Measuring health and safety performance of construction projects in South Africa

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Abstract. The purpose of this study was to develop a client-driven H&S rating model to be used by construction clients to improve their overall project H&S performance. The attitude of clients towards H&S is critical in the overall H&S improvement effort on construction projects. This hypothesis was tested and verified using Covariance-Based Structural Equation Modelling (CB-SEM). Using the framework of factors from previous studies, a survey method was adopted for collecting data for this study. Contrary to the findings of the previous studies, the final CB-SEM results suggested that the contractual H&S arrangement is the only construct which has a direct effect on project H&S performance. Mediation hypothesis testing was performed, and results were that attitude and selection of contractors based on their historical health and safety performance have an indirect effect of project health and safety performance. The study was limited to a selection of projects for a range of clients executed by a major construction contracting organization. The study highlighted the urgent need to change the traditional mindset that H&S is the responsibility of the construction contractors alone.

Keywords: Construction, clients, contractors, critical H&S factors, effectiveness, efficiency.

1. Introduction
The construction industry is one of the sectors that creates the most employment opportunities for unskilled and semi-skilled workers from impoverished local communities due to its relatively labour-intensive nature (Phoya, 2012). It is the driving force behind the economic growth due to its operations having an impact on most sectors of the economy (Oladinrin, Ogunsemi and Aje, 2012). In addition, it contributes indirectly to employment creation in other sectors as most materials used are sourced from these sectors of the economy (Ngandu, Garcia and Arndt, 2010). Notwithstanding its important role and contribution to economic growth, the construction industry remains a risky sector where the most vulnerable (unskilled and semi-skilled) workers are continually involved in serious construction accidents. Although there were interventions by various stakeholders to deal with this problem, the results remain unacceptable as accidents continue to persist in the construction industry.

Despite significant efforts by industry associations, researchers, construction clients and contractors to improve H&S in the construction industry, overall construction H&S performance has not improved and continues to contribute an unacceptably high level of injuries and fatalities. The construction industry continually fails to comply with construction regulations (CR 2014) in South Africa. To address the unacceptably high level of incident rates in the construction industry, many countries have developed laws and regulations that govern the processes in which construction clients must manage H&S on
construction sites. Client influence in construction projects has been cited by numerous researchers as a lasting solution for reducing the number of H&S accidents on sites.

Although there is consensus amongst researchers that client participation throughout the phases of construction projects can lead to improvements in the H&S performance of these projects, very few studies have developed models to assist the industry to improve health and safety in this area. Lack of effective participation of clients in health and safety has left the construction industry with a very high number of accidents every day, resulting in medical treatment cases, lost time incidents, fatalities and damage to property that occur on construction sites. This study builds on Liu et al., (2017) and uses an alternative method to develop a model, the Client-Driven Health and Safety Rating Model (CHSRM), aimed at assisting clients to influence contractors in improving the health and safety performance of construction projects effectively. Structural Equation Modelling (SEM) was applied in displaying how clients could assist contractors to improve H&S performance on project sites.

2. Literature review

2.1. H&S Roles and Responsibilities
Various stakeholders participate during the construction phases of the project. The stakeholders include clients, designers, principal contractors, subcontractors, suppliers, employees and government agencies. Xiaohua et al., (2017) stated that although these stakeholder may have different approaches of how to mitigate health and safety risks, they have the ability to ensure that improvement in this area is not compromised on site. Heravi, Coffey and Trigunarsyah (2015) argued that clients, designers and project managers were the only stakeholders that were heavily involved with project planning while contractors were left out. An earlier study by Kumaraswamy and Wong (2014) found contractors, subcontractors and suppliers only focussed on project completion to satisfy the clients.

Smallwood (1999) argued that the lack of H&S compliance does not only affect contractors, but the sustainability of the country as whole. In South Africa, a clear obligation to all parties is imposed by the Construction Regulation 2014 on construction projects and owners of assets – clients, their agent, the designers, the principal contractors, contractors, and owners of the structure. According to Smallwood, Haupt and Shakantu (2009), CR 2014 has redistributed responsibility for construction health and safety away from the contractor (who was previously solely responsible) to include all participants in the construction process – from the client through to the final end user. According to Smallwood, Haupt and Shakantu (2009), CR 2014 has redistributed responsibility for construction health and safety away from the contractor (who was previously solely responsible) to include all participants in the construction process – from the client through to the final end user. According Smallwood (2004) the negative health and safety performance by contractors also has an impact on customer satisfaction.

2.2. Client involvement in the H&S issues of construction projects
The influence of clients on construction project H&S performance is one of the wide research topics in the construction industry. Liu et al., (2017) stated that a successful construction projects require the involvement of the client, designers, contractors and subcontractors. Ng, Cheng and Skitmore (2005) pointed out that there are several predominant factors affecting construction safety performance at the organisational and project levels. A review of literature has highlighted eleven significant factors based on an empirical analysis. The identified factors were found to be common to all studies and some can be further grouped together to describe one factor. The grouping of some health and safety features resulted in key health and safety factors reducing from eleven to six critical to H&S factors (CTHS) as shown in Table 1. Liu et al., (2017) investigated the importance of these factors by asking construction industry experts to rate the degree of their importance. The study revealed that about ninety per cent of experts agreed with the significant effects of these factors on health and safety performance at construction sites.
### Table 1: Summary of Critical H&S Factors

| Number | Description                               | Author(s)                                                                 |
|--------|-------------------------------------------|--------------------------------------------------------------------------|
| 1      | Client's Attitude Towards H&S             | Umeokafor (2018); Liu et al., (2017); Musonda et al., (2009)            |
| 2      | Client's Communication Attitude Towards H&S | Sperlling et al., (2008); Said et al., (2009); Liu et al., (2017); CR (2014) |
| 3      | Selection of Contractors                  | Smallwood (2004); Sunindijo (2016); Spear (2005); Liu et al., (2017); Huang (2003) |
| 4      | Contractual H&S Arrangement               | CR (2014); HSE (2001); Kikwasi (2008), Liu et al., (2017)               |
| 5      | Client Involvement Before and After Construction | Yin-Hung (2006); Lingard et al., (2009); Liu et al., (2017)             |
| 6      | Monitoring H&S Performance                | CR (2014); HSE (2001); Liu et al., (2017)                               |

#### 2.2.1. Client’s attitude toward H&S
Umeokafor (2018) pointed out that the client’s attitude towards health and safety starts with their understanding that their involvement could contribute to project H&S performance. Musonda et al., (2009) stated that client attitude can be explained by the extent of the client involvement in the management of H&S. This could be achieved by the clients setting zero harm, injury or incidents as the objectives for the project. Liu (2017) stated that the client attitude towards H&S determines the effort the client is willing to make towards ensuring that H&S is not compromised on project sites. One of the efforts the client could make is to go beyond a regulatory compliance approach to prevent injuries or incidents on site.

#### 2.2.2. Client’s ability to communicate H&S requirements to all stakeholders
In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to construction clients to prepare a suitable, sufficiently documented and coherent site-specific health and safety specification based on the baseline risk assessment. Sperlling et al., 2008 stated that if there is effective communication between the client, the designer and the constructor, excellence in occupational health and safety could be easily achieved. Huang (2003) pointed out that all owners have a legal and moral responsibility to insist on the safe performance of their construction contractors and to use reasonable care to prevent contractors from injuring others on the site. Liu (2017) argued that the client should communicate their concerns on health and safety issues to all stakeholders on the construction project, through various channels. The client could demonstrate their commitment to H&S by communicating specific H&S goals and requirements in appointments of all project stakeholders.

#### 2.2.3. Selection of contractors based on H&S performance records
Huang (2003) stated that selection of safe contractors has always been recognised by many owners as the most effective way to guarantee safety performance on their projects. A study by Smallwood (2004) found that the prequalification of contractors on quality and health and safety contributed to an improvement in construction health and safety in Shell projects. Spear (2005) pointed out that the key to improving health, safety and environment (HSE) performance requires the integration of health, safety and environment into the contracting process that includes establishing formal prequalification and contractor selection criteria and incorporating HSE requirements into the contract. Liu (2017) pointed out that if the client selects a contractor with a proven track record of safety, the safety performance should be improved. Sunindijo (2016) recommended that clients should focus on selecting safe contractors to improve health and safety performance.
2.2.4. **Contractual H&S arrangement**

Levitt and Samelson (1993) stated that owners must ensure that contractors recognize their contractual responsibility to perform safely. Huang (2003) pointed out that contractually, most owners have the contractor indemnify the owner from any losses or liabilities resulting from injuries, but it is also essential to include specific and thorough safety requirements in the construction contract. Liu (2017) stated that contracts stipulate the health and safety duties for all participants in the construction project. In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation on all parties to construction projects and owners of assets – clients, the client agent, the designers, the principal contractors, contractors and owners of the structure. According to Smallwood, Haupt and Shakantu (2009), CR 2014 has redistributed responsibility for construction H&S away from the contractor (who was previously solely responsible) to include all participants in the construction process – from the client to the end user.

2.2.5. **Client involvement before and during construction**

Liu (2017) argued that there are many activities before construction commences that could affect the health and safety performance. Huang (2003) stated that owners could impact designers and contractors through their proactive participation in construction safety issues. In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to clients to provide the designers with the health and safety specification and ensure that designers consider safety specification during the design stage.

2.2.6. **Monitoring of contractor H&S performance**

Liu (2017) stated that excellent results in health and safety could be achieved if clients monitor the contractor’s compliance with health and safety. Gambatese (2000b) suggested that owners should request contractors to provide H&S reports that detail information on the results of jobsite inspections, a listing of all injuries, safety meeting minutes and investigations of major accidents. In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to clients to inspect the site at least once every 30 days and issue a copy of H&S audit report to the principal contractor within 7 days of the audit.

3. **Conceptual framework**

Based on the results of literature review, key concepts that constitute the building blocks of a conceptual model for the current study were identified (Table 1). These factors were found to be associated with involvement by clients of H&S improvements in construction projects. For the purpose of this study, these factors are called critical to H&S (CTHS) factors. The conceptual model defines the concepts under study, develops a proposed model of how the concepts are related, and uses a theoretical basis to explain the possible relationships (Hair et al., 2007; Sekaran and Bougie, 2010). According to Hair et al., (2007) and Sekaran and Bougie, (2010), the proposed relationships between the concepts, assumptions, expectations, beliefs and theories must be tested hypothetically and statistically analysed to arrive at the conclusion. Based on the conclusions made by previous studies that client involvement in all phases of the construction project can lead to improvements in the health and safety performance of construction projects (Figure 1), the following hypotheses were developed:

3.1. **CTHS1: Client’s attitude toward H&S**

The client attitude towards H&S is critical to the performance of all stakeholders in construction projects. Once construction clients set the H&S tone for construction projects, their attitude can exert a great influence not only on the performance of H&S but also on other project key performance indicators (KPIs). Based on the review of literature, the first hypothesis was described as follows:

\[ H_1: \text{The construction client attitude towards health and safety has a direct influence on project health and safety performance} \]

3.2. **CTHS2: Client’s ability to communicate H&S requirements to all stakeholders**
The ability of the construction clients to communicate safety issues effectively with all stakeholders is vital to maintaining a safety culture at the construction site. When the construction clients regularly communicate with all stakeholders in an open, respectful manner, they are also more willing to give and receive feedback. Effective communication has the ability to support teamwork and coordination between contractors and subcontractors. Therefore, the second hypothesis was stated as follows:

\[ H_2: \text{The client ability to communicate their health and safety requirements can directly improve project health and safety performance.} \]

3.3. CTHS3: Selection of contractors based on H&S performance records
As construction clients can be held responsible for their contractors' H&S performance, it is advisable that construction clients look at the H&S performance of the contractors before they awarded projects. Selection of contractors with a proven H&S record can be accomplished through looking for a combination of lagging and leading indicators. Selection of safety-minded contractors can lead to improvement in project H&S performance. The third hypothesis was defined as below:

\[ H_3: \text{The selection of contractors by construction clients based on proven health and safety track records can lead to improved project health and safety performance.} \]

3.4. CTHS4: Contractual H&S arrangement
Construction clients are legally obligated to enter into H&S mandatory agreements with contractors that they are intending to employ. The mandatory agreement stipulates the health and safety requirements, roles and responsibilities of all stakeholders on site. Through the mandatory agreement, the construction clients can direct all stakeholders to focus on H&S on site. Therefore, the fourth hypothesis was stated as follows:

\[ H_4: \text{The stipulation of health and safety duties for all participants in the construction project by construction clients in the contractual arrangement can improve project health and safety performance.} \]

3.5. CTHS5: Client involvement in H&S before construction
Construction clients are legally required to: prepare a baseline risk assessment for an intended construction work project, to prepare a suitable, sufficiently documented and coherent site-specific health and safety specification for the intended construction work based on the baseline risk assessment contemplated in paragraph, to provide the designer with the health and safety specification contemplated, to ensure that the designer takes the prepared health and safety specification into consideration during the design stage and to ensure that the designer carries out all responsibilities contemplated in the construction regulation. Therefore, the fifth hypothesis was described as follows:

\[ H_5: \text{The involvement of construction clients before and during construction directly improves project health and safety performance.} \]

3.6. CTHS6: Monitoring Contractor H&S Compliance
Construction clients are required to ensure the mechanisms put in place as part of planning for health, safety and wellbeing are monitored and reviewed throughout the construction period. The purpose of undertaking ongoing monitoring and review is to verify and adjust the mechanisms to ensure they achieve the intended outcome/s. Therefore, the sixth hypothesis was stated as follows:

\[ H_6: \text{The monitoring of contractor health and safety compliance by construction clients can directly improve the project health and safety.} \]

3.7. PERF: Overall project H&S performance
This includes the determination of the criteria against which the construction project’s OHS performance is evaluated, including appropriate indicators (lagging and leading). Criteria are used by the construction
clients to compare performance (e.g. First Aid Incident Frequency Rate (FAIFR), Medical Treatment Incident Frequency Rate (IMTIFR), Lost Time Incident Frequency Rate (LTIFR), Total Recordable Incident Rate (TRIR) / (RCR) and All Incident Frequency Rate (AIFR), etc.)

4. Research Methodology

4.1. Research Design
The purpose of this study was to develop a client-driven H&S rating model to be used by construction clients to improve their overall project H&S performance. In this study, the quantitative research design was used to examine relationships between client involvement in H&S and improvement in the project H&S performance. The quantitative method used in this study comprises survey research strategies with questionnaires to collect the required data. Based on the research questions and research objectives in the study, the researcher opted for the quantitative design in line with the use of a positivist philosophy, following a deductive research approach to examine relationships among the study variables and statistical software analyse the data.
4.2. Research Instrument

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents (McLeod, 2018). To gather the information related to the research problem, the questionnaire must be organized in an orderly manner (Sekaran, 2003; Thakur, 1993). In this study, a questionnaire was adopted as an instrument for collecting data; this form of survey has the ability to enable researchers to collect a large volume of data in a short time, cost-effectively (Murray, 2003). A questionnaire was designed using the health and attributes/indicators from literature. In adopting the attributes/indicators some were either added or deleted as necessary, as the current study was conducted from a South African perspective.

4.3. Data collection

A survey questionnaire was adopted as an instrument for collecting data. The structured questionnaire was used as it promotes faster responses and increases the response rate (Landaeta, 2008). The questionnaire included close-ended questions and used the quantitative research approach as a preferred research design process. For the purpose of this study, the target population includes construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping and platework (SMEIPP). The data was gathered directly from clients, professionals representing client health and safety agents, construction managers, construction health and safety managers and officers by mail. The list carrying the details of construction clients was collected using multiple sources.

For the purpose of meeting the research objectives, two sets of data were collected. In the first data set, a survey questionnaire targeting a total of 150 construction clients who were managing projects with a value of more than R40 million were sent. In the survey questionnaire, respondents were asked to rate the extent to which construction clients are involved in the project site health and safety issues using a five-point Likert scale, namely, never = 1, seldom = 2, sometimes = 3, often = 4 and always = 5.

The second data set used the same respondents as those used in the first data set. Here, the respondents were asked to provide different data in the form of the health and safety performance of the 150 projects, using the five health and safety lagging indicators. The reason for using the same respondents in both the first and second data set was to verify the link between client involvement and improvement in the project health and safety performance. To analyse the project H&S performance, the frequency rate was converted into a five-point Likert scale, namely, 1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent. The choice of this Likert scale was favoured as it rates the extent to which project H&S performance is acceptable or not and this aligns well with the objectives of this study.

4.4. Data analysis

As the current study looked at three or more variables in relation to the subject under investigation with the aim of identifying (or clarifying) the relationships between them, a multivariate analysis technique was preferred. The researcher used a questionnaire for the survey method. IBM Statistical Package for Social Sciences version 25 was utilized to analyse the collected data and to test the research questions, expectations and hypotheses. SPSS version 25 was chosen for its versatility and ability to handle many calculations expeditiously (Champoux and Ommanney, 1986; Obwoge et al., 2013).

Analysis of means, standard deviations and Pearson’s correlations were used to describe and explore the relationships between all the variables used in the current study. Descriptive statistical analyses were used to provide an analysis of measures of central tendency and the measures of dispersion to get an overview of the sample and summarise the demographic details of the respondents (Nguyen, 2010). In ensuring that the data is useable, reliable and valid for testing causal theory, the data was screened for any irregularity using SPSS for outliers, extreme values, missing data and disengaged responses before subjecting them to exploratory factor analysis (EFA) to assess the factor structure and reliability and validity of the measures.
After the EFA, Confirmatory Factor Analysis (CFA) as a pre-requisite for Structural Equation Modelling was conducted following a two-step approach SPSS Analysis of Moment Structures (AMOS) version 25. SPSS AMOS was preferred over other software programs for its user-friendly graphical interface (Huckleberry, 2011). CB-SEM was preferred because it utilises software such as LISREL or AMOS, which do not require programming as compared to other software.

5. Model Development

5.1. Determining the critical elements of CHSRM

Based on an extensive literature review, legal and other requirements, a comprehensive list of attributes that represent the significant factors of the CHSRM was developed. These factors are called critical to H&S factors (CTHS), and are considered key elements to improve and sustain client influence in the construction project health and safety performance. Liu, et al., (2017) maintains that in order for clients to influence improvement of health and safety performance on construction sites, their role has to be established and be deconstructed into specific, quantitative and measurable requirements.

Tyler (2018) pointed out that construction clients can set the tone of the project and make decisions crucial to its development and to project health and safety performance. The survey instrument (Table 2 to Table 7) provides a brief description of constructs (CTHS) and sixty-four attributes/indicators called Critical to Expectation (CTE) associated with each construct for CHSRM. Measurements refer to the rating of CTE performance. The number of attributes/indicators were derived from the review of literature, CR 2014, CDM 2015, legal and other requirements – and the number of attributes/indicators per each CTHS are summarised. These attributes formed the basis of developing the questionnaire for this study.

| CTE  | Questions                                                                                     |
|------|---------------------------------------------------------------------------------------------|
| CTE 1.1 | Does the client understand that their involvement contributes to health and safety performance? |
| CTE 1.2 | Does the client set zero harm, injury or incidents as the objectives for the project?         |
| CTE 1.3 | Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?   |
| CTE 1.4 | Does the client through include all requisite information such as outcomes of baseline H&S hazard identification and risk assessment (HIRA) in the form of H&S specifications as part of tender documentation? |
| CTE 1.5 | Does the client have specific health and safety goals for each project?                       |

Table 2: CTHS1 Establish attitudes towards H&S
Table 3: CTHS2 Survey Questions

| Questions                                                                 | Never (1) | Seldom (2) | Sometimes (3) | Often (4) | Always (5) |
|--------------------------------------------------------------------------|-----------|------------|----------------|-----------|------------|
| CTE 2.1 Does the client communicate with all project stakeholders clearly about their health and safety position and requirements? |           |            |                |           |            |
| CTE 2.2 Does the client communicate specific H&S goals and requirements in appointments of all project stakeholders – consultants and contractors? |           |            |                |           |            |
| CTE 2.3 Does the client communicate their commitment to health and safety to the contractors? |           |            |                |           |            |
| CTE 2.4 Does the client demonstrate their involvement in health and safety to all project stakeholders? |           |            |                |           |            |
| CTE 2.5 Does the client prescribe regular monitoring and reporting of performance of project stakeholders? |           |            |                |           |            |
| CTE 2.6 Does the client impose penalties (punitive measures) and reward excellent health and safety performance? |           |            |                |           |            |

Table 4: CTHS3 Survey Questions

| Questions                                                                 | Never (1) | Seldom (2) | Sometimes (3) | Often (4) | Always (5) |
|--------------------------------------------------------------------------|-----------|------------|----------------|-----------|------------|
| CTE 3.1 Does the client prequalify contractors?                           |           |            |                |           |            |
| CTE 3.2 Does the client consider health and safety in prequalifying contractors for bidding on projects? |           |            |                |           |            |
| CTE 3.3 Does the client require and approve procedures for the appointment of subcontractors with health and safety in mind? |           |            |                |           |            |
| CTE 3.4 Does the client provide specific contractual health and safety goals and requirements to prospective contractors? |           |            |                |           |            |
| CTE 3.5 Does health and safety have a high priority when selecting a contractor? |           |            |                |           |            |
| CTE 3.6 Does the client include the explicit evaluation of the financial provisions and budget for implementing and monitoring health and safety measures when selecting a contractor? |           |            |                |           |            |
| CTE 3.7 Does the client have specific procedures and/or requirements when adjudicating tenders to ensure adequate financial provision in tenders? |           |            |                |           |            |
| CTE 3.8 Does the client have specific procedures and/or requirements when evaluating the adequacy of health and safety plans? |           |            |                |           |            |
CTE 3.9 | Does the client understand what the health and safety file is and its purpose?  
Does the client have specific procedures and/or requirements to ensure that the health and safety file is adequate and handed over as part of completion requirements?  
Does the client require notices and copies of minutes of all meetings and forums where project health and safety will be discussed?  
Does the client ensure that the contractor has all the required health and safety structures in place before awarding tenders such as health and safety representative/s, health and safety committees, etc.?  

CTE 3.10 |  

CTE 3.11 |  

CTE 3.12 |  

**Table 5: CTHS4 Survey Questions**

| CTE | Questions | Never (1) | Seldom (2) | Sometimes (3) | Often (4) | Always (5) |
|-----|------------|-----------|------------|---------------|-----------|------------|
| CTE 4.1 | Does the client assign at least one full-time construction health and safety specialist on the project? |  |  |  |  |  |
| CTE 4.2 | Does the client provide the contractor with health and safety guidelines that must be followed? |  |  |  |  |  |
| CTE 4.3 | Does the client require contractors to submit the resumes of key health and safety personnel for the client approval? |  |  |  |  |  |
| CTE 4.4 | Does the client require contractors to provide specific minimum health and safety training for workers? |  |  |  |  |  |
| CTE 4.5 | Does the client require the contractor’s site-specific health and safety plan? |  |  |  |  |  |
| CTE 4.6 | Does the client require contractors to submit the resumes of key health and safety personnel for the client approval? |  |  |  |  |  |
| CTE 4.7 | Does the client require the contractor to submit a health and safety policy statement signed by its CEO? |  |  |  |  |  |
| CTE 4.8 | Does the client require the contractor to submit an emergency plan? |  |  |  |  |  |
| CTE 4.9 | Does the client require the contractor to submit and utilize an immediate reporting procedure for accidents and near-misses on this project? |  |  |  |  |  |
| CTE 4.10 | Does the client require the contractor to submit a mitigation plan for this project? |  |  |  |  |  |
| CTE 4.11 | Does the client require and approve an appropriate and adequate construction health and safety induction programme? |  |  |  |  |  |
| CTE 4.12 | Does the client require that subcontractors be included in the health and safety programme? |  |  |  |  |  |
| CTE 4.13 | Does the client make it clear that the contractor is ultimately responsible for the health and safety of their employees and other members of the project team and the general public? |  |  |  |  |  |
| CTE 4.14 | Does the client specify the actions that can be taken to contribute to health and safety performance in this project? |  |  |  |  |  |
| CTE 4.15 | Does the client require submission and approval of all requisite health and safety method statement? Does the client require regular inspections and audits to ensure implementation of the contractor’s health and safety plan? |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CTE 4.16 | Does the client enforce adherence to the approved health and safety plan? Does the client impose sanctions for non-approved deviations and failure to adhere to the health and safety plan? |
| CTE 4.17 | Does the client require approval of revised health and safety plans when changes or variations are made including adjustment of the financial provision for health and safety as required? |

**Table 6: CTHS5 Survey Questions**

**CTHS5: Client involvement in health and health and safety before construction**

| CTE   | Questions                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| CTE 5.1 | Does the client address health and safety issues in the feasibility study and conceptual design phases? Does the client require designers to consider construction health and safety during constructability/buildability reviews? Does the client require designers to conduct a review of the design for construction health and safety for this project? |
| CTE 5.2 | Does the client conduct a review of the design for health and safety? Does the client prefer to award the contract to a design-build contractor to promote health and safety performance? |
| CTE 5.3 | Does the client conduct the preconstruction meeting with contractor for health and safety issues? |

**Table 7: CTHS6 Survey Questions**

**CTHS6: Monitoring contractor health and safety compliance**

| CTE   | Questions                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| CTE 6.1 | Does the client assign a full-time site health and safety representative to this project? Does the client specify the responsibilities of the site health and safety representative? |
6. Figures Findings

6.1. Response Rate
Construction projects (150) with a value of more than R40 million were included in this study. The survey was administered through a combination of emails and follow-up calls. The data was gathered directly from clients, professionals representing client health and safety agents, construction managers, construction health and safety managers and construction health and safety officers. By the cut-off date of the survey, 135 usable responses were received. This represented an approximate ninety per cent usable response rate, with most responses (thirty-four per cent) from building (commercial) projects being the highest. The various response rates are in shown in Table 8.

| Research Population                      | Administered Questionnaire | Questionnaire Response/ Return Rate | Percentage of Response |
|------------------------------------------|----------------------------|------------------------------------|------------------------|
| Building (commercial)                    | 49                        | 46                                 | 34%                    |
| Civils                                   | 38                        | 33                                 | 24%                    |
| Housing (residential)                    | 25                        | 22                                 | 16%                    |
| Roads and earthworks                     | 10                        | 9                                  | 7%                     |
| Structural steel, mechanical, electrical, instrumentation and piping (SMEIP) | 19 | 16 | 12% |
| Oil and Gas (petrochemical)              | 9                         | 9                                  | 7%                     |
| Total                                    | 150                       | 135                                | 90%                    |

6.2. Exploratory factor analysis (EFA)
EFA was performed to measure the items interrelation which measured variables has identified in the research instruments. When factor analysis was performed on all of the questionnaires using principal component analysis (PCA) with Kaiser’s criteria (eigenvalue > 1 rule), sixteen factors were extracted (with a total variance of 72.7%). This implies that all of the sixteen latent factors extracted contribute about 72.7% of the total variation – which is a reasonably good contribution. This was supported by the scree plot that showed that after component sixteen there is little contribution from the remaining latent components. A stringent cut-off factor of 0.5 for factor loading as recommended by Anderson and Gerbing (1998) was achieved. There was no cross loading among the extracted factors and a total of fourteen items did not load into any constructs. These items were subsequently omitted from further analysis.

To assess the suitability of the respondent data for factor analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA) and Bartlett's test of sphericity were used. Latihan et al., (2017) described KMO MSA as a test of the extent of variance within the data that could be explained by factors. Latihan et al., (2017) stated that as a measure of factorability, a KMO value of 0.5 is poor, 0.6 is acceptable while a value closer to one is better. Neuman (2003) and Tabachnick & Fidell, (2008) suggested that KMO measure of sampling adequacy must be 0.7 and 0.60 respectively. For this present study, the KMO MSA was 0.771 as indicated in Table 4 suggesting that the sample size is adequate for EFA.

The Bartlett’s test of sphericity needs to be significant for the sample to be deemed to have sufficient variance for EFA. Peri (2012) suggested that for factor analysis to be recommended suitable, the Bartlett’s test of sphericity must be less than 0.05. Taking a ninety-five per cent level of significance, α = 0.05 and from Table 9 the p-value (Sig.) of .000 < 0.05, shows that the factor analysis was therefore valid and CFA can be conducted.

| Table 9: KMO and Bartlett's Test Results |
|-----------------------------------------|
| KMO and Bartlett's Test                  |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | 0.771 |
| Bartlett's Test of Sphericity            |      |
| Approx. chi-square | 5891.295 |
| df          | 2016    |
| Sig.        | 0.000   |

6.3. Structural equation modelling (SEM)

Srivastava (2018) defines structural equation modelling as a multivariate statistical technique that analyses the structural relationships or establishes causal relationships between variables. As shared by Byrne (2006), SEM graphically models hypothesised relationships among constructs with structural equations. Srivastava (2018) explains that SEM can simultaneously test both the measurement model and the structural relationship specified in the model. According to Davcik (2014), there are two SEM streams, namely, Covariance-based SEM (CB-SEM), and Variance-based SEM or Partial Least Square SEM.

CB-SEM is based on the covariance matrices. and is used to explain the relationships between indicators and constructs, and to confirm the theoretical rationale that was specified by the model (Hair et al., 2014). CB-SEM utilizes software such as LISREL or AMOS (Hair et al., 2010; Henseler et al., 2009). According to Hair et al., (2014), VB-SEM is used when identifying key predictor constructs or when the structural model is complex or when the sample is small or non-normal. VB-SEM is considered vigorous when employed on highly non-normal data (Becker et al., 2012). Hazen et al., (2015), recommended that justification for choosing one method over the other method should be explicitly stated in the research report. The collected data in this study was considered normal and the sample size was large, thus suitable for CB-SEM.
SEM consists of confirmatory factor analysis path, analysis with observed variables and path analysis with latent variables. Schreiber et al., (2006) found that CFA is related to EFA but is a theory-driven technique that tests the extent that the proposed factor structure is replicated in another sample. Kelloway (1995) stated that EFA is often considered to be more appropriate than CFA in the early stages of scale development because CFA does not show how well items load on the non-hypothesised factors. The purpose of CFA is to confirm to what extent a model fits the data. The hypothetical model (Figure 1) indicates the relation between client involvement and the overall project health and safety performance.

6.4. Confirmatory factor analysis (CFA)

CFA is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. Yale et al., (2015) described CFA as a necessary and important step that must be followed after the EFA has been conducted. After the EFA analysis was conducted using SPSS, the resulting constructs from the EFA were validated using CFA in SPSS AMOS. The CFA was performed using the initially hypothetical model (Figure 1) to test the covariance structure of latent variables. Ahmad, Zulkurnain and Khairushalimi (2016) point out that CFA is a special form of factor analysis, employed to test whether the measure of a construct is consistent with the researcher’s understanding of the nature of that construct.

As the hypothetical model was based on theoretical expectations and past empirical findings, it was necessary to be subjected to the CFA process so that it shows the extent to which it meets the standard indices of model fit. Figure 2 shows the measurement model combining all constructs after running the CFA process. The items that have factor loading of below 0.60 were deleted. The measurement model was refined to check for reliability and validity, and if the values of fitness indices achieve the required level. In figure 2, CTHS factors were renamed to: CTHS1 = F1, CTHS2 = F2, CTHS3 = F3, CTHS4 = F4, CTHS5 = F5 and CTHS6 = F6
6.4.1. CFA Measurement Model – Reliability and Validity

Table 10 shows the results from the CFA process, and indicates that the factor loadings range from 0.580 to 0.947. All of the factors met the adopted threshold of 0.5 as recommended by Anderson and Gerbing (1988). Taber (2017) stated that Cronbach’s alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose. Goforth (2015) defines Cronbach’s alpha as a measure used to assess the reliability, or internal consistency, of a set of scale or test items.

McLeod (2013) defines internal reliability as the extent to which a measure is consistent with itself, while an external reliability is the extent to which a measure varies from one use to another. Ahmad et al., (2016) states that internal reliability is achieved when the Cronbach’s alpha value is 0.6 or higher.
The Cronbach's alpha of all the constructs from Table 10 ranges from 0.792 to 0.951 which is above the 0.7 threshold and indicate that all the constructs have a high internal consistency.

| Factors | Factor Loading | Cronbach's Alpha | CR    | AVE   |
|---------|----------------|------------------|-------|-------|
| F1.1: Client Attitude towards Health and Safety |                |                  |       |       |
| CTE1.1_1 | 0.845          |                  | 0.829 | 0.821 | 0.606 |
| CTE1.2_1 | 0.749          |                  |       |       |       |
| CTE1.3_1 | 0.754          |                  |       |       |       |
| F2.2: Client Ability to Communicate Health and Safety Requirements to All Stakeholders |                |                  |       |       |       |
| CTE2.3_1 | 0.823          |                  | 0.878 | 0.873 | 0.696 |
| CTE2.4_1 | 0.855          |                  |       |       |       |
| CTE2.5_1 | 0.843          |                  |       |       |       |
| F3.3: Selection of Contractors Based on Health and Safety Performance Record |                |                  |       |       |       |
| CTE3.1_1 | 0.820          |                  | 0.792 | 0.791 | 0.654 |
| CTE3.2_1 | 0.797          |                  |       |       |       |
| F4.4: Contractual Health and Safety Arrangement |                |                  |       |       |       |
| CTE4.5_1 | 0.580          |                  | 0.951 | 0.920 | 0.703 |
| CTE4.7_1 | 0.840          |                  |       |       |       |
| CTE4.8_1 | 0.901          |                  |       |       |       |
| CTE4.9_1 | 0.947          |                  |       |       |       |
| CTE4.13_1 | 0.812        |                  |       |       |       |
| F5.5: Client Involvement Before and During Construction |                |                  |       |       |       |
| CTE5.1_1 | 0.604          |                  | 0.890 | 0.849 | 0.590 |
| CTE5.2_1 | 0.686          |                  |       |       |       |
| CTE5.3_1 | 0.846          |                  |       |       |       |
| CTE5.4_1 | 0.892          |                  |       |       |       |
| F6.6: Monitoring of Contractor Health and Safety Performance |                |                  |       |       |       |
| CTE6.2_1 | 0.640          |                  | 0.821 | 0.797 | 0.570 |
| CTE6.10_1 | 0.694         |                  |       |       |       |
| F7.7: Project Health and Safety Performance |                |                  |       |       |       |
| CTE7.2_1 | 0.865          |                  | 0.920 | 0.900 | 0.819 |
| CTE7.4_1 | 0.943          |                  |       |       |       |

Ahmad et al., (2016) defines the Average Variance Extracted (AVE) as the average percentage of variation explained by the items in a construct; they, too, state that an AVE ≥ 0.5 is required. Table 11 indicates the AVE ranges from 0.570 to 0.819 and that the requirements of AVE ≥ 0.5 were achieved. The convergent validity was conducted using AVE (Table 11). The composite reliability of each latent variable was estimated, as it is a more suitable indicator of reliability than Cronbach’s coefficient alpha (Qazi, and Umer, 2016). Moreover, MaxR (H) that refers to McDonald Construct Reliability and Maximum Shared Variance (MSV) were estimated. Table 11 further shows that the CR results of all of the seven latent constructs are greater than 0.70 and AVE exceeded 0.50, showing a very good construct reliability and convergent validity respectively (Byrne, 2010). Farrell (2009) stated that if the square root of the AVE (which is shown on diagonals in bold faces) is greater than the rest of the inter-construct correlations, the discriminant validity between the seven latent constructs is established. Hair et al., (2010) suggested the following thresholds for testing reliability and validity: CFA: Reliability: CR >
0.7, Convergent Validity: AVE > 0.5, Discriminant Validity: MSV < AVE and Square root of AVE greater than inter-construct correlations.

| Constructure | CR | AVE | MSV | Max R(H) | F1  | F2  | F3  | F4  | F5  | F6  | PERF |
|---------------|----|-----|-----|----------|-----|-----|-----|-----|-----|-----|------|
| F1            | 0.82 | 0.60 | 0.23 | 0.82 | 0.778 |
| F2            | 0.87 | 0.69 | 0.26 | 0.87 | 0.480** | 0.834 |
| F3            | 0.79 | 0.65 | 0.07 | 0.79 | * | 0.215* | 0.158 | 0.809 |
| F4            | 0.92 | 0.70 | 0.08 | 0.95 | 0.290* | 0.276* | 0.275 | 0.839 |
| F5            | 0.84 | 0.59 | 0.25 | 0.89 | 0.278** | * | * | 0.768 |
| F6            | 0.79 | 0.57 | 0.26 | 0.82 | 0.299** | 0.510** | * | 0.163 | 0.137 | 0.509** | 0.75 |
| PERF         | 0.90 | 0.81 | 0.06 | 0.92 | 0.007 | 0.066 | 0.256 | 0.256 | 0.093 | 0.09 | 0.905 |

6.5. CFA model fit indices – Measurement model
According to Byrne (2006) and Hu & Bentler (1999), the primary objective of SEM is the assessment of model fitness against empirical data and the estimation of the regression parameters. There are several model fit indices that are used in the assessment of model fitness namely, absolute, incremental and parsimonious fit indices. The summary of the measurement model fit indices is depicted in Table 12. All value of fitness indices for the measurement model (Figure 2) have achieved the level of acceptance – except for the chi-square which achieved P=0.000 compared to the required threshold of P>0.05 (Wheaton, 1987).

| Measure         | Estimate | Threshold | Interpretation |
|-----------------|----------|-----------|----------------|
| CMIN            | 261,519  | --        | --             |
| DF              | 157,000  | --        | --             |
| CHI-SQUARE      | P=0.000  | P>0.05    | Terrible       |
| CMIN/DF         | 1.666    | Between 1 and 3 | Excellent |
| CFI             | 0.921    | >0.95     | Acceptable     |
| SRMR            | 0.067    | <0.08     | Excellent      |
| RMSEA           | 0.070    | <0.06     | Acceptable     |
| PCLOSE          | 0.016    | >0.05     | Acceptable     |
6.6. Path Analysis
Wuensch (2016) defines path analysis as a method that is employed to determine whether a multivariate set of nonexperimental data fits well with a particular causal model. When comparing to the CFA measurement model and the structural model (Figure 3), two errors (e23 and e21) from construct F6 were unlinked. These two errors were linking the two attributes (CTE6.2_1 and CTE6.10_1) from construct F6. SEM allows for the estimation of the structural or regression relationships among the constructs. As the model was found to be a good fit, the structural model (Figure 3) was developed.
6.6.1. Structural model fit indices
The summary of the structural model fit indices is shown in Table 13. All the value of fitness indices for the model have achieved the level of acceptance – except for the chi-square which achieved $P=0.000$. 
6.6.2. Model structural relationships

Table 14 provides the AMOS text output estimates of structural paths. The critical ratio, which represents the parameter estimate divided by its standard error is a significance. The parameter estimate is significant at \( p \leq 0.05 \) and value of CR is > 1.96. Among the six constructs (F1 to F6), one significant structural path among the exogenous and endogenous latent variables has been found to be significant.

Table 13: Structural Model Regression Weights

| Constructs | Estimate | S.E. | C.R. | P   | Comments       |
|------------|----------|------|------|-----|----------------|
| PERF       | F1       | -0.075 | 0.128 | -0.588 | 0.556 Not Supported |
| PERF       | F2       | 0.124 | 0.132 | 0.940 | 0.347 Not Supported |
| PERF       | F3       | 0.125 | 0.116 | 1.078 | 0.281 Not Supported |
| PERF       | F4       | 0.554 | 0.211 | 2.623 | 0.009 Supported |
| PERF       | F5       | 0.077 | 0.105 | 0.729 | 0.466 Not Supported |
| PERF       | F6       | -0.353 | 0.292 | -1.213 | 0.225 Not Supported |

Supported = Has Impact; Not Supported = No Impact

As depicted in Table 14, the results generally support the relationship between a contractual health and safety arrangement (F4) and project health and safety performance construct (F7). F4 is the only factor, that leads to positive effect on project health and safety performance. This indicates that as F4 increases, performance improves which validated both hypotheses H4 and H7. The relationship between these two factors suggests that if construction clients stipulate their health and safety requirements and also the health and safety duties (for all participants in the construction project) in the contractual arrangement (as per H4), this can lead to improved project H&S performance. In addition, the results confirmed that H7 hypothesised that there is a relationship between client involvement in their own construction projects and the improvement in the H&S performance of construction projects.

Contrary to the findings of previous studies, the structural model did not support the other five constructs (F1, F2, F3, F5 and F6) and as a result, hypotheses (H1, H2, H3, H5 and H6) were
rendered invalid by this structural model as evidenced in Figure 3. The only difference in this
result is that F3 fell short of having a significant positive relationship with performance due to its
CR of 1.078 not meeting the required threshold value of CR > 1.96.

Although the structural model has a good fit and was found to be acceptable, it failed to take into
account the relationships between the other constructs in the model. To ensure that all the possible
relationships among all the constructs in the model were taken into consideration, alternative
structural model (Figure 4) was developed, and its model fitness was evaluated using the same
criteria as the one adapted for the structural model in Figure 3.

6.7. Alternative structural model (ASM1)
M1 builds on the results of structural model (Figure 3) by looking for factors that exhibit relationships
that result in an improved model fit. Figure 4 shows the refined structural model.

![Figure 4: Alternative Structural Model 1](image-url)
6.7.1. Alternative Structural model fit indices

The summary of the structural model fit indices for ASM1 are shown in Table 15. One out of six model fitness indices adopted for the current model did not achieve the level of acceptance in the ASM1.

The resulting structural relationships from the alternative ASM1 model are shown in the Table 16. The significant relationships are highlighted green. In terms of the relationships with performance consistent with the initial structural model and the alternative structural model one, only F4 has an effect on performance. All of the six constructs (F1 to F6), show significant relationships among the exogenous and endogenous latent variables. All six constructs (F1 to F6) show significant relationships among the exogenous and endogenous latent variables. ASM1 has proven to be the best model of the two that were tested. It has a good model fit and has shown positive significant relationships among all constructs, even although only one construct has a direct effect on the project health and safety.

### Table 14: Alternative Structural Model 1 – Model Fit Measures

| Measure         | Estimate | Threshold | Interpretation |
|-----------------|----------|-----------|----------------|
| CMIN            | 275,679  | --        | --             |
| DF              | 166,000  | --        | --             |
| CHI-SQUARE      | P=0.000  | P>0.05    | Terrible       |
| CMIN/DF         | 1.661    | Between 1 and 3 | Excellent     |
| CFI             | 0.917    | >0.95     | Acceptable     |
| SRMR            | 0.086    | <0.08     | Excellent      |
| RMSEA           | 0.070    | <0.08     | Excellent      |
| PCLOSE          | 0.015    | >0.05     | Acceptable     |

### Table 15: Alternative Structural Model 1 Regression Weights

| Constructs | Estimate | S.E. | C.R. | P     | Comment        |
|------------|----------|------|------|-------|----------------|
| F4 ➔ F3    | .119     | .049 | 2.424| .015  | Supported      |
| F2 ➔ F1    | .676     | .146 | 4.624| ***   | Supported      |
| F4 ➔ F1    | .144     | .056 | 2.558| .011  | Supported      |
| F5 ➔ F2    | .518     | .112 | 4.626| ***   | Supported      |
| F5 ➔ F4    | .591     | .230 | 2.567| .010  | Supported      |
| F6 ➔ F2    | .326     | .087 | 3.737| ***   | Supported      |
| F6 ➔ F5    | .211     | .071 | 2.982| .003  | Supported      |
| PERF ➔ F2  | .145     | .140 | 1.037| .300  | Not Supported  |
| PERF ➔ F4  | .640     | .210 | 3.043| .002  | Supported      |
| PERF ➔ F5  | .110     | .098 | 1.132| .258  | Not Supported  |
| PERF ➔ F6  | -.437    | .269 | -1.627| .104  | Not Supported  |
| PERF ➔ F1  | -.096    | .133 | -.721| .471  | Not Supported  |

***p < 0.001

Supported = Has Impact; Not Supported = No Impact
All six constructs (F1 to F6) in Table 16 indicate significant relationships among the exogenous and endogenous latent variables. ASM1 has proven to be the best model of the two that were tested. It has a good model fit and has shown positive significant relationships among all constructs, even although only one construct has a direct effect on the project health and safety performance.

6.8. Direct and Indirect Effect
Hazen et al., (2015) suggested that after examination of adequacy for the measurement and structural model, the results can be used as the basis for hypothesis testing. Schreiber et al., (2006) suggested the reporting of direct, indirect and total effect among the latent constructs as dictated by theory or empirically based suppositions. In figure 5, a direct effect represents the effect of an independent variable on a dependent variable. Hazen et al., (2015) suggested that to ensure simplicity and consistency, the hypothesis test results for direct effects should include the standardized beta, p-value and (if an endogenous variable), the extent of variance explained by the predictor variables (squared multiple correlation or R2).

![Figure 5: Final Structural Model Interrelationships](image_url)
Based on the final model (Figure 5), it was hypothesised that CTHS1 (F1), CTHS2 (F2), CTHS3 (F3), CTHS4 (F4), CTHS5 (F5) and CTHS6 (F6) have a direct effect on performance (PERF or CTHS7). The results of these hypotheses are shown in Table 17. All hypotheses except the one with CTHS4 were rejected. It was also hypothesised that CTHS3 would have a direct effect on CTHS4, CTHS1 on CTHS2, CTHS1 on CTHS4, CTHS2 on CTHS6, CTHS5 on CTHS6, CTHS2 on CTHS5 and CTHS4 on CTHS5. The hypotheses were found to be significant and acceptable (Table 17).

| Parameter | Estimate | Lower | Upper | P     |
|-----------|----------|-------|-------|-------|
| CTHS4 ←→ CTHS3 | 0.119 | 0.012 | 0.25 | 0.019 |
| CTHS2 ←→ CTHS1 | 0.676 | 0.395 | 1.231 | 0.001 |
| CTHS4 ←→ CTHS1 | 0.144 | 0.036 | 0.396 | 0.01 |
| CTHS5 ←→ CTHS2 | 0.518 | 0.225 | 0.753 | 0.004 |
| CTHS5 ←→ CTHS4 | 0.591 | 0.001 | 1.978 | 0.05 |
| CTHS6 ←→ CTHS2 | 0.326 | 0.091 | 0.623 | 0.004 |
| CTHS6 ←→ CTHS5 | 0.211 | 0.009 | 0.372 | 0.039 |
| CTHS7 ←→ CTHS2 | 0.145 | -0.116 | 0.983 | 0.286 |
| CTHS7 ←→ CTHS4 | 0.64 | 0.157 | 1.562 | 0.003 |
| CTHS7 ←→ CTHS5 | 0.11 | -0.097 | 0.603 | 0.275 |
| CTHS7 ←→ CTHS6 | -0.437 | -2.278 | -0.002 | 0.05 |
| CTHS7 ←→ CTHS1 | -0.096 | -0.468 | 0.227 | 0.628 |

6.9. Mediation Results
Hazen et al., (2015) recommended the examination of moderating and mediating variables when employing SEM in supply chain research. Hazen et al., (2015) argued that moderator analyses are important in testing complex relations, because if these relationships are not tested in most structural equation models, the relevance of study results may be seriously affected. Based on the final model (Figure 5), it was also hypothesised that there is mediation and therefore indirect effect on performance (PERF) by CTHS1 through CTHS2, CTHS1 through CTHS4, CTHS2 through CTHS6, CTHS3 through CTHS4, CTHS4 through CTHS5 and CTHS5 through CTHS6.

Following the procedure suggested by Zhao et al., (2010) to identify mediation effects, a bootstrapping procedure of the specific, indirect effects was run to identify unique indirect effects for every possible mediation (Gaskin and Lim 2018). The results (Table 18) show that only the following have an indirect effect on performance and are statically significant: CTHS1 through CTHS4 has an indirect effect on CTHS7 and is statistically significant and CTHS3 through CTHS4 has an indirect effect on CTHS7 and is statically significant.
7. Discussion

The overall objective of the study was to develop a client-driven H&S model for measurement of health and safety performance of construction projects in South Africa based on previous studies and SEM. To achieve this objective, a review of literature was conducted. The conceptual model theorised that construction clients could directly influence project H&S performance through their: attitude towards H&S, ability to clearly communicate H&S requirements to all stakeholders, selection of contractors based on their past H&S performance, contractual H&S arrangement, involvement before and during construction and monitoring of the contractor’s H&S compliance. These hypotheses were verified statically using SEM.

Contrary to the findings of the previous studies, the final SEM results suggested that the contractual H&S arrangement (F4) is the only factor that has a direct effect on project H&S performance. This indicates that as F4 increases, performance improves that validated both hypotheses H4 and H7. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and also the H&S duties for all participants in the construction project in the contractual arrangement (H4), this could directly lead to an improve project H&S performance. The study has also revealed that all six constructs have positive significant relationships among each other. This is an indication of an indirect influence on the project H&S performance.

The relationship between the six constructs with the project H&S performance indicators was tested with correlation analysis. The correlations show that the first aid incident frequency rate and all incident frequency rate indicators of project H&S performance are not influenced by any of the research variables. The medical treatment incident frequency rate, lost time incident frequency rate and the total recordable incident rate indicators of project performance are all influenced by the selection of contractors and contractual H&S arrangements.

### Table 17: Indirect Effect Hypotheses Results

| Indirect Path         | Lower | Upper | P-Value | Standardized Estimate |
|-----------------------|-------|-------|---------|-----------------------|
| CTHS1 → CTHS4 → CTHS5 | 0.014 | 0.179 | 0.045   | 0.073*                |
| CTHS1 → CTHS4 → CTHS7 | -0.074| -0.005| 0.033   | -0.033*               |
| CTHS1 → CTHS2 → CTHS6 | 0.042 | 0.197 | 0.009   | 0.126**               |
| CTHS1 → CTHS2 → CTHS7 | -0.193| 0.008 | 0.141   | -0.091                |
| CTHS3 → CTHS4 → CTHS5 | 0.217 | 0.493 | 0.002   | 0.255**               |
| CTHS3 → CTHS4 → CTHS7 | -0.213| -0.029| 0.028   | -0.114*               |
| CTHS4 → CTHS5 → CTHS6 | 0.264 | 0.542 | 0.001   | 0.290***              |
| CTHS4 → CTHS5 → CTHS7 | -0.124| 0.101 | 0.793   | -0.014                |
| CTHS5 → CTHS6 → CTHS7 | -0.014| 0.161 | 0.194   | 0.098                 |
| CTHS2 → CTHS6 → CTHS7 | -0.001| 0.084 | 0.119   | 0.034                 |

Significance of Estimates:

*** p < 0.001  
** p < 0.010  
* p < 0.050
The final SEM results suggest that the contractual H&S arrangement (F4) was the only factor that has a direct effect on project H&S performance. This indicates that as F4 increases, performance improves that validated both hypotheses H4 and project H&S performance. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and also the H&S duties for all participants in the construction project in the contractual arrangement (H4), this could lead to an improvement of project H&S performance. The study has also revealed that all six constructs have positive significant relationships among each other. This is an indication of an indirect influence on the project H&S performance.

8. Conclusion
Previous studies identified that client attitude towards health and safety, the ability to clearly communicate H&S requirements to all stakeholders, selection of contractors based on the past H&S performance, contractual H&S arrangement, client involvement before and during construction and monitoring contractors’ H&S compliance have a direct effect on project H&S performance. However, contrary to the previous studies, the findings of this study indicated that only the contractual H&S arrangement has a direct effect on project H&S performance. Mediation hypotheses was performed and revealed that client attitude toward H&S and selection of contractors based on their historical H&S have an indirect effect of project H&S performance. The study has also revealed that all six constructs have positive significant relationships among each other. This is an indication that all factors can be applied concurrently to influence the project H&S performance. The study has revealed new key attributes/indicators for measuring project H&S performance in the construction industry.

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