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# FACTORS THAT DETERMINE CONSTRUCTION HEALTH AND SAFETY AGENT COLLABORATION ON CONSTRUCTION PROJECTS: A DELPHI STUDY

RESEARCH ARTICLE[1]

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## ABSTRACT

The construction industry (CI) continues to be the cause of injuries and illnesses to many workers worldwide. Collaboration between the construction health and safety agent (CHSA) and other built environment professionals may improve the impact of the CHSA on health and safety (H&S) performance. However, no study has identified the factors that determine CHSA collaboration on construction sites. A three rounds Delphi study was conducted to identify the factors that determine CHSA collaboration. A panel of 14 experts serving the CI were selected from four continents and were asked to identify additional factors and validate the factors identified from literature. Microsoft Excel 2016 was used to analyse the data; group medians were calculated to reach consensus, and open question responses were summarised qualitatively. The experts confirmed the existence of the factors identified in the literature. The factors that determine CHSA collaboration on construction projects include mutuality, trust, enabling environment, personal characteristics, common purpose, institutional

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support, and project context. Drawing from the findings, the study suggests that these seven factors can influence CHSA collaboration. The study is limited to 14 experts and more experts could have provided more information. The factors that determine CHSA collaboration identified in this study may not be exhaustive and another study may provide different factors. Further research could adopt other research methods such as the quantitative method, in order to determine the impact of these factors on CHSA collaboration. Factors that determine CHSA collaboration on construction projects should be identified, implemented, and monitored, in order to increase the influence of CHSA on H&S performance.

## ABSTRAK

Die konstruksiebedryf (KI) is steeds die oorsaak van beserings en siektes vir baie werkers wêreldwyd. Samewerking tussen die konstruksiegesondheids- en veiligheidsagent (KGVA) en ander professionele persone in die bou-omgewing kan die impak van die KGVA op gesondheids- en veiligheidsprestasie (G&V) verbeter. Geen studie het die faktore geïdentifiseer wat KGVA-samewerking op konstruksieterreine bepaal nie. ’n Delphi-studie van drie rondtes is uitgevoer om die faktore wat KGVA-samewerking bepaal, te identifiseer. ’n Paneel van 14 kundiges uit die KI, is uit vier kontinente gekies. Kenners is versoek om addisionele faktore te identifiseer en die faktore wat uit literatuur geïdentifiseer is, te bekragtig. Microsoft Excel 2016 is gebruik om die data te ontleed en groepmediane is bereken om konsensus te bereik en antwoorde op oop vrae is kwalitatief opgesom. Kenners het die bestaan van die faktore wat in die literatuur geïdentifiseer is, bevestig. Die faktore wat KGVA se samewerking oor bouprojekte bepaal, is onder meer wedersydsheid, vertroue, omgewing, persoonlike eienskappe, gemeenskaplike doel, institusionele ondersteuning en projekkonteks. Uit die bevindinge het die studie voorgestel dat hierdie sewe faktore KGVA-samewerking kan beïnvloed. Die studie is beperk tot 14 kundiges en meer kundiges kon meer inligting verskaf het. Die faktore wat KGVA-samewerking bepaal wat in hierdie studie geïdentifiseer is, is moontlik nie volledig nie en ’n ander studie kan verskillende faktore verskaf. Verdere navorsing kan ander navorsingsmetodes gebruik, soos die kwantitatiewe metode, om die impak van hierdie faktore op KGVA-samewerking te bepaal. Faktore wat KGVA-samewerking op konstruksieprojekte bepaal, moet geïdentifiseer, geïmplementeer en gemonitor word om die invloed van KGVA op G&V-prestasie te verhoog.

Sleutelwoorde: Delphi-studie, gesondheids- en veiligheidsprestasie, konstruksiebedryf, konstruksie gesondheids- en veiligheidsagent, samewerking

# 1. INTRODUCTION

Several studies have been conducted to improve the poor health and safety (H&S) performance on construction sites (Neale, 2013; Smallwood & Deacon, 2017; Goldswain, 2014). H&S legislations have identified the construction health and safety agent (CHSA) as one of the key stakeholders in achieving zero accident goal on construction sites (Deacon, 2016: 83). In this study, the CHSA is defined as “a competent person who acts as representative for clients who has the capability to design, compile, implement and manage the H&S requirements for construction projects from initiation and briefing to project close-out’’ (SACPCMP, 2013: 7).

Although South African Construction Regulations 2014 and UK Construction and Design Management Regulations 2015 (Health and

Safety Executive, 2015: 17-18; Deacon, 2016: 83) require all involved on a project to address H&S, there appears to be a lack of collaboration between the CHSA and project managers, designers, quantity surveyors, engineers, and construction managers (Deacon, 2016: 223). This lack of collaboration continues to frustrate construction H&S professionals and academics worldwide (Benjaoran & Bhoka, 2010: 396; Larson & Almen, 2014: 25; Deacon, 2016: 223). Meanwhile, Erickson (2016: 28) suggested that collaboration may improve the impact of CHSA on H&S performance. However, no study has identified the factors that determine CHSA collaboration. As a result, this study seeks to close this gap in literature. The purpose of this study is to identify the factors that determine the CHSA's collaboration on construction projects.

# 2. LITERATURE REVIEW

## 2.1 Construction industry and construction health and safety agent

Globally, the construction industry (CI) performs poorly in terms of H&S performance (Manu, Emuze, Saurin & Hadikusumo, 2020: 1). It is estimated that at least two construction workers die every week in South Africa (Department of Public Works, 2014: 4). Likewise, according to Samuel (2017: 1), at least 1.5 to 2.5 fatalities occur in South African CI weekly. The increased attention on CHSA has been partly due to the accidents rate and the strong emphasis through H&S legislations (Smallwood & Deacon, 2017). Instead of relying only on project managers, designers, engineers, or construction managers to ensure worker H&S, the involvement of CHSA may add value to project processes and ensure that different project participants address H&S aspects. Meanwhile, the lack of collaboration between CHSAs and other built-environment professionals seems inappropriate, given the importance of H&S management, more specifically, CHSA to construction projects. Due to client, designers and contractors' lack of H&S expertise and experience (Badri, Gbodossou & Nadeau, 2012: 190; Deacon, 2016: 156), CHSAs are usually needed to manage H&S issues (Chunxiang, 2012: 527: Mwanaumo, 2013: 278; Deacon, 2016: 233). In addition, CHSAs are regarded to be among the most important professionals for the management of H&S (Sinelnikov, Inouye & Kerper, 2015: 247; Deacon, 2016: 156; Chunxiang, 2012: 527: Aulin & Caponie, 2010: 93) and also key for the development of H&S culture (Nielsen, 2014: 12; Wu, Lin & Shiau, 2010: 424).

Several studies have been conducted to improve the value or influence of persons managing H&S on H&S performance (Smith & Wadsworth, 2009; Rebbitt, 2012; Cameron, Hare & Duff, 2013; Borys, 2014; Smallwood &

Deacon, 2017; Provan, Dekker & Rae, 2017). These studies agree that the H&S professionals can influence H&S performance, but this influence is dependent on several factors such as personal attributes, trust, body of H&S knowledge, qualification, early involvement, roles, experience, training, line of report, and institutions such as Department of Labour (DoL) and professional bodies.

## 2.2 Collaboration and its related factors

Everyone generally knows collaboration, but the difficulties arise when they must define it. Some authors use the terms 'common purpose' and 'working together' to define it. Others define collaboration as a relationship between contractor and subcontractor working together to achieve a common goal (Deep, Gajendran & Jefferies, 2019: 4), while others use process to define collaboration such as joint problem-solving (Msomba, Matiko & Mlinga, 2018: 152). A recent study confirmed that there is still no consensus on the definition of collaboration (Rantsatsi, Musonda & Agumba, 2020: 122). This shows that collaboration is broad and that different authors define it differently. In this study, collaboration is defined as a "process in which information, activities, responsibilities and resources are shared to jointly plan, implement, and evaluate a program of activities to achieve a common goal, and a joint generation of value" (Camarinha-Matos, Afsarmanesh, Galeano & Molina, 2009: 47-48).

Collaboration theories provide important insights into the factors that determine collaboration and those that improve performance. The effectiveness of collaboration depends on a myriad of factors. From the point of view of social sciences, Bronstein (2003) identifies four factors that influence interdisciplinary collaboration: professional role, structural characteristics, personal characteristics, and history of collaboration. From the point of view of management, Roberts, Van Wyk and Dhanpat (2016: 5) summarise five factors that determine collaboration: trust, common purpose, mutuality, enabling environment, and personal characteristics. From the perspective of construction management, Deep *et al.* (2019: 10) identify three enablers of collaboration: trust, commitment, and reliability.

Previous studies on collaboration have identified mutuality, trust, enabling environment, personal characteristics, common purpose, institutional support, and project context as the critical factors (Thomson, Perry & Miller, 2007; Amabile, Patterson, Mueller, Wojcik, Kramer, Odomirok & March, 2001; Lu, Zhang & Rowlinson, 2013; Bronstein, 2003; Patel, Pettitt & Wilson, 2012; Torneman, 2015; Roberts *et al.*, 2016).

Mutuality occurs when each party contributes unique resources from which other members can benefit (Thomson *et al.*, 2007: 28; Bronstein, 2003: 299; Roberts *et al.*, 2016: 5). This occurs when one party looks after its own interests and those of other parties. Indicators of mutuality include equality in decision-making, mutual trust, and respect (Ylitalo, Eerikki & Ziegler, 2004: 549). On construction projects, professionals are expected to rely on each other, hence mutuality becomes important. Mutuality may be an important factor in determining CHSA collaboration on construction projects.

On the other hand, trust refers to the belief and expectations that parties will be honest in agreements and commitments, adhere to their commitments and not exploit other parties (Roberts *et al.*, 2016: 5; Liu, Van Nederveen & Hertogh, 2017: 692; Patel *et al.*, 2012: 14). Khalfan, McDermott and Swan (2007: 385) indicate that trust involves honest communication, reliance and delivery of outcomes, because reliance on one another builds trust. Not only is the level of trust key for decision-making between H&S professionals and line managers, but it is suggested that the level of trust also improves team performance (Rantsatsi *et al.*, 2020: 136). Since construction projects involve diverse professionals, trust becomes a necessity. Therefore, trust may be an important factor in determining CHSA collaboration on construction projects.

Enabling environment includes provision of systems and processes that support the collaboration objectives and the removal of barriers (Roberts *et al.*, 2016: 5; Bronstein, 2003: 304). According to Camarinha-Matos and Afsarmanesh (2008: 313), collaboration requires an enabling environment that can be characterised by clear and open communication (Faris, Gaterell & Hutchinson, 2019: 9), informal and formal communication channels (Mattessich & Monsey, 1992: 16), collective contributions (Camarinha-Matos *et al.*, 2006: 175), and joint decision-making (Ylitalo *et al.*, 2004: 548). An enabling environment may be an important factor in determining CHSA collaboration on construction projects.

Personal characteristics include attitudes, motivations, knowledge, and skills that individual needs in order to collaborate (Amabile *et al.*, 2001; Lu *et al.*, 2013: 31; Roberts *et al.*, 2016: 2; Bronstein, 2003: 304). Membership characteristics include skills, attitudes and opinions of an individual in a collaborative group (Mattessich & Monsey 1992: 22). This includes the motivation and ability to collaborate effectively with others (Amabile *et al.*, 2001: 419). It is widely acknowledged that personal characteristics determine collaboration (Roberts *et al.*, 2016: 2), because individual characteristics can affect the project outcome (Ozturk, 2019: 11). Mattessich and Monsey (1992: 22) revealed that personal characteristics are extremely significant components of successful collaborative endeavours. Personal characteristics may be an important factor in determining CHSA collaboration on construction projects.

Shared purpose refers to shared vision and unique purpose that bring the team together (Roberts *et al.*, 2016: 4; D'Amour, Ferrada-Videla, Rodriquez & Beaulieu, 2005: 119; Faris *et al.*, 2019: 11). Shared purpose promotes collaboration and improves project performance (Pal, Wang & Liang, 2017: 1127). Working collaboratively simply suggests that members pursue a set of common goals (D'Amour *et al*., 2005: 119). Shared goals can be realised through collaboration. According to Mattessich and Monsey (1992: 32), a shared vision may be developed either when collaboration is in the planning stage or as it begins to function. Having a common purpose is a factor that needs to be in place so that collaboration can happen (Roberts *et al.*, 2016: 4). Common purpose may be an important factor in determining CHSA collaboration on construction projects.

Institutional support refers to the support a project member receives from his/her own institution/organisation such as own company and professional body (Amabile *et al*., 2001 420: Lu *et al.*, 2013: 31), and even government authorities. From the perspective of education, Amabile *et al*. (2001: 420) highlighted that there is a lack of research on the effect of institutional contexts on collaboration. In their study, Barraket and Loosemore (2018: 396) investigated organisational and institutional factors drive cross-sector collaboration. They found that organisational and institutional factors drive cross-sector collaboration (Barraket & Loosemore, 2018: 406). Institutional support to CHSA is provided through government agencies such as DoL and professional bodies. Institutional support may be an important factor in determining CHSA collaboration on construction projects.

Project context includes project structure and culture. Project structure is important for encouraging interaction and collaboration between individuals (Dietrich, Eskerod, Dalcher & Sandhawalia 2010: 60). However, Akintoye, Mcintosh and Fitzgerald (2000: 166) found that inappropriate organisational structure is one of the barriers for implementing an efficient and successful supply chain collaboration. Dietrich *et al*. (2010: 10) suggested that construction organisations should adopt a flexible organisational structure.

Meanwhile, one of the key factors of collaboration is culture (Hasanzadeha, Hosseinalipourb & Hafezi, 2014; Hughes, 2018; Akintan & Morledge, 2013). Culture can exist at both organisational and project levels. Zheng, Yang and McLean (2013: 765) state that organisational culture shapes how members behave. This is reflected in the organisation's influence on members who are working for it or on the project. Organisationally, culture influences collaboration (Faris *et al.*, 2019: 5). Project structure and culture are necessary to support the collaborative activities expected on the project. Project context may be an important factor in determining CHSA collaboration on construction projects.

# 3. METHODOLOGY

This study sought to explore, identify, and prioritise factors that determine CHSA collaboration on construction projects. A qualitative research design was used, in which semi-structured questionnaire surveys enabled the researchers to generalise their findings from a group of experts' consensuses (Brady, 2015: 6). The Delphi study method was used, and the survey data were obtained from three rounds. A Delphi study runs a series of rounds to explore divergence and reach consensus among a panel of experts by means of controlled feedback, anonymity, statistical aggregation of group response, and iteration (Sourani & Sohaila, 2014: 56; Linstone & Turoff, 2002: 11; Rajendran, 2006: 110; Skulmoski, Hartman & Krahn, 2007: 2-3). In Round 1, extracted from extant literature, 50 initial statements were identified in seven components (mutuality, trust, enabling environment, personal characteristics, common purpose, institutional support, and project context) as factors that determine CHSA collaboration on construction projects. In Rounds 2 and 3, initial and additional statements relating to CHSA collaboration were identified and rated, using a 7-point Likert scale until consensus was reached. Likert scale measurement was used because statements could be analysed on the median rating for agreement of experts. Statements with the highest rating indicate that most of the experts agree that the statement or factor determines CHSA collaboration on construction projects.

## 3.1 Sampling and expert panel selection

Delphi sample sizes depend more on group dynamics in reaching consensus than on their statistical power (Okoli & Pawlowski, 2004: 19). The targeted population involved professionals and academics serving the CI that have the relevant abilities and knowledge about the study problem (Etikan, Musa & Alkassim, 2016: 3; Bhattacherjee, 2012: 69; Skulmoski *et al.*, 2007: 3). The purposive sampling method (Welman, Kruger & Mitchell, 2005: 69; Chang & Karen, 2018: 317) was adopted to invite 45 experts from four sources, namely construction H&S literature, registered members of the Council for Research and Innovation in Building and Construction (CIB) on the CIB working commission (W099), authors or speakers who featured very prominently on the CIB W099 Conference Proceedings from 2010 to 2019, as well as registered construction professionals and academics who serve the South African built environment. Purposive sampling was used to ensure that all invited participants met the inclusion criteria, namely that all participants were required to already have obtained a registered qualification in the CI; be registered with a professional body, and have at least five years' experience in the CI, as well as field-specific knowledge (Boulkedid, Abdoul, Loustau, Sibony & Alberti, 2011:2; Skulmoski *et al.*, 2007: 10; Avella, 2016: 310; Hallowell & Gambatese, 2010: 106). The knowledge in construction H&S was considered to be compulsory for all selected experts and their willingness to participate throughout the entire study (Powell, 2003: 379; Avella, 2016: 310). All experts responded to Rounds one, two and three. In the Delphi process, general rules-of-thumb indicate that 14-30 people for a homogeneous population (that is, experts coming from the same discipline such as, for example, CI professionals) are generally considered to be sufficient to enable consensus to be achieved (Clayton, 1997: 378).Fourteen experts participated in three iterations.

## 3.2 Data collection

Using the Delphi study technique, data were collected from three survey rounds between April and May 2021. In Round 1, a two-section semi-structured questionnaire was distributed among the 14 experts via email. In section one, experts were asked to rate the 50 statements related to seven factors, using a 7-point Likert scale, that would improve CHSA collaboration in the CI. In section two, the experts were asked to respond to an open statement: “Please list other additional factors that would encourage CHSA collaboration and list its related indicators or statements”.

In Rounds 2 and 3, the comments provided in Round 1 were included in the questionnaire for Round 2 and Round 2 provided structure for Round 3. Six statements were dropped after Round 1 (Risks and rewards sharing encourages collaboration; professionalism supports collaboration; specialisation supports collaboration; flexibility on project schedule supports collaboration; training on information and technological resources, and availability of Internet for accessing H&S legislations) and three new statements (Trusting the roles more than individuals promotes collaboration; professional bodies to train CHSA on construction processes, and H&S legislations to require involvement of CHSA from stage one of the project) were added, based on experts’ response to section two open question. These statements were retained in Rounds 2 and 3. The researcher compiled and communicated the results of each round to each expert in the form of individualised questionnaires. This included group medians. In Rounds 2 and 3, the experts were also asked to comment on their ratings, if the ratings differed from the group median. Statistical and qualitative feedback was provided to each expert in Round 3. The outcome of Round 3 indicated that there was a consensus and thus no need for Round 4. This finding concurs with previous studies (Skulmoski *et al.*, 2007: 5; Hallowell, 2008: 89; Boulkedid *et al.*, 2011: 7).

The comments included in the questionnaire were not linked to experts, in order to ensure anonymity. Anonymity allows panel members to interact freely without fear of intimidation or peer pressure (Donohoe, Stellefson & Tennant, 2012: 40), while controlled feedback allows every panel member to receive individualised feedback and provide inputs into the entire process (Sourani & Sohaila, 2014: 56). Statistical group response allows for aggregation of responses in the form of group median. This can also be used to indicate consensus (Rajendran, 2006: 110), and iteration allows panel members to change their views (Linstone & Turoff, 2002: 11).

Experts were made aware of the fact that the study would be for academic purposes and as such no material benefit other than knowledge advancement and findings of the study. Inclusion and exclusion criteria were set to ensure that only those who understand and are able to make a decision about what is involved participate. The Delphi study did not require the age, gender, and name of the expert organisation. Confidentiality and anonymity were maintained throughout the study.

## 3.3 Analysis and interpretation of the data

Descriptive analysis was used for the respondents' profile information, in which the frequencies and percentages were generated and reported.

Microsoft Excel 2016 was used for data analysis and the results of each round were analysed using the median; open question responses were summarised qualitatively. The experts were required to rate their level of agreement on the factors/statements that would determine CHSA collaboration on construction projects and identify additional factors/statements. The following 7-point Likert scale measurement was used regarding median value: 1 = strongly disagree; 2 = disagree; 3 = somewhat; 4 = neutral; 5 = somewhat; 6 = agree, and 7 = strongly agree. Cut-off values of group median 6 to 7 were required for reaching consensus and over 60% of the respondents rated the factors between 6 to 7. Previous studies mentioned similar criteria for reaching consensus in Delphi studies (von der gracht, 2012: 1529; Habibi, Sarafrazi & Izadyar, 2014: 11).

Although consensus is usually only reached when 100% of the experts agree, in this study 60% of the experts agreeing on each statement was considered sufficient to indicate common agreement. This is consistent with the studies by Chang, Gardner, Duffield & Ramis (2010: 2322), suggesting that 75% should be used for reaching consensus, and Agumba (2013: 150) using 50% for reaching consensus. Each statement was analysed individually for consensus.

# 4. FINDINGS AND DISCUSSIONS

## 4.1 Demographic characteristics of experts

Table 1 shows the profile of experts. The vast majority of the experts were from South Africa; 42% of the experts had a Doctor of Philosophy (PhD) degree; 50% of the experts were CHSAs, and 57% of the experts had over 10 years' experience in the CI. These experts were from Africa, Europe, Asia and North America. The Middle East, South America and Australia were not represented on the panel.

Table 1: Experts' profile

| *Demographic* | *Characteristic* | *Frequency* | *Percentage* |
|---|---|---|---|
| Country | South Africa | 9 | 64.28 |
| | United Kingdom | 1 | 7.14 |
| | Nigeria | 2 | 14.28 |
| | Malaysia | 1 | 7.14 |
| | United States of America | 1 | 7.14 |
| | Total | 14 | 100.00 |
| Qualification | PhD | 6 | 42.85 |
| | Master of Science degree | 2 | 14.28 |
| | Bachelor Degree | 4 | 28.57 |
| | National Diploma | 2 | 14.28 |
| | Total | 14 | 100.00 |
| Professional registration | Construction project managers | 2 | 14.28 |
| | CHSAs | 7 | 50.00 |
| | Construction managers | 2 | 14.28 |
| | Engineer | 1 | 7.14 |
| | Construction health and safety manager | 1 | 7.14 |
| | Certified safety professional | 1 | 7.14 |
| | Total | 14 | 100.00 |
| Years of experience | 1-5 | 3 | 21.42 |
| | 6-10 | 3 | 21.42 |
| | 11-15 | 1 | 7.14 |
| | 16-20 | 1 | 7.14 |
| | 21-25 | 2 | 14.28 |
| | 26-30 | 2 | 14.28 |
| | 31-40 | 2 | 14.28 |
| | Total | 14 | 100.00 |

Table 2 presents panel members' publication history. Based on publication, eight of the experts on the panel had published in peer-reviewed journals, conferences and books. Between them, they published 8 books, 10 chapters in books, 353 peer-reviewed journal articles, and 201 conference papers. Five of the panel members served on the editorial board of journals; seven had served as referees or reviewers for journal publications, and six as referees for conference papers, while three have also served on the technical committee of the government department of employment and labour.

Table 2: Panel members' publication history

| *Expert publication* | *Number of publications* |
|---|---|
| Peer-reviewed journals | 353 |
| Peer-reviewed conference papers | 201 |
| Editor or author of book | 10 |
| Author of a book chapter | 8 |

## 4.2 Factor results and discussions

The level of agreement was confirmed by evaluating the extent to which the identified factors and their related statements would determine CHSA collaboration on construction projects. Tables 3-9 show the results from Rounds 1, 2 and 3 of agreement medians. A higher score represented a higher level of agreement on the statement.

Table 3 presents the related statements of mutuality for CHSA collaboration. This factor was measured using six statements. All six statements achieved a median rating of between 6 to 7 and over 60% of the experts rated the statements between 6 to 7. Two statements, namely, respect among project members and transparency, attained a high median of 7, while the other four statements achieved a median of 6. This finding concurs with past studies (Henson, 1997: 79; Yuming, 2014: 61). The other four statements achieved a median rating of 6. This finding concurs with past studies, which

Table 3: Mutuality for construction health and safety agent collaboration

| *Mutuality* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| Sharing information encourages collaboration | 6 | 6 | 6 | 100 |
| Equality in decision-making promotes collaboration | 6 | 6 | 6 | 100 |
| Respect among project members facilitates collaboration | 7 | 7 | 7 | 100 |
| Sharing responsibility for project activities promotes collaboration | 6 | 6 | 6 | 100 |
| Sharing knowledge that benefits others promotes collaboration | 6 | 6 | 6 | 100 |
| Transparency promotes collaboration | 7 | 7 | 7 | 92 |

considered exchange of knowledge or ideas and equality in decision to be key indicators of mutuality (Henson, 1997: 80; Brinkerhoff, 2002: 23). The differences in the level of agreement of the related statements of mutuality point to the fact that experts strongly agree on the two statements and agree on the other four. The last column in Table 3 indicates that, for five statements, over three rounds, 100%, and for one statement, 92% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 4 presents the related statements of trust for CHSA collaboration. This factor was measured using seven statements. Five out of the seven statements achieved the median rating between 6 to 7. This finding concurs with the study by Yuming (2014: 61). Similarly, according to Khalfan *et al.* (2007: 386), people tend to trust those who they think are competent. Only two related statements of trust dropped out, namely trusting the position rather than personality and trusting competence of individuals based on professional registration achieved a median of 4 and 5, respectively. Although these statements did not achieve the required median rating of 6 to 7, previous research suggests that personal role in the project, track record and professional standing are essential indicators of trustworthiness (Wong, Cheung, Yiu & Pang, 2008: 824). The importance of this finding was that trusting the position rather than personality and trusting competence of individuals based on professional registration were necessary despite their median rating of below 6. One of the experts mentioned that "developing

Table 4: Trust for construction health and safety agent collaboration

| *Trust* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| An atmosphere of trust encourages collaboration | 7 | 7 | 7 | 100 |
| *Trusting the position rather than personality facilitates collaboration | 4 | 4 | 4 | 21 |
| Trusting that individuals will fulfil their obligations encourages collaboration | 6 | 6 | 6 | 92 |
| Trusting individuals based on previous interactions and experience promotes collaboration | 6 | 6 | 6 | 100 |
| Trusting the competence of individuals based on education background promotes collaboration | 5 | 5 | 6 | 64 |
| *Trusting the competence of individuals based on professional registration promotes collaboration | 4 | 5 | 5 | 7 |
| Trusting the roles more than the individuals promotes collaboration (statement was added after Round 1) | 0 | 6 | 6 | 92 |

* statement dropped out

trust in someone takes time and is based on character and competence, not personality". The values provided in the last column in Table 4 indicate that, over three rounds, for two statements, 100% of experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 5 presents the related statements of enabling environment for CHSA collaboration. All six statements achieved the required median rating of 6 to 7. Based on the comprehensive literature, enabling environment was identified as one of the main factors for collaboration (Roberts *et al.*, 2016: 4). While lack of communication can undermine the effectiveness of collaboration, frequent communication helps adjust project strategies (Yuming, 2014: 120). Similarly, an environment, in which decisions are made jointly and in the interest of all parties (Jackson *et al.*, 2017: 557), promotes collaboration, while the environment of open communication improves certainty and reliability of the behaviours of those involved (Yuming, 2014: 62). A situation where one believes that others can contribute meaningfully to the decision-making (Henson, 1997: 79) is likely to exist when there are no power imbalances. The values provided in the last column in Table 5 indicate that, over three rounds, for four statements, 100% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 5: Enabling environment for construction health and safety agent collaboration

| *Enabling environment* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| Joint decision-making encourages collaboration | 6 | 6 | 6 | 100 |
| Frequent communication encourages collaboration | 6 | 6 | 6 | 100 |
| Sharing power between project members encourages collaboration | 6 | 6 | 6 | 100 |
| Collective contributions encourage collaboration | 6 | 6 | 6 | 100 |
| Collaboration is encouraged when leaders of an organisation support collaboration | 6 | 6 | 6 | 78 |
| Committed project team encourages collaboration | 6 | 6 | 6 | 92 |

Table 6 presents the related statements of personal characteristics for CHSA collaboration. This factor was measured by eight statements and all statements achieved a median rating of 6 to 7 and over 60% of the experts rated the statements between 6 to 7. Two statements, namely willingness to collaborate and respecting the inputs of others had a median of 7. This finding indicates that project members tend to collaborate more when their inputs are appreciated. A previous study indicated that respecting the

Table 6: Personal characteristics for construction health and safety agent collaboration

| *Personal characteristics* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| Willingness to collaborate | 7 | 7 | 7 | 100 |
| Respecting inputs of others | 7 | 7 | 7 | 100 |
| Placing project interests above individual interests | 6 | 6 | 6 | 92 |
| Knowledge of design process | 6 | 6 | 6 | 92 |
| Knowledge of procurement management | 6 | 6 | 6 | 92 |
| Knowledge of construction process | 6 | 6 | 6 | 92 |
| Knowledge of financial and cost | 6 | 6 | 6 | 92 |
| Knowledge of H&S management | 6 | 6 | 6 | 100 |

contributions and ideas of others encourages collaboration (D'Amour *et al.*, 2005: 119). This finding concurs with previous studies that personal characteristics have significant influence on collaboration (Bronstein, 2003: 304; Roberts *et al.*, 2016: 4). Therefore, experts agree that CHSA collaboration is possible by acquiring knowledge in design, procurement, construction process, financial and cost, and H&S management. Put differently, collaborating with other project team members requires CHSA to have knowledge in these areas. The values provided in the last column in Table 6 indicate that, over three rounds, for three statements, 100% of the experts and for five statements, 92% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 7 presents the related statements of common purpose for CHSA collaboration. Six statements were used to measure this factor. All the six statements had an agreement median rating within the cut-off 6 to 7 and over 60% of the experts rated the statements between 6 to 7. Common purpose is the central factor of collaboration as it helps bring other factors together (Yuming, 2014: 61). Some of the findings are similar to those of Faris *et al.* (2019: 8-9). The study by Dietrich *et al.* (2010: 59) emphasizes the importance of joint creation of value for overcoming the lack of resources and skills. Not only is having a shared goal critical for collaboration; it also improves communication (Khalfan *et al.* 2007: 387). The values provided in the last column in Table 7 indicate that, over three rounds, for four statements, 100% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 7: Common purpose for construction health and safety agent collaboration

| *Common purpose* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| Committing to the project vision supports collaboration | 6 | 6 | 6 | 100 |
| Joint working in pursuing common purpose supports collaboration | 6 | 6 | 6 | 100 |
| A clear vision promotes collaboration | 6 | 6 | 6 | 100 |
| Collaboration is encouraged by shared vision | 6 | 6 | 6 | 100 |
| Setting common goals between project members encourages collaboration | 7 | 6 | 6 | 92 |
| Joint creation of value encourages collaboration | 6 | 6 | 6 | 92 |

Table 8 presents the related statements of institutional support for CHSA collaboration. This factor was measured by nine statements. Six of the nine statements achieved the median rating between 6 to 7. This finding shows that experts somewhat agreed on the other three statements, while there was agreement on six statements. This is particularly important, as H&S professionals learn the H&S requirements from government regulatory

Table 8: Institutional support for construction health and safety agent collaboration

| *Institutional support* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| *Provision of information and technological resources | 5 | 5 | 5 | 7 |
| *Availability of building information modelling | 5 | 5 | 5 | 14 |
| Use of integrated project delivery method | 6 | 6 | 6 | 85 |
| *Government H&S authorities provide updated H&S legislations | 4 | 5 | 5 | 14 |
| Government H&S authorities provide guidance to ensure adherence to H&S legislations | 5 | 5 | 6 | 71 |
| Professional bodies provide guidance to ensure implementation of H&S legislations | 5 | 5 | 6 | 71 |
| Professional bodies to provide training on new H&S practices | 5 | 5 | 6 | 64 |
| Professional bodies to train CHSA on construction processes (statement was added after Round 1) | | 6 | 6 | 92 |
| H&S legislations to require involvement of CHSA from stage one of the project (statement was added after Round 1) | | 6 | 6 | 92 |

*statement dropped out

authorities (Wang, Wu & Haung, 2019: 16; Swuste, Zwaard, Groeneweg & Guldenmund, 2015: 85-86) and values, standards, and codes from professional bodies (Ju & Rowlinson, 2013: 350). According to Azhara, Kanga & Ahmad (2014: 215), the use of the integrated project delivery method allows a project team to effectively collaborate throughout project stages. The result further suggests that H&S legislations can determine the need of CHSA on the project. Deacon (2016: 203) and Mwanaumo (2013: 279) highlighted the role of H&S legislations in determining the need of CHSA. However, one of the experts remarked that "project members still do not respect CHSA contributions to the project because they only call CHSA at stage four when they need a construction work permit."

Only three statements of institutional support dropped out. Their median rating for agreement was below the cut-off point of 6 and less than 60% of the experts rated the statements within the cut-off point of 6 to 7. Although provision of information and technological resources and availability of building information modelling were rated below a cut-off point of 6, a previous study by Yuming (2014: 64) posited that collaboration requires reliable access to the latest technological knowledge and resources. Likewise, Azhara *et al.* (2014: 219) highlighted that building information modelling has the potential to facilitate collaboration. However, one of the experts mentioned that "technologies such as the use of building information modelling does not create collaboration by default but things such as emotional intelligence and interpersonal soft skills are what makes it work". The values provided in the last column in Table 8 indicate that, for two statements, over Rounds 2 and 3, 92% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 9 presents the related statements of project context for CHSA collaboration. This factor was measured using eight statements. Seven of the eight identified statements had a median of 6, while one had a median of 5. These support the finding of Larson and Gobeli (1989: 123) which revealed that clearly defined objectives were the strongest and consistent predictor of project success. It also supports the finding of Faris *et al.* (2019: 5) and of Iyer (2015: 38). Based on the findings, it is suggested that lack of clear project roles and objectives may cause other project members to be less likely to engage in collaborative efforts. Only one statement of project context dropped out. Although this statement was rated below a cut-off point of 6, a previous study by Patel *et al.* (2012: 7) emphasises the need of access to adequate resources such as finance, time and equipment, in order to complete the task. The values provided in the last column in Table 9 indicate that, over three rounds, for five statements, 100% of the experts rated the statement between 6 and 7 on a Likert scale measurement.

Table 9: Project context for construction health and safety agent collaboration

| *Project context* | *Agreement medians* | | | *% of responses (6-7)* |
|---|---|---|---|---|
| | *R1* | *R2* | *R3* | |
| Clear project roles | 6 | 6 | 6 | 100 |
| Clearly defined project objectives | 6 | 6 | 6 | 100 |
| Communication promotes collaboration | 6 | 6 | 6 | 92 |
| Project organisational structure supports collaboration between project members | 6 | 6 | 6 | 100 |
| *Financial resources are made available to all disciplines for completing the project | 5 | 5 | 5 | 7 |
| Different disciplines work jointly to deal with the complexity of the project | 6 | 6 | 6 | 92 |
| Good relationships promote collaboration | 6 | 6 | 6 | 100 |
| Sharing of knowledge supports collaboration | 6 | 6 | 6 | 100 |

*statement dropped out

Experts were used to identify and validate the factors that determine CHSA collaboration on construction project. Experts agreed on 44 statements of seven factors based on the cut-off point of 6 and over 60% of the experts rated the factor between 6 to 7. The finding not only confirms that these factors are necessary for collaboration, but it also provides the level of agreement regarding CHSA collaborating with other project team members in a construction project. It can also be concluded that CHSA is more likely to collaborate with project team members in a construction project when there is mutuality, trust, enabling environment, personal characteristics, common purpose, institutional support, and project context.

## 5. CONCLUSION AND RECOMMENDATIONS

Research on the value of persons managing H&S is critical, as CI continues to suffer poor H&S performance. The poor H&S performance is exacerbated by poor collaboration between CHSA and other project actors. The ability of CHSAs to collaborate with other professionals is critical to their long-term existence in the CI. This motivated the current study to identify the factors that determine CHSA collaboration on construction projects. This objective was achieved through conducting a Delphi study involving three rounds. It was found that the critical factors that determine CHSA collaboration are mutuality, trust, an enabling environment, personal characteristics, common purpose, institutional support, and project context.

It can be concluded that the influence of CHSA on construction projects is dependent on collaboration and that construction organisations should pay attention to these seven factors for improving CHSA collaboration. These factors should be identified, implemented, and monitored in order to increase the influence of CHSA. The study not only confirmed that these factors were necessary for collaboration, but it also provided the level of agreement regarding CHSA collaborating with other project team members in a construction project.

The study was limited to a panel of 14 experts and more experts could have provided more information. The factors that determine CHSA collaboration identified in this study may not be exhaustive and another study may provide different factors. Further research could adopt other research methods such as quantitative to determine the impact of these seven factors on CHSA collaboration. Similar studies can use a Delphi study for reaching concrete conclusions.

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