUCTION

According to the Health and Safety Authority (HAS) (1999) scaffolding performs several important functions during the construction process. It enables work to be performed at a height; it is used to protect persons working at height from falling, and to protect persons working below from falling objects.

Although scaffolding contributes substantially to the construction process, it also contributes substantially to the various classes of injuries, which in turn indicates that there is risk associated with scaffolding. The risk associated with scaffolding is acknowledged by *inter alia*, Kelvin Short, Managing Director, Vange Scaffolding, employer of 120 scaffolders, who advocates an H&S management system, which is easily understood by management, supervision, and operatives to address the risk (Health and Safety Executive, 2005). He also states that the need for H&S awareness, healthy and safe working, and best practice must be driven by the directors. Optimum worker participation, which encourages two-way communication and engenders commitment to H&S further contributes to the H&S culture.

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Despite the frequency of use of scaffolding in construction and its contribution to the various classes of injuries, the survey of the literature determined that in terms of the management thereof, there is a paucity of scaffolding related literature.

Given the abovementioned, a study was conducted among a group of 'better practice H&S' general contractors to determine the:

- Frequency at which scaffolding related processes / procedures / interventions are followed / undertaken;
- Prevalence of scaffolding related skills in respondents' organizations;
- Extent to which various aspects contribute to scaffolding related accidents, and
- Degree of importance of various aspects / actions / interventions relative to scaffolding.

REVIEW OF THE LITERATURE

Statistics

In terms of agency, scaffolding, one of twenty-three agencies (4.4%) and which is included in the category 'platforms, scaffolds, stairs', contributes to varying degrees to the various classes of injuries in South African construction: medical aid (5.3%); temporary disablement (7.5%); permanent disablement (4.8%), and fatalities (6.6%) (Compensation Commissioner, 2006).

Legislation

The Occupational Health and Safety Act (OH&SA) (Republic of South Africa, 1993) schedules generic requirements. Employers are required to provide such information, instructions, training and supervision as may be necessary to ensure, as far as is reasonably practicable, the H&S at work of their employees. The General Safety Regulations (Republic of South Africa, 1986) address a range of scaffolding related aspects: categories in terms of loads; foundations; spacing of standards; bracing; provision of ladders; securing to structure; factor of safety; supervision of erection and dismantling; frequency of inspections; width of platforms; distance of platforms from structures; dimensions of planks; guardrails; toe boards, and housekeeping. The Construction Regulations (Republic of South Africa, 2003) refers to a range of generic H&S and scaffolding related issues: definition of a competent person; H&S induction training; the development and implementation of a fall protection plan including the programme for the training of employees working from elevated positions; training requirements for employees using suspended platforms; supervision of all scaffolding work by a competent person; competency of scaffold erectors, team leaders and inspectors, and the ensuring of co-operation between all contractors to enable each of them to comply with the provisions of the regulations.

Problem aspects

The Construction Safety Association Ontario (CSAO) (2001) cites the following as problem areas: erecting and dismantling; climbing up and down; planks sliding off or breaking; improper loading or overloading; platforms not fully decked; platforms without guardrails; failure to install all required components; electrical contact with overhead wires, and moving rolling scaffolds with workers on the platform.

Management and control of scaffolding

Management of scaffolding activities

Active management is required to maintain scaffolding in a high standard (HAS, 1999). The need for a high level of H&S management is amplified by the following: a high rate of activity; changing environment, and the high risk associated with scaffolding. The systematic management of scaffolding requires the following five steps: policy; planning; implementation; checking and corrective action, and review.

Layout and design

The initial layout will have a significant impact upon the safety of the completed scaffold. The gap between the structure and the scaffold should be minimal, and the standards should be positioned such that they have optimum bearing (HAS, 1999).

Certain system scaffolds not exceeding certain heights may be constructed without calculations and related design. All other forms of scaffold, including special scaffolds should be subject to calculation and design (HAS, 1999).

The design of the scaffold can be affected by, or can affect the design of the permanent works (HAS, 1999). Most scaffolds need to be tied to the permanent structure till they are dismantled. Therefore adequate details of the permanent structure need to be obtained to pre-plan scaffolding.

Scheduling

Optimum scheduling of activities is necessary to ensure that scaffolds are available, safe to use when required, and that the activities of any trades do not endanger the scaffolds or users thereof (HAS, 1999). The following issues should be considered: the height of platforms of scaffolds erected to provide edge protection during activities should be maintained as close as practicable to the level of such activities; replacement ties should be installed should original ties have been removed to enable activities such as plastering or tiling; the specific needs of scaffold users should be determined in advance to enable timely provision therefore, and adjacent activities such as excavations should be deliberated to avert encroachment.

Planning for use and maintenance

A scaffold rarely stays the same between initial erection and dismantling. Therefore, there is a need to plan how the scaffold will be modified, inspected, and maintained. The following should be considered: the particular needs of different trades; scheduling; appointment of a competent person responsible for the modifying, inspecting, and maintenance of the scaffold; the availability of competent scaffolders on site to undertake modifications and maintenance; the communication of load restrictions and unauthorized modifications, and the contact person to whom requests should be directed.

Information

The manufacturers and suppliers of scaffolding should provide information such as the use for which the scaffolding has been designed and tested, as well as any information necessary to ensure the safe erection, dismantling and use thereof.

Workers should be provided sufficient and comprehensible information on the conditions for the use of the equipment, instructions for its safe use, assembly and dismantling plans, and any unusual conditions foreseen.

Contributors to an improvement in scaffolding
Kelvin Short, Managing Director, Vange Scaffolding, cites the following as benefits of an optimum H&S culture: a reportable accident and injury rate one third of that of the construction industry, with no fatal or major injuries reported at all in a ten year period; staff retention; the securing of long-term contracts with major clients, and excellent risk ratings from their public and employers liability insurers. He in turn cites the following as contributors to the optimum H&S culture: full morning induction; provision of a 'good scaffolding practice' pocket card to all workers; a workforce awareness checklist which is referred to during pre-shift risk assessments; reporting of problems via a 'hazard hotline' established by a certain client; use of a hazard reporting form; weekly 'toolbox talks', and a weekly 'incident review meeting' held by a certain client (Health and Safety Executive, 2005).

RESEARCH

Sample stratum
The sample frame consisted of 25 general contractors (GCs), which achieved a place in the Building Industries Federation South Africa (BIFSA) National H&S Competition and, or a BIFSA 4 or 5-Star H&S grading on one or more of their projects. 12 GCs responded to the postal survey, which represents a response rate of 48%.

Findings
Table 1 indicates the frequency at which scaffolding related processes / procedures / interventions are followed / undertaken in terms of percentage responses to a range of never to always, and in terms of a mean score ranging between 1 and 5. It is notable that fourteen of the seventeen mean scores are all above the midpoint score of 3.00, which indicates that in general the respondents' organisations can be deemed to follow / undertake the processes / procedures / interventions. However, a more detailed analysis in terms of ranges enables a more in depth review. Mean scores $> 4.20 \leq 5.00$ indicate that the processes / procedures / interventions can be deemed to be followed / undertaken between often to always / always - appointment of scaffolders; weekly inspections, and scientific design for 'heavy scaffolding', which three constitute 17.7% of the processes / procedures / interventions. Eleven of the seventeen (64.7%) processes / procedures / interventions have mean scores $> 3.40 \leq 4.20$, which indicates that they can be deemed to be followed / undertaken between sometimes to often / often. The fifteenth and sixteenth ranked processes / procedures / interventions, 11.8% of the seventeen, have mean scores $> 2.60 \leq 3.40$, which indicates that they can be deemed to be followed / undertaken between rarely to sometimes / sometimes. Last ranked scientific design for 'light' scaffolding has a mean score $> 1.80 \leq 2.60$, which indicates that the intervention can be deemed to be followed / undertaken between never to rarely / rarely.

Table 2 indicates the prevalence of seven scaffolding related skills in respondents' organizations. It is notable that five of the skills have mean scores above the midpoint score of 3.00, which indicates that in general they can be deemed to be prevalent. However, it is notable that the top three (42.9%) ranked skills have mean scores $> 4.20 \leq 5.00$, which indicates that they can be deemed to be between near pervasive to pervasive / pervasive. Given that the skills ranked fourth and fifth (28.6%) have mean scores $> 3.40 \leq 4.20$, their prevalence can be deemed to be between exist to near pervasive / near pervasive. Scientific design, a critical skill relative to scaffolding and

support work, has a mean score > 2.60 ≤ 3.40, which indicates that it can be deemed to be between near non-existent to exist / exist. The last ranked skill, safe loading diagrams, has a mean score, > 1.80 ≤ 2.60, which indicates that the skill can be deemed to be between non-existent to near non-existent / non-existent.

Table 1: Frequency at which scaffolding related processes are followed / undertaken

Process / Procedure / Intervention	Response (%)						MS	Rank
	Unsure	Never	Rarely	Some-times	Often	Always		
Appointment of scaffolders	0.0	0.0	0.0	0.0	16.7	83.3	4.83	1
Weekly inspections	0.0	0.0	0.0	0.0	41.7	58.3	4.58	2
Scientific design for 'heavy' scaffolding	0.0	8.3	0.0	8.3	25.0	58.3	4.25	3
'Scaffold not to be used' signs	8.3	0.0	8.3	8.3	33.3	41.7	4.18	4
H&S induction	0.0	0.0	16.7	0.0	33.3	50.0	4.17	5=
Daily monitoring	0.0	8.3	0.0	8.3	33.3	50.0	4.17	5=
'Toolbox talks'	0.0	0.0	0.0	33.3	25.0	41.7	4.08	7=
Post-inclement weather inspections	0.0	8.3	0.0	8.3	41.7	41.7	4.08	7=
Scaffolding elevations and sections relative to the structure	0.0	8.3	0.0	0.0	66.7	25.0	4.00	9
Written safe work procedures (SWPs)	0.0	16.7	0.0	8.3	33.3	41.7	3.83	10
Reconciliation of scaffolding with design (sign-off)	0.0	8.3	0.0	33.3	25.0	33.3	3.75	11=
'Permit to use' procedure	0.0	16.7	0.0	8.3	41.7	33.3	3.75	11=
Scientific design for 'medium' scaffolding	0.0	10.0	0.0	30.0	40.0	20.0	3.60	13
H&S 'Theme of the month'	0.0	16.7	8.3	33.3	16.7	25.0	3.25	14
Safe loading diagrams	8.3	25.0	0.0	41.7	16.7	8.3	2.82	15
Scientific design for 'very light' scaffolding	9.1	36.4	9.1	18.2	9.1	18.2	2.60	16
Scientific design for 'light' scaffolding	0.0	36.4	0.0	36.4	27.3	0.0	2.55	17

Table 2: Prevalence of scaffolding related skills in respondents' organisations

Skill	Response (%)						MS	Rank
	Unsure	Non-existent ……Pervasive						
		1	2	3	4	5		
Estimating / Budgeting	0.0	0.0	0.0	16.7	33.3	50.0	4.33	1
Maintenance (own equipment)	0.0	0.0	0.0	16.7	41.7	41.7	4.25	2=
Maintenance management (own equipment)	0.0	0.0	0.0	16.7	41.7	41.7	4.25	2=
Supervision of erection / dismantling	0.0	0.0	0.0	25.0	41.7	33.3	4.08	4
Erector	0.0	0.0	16.7	25.0	33.3	25.0	3.67	5
Scientific design	0.0	16.7	41.7	8.3	25.0	8.3	2.67	6
Safe loading diagrams	0.0	16.7	41.7	33.3	8.3	0.0	2.33	7

Table 3 indicates the extent to which thirty-one aspects contribute to scaffolding related accidents in terms of percentage responses to never and a range of 1 (minor extent) to 5 (major extent), and in terms of a mean score ranging between 0 and 5. Given that effectively a six-point scale ('never' linked to a five-point) was used and that the difference between 0 and 5 is five, ranges with an extent of 0.8 (5 / 6) are used to discuss the degree of central tendency. Furthermore, column 2 indicates the category within which the aspects fall: construction management (CM) (4 No.); design (des) (permanent) (5 No.); education and training (E & T) (3 No.); procurement (proc)

(4 No.); scaffolding (scaff) (9 No.), and systems and procedures (S & P) (6 No.). It is notable that with the exception of external fabric (type) all the aspects have mean scores above the midpoint score of 2.50, which indicates that in general the aspects can be deemed to contribute to scaffolding related accidents. However, a more detailed analysis in terms of ranges enables a more in depth review.

Mean scores > 3.33 ≤ 4.17 indicate that the aspects can be deemed to make between a contribution and a near major / near major contribution to scaffolding related accidents.

Table 3: Extent to which various aspects contribute to scaffolding related accidents

Aspect	Category	Response (%)							Mean score	Rank
				Minor …..……..…… Major						
		Never	Unsure	1	2	3	4	5		
Multi-use i.e. range of subcontractors	Proc	0.0	0.0	0.0	0.0	16.7	66.7	16.7	4.00	1=
Overloading (materials)	S & P	0.0	0.0	0.0	16.7	16.7	16.7	50.0	4.00	1=
Inadequate guardrails	Scaff	0.0	0.0	0.0	8.3	16.7	50.0	25.0	3.92	3
Pyramid subcontracting (sub-sub-subcontracting etc.)	Proc	0.0	0.0	8.3	8.3	8.3	58.3	16.7	3.67	4=
Inadequate access	Scaff	0.0	0.0	8.3	8.3	16.7	41.7	25.0	3.67	4=
Inadequate framework	Scaff	0.0	0.0	0.0	27.3	9.1	36.4	27.3	3.64	6=
Inadequate platform	Scaff	0.0	0.0	0.0	18.2	27.3	27.3	27.3	3.64	6=
Lack of / inadequate coordinating of the project	CM	0.0	0.0	0.0	25.0	16.7	33.3	25.0	3.58	8=
Overloading (plant and equipment)	S & P	8.3	0.0	0.0	25.0	8.3	8.3	50.0	3.58	8=
Non-compliance to legislation	Scaff	0.0	0.0	0.0	16.7	33.3	25.0	25.0	3.58	8=
Inadequate budgeting	Proc	8.3	0.0	0.0	0.0	33.3	41.7	16.7	3.50	11=
Inadequately educated / trained Construction Managers	E & T	8.3	0.0	8.3	16.7	0.0	25.0	41.7	3.50	11=
Inadequately educated / trained Scaffold Supervisors	E & T	8.3	0.0		8.3	25.0	33.3	25.0	3.50	11=
Lack of / inadequate programming and scheduling of the project	CM	0.0	0.0		25.0	8.3	58.3	8.3	3.50	11=
Alteration in use	S & P	0.0	0.0	8.3	8.3	33.3	25.0	25.0	3.50	11=
Inadequate base	Scaff	0.0	0.0	0.0	36.4	18.2	9.1	36.4	3.45	16
Inadequately educated / trained Scaffold Erectors	E & T	8.3	0.0	0.0	8.3	33.3	25.0	25.0	3.42	17=
Overloading people	S & P	0.0	0.0	8.3	25.0	25.0	0.0	41.7	3.42	17=
Lack of written safe work procedures (SWPs)	S & P	0.0	0.0	0.0	25.0	25.0	41.7	8.3	3.33	19=
Inadequate ground / founding conditions	Scaff	0.0	0.0	8.3	33.3	8.3	16.7	33.3	3.33	19=

Table 3: Extent to which various aspects contribute to scaffolding related accidents

		Response (%)								
Encroaching plant / vehicles	CM	0.0	0.0	8.3	16.7	33.3	16.7	25.0	3.33	19=
Encroaching excavations / trenches	CM	0.0	0.0	16.7	16.7	16.7	25.0	25.0	3.25	22
Inadequate tying to structure	Scaff	0.0	0.0	8.3	25.0	25.0	25.0	16.7	3.17	23=
Inadequate screening (or lack of)	Scaff	0.0	0.0	0.0	33.3	33.3	16.7	16.7	3.17	23=
External fabric (Method of fixing)	Des	0.0	8.3	8.3	16.7	8.3	50.0	8.3	3.08	25
Lack of scientific design	S & P	0.0	8.3	8.3	16.7	33.3	8.3	25.0	3.00	26
External fabric (Mass)	Des	0.0	8.3	8.3	16.7	25.0	33.3	8.3	2.92	27
Separation of design and construction	Proc	8.3	0.0	8.3	25.0	25.0	25.0	8.3	2.75	28=
Building / Structure (General design)	Des	0.0	0.0	8.3	41.7	16.7	33.3	0.0	2.75	28=
Building / Structure (Details)	Des	0.0	8.3	8.3	16.7	33.3	33.3	0.0	2.75	28=
External fabric (Type)	Des	8.3	8.3	8.3	16.7	25.0	33.3	0.0	2.50	31

Multi-use i.e. range of subcontractors and overloading (materials) ranked joint first, followed by inadequate materials, predominate. It is notable that the joint first ranked aspects are procurement and systems and procedures related, whereas third ranked inadequate materials is scaffolding related. The top three aspects in turn are followed by a cluster of seven aspects which fall within a range of 0.09 on the mean score range. Pyramid subcontracting (sub-sub-subcontracting etc.) ranked joint fourth with inadequate access reinforces the contention that procurement issues impact on scaffolding. Inadequate access is followed by joint sixth ranked inadequate framework and inadequate platform – all three being scaffolding related aspects.

Table 4 provides an overview in terms of the extent to which various aspects contribute to scaffolding related accidents. It is notable that 60% of the top five and 50% of the top ten ranked aspects are not scaffolding aspects *per se*. Notable categories include procurement – 50% of such aspects are ranked within the top five and 50% within the top ten. Although only 22% of scaffolding aspects are ranked within the top five, 55.6% are ranked within the top ten. Furthermore, 100% of education and training, 75% of procurement, 66.7% of systems and procedures, and 66.7% of scaffolding aspects have mean scores > 3.33.

Table 4: Overview of extent to which aspects contribute to scaffolding related accidents

Category	**Total No. / 31**	**Top 5**	**Top 10**	**Top 15**	**MS > 3.33**	**MS > 2.50**	**MS > 1.67**
Design (Permanent)	5	0	0	0	0	4	5
Procurement	4	2	2	3	3	4	4
Education and training	3	0	0	2	3	3	3
Systems and procedures	6	1	2	3	4	6	6
Scaffolding	9	2	5	5	6	9	9
Construction Management	4	0	1	2	2	4	4

Table 5 indicates the degree of importance of fifteen aspects / actions / interventions relative to scaffolding in terms of percentage responses to a range between 1 (not) and 5 (very important), and a mean score ranging between 1 and 5. It is notable that all aspects / actions / interventions have mean scores above the midpoint score of 3.00, which indicates that in general the aspects / actions / interventions can be deemed to be important. However, it is significant that the top eight ranked aspects / actions/ interventions have mean scores > 4.20 ≤ 5.00, which indicates that their importance can be deemed to be between more than important to very important / very important. Furthermore, it should be noted that the two joint ninth ranked aspects fall marginally outside this range. It is significant that the predominating joint first ranked interventions are both training related, namely scaffold supervisor training and scaffold erector training. Training is a legal requirement and is necessary to enable people to fulfil their functions. These training related interventions are followed by yet a further education related intervention, namely education of construction managers. The fourth ranked intervention is construction management related in the form of daily monitoring by general contractor. Daily monitoring by general contractor is important as scaffolding is invariably used by a range of users, and can be altered which may compromise its integrity. It is notable that the only scaffolding related intervention is ranked fifth, namely maintenance of components. Maintenance of components is important as it enables the identification of corrosion and the enhancement of the life of components. It is also notable that the highest design related aspect is that of joint sixth ranked method of fixing of external fabric (buildings / structure). This is important as it influences the need for and nature of the scaffolding. The other two joint sixth ranked aspects / interventions are coordinating of the project – construction management related, and written safe work procedures

Table 5: Degree of importance of various aspects relative to scaffolding

Aspect / Action / Intervention	Category	Response (%) Not …….. Very					MS	Rank
		1	2	3	4	5		
Scaffold Supervisor training	E & T	0.0	0.0	0.0	25.0	75.0	4.75	1=
Scaffold Erector training	E & T	0.0	0.0	0.0	25.0	75.0	4.75	1=
Education of Construction Managers	E & T	0.0	0.0	8.3	25.0	66.7	4.58	3
Daily monitoring by general contractor	CM	0.0	0.0	8.3	33.3	58.3	4.50	4
Maintenance of components	Scaff	0.0	9.1	0.0	27.3	63.6	4.45	5
Method of fixing of external fabric (buildings / structures)	Des	0.0	0.0	16.7	41.7	41.7	4.25	6=
Coordinating of the project	CM	0.0	0.0	16.7	41.7	41.7	4.25	6=
Written safe work procedures (SWPs)	S & P	0.0	0.0	16.7	41.7	41.7	4.25	6=
General design (buildings / structures)	Des	0.0	16.7	8.3	16.7	58.3	4.17	9=
Mass of external fabric (buildings / structures)	Des	0.0	0.0	25.0	33.3	41.7	4.17	9=
Site layout	S & P	0.0	8.3	25.0	16.7	50.0	4.08	11=
Scientific design	S & P	0.0	8.3	16.7	33.3	41.7	4.08	11=
Programming and scheduling of the project	CM	0.0	0.0	33.3	33.3	33.3	4.00	13
Details (buildings / structures)	Des	0.0	16.7	16.7	25.0	41.7	3.92	14=
Type of external fabric (buildings / structures)	Des	0.0	8.3	25.0	33.3	33.3	3.92	14=

(SWPs) – systems and procedures related. Coordinating is important as activities requiring the use of scaffolding need to be sequenced, and provision needs to be made for the respective uses and consequential loads. SWPs in turn assure the safe erection, use, and dismantling of scaffolding. Furthermore, SWPs should be used during training, induction included.

Table 6: Degree of concurrence relative to scaffolding related statements

Statement	Response (%)						
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	MS
Scaffolding is impacted upon by management systems, processes and procedures	0.0	0.0	8.3	0.0	58.3	33.3	4.17
Construction Manager education / training addresses issues related to scaffolding e.g. planning and coordinating of the works, systems, processes and procedures	0.0	0.0	16.7	0.0	33.3	50.0	4.17
Education / training of Scaffold Erector focuses on technical issues	0.0	0.0	8.3	8.3	50.0	33.3	4.08
Education / training of Construction Managers focuses on technical issues	0.0	0.0	8.3	16.7	41.7	33.3	4.00
Education / training of Assistant Scaffold Erector focuses on technical issues	0.0	0.0	8.3	16.7	41.7	33.3	4.00
Scaffolding is impacted upon by contractual related issues	0.0	0.0	8.3	8.3	66.7	16.7	3.92
Scaffold Erector education / training addresses issues related to scaffolding e.g. planning and coordinating of the works, systems, processes and procedures	0.0	0.0	16.7	8.3	41.7	33.3	3.92
Assistant Scaffold Erector education / training addresses issues related to scaffolding e.g. planning and coordinating of the works, systems, processes and procedures	0.0	0.0	16.7	16.7	33.3	33.3	3.83
Generally, scaffolding is approached from a technical perspective	0.0	0.0	8.3	8.3	75.0	8.3	3.83
Generally, scaffolding is not approached in a holistic manner	0.0	0.0	16.7	16.7	33.3	33.3	3.83
Scaffolding is impacted upon by procurement related issues	0.0	0.0	25.0	33.3	41.7	0.0	3.17
Scaffolding is solely a technical issue	8.3	16.7	66.7	8.3	0.0	0.0	1.91

The aspects / actions/ interventions ranked joint ninth to joint fourteenth have mean scores > 3.40 ≤ 4.20, which indicates that their importance can be deemed to be between important to more than important / more than important. The top ranked aspects in this category, which fall marginally outside the higher range, joint ninth ranked general design (buildings / structures) and mass of external fabric (buildings / structures) are both design related. General design impacts on the need for and nature of scaffolding. Mass of external fabric impacts on scaffolding in terms of the material loads scaffolding is subjected to. Joint eleventh ranked site layout and scientific design are both system and procedure related. Site layout is important as provision should be made for the storage and erection of scaffolding. Scientific design is important as scaffolding is subjected to a range of loads - environmental, live,

material, plant and equipment, and environmental. Programming and scheduling of the project, ranked thirteenth, impacts on scaffolding as the sequencing and coordinating of activities needs to be optimized to enable the provision of the required type and category of scaffolding. Details (buildings and structures) ranked joint fourteenth may be of such a nature that special access or that a specific category of scaffolding is required. The other joint fourteenth ranked aspect, namely type of external fabric (buildings and structures), influences the mass of the external fabric (buildings and structures), and subsequently the type and category of scaffolding required.

Table 6 indicates the degree of concurrence with twelve statements in terms of percentage responses to a range strongly disagree to strongly agree, and in terms of a mean score ranging between 1 and 5. The concurrence relative to the mean score ranges can be deemed to be: $> 3.40 \leq 4.20$: between neutral to agree / agree; $> 2.60 \leq 3.40$: between disagree to neutral / neutral, and $> 1.80 \leq 2.60$: between strongly disagree and disagree / disagree - scaffolding is impacted upon by procurement related issues.

The mean percentage of the respondents' workforce which had received scaffold erector and assistant scaffold erector training is 10.5% and 7% respectively. On average, 62.2% of the scaffolding on projects is erected by the respondents, 30.8% is subcontracted to specialist scaffolding subcontractors and 7% is erected by SCs for their own use.

CONCLUSIONS

Scaffolding is a dynamic process that requires a range of contributions and interventions commencing during the design phase through the construction, and including the commissioning stages of projects.

Scaffolding is a scientific process and not just about assembling and dismantling components. Consequently, education and training and management systems and procedures are critical.

A range of aspects contribute to scaffolding related accidents. However, procurement, scaffold *per se*, and system and procedure related aspects predominate.

Procurement, design, education and training, systems and procedures, scaffolding per se, and construction management, all influence scaffolding H&S and can prevent scaffolding related accidents.

RECOMMENDATIONS

Scaffolding training should be structured in a holistic manner such that it addresses the influence and role of permanent design, procurement, systems and procedures, and general construction management in scaffolding, in addition to the technical aspects of scaffolding per se. Tertiary built environment and Construction Management education should address the influence and role of permanent design, and procurement. Furthermore, Construction Management education should focus on the role of education and training, design of scaffolding, planning, and systems and procedures.

Estimators must ensure that the requisite scaffolding is adequately budgeted for.

Contracts Managers should: raise and maintain awareness relative to scaffolding and related issues on their projects; promote and expedite scaffolding related education and training at all levels; ensure that scientific designs are undertaken when required; develop appropriate scaffolding related systems and procedures; review and monitor the procurement and maintenance of scaffolding, and periodically include scaffolding as a 'theme of the month'

Site Managers and Site Agents / General Foremen should ensure that: the appropriate scaffolding related systems and procedures are used and implemented - design; 'sign-off' / 'permit to use'; SWPs, and safe loading diagrams; only trained Scaffold Supervisors are appointed; only trained Scaffold Erectors are used; inspections are conducted daily; H&S induction includes scaffolding and is presented, and scaffolding toolbox talks are periodically presented. Given the complementary role of planning in H&S and scaffolding, particularly site layouts, programming and scheduling, planning should be optimised. Furthermore, coordinating of activities and SCs involving the use of scaffolding should include recognition of differing requirements. However, Site Agents / General Foremen should pay increased attention to daily programming and scheduling.

Supervisors should focus on: daily programming and scheduling; maintenance of erected scaffold through *inter alia*, daily inspections; safe loading relative to labour, materials, and plant and equipment, and presenting of scaffolding 'toolbox talks'.

Scaffold Supervisors should ensure: the implementation of SWPs; conformance of the erected scaffold to design, and the implementation of a permit to use / 'sign-off' procedure.

Scaffold Erectors should: follow SWPs, and erect scaffolding in accordance with design.

Users should follow: SWPs, and ensure optimum housekeeping at all times.

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