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Powered Aerial Access Platforms (PAAPs): Their Use and Benefits

JJ Smallwood, Department of Construction Management,
Nelson Mandela Metropolitan University

ABSTRACT

Construction is undertaken at elevated heights, while exposed to the natural elements often requiring: access to 'difficult to reach' areas of structures and facades; installation of services at heights, and the erection of isolated structures such as street lamp poles. Furthermore, it entails manual handling, adopting of uncomfortable postures, and repetitive movements.

PAAPs generally provide immediate access to areas that are difficult to reach, and or that are high up. There are generally three categories of PAAPs: boom lifts; scissors lifts, and personnel lifts. However, within each category a number of variants are available. Given that PAAPs have generally only been available in South Africa for a few years, a study was conducted among customers of a lessor of PAAPs to determine the reasons for using PAAPs, and the benefits and limitations thereof, if any.

Salient findings include: scissor lifts predominate in terms of the type of PAAPs used; position of work (reach of PAAPs), manoeuvrability, and constraints relative to the use of alternative access predominate among reasons for using PAAPs; enhanced access, enhanced productivity, manoeuvrability and enhanced safety predominate among benefits resulting from using PAAPs in lieu of other access, such as scaffold platforms and ladders, and rough terrain / uneven ground, the need for skilled operators, and cost were the most frequently cited limitations to use of PAAPs.

The paper concludes that a major advantage of PAAPs is their reach and manoeuvrability, which is amplified by the limitations of traditional forms of access such as scaffolding and ladders. Recommendations include: there is a need to raise the level of awareness relative to the use of PAAPs, and optimum communication and

programming of construction works can circumvent the limitations of PAAPs.

Keywords: Construction, Health and Safety, Powered Aerial Access Platforms

1. INTRODUCTION

There are generally three categories of PAAPs: boom lifts; scissors lifts, and personnel lifts. Within each category a number of variants are available. PAAPs generally provide immediate access to areas that are difficult to reach, and or that are high up.

Herbele (1998) says that PAAPs are incredibly convenient on a project, but that they can also be incredibly dangerous if recommended work practices are not followed. He stresses that each category has unique characteristics that must be understood and trained on by all operators and workers operating and using same respectively.

Given that PAAPs have generally only been available in South Africa for a few years, a study was conducted among customers of a PAAP supplier to determine the reasons for using PAAPs, and if any, the benefits and limitations thereof.

2. REVIEW OF THE LITERATURE

2.1 PAAP categories and uses

The Civil Engineering & Building Contractor (2000) describes the three categories of PAAPs, their capabilities, and their uses.

Boom PAAPs allow vertical as well as outreach movement. They are designed to reach over equipment and machinery mounted on floors and over other obstacles not easily circumvented by other vertical lifting devices. Various models are available with a maximum platform height of 45.7m and are designed to carry a safe working load of up to 227kg. The PAAP's telescopic and / or articulated boom may be rotated up to 360° in either direction, raised or lowered from vertical to below horizontal, and extended while the work platform remains horizontal and stable. The PAAP can be manoeuvred forward or backward and steered in any direction by the operator from the work platform, even while the boom is extended.

Scissor PAAPs allow vertical movement and have a large platform for lifting and installing bulky sheet materials such as cladding. They are available in various models with maximum platform heights of up 15.3m and are designed to carry safe working loads of up to 1 134kg. They may

scaffolding. The use of PAAPs also reduces the need for scaffolders, which results in a reduction in labour costs.

Pope (2000) says that PAAPs have measurable advantages over other means of working at height such as scaffolding or ladders. He contends that there is a need for both means of access – scaffolding should be used primarily for wet works such as bricklaying and plastering where there is a continued and concentrated workload, high loads are anticipated and there are a large number of workers undertaking the work. Thereafter, PAAPs are more suited to the finishing trades such as lighting, and air conditioning.

Smith (1991) relates the deployment of a PAAP on a section of the Interstate 670 in Kansas City, Kansas, USA. The contractor was required to dress the tops of 25 concrete piers, spaced over a length of 306.5m. The use of scaffolding would have required dismantling and re-assembly of the scaffolding at each pier, making it difficult to complete the project on schedule. Furthermore, the piers were surrounded by soft sandy soil, uneven ground, and jobsite debris. The soft sandy soil and uneven ground would have made the erecting of scaffolding difficult. Consequently, the contractor rented a PAAP with a maximum working height of 20.2m and horizontal reach of 15m. The platform's 227kg load capacity enabled workers to use concrete saws and chipping tools at the work height. Furthermore, the platform had hydraulic rotation so workers could optimally position themselves regardless of the angle of the boom, which is imposed by the ground conditions. The PAAP not only provided quick access to the tops of the piers, but also traveled easily between the piers as the four-wheel drive gave the PAAP enough traction and gradability to counter the soft sandy soil and uneven ground.

2.4 Barriers to deployment of PAAPs

Pope (2000) states that the perception existed, and still does, that PAAPs are for use only by utilities, local authorities, and fire brigades.

3. RESEARCH

3.1 Methodology and sample stratum

Fifty customers of a PAAP supplier were surveyed using a mailed questionnaire. Eighteen responses were included in the analysis of the data, which equates to a response rate of 37.1% (18 / 49). The denominator is forty-nine as one questionnaire was returned to the sender.

3.2 Findings

Table 1 indicates that position of work (reach of PAAPs), maneuverability, and constraints relative to the use of alternative access, predominate among reasons for using PAAPs. Slightly more than the minority of respondents also identified safety. It is notable that no respondents identified risk related to alternative access.

Table 1: Reasons for using PAAPs.

Reasons for using PAAPs	**Yes response (%)**
Position of work (reach of PAAPs)	61.1
Maneuverability	55.6
Constraints relative to the use of alternative access	50.0
Safety	38.9
Cost of alternative access	22.2
Project duration	16.7
Simultaneous movement of workers, materials and equipment	16.7
Safety of alternative access	11.1
Risk related to alternative access	0.0

Enhanced access, enhanced productivity, maneuverability, and enhanced safety predominate among benefits resulting from using PAAPs in lieu of other access, such as scaffold platforms and ladders (Table 2). Enhanced worker satisfaction, overall cost savings, and enhanced client satisfaction were identified by between 33 % and 40 % of respondents. Slightly more than a quarter of respondents identified enhanced stability, hassle-free work, and lifting of materials and equipment.

Table 2: Benefits from using PAAPs in lieu of other access.

Benefits from using PAAPs	Yes response (%)
Enhanced access	66.7
Enhanced productivity	66.7
Maneuverability	66.7
Enhanced safety	61.1
Enhanced worker satisfaction	38.9
Overall cost savings	33.3
Enhanced client satisfaction	33.3
Enhanced stability	27.8
Hassle-free work	27.8
Lifting of materials and equipment	27.8
Increased direct cost*	22.2
Enhanced schedule	22.2
Decreased direct cost*	16.7
Overall cost increase	16.7
Enhanced ergonomics	11.1
Enhanced quality	11.1

* = Cost of alternative access

Respondents were requested to cite any limitations to the use of PAAPs. 16.7 % of respondents cited three limitations, 11.1 % two, 50 % one, and 22.2 % zero. Rough terrain / uneven ground (21.4 %), the need for skilled operators (14.3 %) and cost (14.3 %) were the most frequently cited. The citing of rough terrain / uneven ground is probably attributable to external work where site works are at such a stage that the use of PAAPs is marginalized.

Table 3 indicates that personnel lifts predominate in terms of the mean hire / use of a particular type of PAAP.

Table 3: Number of times respondents have hired / used a PAAP.

Type of PAAP	Times hired / used (No.)		
	Mean	Min	Max
Personnel lift	32.1	1	200
Scissor lift	21.4	1	50
Boom lift	22.3	1	200

Table 4 indicates that on average, respondents had used scissor lifts on 49.3 % of the projects they had undertaken, followed by boom lifts (24.2%), and personnel lifts (11.6%).

Table 4: Frequency of use of PAAPs on projects by respondents.

Type of PAAP	Use per projects (%)		
	Mean	**Min**	**Max**
Personnel lift	11.6	1	40
Scissor lift	49.3	5	100
Boom lift	24.2	1	100

4. CONCLUSIONS

A major advantage of PAAPs is their reach and maneuverability, which is amplified by the limitations of traditional forms of access such as scaffolding, and ladders. However, these advantages are reinforced by the enhanced safety and enhanced productivity. Limitations cited include access on projects where rough terrain / uneven ground is prevalent. However, this limitation can be circumvented through optimum communication and planning.

5. RECOMMENDATIONS

Contractors and co-contractors should consider using PAAPs where traditional forms of scaffolding are not the ideal or optimum form of access. Their use can be facilitated through optimum planning, *inter alia*, site layout, and programming, scheduling, and coordinating.

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Health and Safety (H&S) in Roofing

Professor John Smallwood, PhD (Construction Management)
Department of Construction Management, Nelson Mandela Metropolitan University, South Africa

ABSTRACT

Roofing is undertaken at elevated heights, while exposed to the natural elements. Furthermore, roofing entails manual handling, adopting of uncomfortable postures, and repetitive movements.

Roofing H&S, as construction in general, is influenced by: client decisions; design, details, and specification; general contractor (GC) practices, and roofing contractor practices.

Empirical findings emanating from a study conducted in provinces in South Africa are reported on. Salient findings include: H&S is not as important to roofing contractors as other project parameters; there is a preference for task specific, as opposed to general H&S interventions; design has an effect on roofing H&S through roof design, roof height above ground level, roof pitch, girder / truss and purlin / batten spacing, and material specification; the mass, edge characteristics, span, profile, and method of fixing of materials have an effect on roofing H&S; clients, designers and GCs can and do play a major role in roofing H&S, and safe work procedures (SWPs) accompanied by optimum first line supervision and overall project supervision, and reinforced by site management commitment to H&S, will assure H&S while roofing.

Recommendations include: the level of awareness with respect to the role of designers in roofing H&S should be raised; employer associations should evolve guidelines for roofing H&S, and assist roofing contractors with the development of roofing SWPs; GCs should monitor and enforce the use of roofing SWPs, and roofing contractors should conduct H&S induction on every project, always make use of roofing SWPs, and ensure that there is adequate supervision.

Keywords: Health and Safety, Roofing

1. INTRODUCTION

The first sentence of the leaflet *Working on Roofs* published by the Health & Safety Executive (HSE) (1999) reads: "Working on a roof can be dangerous." The opening statement is followed by the mention that falls account for more deaths and serious injuries in construction than any other cause of injury, and that nearly half of them are from or through roofs and involve fragile materials.

Herbele (1998) contends that employees can get lulled into a sense of false security from spending considerable time on roofs and adds: "That edge just so far away." He further contends that many employees simply forget that they are on a roof and that being off balance or out of position anywhere on the surface of a sloping roof can mean trouble. He also mentions that working on a roof in bad weather can make such work extremely dangerous.

In the 'quick scan' of the chapter 'Fall protection' Herbele (1998) provides an overview of the key issues relative to roofing H&S. Set a goal of 100% fall protection for all employees, using personal protective equipment (PPE), and safe work practices and procedures. Install guardrails around open floors, walls, and platforms. Train workers in safe work practices. Deploy fall-protection systems such as slide guards and roof anchors, and alternative work practices when a guard rail system cannot be used. Train all employees to recognise fall hazards and support the training of competent persons to establish and maintain effective fall-protection systems. Understand and abide by, or exceed minimum fall-protection regulations.

A study was conducted among roofing SCs that were members of the East Cape MBA, Gauteng MBA, Kwazulu–Natal MBA, and MBA (Cape Peninsula) to determine the:

- Importance of various project parameters;
- Extent of H&S related documentation;
- Frequency of H&S related interventions;
- Frequency of use of fall arrest systems (FASs) and personal protective equipment (PPE), and
- The effect of various aspects on roofing H&S.

2. REVIEW OF THE LITERATURE

2.1 Statistics

United Kingdom (UK) statistics indicate that in terms of cause, 214 (49.5%) of 432 accidents were falls, 76 (35.5%) of which were from roofs. Overall, fall from roofs accounted for 17.6% of the 432 accidents (HSE, 1998).

2.2 General issues

The HSE (1998) cites the following: safe place of work on the roof; safe access to the roof; escape in case of fire; materials handling; mechanical handling; falling materials; weather conditions; health risks, and electricity.

2.3 H&S interventions

CentiMark (2006) contends that their H&S programme is unmatched in the USA construction industry and cites a range of statistics to substantiate their claim. They reduced their total recordable cases incidence rate from 7.77 in 2001 to 4.23 in 2005, which is substantially lower than the national incidence rate of 8.1 in 2004.

CentiMark's H&S programme consists of a policy and procedures documented in a manual, training, and inspections. Fifteen topics are included in the manual: introduction; responsibilities; indoctrination; drug policy; rules; general liability; fleet; fall protection; back injury protection; assured grounding programme; hazard communications; respirator programme; OSHA jobsite inspections; OSHA regulations, and H&S meeting / daily checklist.

H&S training interventions include: all new hires are required to attend a mandatory training programme; weekly toolbox talks presented by the foremen; monthly meetings conducted by the operations managers; quarterly mandatory meetings conducted by regional H&S specialists; periodic H&S meetings conducted by regional H&S specialists to address accident trends, potential problems, and / or the findings of unannounced inspections; an H&S training certification programme consisting of seventeen units, and subcontractor training.

H&S inspections include: pre-job, spot-check; daily, and unannounced. Pre-job inspections entail a survey, which includes a written fall protection plan; the required H&S equipment, and the required procedures to complete the proposed project. Spot-check inspections are conducted by operation managers and field supervisors to ensure that procedures are being implemented. Foremen conduct daily inspections to identify any hazardous conditions to ensure that workers are protected from hazards and that they are following safe work practices. Unannounced inspections are conducted by H&S specialists to ensure that foremen and workers are following safe work practices. Disciplinary action is implemented should H&S violations exist.

2.4 The role of clients

The HSE (1998) states that those who own, occupy, or have responsibility for a building have an important role to play. This includes considering the

design and specification of the roof, and appointing a contractor. Furthermore, clients should avoid placing unreasonable programming demands, as doing so can lead to undue pressure on those undertaking the work. This in turn can make it harder for contractors to: plan for healthy and safe working; prepare optimum H&S method statements; review and amend systems of work, and implement safe work procedures (SWPs).

The HSE (1998) argues that clients can benefit considerably from a structured approach to H&S as better coordination between clients, designers, contractors, and specialist subcontractors, can result in reduced delays, and a building that is cheaper and easier to maintain.

2.5 The role of designers

The HSE (1998) states that designers, through the use of their skills and judgement, can eliminate hazards make risks easier to manage, which assists contractors to provide a healthier and safer place of work on the roof. However, designers should consider the initial construction as well as future maintenance and cleaning.

The design of the roof should be reviewed as a total design package i.e. consider the interaction between all components, in both the final and partially erected stages, and their effect on the systems of work necessary to erect the structure.

3. RESEARCH

3.1 Methodology and sample stratum

The sample stratum included roofing SCs that were members of the East Cape MBA, Gauteng MBA, Kwazulu–Natal MBA, and MBA (Cape Peninsula). 47 Roofing SCs were surveyed using a written questionnaire. 19 Responses were received and included in the analysis of the data, which equates to a response rate of 40.4 %.

3.2 Analysis of the data

The analysis of the data consisted of the calculation of descriptive statistics to depict the frequency distribution and central tendency of responses to fixed response questions to determine the degree of importance of various parameters, the frequency of intervention and use, and the nature of the effect of various aspects.

3.3 Findings

Table 1 indicates the importance of the traditional and non-traditional project parameters by roofing SCs in terms of percentages relative to importance on a scale of 1 (not) to 5 (very), and a ranking based upon a MS with a minimum value of 1.00, and a maximum value of 5.00. Given that all the parameters have MSs above the midpoint 3.00, in general the parameters can be deemed to be important to SCs. It is notable that eight of the nine parameters have MSs $> 4.20 \leq 5.00$, which indicates that they can be deemed to be perceived to be between more than important to very important / very important. It is notable that two of the top four ranked parameters, namely quality and time, are two of the three traditional parameters. It is also significant that H&S, the subject of the study, achieved a ranking of seventh. However, it has a MS of 3.28, which falls within the range $> 4.20 \leq 5.00$.

Table 1: Degree of importance of various parameters.

Parameter	Response (%)					MS	Rank
	Not ……. Very						
	1	2	3	4	5		
Quality	0.0	0.0	0.0	21.1	78.9	4.79	1
Productivity	0.0	0.0	0.0	42.1	57.9	4.58	2=
Time	0.0	0.0	0.0	42.1	57.9	4.58	2=
Client satisfaction	0.0	0.0	5.3	31.6	63.2	4.58	2=
Main contractor satisfaction	0.0	0.0	5.3	36.8	57.9	4.53	5
Cost	0.0	5.3	5.3	26.3	63.2	4.47	6
H&S	0.0	0.0	16.7	38.9	44.4	4.28	7
Worker satisfaction	0.0	0.0	15.8	42.1	42.1	4.26	8
Environment	5.6	11.1	33.3	16.7	33.3	3.61	9

Written H&S rules predominate among types of documentation roofing SCs have available. Less than half of the SCs have written safe work procedures (SWPs), a written H&S policy and a documented H&S programme (Table 2).

Table 2: Extent of H&S related documentation.

Documentation	Response (%)		
	Unsure	No	Yes
Written H&S rules	5.9	41.2	52.9
Written safe work procedures (SWPs)	11.1	44.4	44.4
Written H&S policy	5.9	52.9	41.2
Documented H&S programme	5.6	61.1	33.3

Table 3 indicates the frequency roofing SCs undertake interventions in terms of percentages relative to a scale of never to always, and a ranking based upon a MS with a minimum value of 0.00, and a maximum value of 5.00. Reference to H&S upon instruction to execute a task predominates among the interventions. Given that the top three ranked interventions have MSs above the midpoint value of 3.00, in general the interventions can be deemed to be prevalent. It is notable that the interventions ranked fourth, fifth, and sixth have MSs below the midpoint value of 3.00, which indicates that they cannot be deemed to be prevalent. MSs: > 1.80 ≤ 2.60 indicate that an intervention can be deemed to be undertaken between never to rarely / rarely; > 2.60 ≤ 3.40 between rarely to sometimes / sometimes, and > 3.40 ≤ 4.20 between sometimes to often / often.

Table 3: Frequency of H&S related interventions.

Intervention	Response (%)						MS	Rank
	Unsure	Never	Rarely	Sometimes	Often	Always		
Reference to H&S upon instruction to execute a task	0.0	0.0	16.7	5.6	38.9	38.9	4.00	1
'Toolbox talks'	0.0	10.5	5.3	31.6	31.6	21.1	3.47	2
Project H&S plans	0.0	5.6	27.8	27.8	27.8	11.1	3.11	3
H&S induction	0.0	21.1	21.1	26.3	21.1	10.5	2.79	4
H&S meetings	0.0	31.6	5.3	36.8	15.8	10.5	2.68	5
H&S training	0.0	21.1	26.3	36.8	10.5	5.3	2.53	6

Table 4 indicates the frequency roofing SCs make use of fall arrest systems (FASs) and personal protective equipment (PPE) in terms of percentages relative to a scale of never to always, and a ranking based upon a MS with a minimum value of 1.00, and a maximum value of 5.00. Respondents were also provided with a 'not possible' option. No respondents identified the 'Unsure' response. Safety belts / lanyards attached to static lines, and safety harnesses attached to static lines, predominate among the FASs and PPE. Given that the top two ranked FASs and PPE have MSs above the midpoint value of 3.00, their use can be deemed to be prevalent. It is notable that the other FASs and PPE have MSs below the midpoint value of 3.00, which indicates that their use cannot be deemed to be prevalent. MSs: > 1.00 ≤ 1.80 indicate that an intervention can be deemed to be undertaken between never to rarely; > 1.80 ≤ 2.60 between never to rarely / rarely; > 2.60 ≤ 3.40 between rarely to sometimes / sometimes, and > 3.40 ≤ 4.20 between sometimes to often /

often. It is notable that no FAS / PPE falls within the upper most range > 4.20 ≤ 5.00

Table 4: Frequency of use of fall arrest systems (FASs) and personal protective equipment (PPE).

FASs / PPE	Response (%)						MS	Rank
	Not possible	Never	Rarely	Sometimes	Often	Always		
Safety belts / lanyards attached to static lines	0.0	0.0	15.8	36.8	31.6	15.8	3.47	1
Safety harnesses attached to static lines	0.0	5.3	15.8	47.4	15.8	15.8	3.21	2
Tool belts	0.0	31.6	15.8	31.6	15.8	5.3	2.47	3
Life lines	0.0	31.6	10.5	42.1	15.8	0.0	2.42	4
Guard rails to perimeter / edges	0.0	38.9	11.1	33.3	5.6	11.1	2.39	5
Inertia reels	0.0	50.0	27.8	11.1	11.1	0.0	1.83	6
Safety nets	0.0	57.9	31.6	10.5	0.0	0.0	1.53	7

Table 5 indicates the impact twenty-one aspects have on H&S in terms of percentages relative to 'No' and on a scale of 1 (minor) to 5 (major), and a ranking based upon an MS with a minimum value of 0.00, and a maximum value of 5.00. Given that a 'No' option was provided the scale effectively consists of six points. No respondents identified the 'Unsure' response.

The aspects tabled were extracted from literature based upon their influence and impact on both general and roofing H&S. Essentially the aspects can be divided into six categories – an asterisk * indicates that the aspect can be related to more than one category:

- Design: roof design (irregular); roof pitch (high); height above ground level (high); girder / truss spacing (far)*; profile of roof covering (deep)*, and span of roof covering (long)*;
- Materials: profile of roof covering (deep)*; span of roof covering (long)*; mass of roof covering (heavy); edge of roof covering (sharp); method of fixing roof covering (complex); girder / truss spacing (far)*, and purlin / batten spacing (far);
- Culture (client, designer and contractor): H&S = cost, quality and time (project focus on H&S);
- Culture (contractor): site management commitment to H&S;
- Management systems: safe work procedures (SWPs); H&S induction, and H&S training;

- Site management / supervision: overall project supervision; first line supervision of roofing, and wearing of PPE by roofers, and
- Elements: wind speed (high); precipitation / rain, and temperature (extreme).

Table 5: Effect of various aspects on roofing H&S.

Aspect	Response (%)						MS	Rank
		Minor …… Major						
	No	1	2	3	4	5		
Wind speed (high)	0.0	0.0	5.3	0.0	15.8	78.9	4.68	1
Precipitation / Rain	0.0	0.0	0.0	0.0	36.8	63.2	4.63	2
Roof pitch (high)	0.0	0.0	5.3	15.8	21.1	57.9	4.32	3
First line supervision of roofing (close)	5.3	0.0	0.0	10.5	47.4	36.8	4.28	4
Safe work procedures (SWPs)	0.0	0.0	5.9	17.6	29.4	47.1	4.18	5
Overall project supervision (competent)	0.0	0.0	0.0	21.1	47.4	31.6	4.11	6
Site management commitment to H&S	0.0	0.0	16.7	11.1	22.2	50.0	4.06	7
Height above ground level (high)	0.0	5.3	5.3	21.1	26.3	42.1	3.95	8
Wearing of PPE by roofers	0.0	0.0	10.5	31.6	1.6	26.3	3.74	9
H&S = cost, quality and time (project focus on H&S)	0.0	0.0	11.1	38.9	16.7	33.3	3.72	10
Edge of roof covering (sharp)	0.0	0.0	11.8	35.3	35.3	17.6	3.59	11
Temperature (extreme)	0.0	0.0	21.1	31.6	21.1	26.3	3.53	12
Mass of roof covering (heavy)	0.0	11.1	5.6	33.3	27.8	22.2	3.44	13
Method of fixing roof covering (complex)	0.0	0.0	15.8	42.1	31.6	10.5	3.37	14
Roof design (irregular)	0.0	16.7	5.6	22.2	38.9	16.7	3.33	15
H&S induction	0.0	0.0	37.5	37.5	0.0	25.0	3.13	16
Girder / Truss spacing (far)	0.0	16.7	11.1	27.8	38.9	5.6	3.06	17=
H&S training	0.0	0.0	43.8	25.0	12.5	18.8	3.06	17=
Purlin / Batten spacing (far)	0.0	15.8	15.8	31.6	31.6	5.3	2.95	19
Span of roof								

covering (long)	0.0	15.8	5.3	63.2	5.3	10.5	2.89	20
Profile of roof covering (deep)	0.0	10.5	31.6	47.4	10.5	0.0	2.58	21

Given that the MSs of all the aspects are above the midpoint value of 2.50, they can all be deemed to have an impact on H&S.

It is significant that the top five ranked aspects have II values > 4.17 ≤ 5.00, which indicates that they have between a near major to major impact / major impact on H&S. The following categories are represented: elements (first and second); design (third); site management / supervision (fourth, and management systems (fifth).

Those aspects ranked from sixth to fourteenth have MSs > 3.34 ≤ 4.17, which indicates that they have between an impact and a near major impact / near major impact on H&S. The following categories are represented: site management / supervision (sixth and ninth); culture (contractor) (seventh); design (eighth); culture (client, designer and contractor) (tenth); material (eleventh, thirteenth, and fourteenth), and elements (twelfth).

Those aspects ranked from fifteenth to twenty-first have MSs > 2.51 ≤ 3.34, which indicates that they have between a near minor impact to impact / impact on H&S. The following categories are represented: design (fifteenth, seventeenth, twentieth, and twenty-first); management systems (sixteenth and seventeenth), and material (nineteenth, twentieth, and twenty-first).

4. CONCLUSIONS

H&S is not as important to roofing SCs as other project parameters. However, this could be attributable to the general importance attached to H&S by all industry stakeholders. Further, the MS and consequent ranking of 'H&S = cost, quality and time (project focus on H&S)' in terms of the effect of various aspects on roofing H&S, reflects the importance of a project environment that is complementary to H&S.

The predominance of reference to H&S upon instruction to execute a task and 'toolbox talks' in terms of H&S related interventions, indicates a preference for task specific, as opposed to general H&S interventions i.e. the 'mechanics' as opposed to the 'dynamics'. Furthermore,

Roofing SCs generally do not have written H&S related documentation available, and therefore it can be concluded that they adopt an informal approach.

Design, materials, culture (client, designer and contractor), culture (contractor), management systems, and site management / supervision all affect roofing H&S.

Design has an effect on roofing H&S through roof design, roof height above ground level, roof pitch, girder / truss and purlin / batten spacing, and material specification. The mass, edge characteristics, span, profile,

and method of fixing of materials all have an effect on roofing H&S. Although wind speed and precipitation predominated in terms of the effect aspects have on roofing H&S, certain characteristics of a roofing material such as length, can compound the difficulty of roofing while high wind speeds prevail. Designers should consider the potential influence of the elements on roofing H&S when designing, detailing and specifying.

Roofing SCs do not make use of a wide range of FASs / PPE.

An optimum project H&S culture reinforced by optimum site management commitment to H&S is complementary to and a pre-requisite for roofing H&S – clients, designers and general contractors (GCs) can and do play a major role in roofing H&S. SWPs accompanied by optimum first line supervision and overall project supervision, and reinforced by site management commitment to H&S, will assure H&S while roofing.

5. RECOMMENDATIONS

Design related professional associations should raise the level of awareness with respect to the role of designers in roofing H&S, and evolve related practice notes.

Employer associations should evolve guidelines for roofing H&S, and assist roofing SCs with the development of roofing SWPs.

GCs should monitor and enforce the use of roofing SWPs by roofing SCs.

Roofing SCs in turn should: conduct H&S induction on every project; always make use of roofing SWPs, and ensure that there is adequate supervision.

6. REFERENCES

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