IMPACT SIGNIFICANCE OF CONSTRUCTION CLIENTS ON DESIGNERS' AND CONTRACTORS' HEALTH AND SAFETY (H&S) CULTURE- AN EXPLORATORY DELPHI STUDY

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ABSTRACT: Designers and Contractors' top management have been identified in many studies to be of great importance to health and safety performance and its continual improvement. Therefore developing strategies that support and motivate designers and contractor top management to implement health and safety elements would ensure a gradual and sustained improvement of health and safety in the construction industry.

In order to determine the impact significance of clients/owners on designers and contractor top management, a Delphi study was conducted.

Findings from the study where that client culture has critical impact significance on designers and contractors' top management culture. Further findings were that implementation of health and safety elements by designers and contractors were 'very likely to occur' with clients influence.

This paper reports on findings from an analysis of impact significance of clients on designers and contractors. It will underscore the point that has been made before using different methodologies that client health and safety culture is critical to designers and contractors' health and safety culture. The paper argues that an improved client health and safety culture will result in an improved health safety culture of designers and contractors. Pursuing this strategy can result in prevention of many accidents and incidents.

Keywords: Clients, Contractors, Culture, Designers, Health and safety, Impact significance, improvement,

1.0   INTRODUCTION

Construction H&S performance improvement has in recent years become a priority and thus has gained industry-wide attention (Cheung, Cheung and Suen, 2004 and Hamalainen, Saarela and Takala, 2009) because of the economic benefits, the need to improve construction industry image, the need for organisations to be socially responsible and the need for an improved general regard and respect for people working in the construction industry. In addition, the legislative pressure coupled with debate concerning the personal responsibility that senior managers should bear for their organisations on health and safety failures (Fitzgerald, 2005) has contributed to most organisations to focus on health and safety improvement. However improving health and safety performance in the construction industry has proved to be somewhat challenging partly due to the industry's complex character. Despite this complexity of the industry, health and safety performance improvement remains a crucial issue and its importance or need has been demonstrated in numerous studies (Smallman and John, 2001; Lee, Halpin and Chang, 2006; ILO, 200; and Hoonakker et al, 2005).

A number of ways to improve and promote H&S performance in the construction industry have been suggested. Some of the suggested methods to improve or manage H&S in the industry include designing for construction worker safety (Gambetese and Hinze, 1999; Gambetese, Behm and Hinze, 2005; Hecker, Gambatese and Weinstein, 2005), continual improvement of safety management systems (Chua and Goh, 2004), addressing H&S culture (Molenaar, Park and Washington, 2009; Parker, Lawrie and Hudson, 2006; Chinda and Mohamed, 2007), adopting the model client framework (Lingard, Blismas, Cooke and Cooper, 2009), use of incentives and disincentives (Tang, Qiang, Duffield, Young and Lu, 2008), multi-stakeholder involvement (Suraji, Sulaiman, Mahyuddin and Mohamed, 2006) and many other strategies that have not been mentioned above. However, although many ways of improving H&S have been suggested, there has not been much study on approaches that advocate for a holistic approach to achieve a multi-stakeholder involvement and objective identification of each party's capacity to influence H&S outcome and thus attain the desired H&S improvement in the industry.

This paper presents an analysis of clients' impact significance on H&S performance of designers and in the construction industry. Based on this analysis, the extent to which clients can influence designers and contractors H&S performance and which client cultural aspects are essential to influence H&S performance will be established. These can then be used as an H&S assurance or leading indicator of contractor H&S performance.

The importance of designers and contractors to project H&S performance has been recognized in many studies (Suraji et al 2006 and Gould and Joyce, 2002). Designers and Contractors H&S performance is therefore very important. Crucially therefore, the knowledge on the impact significance of clients on designers and contractors' H&S performance is essential as it can aid in formulating targeted strategies to assure designer and contractor H&S performance.

2.0   THE STUDY

A Delphi study method was used to explore the impact significance of the identified stakeholders on project H&S. The Delphi method was preferred to common survey methods as the current study was addressing the 'what could' kind of questions as opposed to the 'what is' kind of questions (Hsu and Sandford, 2007). The Delphi methodology was also considered to be a much stronger methodology for its rigorous query of experts which is achieved through many iterations and feedback.

The Delphi study involved invited panellists and it retained 11 active members. This number of panellists was considered adequate based on what other Delphi studies have used and recommended. Delbecq, Van de Ven and Gustafson (1975) suggest that 10 to 15 panellists could be sufficient if the background of the panellists is homogenous. A review by Rowe and Wright (1999) indicates that the size of a Delphi panel has ranged from three to 80 in peer reviewed studies. Okoli and Pawlowski (2004) and Skulmoski, Krahn and Hartman (2007) also mention a panel size of about 10 to 18 members. Hallowell and Gambatese (2010) suggest a minimum of eight panellists. Based on the above and the fact that the Delphi method does not depend on the statistical power (Okoli et al, 2004), but rather on group dynamics for arriving at consensus among experts, a panel of 11 members was considered adequate.

The selection of panellists was based on criterion sampling. Panellists were selected for a purpose to apply their knowledge to a concept raised in the study based on the criteria that was developed from the research questions under investigation. A Delphi study does not depend on a statistical sample that attempts to be representative of any population. It is a group decision mechanism requiring qualified experts who have deep understanding of the issues (Okoli et al, 2004). Therefore, one of the most critical requirements is the selection of qualified experts as it is the most important step in the entire Delphi process because it directly relates to the quality of the results generated (Hsu and Sandford, 2007). In view of the above, successful panel members had to meet at least four of the following criteria adopted from Skulmoski et al (2007) and Hallowell et al (2010):
- Knowledge and experience in construction H&S;
- Knowledge and experience in construction project management;
- Have appropriate academic qualifications;

- Professional registration with a recognized built environment or H&S registration body;
- Have published articles in peer reviewed journals, books and or conferences;
- Industry experience of at least five years;
- Capacity and willingness to participate;
- Sufficient time to participate;
- Effective communication skills

Panel members were identified from three sources. The first source was the CIB W099 register of members located on the CIB WO99 website (CIB W099-Safety and Health in Construction, 2010). The CIB W099 is a working commission that was set up on royal appointment to enable researchers on construction H&S in the world collaborate as well as protect H&S. The second source was the conference proceedings of the CIB WO99 from year 2005 to 2009. Individuals who had frequently appeared as authors or keynote speakers were identified as potential experts on the study. The third and last source was identifying through references of individuals working in the area of H&S in the local construction industry in Southern Africa.

The panel consisted of two members from South Africa, three each from United States of America (USA), and the United Kingdom (UK), one each from Singapore, Hong Kong, and Sweden. Of these one of the panellists had a Doctor of Science (DSC) Degree, six had a Doctor of Philosophy (PhD) degree, two had a Master of Science (MSc) degree, one had a Bachelor of Science (BSc.) degree and the last one had a Diploma in safety management. All the panellists specialized in construction safety. In terms of their current occupation, three of the panellists were employed by contracting organizations, one by a consulting organization, and six by Universities. All panellists held very senior positions in their organizations and were involved in community service.

The panel had a cumulative of 243 years of experience. The lowest number of years of experience was seven and the highest was 45 years. The calculated mode of years of experience was 15, the mean was 22.1 years and the median was 15 years. Experience was an important factor in determining who an expert was and therefore a minimum number of years was set to be five years. In terms of publications, 10 of the panellists had published in peer reviewed journals, conference proceedings and books. Between them, they had published 57 books and monographs, 19 chapters in books, 187 peer reviewed academic journals, 345 recent conference papers and 341 other publications comprising of articles in professional journals, technical reports, policy papers, expert witness documentation and key note addresses. In addition to their publication, the panel had led and managed 108 funded research projects. Three panellists served on editorial boards of 43 peer reviewed journals and conference proceedings. The bar chart labelled figure 1.0 below shows the contribution of panellists to the above mentioned publications.

Table 1: Panellists publications

Panel publications	No. of publications
Books and monographs	57
Chapters in books	19
Peer reviewed Journals	187
Peer reviewed Conference proceedings	345
Funded research	108
Other publications	341
Editorial board membership	43
Referee for journals	22
Referee for Conference proceedings	30
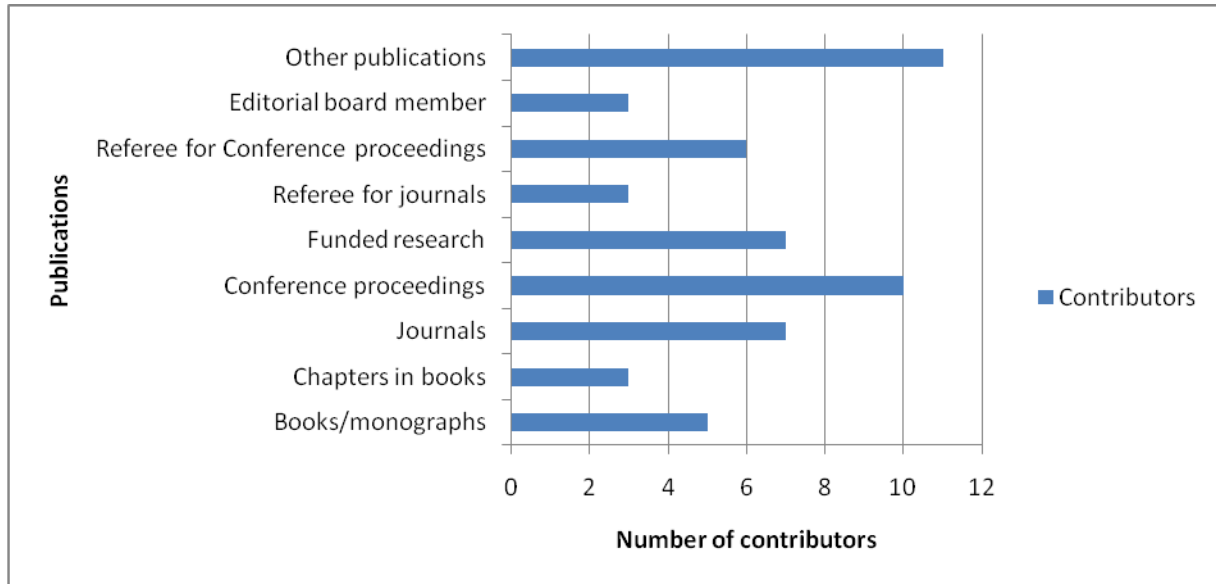
Figure 1: Publications by panel members

The current Delphi study involved three rounds of an iterative process with the view of achieving consensus between the panel members on the impact significance of clients and designers on H&S consideration at various project phases. Panellists were requested to rate the probability that H&S would be considered at project phases as a result of clients and designers H&S cultural influence. The probability scale ranged from 1 to 10 representing 0 to 100%. Further, panellists were requested to rate the negative impact that would result if a particular stakeholder's cultural element was absent. The impact scale was based on a 10 point rating scale ranging from low to critical. This aspect indicated the severity of the culture or cultural element.

A two stage analysis of data from the Delphi was conducted using Microsoft office Excel, a spreadsheet software program. The first stage involved analysis to establish or confirm consensus on responses to the predetermined criteria. This involved determining the group median responses for each question. After the third round of the Delphi, absolute deviations (D_i) about the group medians ($m(X)$) of each rating for every question were calculated using equation 1.0. In addition, mean absolute deviations (MAD) were calculated for every question. This is a calculated mean of all absolute deviations for all panellists about the median on each question. Further analysis involved determining the statistical range in ratings by panellists on each question and the percentage of panellists with a similar opinion inclination on each and every question. Consensus was determined to have been achieved when the MAD was less than one unit below or above the group median, the range in ratings on each question between all panellists was below 4.0 and the percentage of panellists that were of a similar inclination in opinion was 60% and above on a particular question.

$$D_i = \left| x_i - m(X) \right|$$
Equation 1

Where:

D_i = Absolute deviation

x_i = Panellist rating

$m(X)$ = Measure of central tendency

The second stage of Delphi data analysis, involved determining the impact significance of clients' cultural

factors on contractors' top management, H&S performance. The significance of the impact of various factors associated with the clients' H&S culture was categorised as critical, major, moderate, minor or low. The categorisation was helpful in determining which client factor was key and relevant for contractor H&S performance. The impact significance of a factor was obtained as a product of the overall rated probability (likelihood) that a client factor would influence contractor to implement H&S elements and the rated negative impact (severity) on the contractor implementing the elements that would result if the client factor was absent. This relationship is illustrated in equation 2.0 below.

$$\textit{Impact Significance} = \textit{Likelihood factor} \times \textit{Severity factor}$$

Equation 2

2.0 RESULTS

Designers' role has been recognised as important to health and safety performance on construction projects. However some studies have suggested that designers are unwilling to participate fully through their designs or taking up a leadership role for example in managing health and safety and this has in a way inhibited a better project H&S performance. It seems as though, designers can only fully participate in H&S performance with external influence apart from their own motivations which should include ethics. Although the situation is somewhat different for contractors, optimal H&S performance from contractors is also far from the desired level. Contractors too require external pressure or motivation for them to perform better.

One such external influence is the clients' influences who in fact are their employers. It was therefore determined to establish the impact significance of the clients' influence on designers and contractors to implement certain important H&S elements. The impact significance of factors of client H&S culture of *commitment, involvement, competence* and *leadership* was evaluated. In addition, the resultant likelihood of designers and contractors implementing H&S elements as a result of client culture influence was also determined.

Findings were that the average impact significance of factors of client culture on designers was determined to be 6.45. This is slightly lower than the client culture influence on contractors of 6.60. There is however more variability in the impact significance values with the standard deviation of 0.8 compared to 0.34 for the impact significance of clients' influence on contractors'. This was suggestive of the fact that some factors of client H&S culture have more influence than others. *Client involvement* in H&S performance was considered to be more critical to designers at 7.31 compared to clients' *competence* which was determined to be 5.42. Clients' *leadership* was the second rated factor followed by *commitment*. These were rated at 6.75 and 6.30 respectively (Figure 2.0).

The impact significance rating of the factor, '*client involvement*', was found to be 'critical' to designers' H&S performance whilst all other factors were found to be of 'major' impact significance.
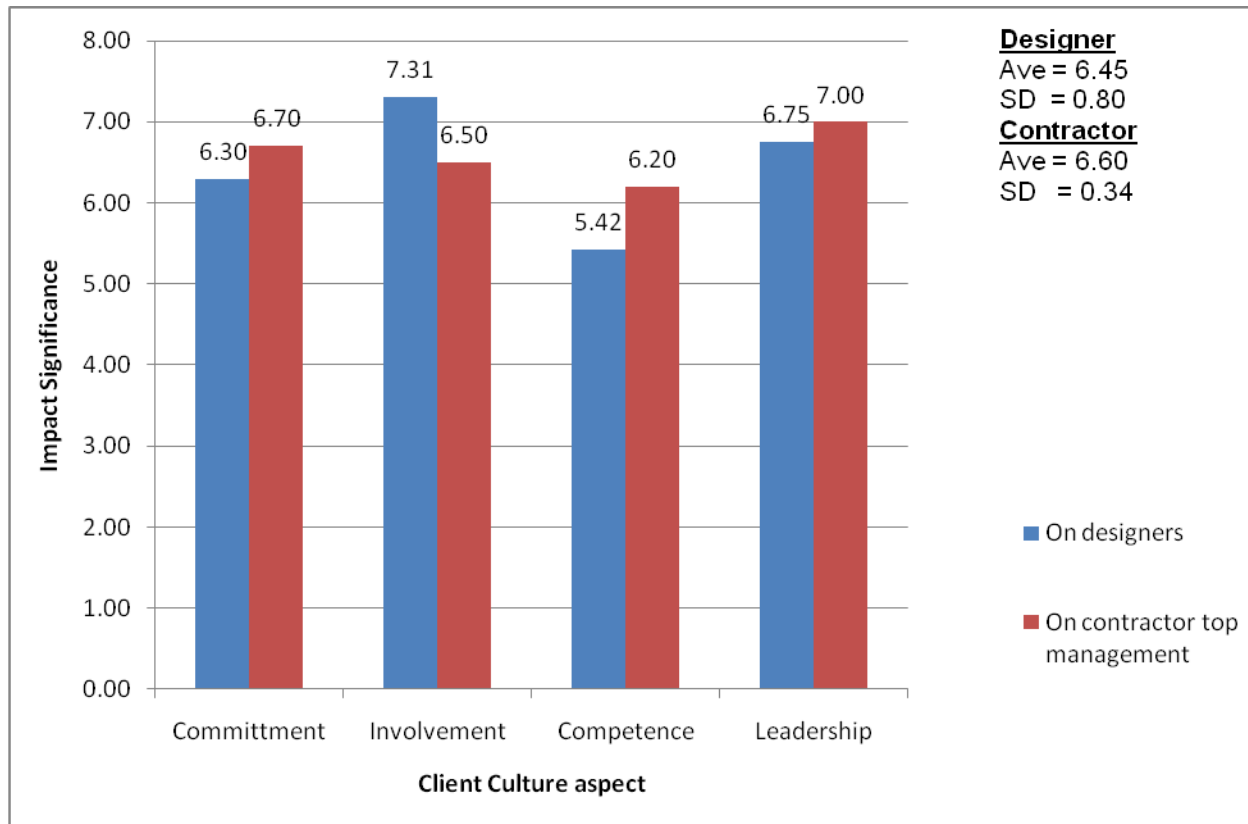
Figure 2: Impact significance of clients' factors of H&S culture on designers and contractors

All the impact significance values of client culture were above 5.0 suggesting that their impact significance's criticality to designers' and contractors' H&S performance was 'major'. As observed earlier, client *competence* was found to be the least rated factor even on influence to contractors' H&S performance. Notwithstanding, client *competence* was rated higher at 6.20 to contractors' whilst to designers, it was rated at 5.42. This suggested that client *competence* was slightly more critical to contractors than designers.

The factor of client H&S culture with the highest impact significance to designers was found to be '*client involvement*'. The impact significance rating on designers' H&S performance for '*client involvement'* was determined to be 7.31. This was suggestive of the fact that *client involvement* in H&S management is crucially important to motivate designers to implement and be committed to H&S performance.

From the results shown in figure 2.0, all factors of client H&S culture are seen to be of critical importance to influencing designers and contractors to implement H&S elements.

The likelihood of designers implementing H&S elements identified as important to H&S culture of designers was an average of 78% with a standard deviation in the likelihood values of 0.04. The 78% value suggested that the implementation of all H&S elements by the designers was 'likely to occur' with clients influence. The elements with the highest likelihood i.e. those elements with the likelihood of above 80% of being implemented by designers as a result of client influence were found to be:
1. Involving contractors in design reviews;
2. Undertake hazard identification and risk analysis;
3. Designing for H&S and
4. Establish effective H&S policies, procedures and goals.

According to the scale used in this study, the ratings for all scales above suggested that with clients' influence, the implementation of the above elements was 'likely to occur'. In other words, clients' influence is a leading indicator of designers' possibility to involve contractors, undertake hazard identification and risk assessment, and design for H&S and also to establish effective H&S policies, procedures and goals.
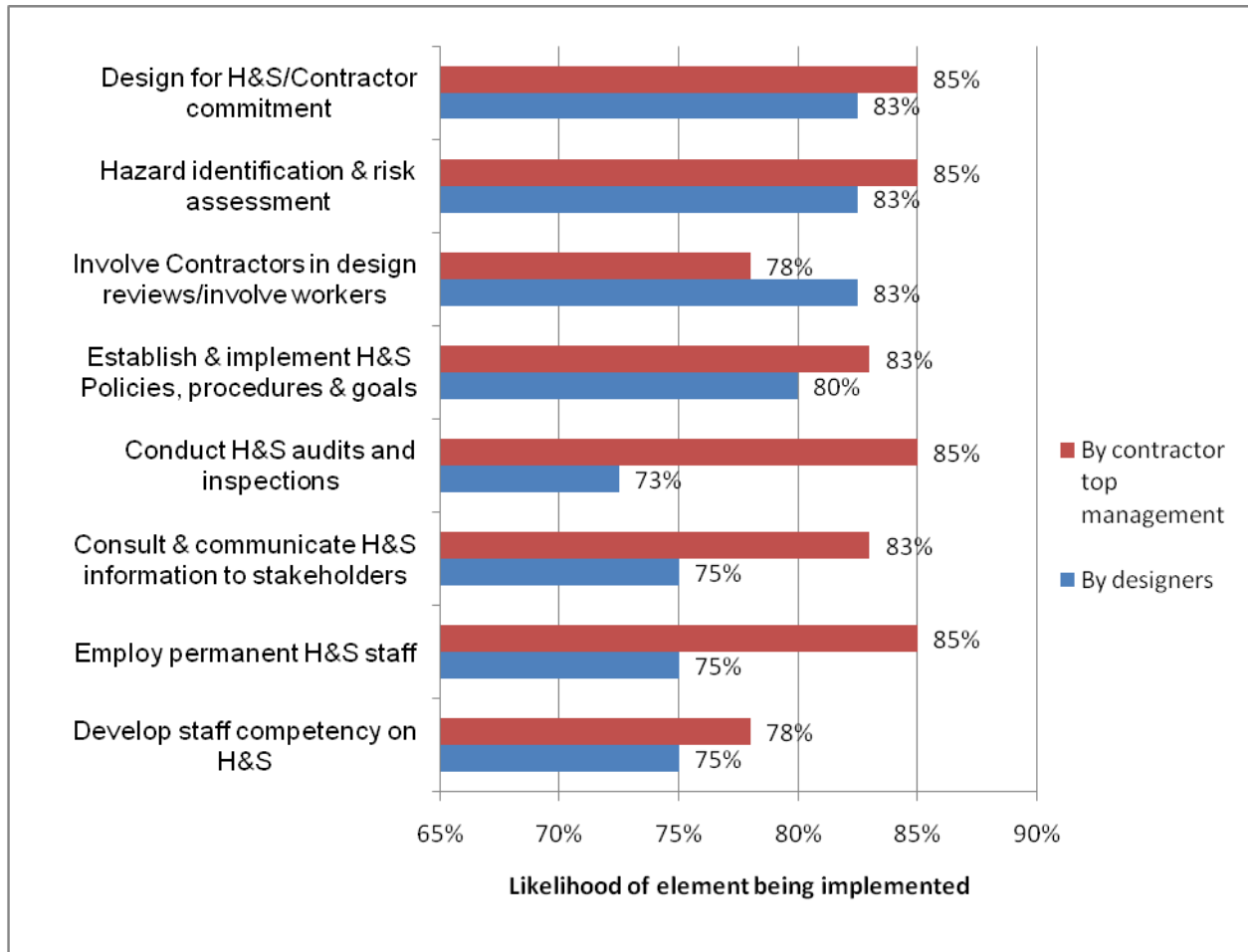
Figure 3: Designers' and Contractors' likelihood to implement H&S elements as a result of clients' influence

Developing staff competence, consult and communicate H&S information and employing permanent H&S staff were the second most likely elements to be implemented by designers as a result of client influence. All these H&S elements had a likelihood of 75% which was described as 'likely to occur'.

The least likely H&S element to be implemented compared to all other elements was found to be 'conducting H&S audits and inspections'. This element had a likelihood of 73%. Although this is a low likelihood compared to others, it is actually a high likelihood and the implementation of the elements by the designers is described as 'likely to occur'.

The largest disparity in the likelihood between contractors and designers was observed in the following elements:
1. Employ permanent H&S staff;
2. Consult and communicate H&S information to stakeholders;

3. Conduct H&S audits and inspections.

In all the, above the likelihood was higher for contractors'. The difference between the two was found to be about 10% points i.e. contractors were more likely to implement the H&S elements than designers. The rating relating to contractors' was described as 'very likely to occur' whilst implementation by designers of the elements listed above was described as 'likely to occur'.

With the exception of the H&S elements of '*involving contractors in design reviews'* or '*involving workers in H&S management'*, the likelihood of contractors implementing all elements was consistently higher than that of designers. On average, the likelihood of contractors' implementing the elements was found to be 83% whilst that of designers was about 78%. This is about 5% percentage points higher for contractors.

3.0   DISCUSSION

Improving H&S performance on a construction project has to do with the extent to which designers and contractors perform in terms of H&S. The aspect of designer and contractor H&S performance is therefore an important aspect to improving H&S performance in an overall construction project. Therefore measures should be in place to ensure that designers and contractors' H&S performance was encouraged. The question however is, 'how do we assure designer and contractor H&S performance?

The current study was therefore a response in part to the above question and sought to determine the impact significance of clients on designers and contractors' H&S performance.

The consensus among panellists regarding the likelihood of contractors implementing identified H&S elements as a result of client influence was an average of 83% whilst that of designers was found to be 78%. The panel determined that contractor H&S performance i.e. implementing the identified elements was 'very likely to occur' with clients' influence and designers' implementation was 'likely to occur'. This finding is in agreement with other studies that have alluded to the fact that clients can influence H&S performance (Huang et al 2006). The current finding in addition, estimates the extent to which clients could influence contractor H&S performance.

The panel determined that the severity of clients' H&S culture on H&S consideration was 'critical'. Panellists indicated that the negative impact on contractor performance if factors of clients' culture were not apparent was determined to be above 8.0.

The resulting client culture impact significances to designers and contractors' H&S performance ranged from 'major' to 'critical'. The suggestion was that clients' influence would assure designers and contractors H&S performance. The client cultural factor of *leadership* was rated to be more critical compared to other client cultural factors to contractor H&S performance. On the contrary, the client factor, *involvement*, was the most critical to designers The suggestion was that in order to ensure contractor H&S performance, clients need to provide visible leadership on H&S and a motivation for designers, was client involvement.

3.0   CONCLUSION

Findings from the study reviewed the following:
- Clients H&S culture influence on designers and contractors H&S performance has a high impact significance;
- All clients H&S cultural aspects of involvement, commitment, competence and leadership have impact significance ranging from 'major' to 'critical';
- Contractors were on average 'very likely' to implement H&S elements with clients' influence;
- Designers were on average 'likely' to implement H&S elements with clients' influence;
- In order to assure designers and contractors H&S performance, client H&S culture and influence is necessary.

It was observed that Clients' influence would cause designers' and contractors' implementation of H&S to 'likely to occur' and 'very likely to occur' with a likelihood of 78% and 83% respectively. The significance of this finding was that with the influence of clients, there is an assurance of a better designer and contractor H&S performance and thus may achieve the desired H&S performance. Positive clients' H&S culture could therefore be taken as a leading indicator for a better designer and contractor H&S performance.

In conclusion, generalisability of the current study is limited as validation of the Delphi findings has not been done. The validation is however currently under way using the structural equation modelling (SEM).

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