Identification of Health and Safety Performance Improvement Indicators for Small and Medium Construction Enterprises: A Delphi Consensus Study

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Abstract This study sought to identify and validate a comprehensive set of health and safety (H&S) leading indicator metrics that will enable small and medium construction enterprises (SMEs) personnel to monitor the level of H&S performance in their projects. The Delphi approach was used where the opinion of H&S experts, academics and industry practitioners were canvassed on 64 potential indicator metrics, categorized in 10 elements or leading indicators that will enable H&S performance improvement e.g. reduction in accidents, injuries, diseases but to name a few. The experts rated each indicator metric on a 10-point Likert scale of impact, where 1= no major impact or 10% impact and 10 = major impact or 100% impact. Consensus was reached on 32 indicator metrics after four successive rounds of Delphi if the indicators attracted final scores of, percentage median impact of 90% to 100% which is 9.00 to 10.00 median rating and over 50% of respondents rating the indicator metrics in the band of 9.00 to 10.00 or 90% to 100% impact to improve H&S performance. The experts had the opportunity to reconsider their scores informed by the group median score in rounds 2, 3 and 4. The limitation of the study was the reliance of a structured questionnaire in the first round as experts were not allowed to add any new indicators, until the fourth round. This study contributes to the H&S body of knowledge where no consensus has been reached pertaining to the indicator metrics that have major impact to improve H&S performance at project level of construction SMEs in South Africa.

Keywords: Experts, Proactive indicators, Health and safety, Performance improvement

1. Introduction

The construction industry is unique as construction activities are performed outdoor under conditions not conducive for health and safety (H&S). Most of the people tend to relate construction industry to high risk working environment (Loosemore et al., 2003; Root 2005).

The Department of Labour (DoL) indicated that the construction H&S statistics in South Africa covering the period 2004/05 to 2007/08 showed a sharp rise in accidents from, 54 fatalities and 159 non-fatal accidents (i.e. temporary or permanent disablement) to around 160 fatalities and around 400 non-fatal accidents respectively (DoL, 2008 cited in construction industry development board report (CIDB, 2008). Furthermore, the Department of Labour (DoL, 2007) indicated that construction accidents accounted for 4% of the global gross domestic product (GDP). In South Africa the occupational accidents and diseases accounted for approximately 3.5% of its GDP, which, translated to about R30 billion (about US$4.2 billion). These statistics are inclusive of large, medium and small contractors. Aside from the direct compensation and medical costs associated with accidents the costs to the economy are immense and include rework, lost time, damage to plant and equipment, disruption, productivity loss and loss of skills to the economy (CIDB, 2004). Furthermore the strain of the loss of a family member, particularly if the worker was the only family bread winner (CIDB, 2008).

The CIDB, (2008) report further indicated that despite isolated reports of improvement, there was very limited commitment to comply with basic requirements, let alone promote a culture of H&S. Employers view health and safety as a cost in the system. Small contractors can barely maintain tools and regard safety equipment as luxury items. Even where protective clothing and equipment are provided, workers often avoid their use, including the use of safety goggles and masks when working with grinders and asbestos (CIDB, 2004).

Walker, (2001) cited in Health and Safety Executive (HSE), (2007) indicated that SMEs have shown to experience proportionately more accidents than large enterprise. It has also been indicated that models for measuring H&S performance for large contractors will not be applicable to SMEs. This is verified in a study conducted by Lin et al., (2001) in Australia. The authors further concluded there is need to improve H&S performance within small construction enterprises.

2. Measurement of construction health and safety performance

Health and safety performance measurement allows comparison of H&S performance between projects and can be used by organizations internally to maintain line accountability for H&S and to pin point problem areas. Health and safety performance measurement can broadly be classified in two types of indicators, namely lagging indicators such as accident rates, and leading indicators (LIs) or positive performance indicators (PPIs) that address H&S climate (Flin et al., 2000) and H&S culture (Grabowski et al., 2010). Grabowski, et al., (2007) asserts that leading indicators can either be subjective or objective indicator metrics. Unfortunately, the construction industry continues to rely heavily on traditional measures such as accident rates and workers compensation statistics (Mohamed, 2002). This implies that measuring LIs in construction industry are in their infancy and needs to be addressed especially in SMEs.

When using LIs a more thorough and constant surveillance is required than when using lagging indicators (Hinze, 2005). The real value of using H&S leading indicators on the construction project is that changes can be made early. An intervention can be devised that can address the weakness before there is an accident. Hinze (2005) advocated for the use of LIs in H&S performance measurement, rather than using lagging indicators.

Traditionally, senior managers of most organizations frown upon the management of a workplace where high injury rates are reported. This pre-occupation with outcome performance measures fuels the culture of underreporting of accidents and incidents. Arguably, therefore the use of traditional outcome H&S measures as a stand alone assessment of workplace H&S or as a measure of performance amongst different organizations in the same industry is inherently flawed (Trethewy, 2003). Trethewy (2003) further indicates that the absence of low probability incident does not necessarily mean that core risks are effectively managed but merely that such an incident has just not happened yet.

This research builds on the aforementioned debate of leading indicator measures of H&S that are ideal for improving H&S performance, than using lagging indicators. Currently there are no major studies that have focused on H&S leading indicators and indicator metrics tailored towards SMEs in South Africa which makes this study important.
Based on the gaps in literature review this study poses the following research questions;

- What are the indicator metrics that will improve H&S performance at project level of small and medium construction enterprises? and;
- What are the indicator metrics with major impact in improving H&S performance at project level of small and medium construction enterprises?

3. Literature review to identify health and safety indicators

Ng et al., (2003) developed a framework for evaluating the safety performance of contractors in Hong Kong at both the organization level and project level. The factors identified by the researchers to improve H&S performance at project level were: project management commitment, hazard management, information, training, and promotions, but to name a few. The factors for organization level were administrative and management commitment, H&S training, selection and control subcontractors, safety review; accident record and legislation, codes and standards.

Levitt and Parker (1976) studied the role of top management in construction firms in reducing construction injuries. They established that: companies whose top managers talked about safety when they visited jobsites had lower Experience Modification Rating (EMR's) than companies in which safety was not mentioned during these events. They also found that companies with formal orientation programs had lower EMR's compared to companies with no orientation programs.

Cooper (1998) indicated the importance of communication in influencing H&S performance improvement and categorized communication into formal and informal, verbal and written communication. Kheni et al., (2006) indicated verbal communication as a good measure for safety management practice. Sawacha et al., (1999) established that the most important factors to improve H&S performance under organization safety policy are: management communication in regards to safety, provision of safety booklets, provision of safety equipment, assuring a tidy site, appointing safety representatives and training of operatives on safety.

Jaselskis et al., (1996) assert that to achieve better construction safety performance at the project level, the H&S factors/elements that are important for achieving better safety performance are: increased project manager experience level, more supportive upper management attitude towards safety, reduced project team turnover, increased time devoted to safety representative, more formal meetings with supervisors and specialty contractors, more informal safety meetings with supervisors, a greater number of informal site safety meetings with supervisors, a greater number of informal site safety inspections, reduced craft worker penalties, and increased budget allocation to safety awards.

Furthermore, Toellner, (2001) established LIs that are essential to improving safety performance to be: safety walkthroughs by management, barricading a given place, tool box talk meeting and housekeeping. Jannadai et al., (2002) revealed that management involvement, personal protective equipment, and emergency planning and preparation were considered to be extremely important factors in influencing safety performance as they reveal the greatest impact.

Fernandez-Muniz et al., (2007), indicated that the critical elements influencing H&S performance improvement, that have been replicated in most literature are management commitment and involvement and employee involvement and empowerment and they appear to be easily demonstrated and promoted through risk assessments, inspections, audits, training, hazard reporting and completing corrective actions.

Based on the above discussions this research identified 64 potential indicator metrics categorized in ten core elements/leading indicators viz.; appointment of H&S staff, formal and informal written communication, formal and informal verbal communication, H&S resources, project planning of H&S, project supervision, training in H&S, upper management commitment and involvement in H&S, policy on H&S and worker's/employee involvement and empowerment as indicated in Table 1.

Table 1: Core elements/leading indicators and leading indicator metrics identified

Core elements/leading indicators	*Leading indicator metrics*	*Source(s)*
Appointment of H&S staff, Sawacha et al., (1999); Vredenburgh, (2002)	Employing at least one qualified manager with H&S training to oversee H&S [*on multiple projects]*	Findley et al., (2004) and researchers addition *italics*
	At least one staff member with H&S training is employed on each project	Ng. et al., (2005)
	Employing at least one H&S representative on each project	Sawacha et al., (1999) Rajendran, et al., (2009)
Formal and informal written Communication Cooper, (1998); HSE, (2008)	Provision of written information about H&S procedures	HSE, (2008); Fernandez-Muniz et al., (2007)
	Provision of written information about the correct way to perform tasks	HSE, (2008); Fernandez-Muniz et al., (2007)
	Written circular/brochure that informs workers about the risks associated with their work	Sawacha et al., (1999) Fernandez-Muniz et al., (2007)
	Written circular/brochure that inform workers about the preventive measures to reduce risk	Sawacha et al., (1999) Fernandez-Muniz et al., (2007)
Formal and informal verbal communication Cooper, (1998); HSE, (2008)	Provide clear verbal instructions to both literate and illiterate employees about H&S	Fernandez-Muniz et al., (2007)
	H&S information verbally communicated to workers before changes are made to the way their work activities are executed	HSE, (2008); Kheni et al., (2006) Fernandez-Muniz et al., (2007)
	Organize regular meetings to verbally inform workers about the risks associated with their work	Fernandez-Muniz et al., (2007)
	Organize regular meetings to verbally inform workers about the preventive H&S measures of risky work	Fernandez-Muniz et al., (2007)

Source: Authors work

Continuation Table 1: Core elements/leading indicators and leading indicator metrics identified

Core elements/leading indicators	*Leading indicator metrics*	*Source(s)*
H&S resources Abudayyeh et al., (2006); Rajendran et al., (2009)	Provision of personal protective equipment (PPE)	Kheni et al., (2006) Rajendran et al., (2009)
	Training in H&S through attending seminars/workshops	Fernandez-Muniz et al., (2007)
	Material schedule data sheets provided for all hazardous materials on site	Lingard et al., (2005)
	Employing technically skilled employees with H&S training	Rajendran et al., (2009)
	Adequate information brochures given on H&S	Sawacha et al., (1999) Fernandez-Muniz et al., (2007)
	Provision of a budget for H&S	Kheni et al. (2006)
	Provision of correct tools, equipment and plant to execute construction	Teo et al., (2005); Rajendran et al., (2009)
	Provision of good welfare facilities such as showers, canteens, toilets	Kheni et al., (2006) Rajendran et al., (2009)
Project supervision/inspection Fang et al., (2004); Rajendran et al., (2009)	Proper supervision by staff trained in H&S	Fang et al., (2004)
	Identification of hazards by at least (*one staff member trained in H&S)*	Mitchell, (2000); Jannadi et al., (2002)
	Results of inspections discussed at H&S meetings	Mitchell, (2000);
	H&S inspections done at least daily	Jaselskis et al., (1996); Jannadi et al., (2002);
	Local authorities and H&S enforcement agencies visit sites for inspection	Aksorn, et al., (2008);
	Ad hoc informal H&S inspections of work place	Jaselskis et al., (1996); Lin et al., (2001)
	Regular H&S audits of projects	Mitchell, (2000); Trewthewy, (2003)
Project planning of H&S Sawacha et al., (1999); Mitchell, (2000); Teo et. al., (2005); Rajendran et al., (2009)	Ergonomics is considered when deciding the method of construction	Shikdar et al., (2003); Rajendran et al., (2009)
	Reengineering is considered to reduce hazards	Vredenburgh.,(2002) Mitchell, (2000);
	When head office decides on the method of construction H&S is included in decision making process	Vredenburgh., (2002)
	Each project has a site-specific H&S plan	Fernandez-Muniz et al., (2007); Rajendran et al., (2009)
	Layout of the site considers H&S aspects	Mitchell, (2000); Rajendran et al., (2009)
	Use hazard identification procedures	Trewthewy, (2003); Teo et al., (2005)
	Use of risk assessment procedures	Trewthewy, (2003)
	Constructability of project is reviewed	Coble et al., (2000); Sawacha et al., (1999)
	Scheduling for H&S	Mitchell, (2000); Rajendran et al., (2009)

Source: Authors work

Continuation Table 1: Core elements/leading indicators and leading indicator metrics identified

Core elements/leading indicators	*Leading indicator metrics*	*Source(s)*
Training in H&S Sawacha et al., (1999); Kheni et al., (2006); Fernandez-Muniz et al., (2007)	Workers undergo induction on H&S before commencing work on a particular site	Trewthewy, (2003); Fernandez-Muniz et al., (2007)
	Workers trained in proper care and use of personal protective equipment	Sawacha et al., (1999) Shannon, et al., (1997); Fernandez-Muniz et al., (2007)
	Workers are regularly trained in H&S	Shannon, et al., (1997); Ng, et al., (2005); Rajendran et al., (2009)
	Instruction manuals or safe work procedures are used to aid in preventive action	Sawacha et al., (1999) Fernandez-Muniz et al., (2007)
	Workers are given time off for training	Findley et al., (2004); Fernandez-Muniz et al., (2007)
Worker/employee involvement & empowerment in H&S Aksorn et al., (2008); Fernandez-Muniz et al., 2007)	Workers are involved in production of H&S policy	Fernandez-Muniz et al., (2007)
	Workers provide written suggestions on H&S	Kheni et al., (2006)
	Workers kept informed of provisions of H&S plan	Fernandez-Muniz et al., (2007);
	Workers are involved in H&S inspections	Jaselskis et al., (1996)
	Workers are consulted when the H&S plan is compiled	Fernandez-Muniz et al., (2007);
	Workers are involved in development of H&S rules and safe work procedures	Fernandez-Muniz et al., (2007)
	Workers have the explicit right to refuse to work in potentially unsafe, unhealthy conditions	Sawacha et al., (1999) Rajendran et al., (2009);
Upper management commitment & involvement in H&S Levitt et al., (1976); Abudayyeh et al., (2004); Aksorn, et al., (2008)	Managers encourage and support worker participation, commitment and involvement in H&S activities	Abudayyeh et al., (2004); Fernandez-Muniz et al., (2007)
	Managers encourage and support training of employees in H&S	Abudayyeh et al., (2004); Fernandez-Muniz et al., (2007)
	Managers communicate regularly with workers about H&S	Abudayyeh et al., (2004); Fernandez-Muniz et al., (2007)
	Managers actively monitor the H&S performance of their projects and workers	Toellner (2001); Abudayyeh et al., (2004);
	Managers take responsibility for H&S	Shannon et al., (1996) Trethewy (2003); Teo et al., (2005)
	Managers actively and visibly lead in H&S matters	Aksorn et. al., (2008); Fernandez-Muniz et al., (2007)
	Managers regularly visit workplaces to check work conditions or communicate with workers about H&S	Findley et al., (2004); Toellner et. al., (2009)
	Managers encourage and arrange meetings with employees & other managers to discuss H&S matters	Findley et al., (2004); Fernandez-Muniz et al., (2007)
	Managers conduct toolbox talks themselves	Toellner (2009);
	Managers ensure that the H&S budget is adequate	Abudayyeh et al., (2004); Jaselskis et al., (1996)
	Managers recognize and reward outstanding H&S performance of workers	Teo et al., (2005)

Source: Authors work

Continuation Table 1: Core elements/leading indicators and leading indicator metrics identified

Core elements/leading indicators	*Leading indicator metrics*	*Source(s)*
H&S policy Shannon et al., (1997); Ng et al., (2005); Fernandez-Muniz et al., 2007)	Proper implementation of safety management system	Teo et al., (2005)
	Company has H&S policy	Ng et al., (2005); Teo et al., (2005)
	Written in-house H&S rules and regulations for all workers reflecting management concern for safety, principles of action and objectives of achievement	Teo, et al., (2006); Fernandez-Muniz et al., (2007)
	The firm coordinates its H&S policies with other human resource policies to ensure the well-being of workers	Fernandez-Muniz et al., (2007)

Source: Authors work

4. Problem statement

Based on the research questions posed, so far there has been scant research of proactive indicators that can be more closely tied to the H&S measurement of SMEs in South Africa, to get a better understanding of their influence in attitudinal and other cultural factors. This current study identifies and validates appropriate leading indicator metrics that can be used for monitoring and measuring H&S performance at project level of SMEs, hence assist in reducing accidents, injuries, fatalities, illnesses, improve the productivity of the workers in projects but to name a few.

4.1 Objectives of the study

In order to answer the aforementioned research questions. This study therefore delves into the following research objectives;

- To identify leading indicator metrics that will influence health and safety performance improvement at project level of SMEs; and
- To determine the impact of the leading indicator metrics when used for monitoring and measuring health and safety performance improvement at project level of SMEs.

5. Methodology

A total of 64 leading indicator metrics that have the potential to improve H&S performance of SMEs at project level were identified. The indicators were categorized into ten core elements as indicated in Table 1. The experts rated the impact of the indicator metrics on a Likert scale of 1 = no major impact (10%) and 10 = major impact (100%) in improving H&S performance at project level of SMEs.

In order to reach consensus of the identified indicators in the literature, experts experience and knowledge was required using Delphi method. This consensus method is structured facilitation technique that explore consensus among a group of experts, by synthesizing their opinions (Murphy et al., 1998), they share common objective of synthesizing judgment when a state of uncertainty exists, in this case the leading indicator metrics to be used by construction industry SMEs at project level to successfully measure and improve there H&S performance. Delphi method has not been widely used in construction research (see Hallowell, 2008) but widely used in the health care research Addington et al., (2005), hence the reason for using it in this research to alleviate the existing uncertainty.

The Delphi technique has four important features. First it is characterized by its anonymity, thus encouraging honest opinion free from group pressure (Jones et al., 1995). This method is an advantage when both academics and industry practitioners are included, lest academics dominate discussions. Second iteration allows experts to change their opinions in subsequent rounds. Third, controlled feedback illustrates the distribution of the group's response, in addition to individual's previous response. Finally the Delphi technique can be used to engage participants who are separated by large distances because it can be distributed by mail or online (Hasson et al., 2000). This method was therefore appropriate in validating and identifying the H&S indicators.

Based on the identified indicators a structured questionnaire was developed for the first round of Delphi, the questionnaire was piloted with two H&S experts. The statisticians also checked for the suitability of wording and the rating scale. The ideal questionnaire was electronically presented in four rounds of Delphi to a panel of purposely selected

experts who voluntarily accepted to participate. The survey was via e-mail from September 2010 to June 2011. Purposive sampling was used, as this form of sampling is based on the assumption that the researcher's knowledge of the population can be used to carefully select individuals to be included in the sample (Polit et al., 1997). For this particular study purposive sampling is superior to, for example random sampling, because the stakeholders were selected on the basis of there breadth of experience and knowledge as well as their willingness and ability to articulate their opinions. Optimal sample size in research with the Delphi technique has not been established. Research has been published that was based on samples that vary from 10 and 50 to much larger numbers (Campbell et al., 2001). Murphy et al., (1998) asserted that a larger sample is better, concluding that as the number of stakeholders/experts increases, the reliability of 'composite judgment' increases. However these authors also stated that there is scant empirical evidence about the effect of the number of stakeholders/experts on either the reliability or the validity of consensus process.

A total of 30 H&S experts were identified and invited to participate, 20 experts both academics and industry practitioners of H&S voluntarily agreed to participate. The experts were selected globally using an introductory questionnaire survey via e-mail which they responded to. In the first round of Delphi the experts were asked to rate the impact of the indicators to the improvement of H&S at project level of SMEs projects without adding any new indicators, this approach was different as compared to the one applied by Addington et al., (2005) where they allowed the experts to add new measures in the first round. The second and third round questionnaires included a qualitative component that offered the experts the opportunity to provide additional feedback in the form of written comments if there rating was two units out of the group median. In round 4 the experts were allowed to add new indicators they thought would improve H&S performance at project level of SMEs and were also given the opportunity to change there rating if they were two units out of the group median. There were no new indicators that were added, hence indicating content validity and face validity of the indicators presented to the experts. After round 4, the degree of consensus achieved was assessed by calculating the median, mean and percentage response in the band of 9 and 10, of each indicator. Consensus was reached when indicators attracted final scores of, percentage median impact of 90% to 100% which is 9.00 to 10.00 median rating and over 50% of respondents rating the indicator metric in the band of 9.00 to 10.00.

The results presented in this paper are based on the fourth round of Delphi process. After the fourth round the experts were sent the final results of the survey.

6. Results

6.1 Demographic characteristics of experts

Twenty potential experts agreed to participate, and eventually sixteen experts finished all the four rounds of the Delphi study. The experts were internationally recruited and voluntarily accepted to participate. The experts were from Australia (6), America (1), South Africa (7), Italy (1), Portugal (2), Ireland (1), Scotland (1), and Pakistan (1). Ninety-five (95%) of experts were male, the female experts who were invited to participate declined the invitation, hence the result indicates the dominance of males in this field. The sixteen experts who completed the four rounds of Delphi, eight had PhDs, five with master's degree, one with bachelor degree and two with diploma. The accumulated industrial experience of the experts was 118 years at an average of 7.38 years per expert and academic experience of 95 years at an average of 5.94 years per expert. The experts especially the academics have extensively contributed to the body of knowledge on H&S with vast publications in peer reviewed conferences and journals. The experts are professionally registered in their countries.

6.2 Leading indicator metrics analysis

Table 2 indicates the Delphi results for round 4. The leading indicator metrics for measuring appointment of H&S staff were not retained. The indicators achieved median score of 8.00 and below or a median percentage impact of 80% and below. The percentage rating of the respondents in the median band of, 9.00 to 10.00 was less than 50%.

Formal and informal written communication was measured by four leading indicator metrics. The four indicator metrics were not retained. The percentage impact median was below 90% and the response rate of three indicator metrics, in the band of 9.00 to 10.00, was below 50%. One indicator metric attained over 50% response rate, but was not retained because the impact median was below 90%. This indicator metric was provision of written information about H&S procedures.

The experts rating for the formal and informal verbal communication metrics allowed the retention of one leading indicator metric i.e. organize regular meetings to verbally inform workers about preventive H&S measures of risky work. This indicator was rated to impact improvement at 90% and 68.75% rated it in the median band of 9.00 to 10.00. The

other three indicator metrics were not retained as they did not attain the two criteria's.

Health and safety resource was measured using 8 leading indicator metrics. Two of the metrics were retained as they were rated as having major impact to improve H&S performance. These indicator metrics were; provision of H&S budget and the provision of correct tools, equipment and plant to execute the construction work. Furthermore, material safety data sheet (MSDS) indicator metric was rated as having an impact percentage of 80%, and only 25% of experts rated it as having a major impact to improve H&S performance. The other five metrics were not retained because they did not fulfill both criteria's as indicated in Table 2.

The leading indicator of H&S project planning had nine leading indicator metrics to measure it, of which three were retained after the fourth round. The retained metrics were; layout of the site considers H&S aspects, use of hazard identification procedures and scheduling for H&S in projects. There percentage median impact to improve H&S performance was 90% and were rated by over 50% of experts as having a major impact to improve H&S performance.

Six of the seven leading indicator metrics measuring the construct of project supervision were retained. One of the metric i.e. results of inspection discussed at H&S meeting, was not retained as experts believe it had only 85% impact to improve H&S performance.

Training in H&S indicator was revealed using five leading indicator metrics. The experts rated three of the metrics as having major impact to improve H&S performance. The other two metrics that were not retained were; instruction manuals or safe work procedures used to aid in preventive action and workers given time off for training. There percentage impact to improve H&S performance was rated at 80%. The experts rating in the band of 9.00 to 10.00 was below 50%.

Upper management commitment and involvement had the highest number of leading indicator metrics i.e. 11. All the metrics were retained, and they were all considered to have major impact to improve H&S performance at project level of SMEs. This result reflects the importance of upper management commitment and involvement in improving H&S performance.

This leading indicator i.e. H&S policy had four leading indicator metrics to measure it. Based on the ratings from experts one metric was retained. Two of the indicator metrics attained a median percentage impact of 80% i.e. company having H&S policy and written in house H&S rules and regulations for all workers, which reflects management concern for safety principle of action and objectives of achievement. The retained indicator metric was; the firm coordinates its H&S policies with other human resource policies to ensure the well-being of workers.

Worker involvement and empowerment was reduced to five leading indicator metrics after the fourth round. The two leading indicator metrics that were not retained were; workers provide written suggestions on H&S and workers are kept informed of provision of H&S plan. Their impact rating was 85%. As per the experts rating, employees need to be involved and be empowered in H&S. Consulting employees when H&S plan is compiled was rated as having 90% impact to improve H&S performance, with 62.5% of experts rating it between the band of 9 to 10.

Table 2: leading indicator metrics perceived to have major impact in improving H&S performance

H&S core elements/leading indicators & leading indicator metrics	% response (9-10)	% Mean impact	% median Impact	median
Appointment of H&S staff				
Employing at least one qualified manager with H&S training to oversee H&S on multiple projects	*37.50*	*77.50*	*75.00*	*7.50*
At least one staff member with H&S training is employed on each project	*31.25*	*77.50*	*80.00*	*8.00*
Employing at least one H&S representative on each project	*18.75*	*70.00*	*70.00*	*7.00*
Formal and informal written Communication				
Provision of written information about H&S procedures	*50.00*	*77.50*	*85.00*	*8.50*
Provision of written information about the correct way to perform tasks	*37.50*	*75.60*	*80.00*	*8.00*
Written circular/brochure that informs workers about the risks associated with their work	*25.00*	*74.40*	*80.00*	*8.00*
Written circular/brochure that inform workers about the preventive measures to reduce risk	*31.25*	*74.40*	*80.00*	*8.00*

Data source: Delphi survey; September 2010 - June 2011

Continuation Table 2: leading indicator metrics perceived to have major impact in improving H&S performance

H&S core elements/leading indicators & leading indicator metrics	% response (9-10)	% Mean impact	% median Impact	median
Formal and informal verbal communication				
Provide clear verbal instructions to both literate and illiterate employees about H&S	*43.75*	*83.10*	*80.00*	*8.00*
H&S information verbally communicated to workers before changes are made to the way their work activities are executed	*37.50*	*82.50*	*80.00*	*8.00*
Organize regular meetings to verbally inform workers about the risks associated with their work	*50.00*	*86.30*	*85.00*	*8.50*
Organize regular meetings to verbally inform workers about the preventive H&S measures of risky work	68.75	87.50	90.00	9.00
H&S resources				
Provision of personal protective equipment (PPE)	*31.25*	*80.00*	*80.00*	*8.00*
Training in H&S through attending seminars/workshops	*37.50*	*77.50*	*80.00*	*8.00*
Material schedule data sheets provided for all hazardous materials on site	*25.00*	*74.70*	*80.00*	*8.00*
Employing technically skilled employees with H&S training	*43.75*	*84.40*	*80.00*	*8.00*
Adequate information brochures given on H&S	*12.50*	*72.50*	*80.00*	*8.00*
Provision of a budget for H&S	50.00	88.00	90.00	9.00
Provision of correct tools, equipment and plant to execute construction	68.75	86.30	90.00	9.00
Provision of good welfare facilities such as showers, canteens, toilets	*50.00*	*82.50*	*85.00*	*8.50*
Project planning of H&S				
Ergonomics is considered when deciding the method of construction	*37.50*	*82.50*	*80.00*	*8.00*
Reengineering is considered to reduce hazards	*50.00*	*85.00*	*85.00*	*8.50*
When head office decides on the method of construction H&S is included in decision making process	*50.00*	*85.60*	*85.00*	*8.50*
Each project has a site-specific H&S plan	*50.00*	*84.40*	*85.00*	*8.50*
Layout of the site considers H&S aspects	56.25	85.00	90.00	9.00
Use of hazard identification procedures	56.25	88.00	90.00	9.00
Use of risk assessment procedures	*50.00*	*81.90*	*85.00*	*8.50*
Constructability of project is reviewed	*43.75*	*82.50*	*80.00*	*8.00*
Scheduling for H&S	68.75	88.10	90.00	9.00
Project supervision				
Proper supervision by staff trained in H&S	62.50	86.30	90.00	9.00
Identification of hazards by at least one staff member trained in H&S	56.25	83.80	90.00	9.00
Results of inspection discussed at H&S meeting	*50.00*	*82.50*	*85.00*	*8.50*
H&S inspections done at least daily	56.25	85.00	90.00	9.00
Local authorities and H&S enforcement agencies visit sites for inspection	56.25	83.10	90.00	9.00
Ad hoc informal H&S inspections of work place	62.50	85.00	90.00	9.00
Regular H&S audits of projects	62.50	86.30	90.00	9.00

Data source: Delphi survey; September 2010 - June 2011

Continuation Table 2: leading indicator metrics perceived to have major impact in improving H&S performance

H&S core elements/leading indicators & leading indicator metrics	% response (9-10)	% Mean impact	% median Impact	median
Training in H&S				
Workers undergo induction on H&S before commencing work on a particular site	68.75	85.60	90.00	9.00
Workers trained in proper care and use of personal protective equipment	62.50	83.80	90.00	9.00
Workers are regularly trained in H&S	75.00	90.00	90.00	9.00
Instruction manuals or safe work procedures are used to aid in preventive action	*43.75*	*80.60*	*80.00*	*8.00*
Workers are given time off for training	*31.25*	*82.10*	*80.00*	*8.00*
Upper management commitment & involvement in H&S				
Managers encourage and support worker participation, commitment and involvement in H&S activities	75.00	90.00	90.00	9.00
Managers encourage and support training of employees in H&S	75.00	89.40	90.00	9.00
Managers communicate regularly with workers about H&S	81.25	90.00	90.00	9.00
Managers actively monitor the H&S performance of their projects and workers	75.00	88.80	90.00	9.00
Managers take responsibility for H&S	75.00	90.00	90.00	9.00
Managers actively and visibly lead in H&S matters	75.00	90.00	90.00	9.00
Managers regularly visit workplaces to check work conditions or communicate with workers about H&S	75.00	88.80	90.00	9.00
Managers encourage and arrange meetings with employees & other managers to discuss H&S matters	68.75	88.80	90.00	9.00
Managers conduct toolbox talks themselves	62.50	83.80	90.00	9.00
Managers ensure that the H&S budget is adequate	75.00	90.00	90.00	9.00
Managers recognize and reward outstanding H&S performance of workers	68.75	85.60	90.00	9.00
H&S policy				
Proper implementation of safety management system	*50.00*	*85.00*	*85.00*	*8.50*
Company has H&S policy	*31.25*	*76.30*	*80.00*	*8.00*
Written in-house H&S rules and regulations for all workers reflecting management concern for safety, principles of action and objectives of achievement	*37.50*	*75.60*	*80.00*	*8.00*
The firm coordinates its H&S policies with other human resource policies to ensure the well-being of workers	56.25	80.60	90.00	9.00
Worker/employee involvement & empowerment in H&S				
Workers are involved in production of H&S policy	62.50	83.80	90.00	9.00
Workers provide written suggestions on H&S	*50.00*	*80.60*	*85.00*	*8.50*
Workers are kept informed of provisions of H&S plan	*50.00*	*81.30*	*85.00*	*8.50*
Workers are involved in H&S inspections	75.00	88.80	90.00	9.00
Workers are consulted when H&S plan is compiled	62.50	83.10	90.00	9.00
Workers are involved in development of H&S rules and safe work procedures	62.50	88.10	90.00	9.00
Workers have the explicit right to refuse to work in potentially unsafe, unhealthy conditions	75.00	89.40	90.00	9.00

Data source: Delphi survey; September 2010 - June 2011

7. Discussions

The aim of the present study was to establish the indicator metrics having major impact to improve H&S performance at project level of SMEs i.e. reduce accidents, injuries, diseases, damage to property but to name a few. To achieve this objective four round Delphi was used in which 64 statements were drawn up and then evaluated by a panel of experts.

The experts rated 32 indicator metrics as having major impact to improve H&S performance, but none of the indicators were rated below median of 7.00, indicating that the experts opined that the indicators had a high to major impact in improving H&S performance.

As concerns appointment of H&S staff three indicator metrics were identified none of the indicators were retained. One expert commented that these indicators were expensive tasks for SMEs in their projects.

Verbal communication in H&S i.e. formal and informal was measured using four indicator metrics, only one of the indicator metric was retained i.e. organizing regular meetings to verbally inform workers about the preventive H&S measures of risky work, this is supported by Fernandez-Muniz et al., (2007).

Studies of Shannon et al., (1997), Ng et al., (2005) and Fernandez-Muniz et al., (2007) address the positive effect of H&S policy to improve H&S. This element revealed itself in using four indicator metrics only one attained consensus i.e. the firm coordinates its H&S policies with other human resource policies to ensure the well-being of workers. This finding is supported by, Fernandez-Muniz et al., (2007). The other three were rated as having high impact and not having major impact to improve H&S performance, hence they were not retained.

Quite a number of studies are supportive of employee involvement and empowerment to improve H&S performance (Aksorn et al., 2008; Fernandez-Muniz et al., 2007). Experts in rating the indicator metrics reached consensus on five of them. Two of the indicator metrics were not retained despite being voted by 50% of the experts as having a major impact. Unfortunately the impact rating was below 90% these indicator metrics were; workers provide written suggestions on H&S and workers are kept informed of provisions of H&S plan.

Upper management commitment and involvement is an important factor in enhancing H&S performance improvement as replicated in the studies of; Fernandez-Muniz et al., (2007), Levitt et al., (1976); Abudayyeh et al., (2004) and Aksorn, et al., (2008). Eleven of the indicators identified in the literature were rated as having major impact to improve H&S performance. These finding supports the literature that upper management involvement and commitment in any organization is critical to the improvement of H&S performance. The experts indicated that managers being active, visible on projects and leading in H&S matters will have a major impact in improving H&S performance, 75% of the experts rated the indicators in the band of 9 to 10 i.e. major impact.

Training in H&S has been indicated to improve H&S performance (see Sawacha et al., 1999; Kheni et al., 2006; Fernandez-Muniz et al., 2007). Three indicator metrics measuring H&S training attained consensus. Two indicator metrics that were not retained were: instruction manuals or safe work procedures are used to aid in preventive action and workers are given time off for training.

The H&S resource element is revealed using eight indicators of which two attained consensus i.e. provision of correct tools, equipment and plant to execute construction and provision of H&S budget. Material safety data sheet (MSDS) was rated by 25% of experts as having major impact to improve H&S performance; furthermore, one expert indicated that MSDS are *"cumbersome for SMEs to use"*.

Project supervision has been indicated to improve H&S performance (Fernandez-Muniz et al., 2007, Fang et al., 2004 and Rajendran et al., 2009). Six of the indicator metrics attained consensus. One metric i.e. results of inspection discussed at H&S meeting, was not retained as it was rated as having 85% impact to improve H&S performance. The non-retention of this indicator metric is supported by Mitchell, (2000).

Project planning of H&S has been indicated as a factor that will improve H&S performance of construction projects (see Sawacha et al., 1999; Mitchell, 2000; Teo et. al., 2005; Rajendran et al., 2009). Three of the nine indicator metrics measuring project planning of H&S attained consensus and were retained i.e. layout of the site considers H&S aspects, use of hazard identification procedures and scheduling for H&S. These indicator metrics are highly acknowledged by the experts as having major impact and voted with more than 50% of experts as having major impact to improve H&S performance at project level of SMEs.

8. Conclusions

This is the first reported study to develop a set of performance measures based on leading indicators and indicator metrics, specifically designed to evaluate H&S performance at project level of SMEs. These measures are deemed relevant for all SMEs in South Africa construction industry. Publication of this set of indicators is timely because of the interest of providing alternative measurement from traditional measurement of lagging indicators and the current perception of their superiority over lagging indicators in improving H&S performance by reducing accidents in their projects.

The review of literature identified 64 indicator metrics in round one, two indicators were later corrected after round two to allow for 62 indicator metrics to be rated until the end of round 4. The experts did not add any new indicators at the

end of round four, it can be indicated that the questionnaire used achieved both face and content validity. Consensus was attained on 32 leading indicator metrics categorized under seven leading indicators or elements.

The attrition rate of experts was low as four of the twenty experts did not continue till the final round, considering this was four rounds of Delphi process. It can therefore be indicated that the use of closed ended questionnaire in the first round was a success and the research area is of interest to the H&S experts. The Delphi approach has been discussed in detail and the procedure can be replicated in other studies.

9. Limitations

This study has a number of limitations. The indicators identified were based on literature review, with structured closed questionnaire in the first round of Delphi, instead of open ended questionnaire, which has been used in other Delphi survey study. This is viewed as a potential bias in this study and highly acknowledged. The other limitation was the limited feedback included between rounds especially the qualitative discussions which were interpreted based on the interpretation of the researchers and the statistical information being the group median. At this stage the reproducibility of the results of the approach is not known. However, the Delphi technique used in this study has been clearly discussed and can be replicated by other researchers.

10. Recommendations for future research

The H&S indicator metrics retained will form part of a conceptual model of H&S performance improvement that will be tested among senior personnel of construction SMEs in South Africa, in order to develop the "best fit" model of improving H&S performance in SMEs projects.

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