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IDENTIFYING FACTORS OF COLLABORATION CRITICAL FOR IMPROVING HEALTH AND SAFETY PERFORMANCE IN CONSTRUCTION PROJECTS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Collaboration is key to the success of construction project delivery. Several researchers have realised the importance of collaboration for health and safety (H&S) performance. The construction industry (CI) is affected by poor H&S performance exacerbated by lack of collaboration. The purpose of the article is to conduct a systematic literature review to identify factors of collaboration that will improve H&S performance in CI. A literature review method was adopted; identification test method was used to identify collaboration factors. Using Scopus and Google Scholar, a total of 758 papers were identified. 57 papers were found to be relevant for review through content analysis and were analysed in terms of source and year of publication, research method, country of origin, and research focus. The review identified 11 critical success factors of collaboration: trust, culture, commitment, communication, clear roles and responsibilities, resource/information sharing, mutual goals, conflict resolution, early involvement of key participants, competence, and

continual improvement. These factors can influence H&S performance in construction projects. Focusing on these factors can facilitate collaboration, thus improving H&S performance. The limitation of this article is that the literature review covered a period between 2010 to 2019. Searches in other search engines might have provided additional information on collaboration. The findings of this study make way for future research into the impact of collaboration on H&S performance and provide an understanding that H&S performance can be improved by adopting collaboration. The review concludes that CI should adopt collaboration to influence H&S performance.

Keywords: Construction industry, factors of collaboration, health and safety performance, literature review

ABSTRAK

Samewerking is die sleutel tot suksesvolle konstruksieprojekte. Verskeie navorsers besef die belangrikheid van samewerking vir gesondheids- en veiligheidsprestasies (G&V). Die konstruksiebedryf word geraak deur swak G&V-prestasies wat vererger word deur gebrek aan samewerking. Die doel van die artikel is om 'n sistematiese literatuuroorsig te doen om faktore van samewerking te identifiseer wat die prestasie van G&V in die konstruksiebedryf sal verbeter. 'n Literatuurbeoordelingsmetode is gebruik; die identifikasietoetsmetode is gebruik om samewerkingsfaktore te identifiseer. Met behulp van Scopus en Google Scholar is altesaam 758 artikels geïdentifiseer. Daar is bevind dat 57 artikels relevant is vir hersiening deur middel van inhoudsanalise en is geanaliseer in terme van bron en jaar van publikasie, navorsingsmetode, land van herkoms en navorsingsfokus. Die oorsig het 11 kritieke suksesfaktore van samewerking geïdentifiseer: vertroue, kultuur, toewyding, kommunikasie, duidelike rolle en verantwoordelikhede, die deel van hulpbronne/inligting, onderlinge doelwitte, konflikoplossing, vroeë betrokkenheid van sleuteldeelnemers, bekwaamheid en voortdurende verbetering. Hierdie faktore kan H&S-prestasie in bouprojekte beïnvloed. Deur op hierdie faktore te konsentreer, kan dit samewerking vergemaklik en sodoende die prestasie van G&V verbeter. Die beperking van hierdie artikel is dat die literatuuroorsig 'n tydperk tussen 2010 en 2019 beslaan. Soektogte in ander soekenjins kon moontlik aanvullende inligting oor samewerking verskaf. Die bevindinge van hierdie studie maak plek vir toekomstige navorsing oor die impak van samewerking op G&V-prestasies en bied 'n begrip dat G&V-prestasies verbeter kan word deur samewerking. Die oorsig kom tot die gevolgtrekking dat die konstruksiebedryf samewerking moet aanneem om G&V-prestasies te beïnvloed.

Sleutelwoorde: Konstruksiebedryf, faktore van samewerking, gesondheids- en veiligheidsprestasies, literatuuroorsig

1. INTRODUCTION

The construction industry (CI) is important for the development of any country (Idrus, Sodangi & Haq Husin, 2011: 1142; Ofor, 2012: 5; Umeokafor, 2018: 473;). The CI is significant for the development of infrastructure and physical structures (Ofori, 2012: 5; Kayumba, 2013: 34; Kumar & Bansal, 2013: 34) and is the driver for social and economic developments in a country (Idrus *et al*., 2011: 1142; Windapo & Cattell, 2013: 65; Kayumba, 2013: 510; Pillay & Haupt, 2016: 374). The CI is deemed critical for the economic advancements of South Africa through infrastructure delivery such as roads, buildings and stadiums and, hence, the creation of

employment (Pillay & Haupt, 2016: 374; Windapo & Cattell, 2012: 65). Conversely, a poorly performing CI can affect other industries.

Internationally, the CI ranks high in terms of dangerous and risky workplaces (Atkinson & Westall, 2010: 1007; Pillay, 2014: 75; ILO, 2014: 8; Okorie, 2014: 2). Poor health and safety (H&S) performance is reported as a serious problem in the CI and results in loss of lives, skills, resources, time, and money (Mroszczyk, 2015: 67; Okorie, 2014: 12; Saifullah & Ismail, 2012: 604; Benjaoran & Bhokha, 2010: 395).

Poor collaboration between project participants has been identified as a serious impediment to achieving project objectives (Sebastian, 2011: 179; Akintan & Morledge, 2013: 2; Faris, Gaterell & Hutchinson, 2019: 2), including H&S objectives. Scholars have criticised the CI for, specifically, relationships between clients, designers and contractors, where poor collaboration is identified as one of the shortcomings (Sebastian, 2011: 179; Akintan & Morledge, 2013: 2; Faris *et al*., 2019: 2). Professionals such as project managers, designers, engineers, construction managers, and H&S professionals contribute to H&S in construction projects. Despite, these contributions, the CI continues to experience accidents, injuries, and ill health at an unacceptable rate (Mroszczyk, 2015: 67; Okorie, 2014: 12). This poor H&S performance is exacerbated by lack of collaboration (Deacon, 2016: 154; Mroszcyk, 2015: 67; Olsen, 2012: 2625). The purpose of this article is to conduct a systematic literature review to identify factors of collaboration that will improve H&S performance in the CI.

2. LITERATURE REVIEW

2.1 Collaboration

There is no one universally accepted definition for collaboration. The vast majority of researchers agree that collaboration is about jointly working towards achieving common goals (Dietrich, Eskerod, Dalcher & Sandhawalia, 2010: 60; Patel, Pettitt & Wilson, 2012: 1; Ozturk, Arditi, Yitmen & Yalcinkaya, 2016: 798). In this article, collaboration refers to a process in which information, activities, responsibilities, and resources are shared to jointly plan, implement, and evaluate a programme of activities in order to achieve a common goal and a joint generation of value (Camarinha-Matos, Afsarmanesh, Galeano & Molina, 2009: 47-48). The concepts of collaboration in the CI are complex and are influenced by different factors during the execution of projects (Patel *et al*., 2012: 21). Although there is evidence that collaboration as a management strategy (Bidabadi, Hosseinalipour, Hamidizadeh & Mohebifar, 2016: 1438) improves project performance, there is a paucity of empirical studies on the concept of collaboration in the CI (Skinnarland & Yndesdal, 2010: 356).

Dietrich *et al*. (2010: 60) and Faris *et al.* (2019: 1) stress the need for collaboration during construction projects worldwide, including South Africa, that face problems such as poor collaboration between participants, frequent disputes, high stress levels (Masemeni, Aigbavboa & Thwala, 2015: 8), poor quality workmanship, project delay, time and cost overrun (Greenwood & Wu, 2012: 299; Pal, Wang & Liang, 2017: 1226), and poor H&S performance (Saifullah & Ismail, 2012: 604; Mroszcyk, 2015: 67).

Mutual objectives, sharing of information, trust, commitment, culture, gain/pain sharing, as well as clear roles and responsibilities typify the collaboration process (Hughes, Williams & Ren, 2012: 365; Meng, 2013: 4260; Faris *et al*., 2019: 4).

The project-based nature of the CI justifies the need to focus on the collaboration process, in order to solve problems and exploit opportunities (Cao & Zhang, 2011: 174; Ozturk *et al*., 2016: 798). Through collaboration, simple construction processes are created; better quality service is provided (Emuze & Smallwood, 2014: 302); better relationships between main and subcontractors are created (Schottle, Haghsheno & Gehbauer, 2014: 1278); H&S performance is influenced (Deacon, 2016: 218; Tau & Seoke, 2013: 58), and performance in the construction supply chain improves (Bidabadi *et al*., 2016: 1437; Cao & Zhang, 2011: 174).

Factors critical for collaboration include top management support, selection of an appropriate partner, and commitment to a win-win attitude (Hasanzadeh, Hosseinalipourb & Hafezi, 2014: 816), no-blame culture, communication, fair distribution of responsibility, and proactive problem-solving (Msomba, Matiko & Mlinga, 2018: 152), mutual goals, gain-pain sharing, early involvement of key participants, and trust (Faris *et al*., 2019: 4). Other factors such as continuous improvement (Meng, 2012: 191), mutual goals (Hosseini, Wondimu, Bellini, Tune, Haugseth, Andersen & Laedre, 2016: 250; Meng, 2012: 190) and trust between actors (Dietrich *et al*., 2010: 70; Hosseini *et al*., (2016: 244), communication, conflict resolution, and understanding roles (Rahman, Induta, Faisol & Paydard, 2014a: 417; Dietrich *et al*., 2010: 70; Mensah, 2016: 16) have been mentioned as critical for collaboration. In South Africa, findings indicate that the CI does not have enough partners with appropriate collaborative skills (Emuze & Smallwood, 2014: 302).

2.2 Collaboration and health and safety management

H&S on construction projects is managed by project managers, designers, engineers, construction managers, and H&S professionals who have diverse work experiences, resources, and skill sets. These professionals contribute to H&S (Tymvios, Gambatese & Sillars, 2012: 342; Antonio, Isabel, Gabriel & Angel, 2013: 92). Dietrich *et al*. (2010: 70) argued that collaboration may

lead to the creation of new or emergent knowledge or skills not possessed previously by every professional on the project. Collaboration between designers and construction professionals could be effective in reducing construction worker injuries and fatalities (Qi, 2011: 32). Based on this, Tymvios *et al*. (2012: 353) concluded that increased collaboration between professionals should be encouraged, in order to increase understanding of issues relating to H&S. Since each professional provides resources and a set of skills to the team, collaboration and communication become critical (Sebastian, 2011: 177), because collaboration is important for knowledge integration within projects (Dietrich *et al*., 2010: 68).

Although, the South African Construction Regulations 2014 and the United Kingdom (UK) Construction Design and Management (CDM) regulations 2015 (HSE, 2015: 17-18; Deacon, 2016: 83) require that all those involved in projects should collaborate and address H&S, the CI continues to experience accidents, injuries, and ill health, because of an apparent lack of collaboration among these professionals (Deacon, 2016: 223).

2.3 Benefits of collaboration

Benefits of collaboration may include improvement in construction quality, risk sharing, and innovation (Hasanzadeha *et al*., 2014: 816), creativity and working relationship (Smith & Thomasson, 2018 192), information sharing, and better communication (Rahman *et al*., 2014a: 419). It may also include project efficiency improvements and the development of shared vision or objective (Fulford & Standing, 2014: 324; Bidabadi *et al*., 2016: 1439), productive conflict-resolution strategy, mutual trust (Mensah, 2016: 44), and reduction of supply-chain costs (Bidadabi *et al*., 2015: 554). Collaboration facilitates a combination of resources and expertise to increase project performance (Faris *et al*., 2019: 2). Collaboration leads to high levels of productivity among project participants and reduced reworks (Torneman, 2015: 23). Past studies have provided several benefits of collaboration to H&S management. Collaboration between project stakeholders can lead to success in H&S management (Lingard, Blismas, Cooke & Cooper, 2009: 132). Examples of collaboration benefits to H&S performance include better buildability and integration of H&S in projects (Lingard, Pirzadeh, Blismas, Wakefield & Kleiner, 2014: 920). Collaboration can facilitate trust, improve communication and better working relationships (Jitwasinkul & Hadikusumo, 2011: 524; Deacon, 2016: 183), and can help share H&S information and resources (Vinodkumar & Bhasi, 2020: 2091).

2.4 Barriers to collaboration

Barriers to collaboration include lack of commitment, communication, and breach of trust (Deep, Gajendran & Jefferies, 2019: 1); lack of trust, unfair

risk sharing (Faris *et al*., 2019: 1); ineffective communication (Nursin, Latief & Ibrahim, 2018: 1); consultant managerial incompetence (Akintan & Morledge, 2013: 7); conflicting personalities, bullying, and lack of understanding (Ey, Zuo & Han, 2014: 154), as well as lack of consistent production standards, and absence of formal training systems (Kalantari, Shepley, Rybkowski & Bryant, 2017: 569). It also includes lack of top management support and unrealistic deadlines (Masemeni *et al*., 2015: 8), as well as fear of micromanagement, lack of trust, and lack of common goals (Mensah, 2016: 40). Barriers such as lack of commitment, resources and expertise, trust and confidence undermine effective collaboration (Patel *et al*., 2012: 7; Umeokafor, 2017: 481). Barriers of collaboration on H&S performance are not limited to a lack of H&S legislation that specifies the H&S roles and responsibilities of all involved (Dewlaney & Hallowell, 2012: 169; Umeokafor, 2017: 481). Not being familiar with H&S principles, design and the construction process; lack of management commitment to H&S (Mwanaumo, 2013: 208), and a poor safety culture (Sunindijo, 2015: 111) are also barriers to collaboration in H&S.

3. RESEARCH METHODOLOGY

3.1 Search strategy

A systematic literature search was performed to identify critical success factors of collaboration. This search consisted of literature published between 1 January 2010 and 31 December 2019. First, the Identification Test from Wu, Greenwood & Steel (2008) and Faris *et al*. (2019), which reviewed 35 articles/papers on factors of collaboration for influencing project performance in the CI from 2000 to 2018, was used to identify related keywords based on their frequency rate (Wu *et al*., 2008: 5). The Identification Test resulted in 11 most prevalent factors of collaboration (Table 1).

Table 1: Critical success factors of collaboration and their frequency of occurrence

Rank	*Factors of collaboration*	*Frequency*
1	Trust	31
2	Communication	26
3	Conflict resolution	21
4	Mutual goals	20
5	Top management support	20
6	Commitment	19
7	Gain-pain sharing	18
8	Culture	16
9	Resource sharing	14
10	Early involvement of key participants	14
11	Clear roles	13

Source: Faris *et al*. (2019)

The search was performed between 1 August 2019 and 25 February 2020. Thereafter, a systematic search of the literature was performed on 1 April 2020 on Google Scholar and Scopus (Li, Burnham, Lemley & Britton, 2010: 205-206). Free search phrases with Boolean search operators (AND, OR, NOT), including titles, abstracts and keywords, were used. In the main database search (Scopus and Google Scholar), two sets of entry terms were applied (Figure 1). The first set of entry terms describes studies on collaboration that influence project performance in the CI. The second set of entry terms describes factors of collaboration in the CI to be considered for H&S performance.

3.2 Inclusion and exclusion criteria

Inclusion criteria:

- Papers published between 2010 to 2019.
- Papers with more than four factors of collaboration.
- Factors of collaboration in the CI, factors of collaboration between H&S professionals and project participants, factors of collaboration in the CI, impact of collaboration on project performance, success factors of collaboration, and impact of collaboration on H&S performance in the CI.

Exclusion criteria:

- Papers without the name of the author or the date of publication.
- Papers published prior to 2010 and post-2019.
- Papers investigating H&S performance mentioned nothing about factors of collaboration.

3.3 Identification of studies

The reference lists of the included literature were scanned, and relevant literature included. Only full text research papers on collaboration and the CI written in English were considered. Papers published in management science journals on the factors of collaboration were also considered, because some construction-related papers are published in management and social sciences journals. Papers that addressed collaboration, H&S performance and the CI, but did not include any factors of collaboration, were consequently removed. Another criterion was to target the majority of papers published by construction management journals such as *International Journal of Construction Management* (*IJCM*), *International Journal of Engineering and Management* (*IJEM*), *Journal of Construction Management and Economics* (*JCME*), *International Journal of Project Management* (*IJPM*), *Journal of Built Environment Project and Asset Management* (*JBEPAM*), *Journal of Construction Engineering* (*JCE*), and other peer-reviewed publications. Ibrahim and Belayutham (2019: 3), Oraee, Hosseini, Namini & Merschbrock (2017: 124) and Wu *et al*. (2008: 6) recommended some of these construction journals. Similarly, Bemelmans, Voordijk & Vos (2012: 344) as well as Ibrahim and Belayutham (2019: 3) supported the idea of using construction-related publications that publish peer-reviewed papers, as these journals also include reference to other publications such as conference papers, masters or doctoral dissertations.

3.4 Search findings

A total of 769 results from each individual database search (Google Scholar, 426 results, and Scopus, 343 results) were sent to Endnote X5 and Microsoft Excel and the papers' abstract and content were subsequently analysed (Rokni, Ahmad & Rokni, 2010: 230; Deep *et al*., 2019: 2; Jessica, 2011: 23-37). After removing duplicates, the number of results was 520. The second search returned 220 paper results (Figure 1). Papers screened based on titles and abstracts produced 68 construction management papers and the use of references of the identified articles produced 10 non-construction management papers, some of which included dissertations. Seventy-eight papers were subjected to content analysis, in order to identify critical success factors of collaboration. Some of these factors of collaboration that influence project performance can be considered for H&S performance, but some of these factors are not limited to communication, trust, commitment, clear roles and responsibilities, culture, continual improvement, competence, early involvement of key participants, and top management. Full text analysis resulted in 58 relevant papers, to be used in the final analysis (see Figure 1).

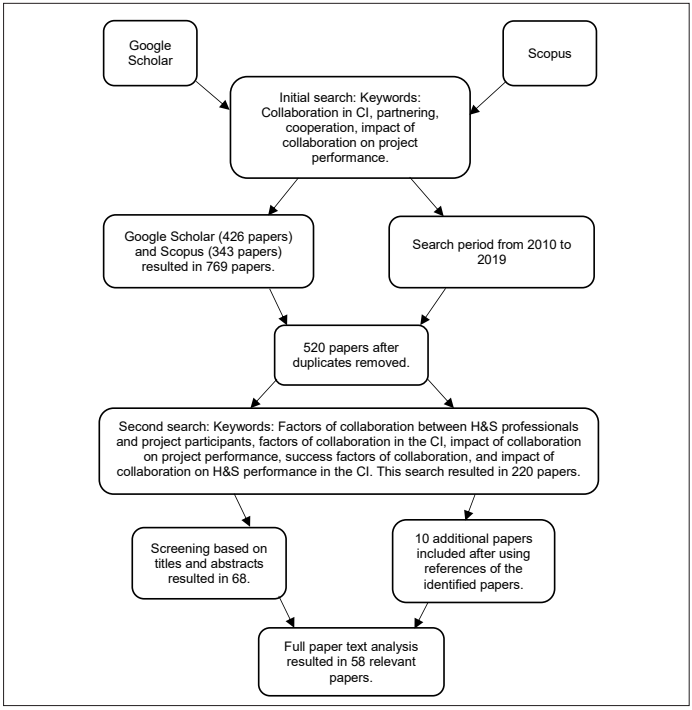

Figure 1: Procedure of systematic literature review
Source: Author's own construction

3.5 Analysis of identified literature

One author scanned the titles and abstracts of the identified literature. Literature that did not comply with the inclusion criteria was excluded. The full text was obtained for articles, and inclusion was subject to consensus among all three of the authors. First, data analysis was performed on the 58 relevant studies to identify articles on collaboration that influence project performance in the CI. They were classified according to the author(s), year of publication, type of study/research methods used, country where the study was conducted, journal/source of publication, and the research purpose/focus of the study. The results were reported by arranging the year of publication in ascending order (see Table 2). Thereafter, results from the Identification Test (Table 1) were used as criteria to do data extraction by classifying the factors of collaboration in the CI. Based on Table 1, collaboration is demonstrated by 11 common factors. For this analysis, two factors were added, thus the criteria classified the data into

Table 2: Articles on collaboration that influence project performance in the CI (2010 to 2019)

No.	*Author(s) and year of publication*	*Type of study*	*Country*	*Journal/Source of publication*	*Research purpose/focus of study*
1	Dietrich *et al.* (2010)	Literature review	Denmark	International Journal of Project Management	Collaboration elements and their dependencies in multi-partner projects
2	Eriksson (2010)	Case study	Sweden	Supply Chain Management: An International Journal	Supply chain in construction; factors affecting collaboration
3	Skinnarland & Yndesdal (2010)	Case study	Norway	People Culture and Change	Collaboration indicators to describe the collaborative development process
4	Löfgren & Eriksson (2010)	Survey	Sweden	Lulea University of Technology	Collaboration effects on project performance
5	Eriksson & Westerberg (2011)	Literature review	Sweden	International Journal of Project Management	How procurement-related factors affect performance criteria
6	Phong-arjarn & Jeenanunat (2011)	Survey	Thailand	Neresuan University Journal	Factors that have influence supply chain collaboration
7	Patel *et al.* (2012)	Literature review	UK	Applied Ergonomics	Factors for the Cospaces collaborative model
8	Meng (2012)	Survey	UK	International Journal of Project Management	Specific factors of supply chain relationships
9	Hughes *et al.* (2012)	Mixed method	UK	Journal of Construction Innovation	Producing a clear definition for collaboration within the UK CI
10	Bemelmans *et al.* (2012)	Literature review	The Netherlands	Engineering, Construction and Architectural Management	Supplier-contractor collaboration
11	Akintan & Morledge (2013)	Mixed method	UK	Journal of Construction Engineering	Collaboration in the traditional construction procurement supply chain
12	Meng (2013)	Survey	UK	Journal of Civil Engineering Management	Supply chain collaboration and its role in construction
13	Groenewegen (2013)	Case study	The Netherlands	Delft University of Technology	Individuals' views on factors influencing collaboration
14	Hasanzadeha *et al.* (2014)	Case study	Iran	Social and Behavioral Sciences	Project partnering as applied in CI
15	Fulford & Standing (2014)	Case study	UK	International Journal of Project Management	Identifying factors inhibiting collaboration

Table 2 continued ...

No.	Author(s) and year of publication	Type of study	Country	Journal/Source of publication	Research purpose/focus of study
16	Rahman *et al.* (2014a)	Mixed method	Malaysia	Innovation, Management and Technology Research	Importance of collaboration from contractors' perspectives
17	Hudnurkar *et al.* (2014)	Literature review	India	Social and Behavioural Sciences	Factors affecting supply chain collaboration
18	Ey *et al.* (2014)	Case study	Australia	International Journal of Construction Management	Current practices of collaborative procurement
19	Rahman *et al.* (2014b)	Survey	Malaysia	Business, Engineering and Industrial Applications Colloquium	Readiness of main contractor for collaboration in CI
20	Jefferies *et al.* (2014)	Case study	Australia	Engineering, Construction and Architectural Management	Factors that influence the successful implementation of project alliance
21	Kumar & Banerjee (2014)	Survey	India	Benchmarking: An International Journal	Supply chain collaboration index
22	Emuze & Smallwood (2014)	Survey	South Africa	Journal of Engineering, Design and Technology	A level of collaborative working among partners in South African construction
23	Donato *et al.* (2015)	Literature review	Australia	International Journal of Procurement Management	Conceptual model for construction supply chain actors
24	Bidabadi *et al.* (2015)	Case study	Iran	International Journal of Innovative Science, Engineering & Technology	Importance of collaborating in construction supply chain
25	Torneman (2015)	Case study	Sweden	Chalmers University of Technology	Technical consultant engagement in a collaborative project
26	Suprapto *et al.* (2015)	Case study	The Netherlands	International Journal of Project Management	Effects of collaboration antecedents on project performance
27	Lavikka *et al.* (2015)	Case study	Finland	Supply Chain Management: An International Journal	Coordination of supply chain networks
28	Masemeni *et al.* (2015)	Survey	South Africa	SACQSP	Barriers in the execution of collaborative models
29	Iyer (2015)	Literature review	USA	Texas A&M University	Framework to assess construction collaboration
30	Hosseini *et al.* (2016)	Case study	Norway	Energy Procedia	Partnering practices
31	Ozturk *et al.* (2016)	Literature review	Turkey	Procedia Engineering	Factors affecting collaboration in the design

Table 2 continued ...

No.	Author(s) and year of publication	Type of study	Country	Journal/Source of publication	Research purpose/focus of study
32	Bidabadi *et al.* (2016)	Survey	Iran	Organisation, Technology and Management in Construction: International Journal	Collaboration to improve supply chain construction
33	Roberts *et al.* (2016)	Literature review	South Africa	Southern African Institute of Management	Development of a model of collaboration
34	Kozuch & Sienkiewicz-Malyjurek (2016)	Literature review	Poland	Transylvanian Review of Administrative Sciences	Factors driving effective inter-organisational collaboration
35	Mensah (2016)	Survey	Ghana	Khame Nkruma University of Science and Technology	Barriers and benefits of collaboration
36	Liu *et al.* (2017)	Literature review	China	International Journal of Project Management	Critical effects on building information modelling (BIM) collaborative design
37	Pal *et al.* (2017)	Survey	China	International Journal of Project Management	Supplier and contractor relationships
38	Boton & Forgues (2017)	Literature review	Canada	International Journal of Project Management	Complexity of collaboration in CI
39	Kapogiannis & Sherrat (2017)	Survey	UK	Built Environment Project and Asset Management	Integrated collaborative technologies
40	Kalantari *et al.* (2017)	Mixed method	Middle East	Facilities	Obstacles to collaboration
41	Ayegba *et al.* (2017)	Literature review	South Africa	University of the Witwatersrand	Collaboration and long-term relationships in CI
42	Bond-Barnard *et al.* (2018)	Survey	South Africa	International Journal of Managing Projects in Business	Trust and collaboration for increasing project success
43	Nursin *et al.* (2018)	Mixed method	Indonesia	MATEC web of conferences	Critical success factors of collaboration
44	Msomba *et al.* (2018)	Literature review	Tanzania	International Journal of Engineering Research and Technology	Enabling factors of collaboration in risk
45	Smith & Thomasson (2018)	Case study	Sweden	Public OrganizReve	Public-private partner collaboration
46	Andreas & Ida (2018)	Case study	Sweden	Jonkoping University	Collaboration aspects during tender process
47	Hughes (2018)	Mixed method	UK	University of South Wales	Aspects of collaboration
48	Deep *et al.* (2019)	Literature review	Australia	International Journal of Construction Management	Enablers governing factors of collaboration
49	Faris *et al.* (2019)	Survey	Iraq	International Journal of Construction Management	Underlying factors of collaboration

Table 2 continued ...

No.	Author(s) and year of publication	Type of study	Country	Journal/Source of publication	Research purpose/focus of study
50	Aghania *et al.* (2019)	Survey	Indonesia	International Journal of Civil Engineering and Technology	Collaboration in building projects
51	Hamzeh *et al.* (2019)	Survey	Middle East (Qatar, Lebanon)	Built Environment Project and Asset Management	Extent of forms of contract addressing collaboration
52	Nader (2019)	Case study	The Netherlands	Delft University of Technology	Client and contractor collaboration
53	Ozturk (2019)	Survey	Turkey	Journal of Materials Science and Engineering	Individual level collaboration and BIM
54	Bygballe & Sward (2019)	Case study	Norway	International Journal of Project Management	Model of how partnering is institutionalised
55	Oraee *et al.* (2019)	Literature review	Australia	International Journal of Project Management	Barriers to collaboration in BIM
56	Marinelli & Salopek (2019)	Mixed method	UK	Journal of Engineering, Design and Technology	Dimensions of the collaborative ethos
57	Liu *et al.* (2019)	Survey	Malaysia	MATEC Web of Conferences	Collaboration critical factors
58	Ibrahim & Belayutham (2019)	Literature review	Malaysia	MATEC Web of Conferences	Social collaboration in BIM-based construction projects

Research themes total and %
Collaborative procurement 2 (13.7%)
Factors of collaboration in construction management 10 (17.2%)
Supply chain in construction and factors affecting collaboration 11 (18.9%)
Collaboration in the design building environment 8 (13.7%)
Contractor and subcontractor collaboration 4 (6.8%)
Client and contractor 4 (6.8%)
Collaboration models 5 (8.6)
Barriers and benefits of collaboration 4 (6.8%)
Other 10 (17.2%)

Source: Author's own construction

13 factors, namely trust, communication, resource/information sharing, mutual goals/vision, culture, commitment, clear roles and responsibilities, top management support, conflict resolution, early involvement of key participants, competence/experience, gain and pain sharing, and continuous improvement. Content analysis was used to rank each factor of collaboration by reporting the number of articles that mentioned the factor. The ranking results show the factors of collaboration critical for improving H&S performance in construction projects (see Table 3). One author performed data extraction, and a second author checked the results

4. FINDINGS AND DISCUSSION

4.1 Collaboration in the CI

The classification of articles on collaboration that influence project performance in the CI can be considered for H&S performance. Table 2 ranks the articles based on the year in which they were published.

4.1.1 Publication year and sources of publication

The construction journals delivered 46 of the 58 articles, the largest contribution came from the IJPM (11), the IJCM (6), the IJEC (4), other construction-related journals, and some papers from university masters and doctorate studies. Social and management sciences studies delivered 11 of the 58 articles. The inclusion of other articles besides construction management-related journals was an attempt to bring a balanced view on factors of collaboration. Publication sources included 51 journal articles and 7 papers from university masters and doctorate studies. The IJPM (11) has been the most used journal for publishing papers on collaboration factors in the CI. From the non-construction journals, Journal of Social and Behavioral Sciences provided 3 articles, which is the highest contribution. From 2010 to 2013, there was less focus on collaboration in the number of articles per year, but more articles focus on collaboration since 2014. This finding is consistent with a recent finding by Deep *et al*. (2019: 4), indicating that construction organisations and professionals are realising the benefits of collaboration in the CI.

4.1.2 Research methods used

Analysis based on the research methods used shows that most of the authors used surveys 18 (31%), literature reviews/conceptual 17 (31%), and case studies 16 (29%), while only a few 7 (13%) employed mixed method design in researching collaboration. Existing empirical studies investigating collaboration, for example by Suprapto, Bakker and Mooi (2015) and Ey *et*

al. (2014), used case study method. The lack of studies on collaboration using the mixed method strategy points to a gap in knowledge.

4.1.3 Country of origin

Studies on collaboration were undertaken in over 25 countries. Researchers from Europe published 27 (49%) articles; UK 9 (16%); Asia 8 (14%); Sweden 6 (11%); Africa 6 (11%) (5 from South Africa); Middle East 6 (11%) (3 from Iran); Australia 5 (9%); North America 2 (4%), and India 2 (4%). Based on the analysis, Europe published almost half (49%) of the articles and Africa only 12%. This suggests that collaboration in the CI is more researched in Europe, with 9 articles in the UK and 6 in Sweden, while Africa only published 6 articles with 5 from South Africa. This could mean that, in Africa, there is less focus on collaboration in the CI and that research on collaboration is still at an early stage in Africa and South Africa. Only one paper from Africa (Tanzania) investigated the factors of collaboration. The study used a literature review to identify factors of collaboration in construction risk management.

4.1.4 Research purpose/focus of the study

Analysis on the research purpose/focus of the studies shows that researchers have investigated collaboration from many perspectives such as collaborative procurement 2 (13.7%); factors of collaboration in construction management 10 (17.2%); supply chain in construction and factors affecting collaboration 11 (18.9%); collaboration in the design building environment 8 (13.7%); contractor and subcontractor collaboration 4 (6.8%); client and contractor 4 (6.8%); collaboration models 5 (8.6%); barriers and benefits of collaboration 4 (6.8%), and other 10 (17.2%).

Only 4 (6.8%) studies investigated barriers to collaboration that are consistent with a study by Bemelmans *et al*. (2012: 355); only one study discussed the barriers or obstacles to partnering. Only 8 (13.6%) articles investigated interpersonal collaboration (client, contractor, subcontractor). This suggests that most of the studies are focused on interorganisational collaboration and a few studies focused on interpersonal collaboration.

From the 58 identified articles, only 10 (17.2%), of which one is from Africa, investigated factors of collaboration. None focused on factors of collaboration that improve H&S performance in the CI. It is reasonable to conclude that, while collaboration is slowly gaining the attention it deserves from researchers and practitioners, studies focusing on factors of collaboration for improving H&S performance are limited or not available. This suggests that identifying factors of collaboration critical for improving H&S performance is an important aspect to consider.

4.2 Factors of collaboration in the CI to be considered for H&S performance

Table 3 shows the ranking of each factor of collaboration by reporting the number of included articles that mentioned or discussed the factor. Mentioned 43 or more times, results show that the top three factors of collaboration critical for improving H&S performance in construction projects are trust (48), communication (47), resource/information sharing (43), as well as mutual goals and commitment (43). Factors such as continuous improvement, gain and pain sharing, early involvement of key participants, top management support, and culture have been overlooked, with only a

Table 3: Factors of collaboration critical for improving H&S in the CI

Rank	*Factor of collaboration*	*Frequency*	*Article number from Table 2 that mentioned the factor*
1	Trust	48	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,17,18,19,20,21,22,23,25,26,28,29,31,32,33,34,35,36, 38,40,41, 42,43,44,46,47,48,49,50,51,52,53,55,56
2	Communication	47	1,2,3,5,6,7,8,9,10,12,13,16,17,18,19,20,21,22,23 ,24,25,26,27,28,29,30,31,32,33,35,36,39,40,41, 42,43,44,45,46,48,49,50,51,53,54,55,56
3	Resource/ information sharing	43	1,2,3,4,6,7,9,10,11,14,16,17,18,19,20,21,23,24,25,26,27,28,30,31,32,33,35,36,39,40,42,43,44,45, 46,48,49,50,52,53,54,55,56,57
4	Mutual goals/ vision	43	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,20,21,22,23,24,25,26,27,30,33,34,36,37,38,39,40,42,43,45,46, 47,48,50,51,52,53,55,56
5	Commitment	36	1,2,3,4,5,6,7,9,11,14,16,17,19,20,21,22,24,25,27,28,29,32,33,35,38,40,41,42,43,44,47,48,51,53,55,57
6	Clear roles and responsibilities	30	1,2,3,7,9,11,12,13,14,16,20,21,24,26,27,31,32,33 ,38,40,44,46,48,49,50,51,54,55,56,57
7	Competence	29	1,2,3,7,10,18,20,21,23,24,25,26,30,34,35,39,40,42,43,46,47,49,51,52,53,54,55,56,57
8	Conflict/problem resolution	27	1,2,3,4,6,7,9,10,12,20,21,24,25,27,28,32,36,37,38,41,43,44,46,47,48,53,65
9	Culture	26	1,3,6,7,10,11,14,19,21,22,24,25,28,31,32,33,38,39,42,43,44,46,48,53,54,57
10	Top management support	20	3,6,7,9,14,16,17,18,23,24,25,27,28,30,31,33,40 ,42,46,48
11	Early involvement of key participants	19	1,2,7,9,10,11,23,22, 24,28,39,46,47,48,50,53,54,55,56
12	Gain and pain sharing	16	3,8,9,10,12,13,16,20,46,47,48,50,53,54,55,56
13	Continual Improvement	12	5,10,21,22,24,25,32,36,40,45,46,57

Source: Author's own construction

few studies mentioning or discussing them. This indicates that the present literature focuses on certain factors, while others are disregarded.

As the top-rated factor of collaboration critical for improving H&S performance in construction projects, **trust** is an important collaboration factor in project success (Phong-arjarn & Jeenanunat, 2011: 10; Meng, 2013: 423; Bond-Barnard, Fletcher & Steyn, 2018: 434). For project success, knowledge exchange on time, cost, quality and H&S objectives creates expectations between project participants and is more likely to determine the level of trust between project members (Hosseini *et al*., 2016: 244). A situation where project participants trust each other plays a critical role in ensuring collaboration (Msomba, Matiko & Mlinga, 2018: 152). A more recent study by Bond-Barnard *et al*. (2018: 466) confirmed that the degree of collaboration did indeed increase as the level of trust in the project increased. The level of trust between H&S professionals and line managers (Provan, Dekker & Rae, 2017: 27) is a key factor in influencing decision-making processes, as trust between team members influences the level at which the team performs (Patel *et al*., 2012: 5).

Rated as the top-two factor of collaboration critical for improving H&S performance in construction projects, **communication** is a key for minimising project conflicts where diverse professionals with varying levels of knowledge and skills are involved (Aghania, Ramzani & Raju, 2019: 125). Previous studies identified lack of communication as the reason for project participants failing to collaborate, due to distrust and poor relationships (Meng, 2012: 190; Pal *et al*., 2017: 1227). Information exchange among participants on achieving H&S goals (Lingard *et al*., 2014: 920) to improve project performance in the CI include formal and informal or verbal and written means of communication (HSE, 2008: 29; Jitwasinkul & Hadikusumo, 2011: 524). The importance of effectively communicating safety hazards and control measures among participants limits the probability of accidents (Pandit, Albert, Patil & Al-Bayati, 2018: 2). To demonstrate its significance, the International Organisation for Standardisation (ISO) (2018: 17) and the South African Council for Project and Construction Management Professions (SACPCMP) (2013: 7) identified communication management as a key knowledge area within H&S management practice.

Resource/information sharing was rated one of the top-three factors of collaboration critical for improving H&S performance in construction projects. Free information exchange between clients, designers and contractors (Jefferies, Brewer & Gajendran, 2014; Akintan & Morledge 2013; Ey *et al*., 2014) is critical for improving collaboration, overall project performance (Pal *et al*., 2017: 1227), and successful project completion (Rahman *et al*., 2014a: 419). Sharing of information and resources is important not only

for ensuring successful contractual relationships (Bemelmans & Voordijik, 2012: 355; Banerjee & Kumar, 2014: 188; Rahman *et al*., 2014a: 414), but also for effective supply chain collaboration, because sharing of information ensures that activities are executed efficiently and effectively (Banerjee & Kumar, 2014: 189).

As one of the top-three factors of collaboration critical for improving H&S performance in construction projects, **mutual goals and commitment** is key to improve collaboration between project participants (Pal *et al*., 2017: 1227) and establishing mutual objectives among project stakeholders (Faris *et al*., 2019: 5). In general, project managers, designers, construction managers, and H&S professionals have conflicting objectives (Meng, 2013: 427), but mutual goals between project participants promote collaboration and better project performance (Hosseini *et al*., 2016: 250). H&S performance improvement through mutual goals and commitment is key when setting H&S objectives in the CI (ISO, 2018: 14).

Commitment was rated the top-four factor of collaboration critical for improving H&S performance in construction projects and is important for interpersonal and interorganisational collaboration in the CI (Bond-Barnard *et al*., 2018: 439). Commitment from top management (Deep *et al*., 2019: 8) and individual project participants plays a vital role in achieving project H&S goals (Msomba *et al*., 2018: 155). Top management commitment for improving H&S performance is demonstrated by providing resources for H&S activities (ISO, 2018: 9; El-nagar, Hosny & Askar, 2015: 185), while individual commitment is reflected through attending H&S meetings and other H&S-related activities. For instance, commitment to H&S can be shown through monitoring leading indicators of H&S performance (Hinze, Thurman & Wehle, 2013: 26). Conversely, findings of Okori (2014: 208) revealed that inadequate site management commitment contributes to poor H&S performance.

Rated as the top-five factor of collaboration critical for improving H&S performance in construction projects, defining **clear roles and responsibilities** is important for successful collaborative relationships in the CI (Meng, 2013: 426; Kapogiannis & Sherratt, 2017). Clearly defined roles and responsibilities limit uncertainty and provide a fair distribution of the roles and responsibilities of project participants in H&S management (Aghania *et al*., 2019: 125). Unclear roles and responsibilities may lead to conflict that affects project team members psychologically and leads to poor performance (Patel *et al*., 2012: 10).

Conflict/problem resolution, as a factor of collaboration critical for improving H&S performance in construction projects, refers to resolving or dealing with issues such as technical problems and disagreements between partners (Banerjee & Kumar, 2014: 189) that may affect procurement,

design, construction, and H&S processes. In the CI, setting proactive strategies for resolving conflict or problems is vital within a collaboration process, in order to save time, cost and improve H&S processes (Msomba *et al*., 2018: 156).

According to Patel *et al*. (2012: 4), **culture** exists at national, organisational and professional levels, showing that each organisation, nation and professional has its own way of doing things. A culture of blaming each other is prevalent in construction projects (Akintan & Morledge, 2013: 3) and influences performance, people/employee behaviour and their level of optimism (Meng, 2013: 190). A "no blame" culture enabling collaboration in risk management (Msomba *et al*., 2018: 156). Managing risks in high-risk industries such as the CI includes setting H&S objectives and establishing a good H&S culture in the CI. This becomes necessary for the safe improvement of H&S performance (Lingard *et al*., 2009: 134; Nielsen, 2014: 7).

Competence/experience, as a factor of collaboration critical for improving H&S performance in construction projects, refers to knowledge, skills and experience among project team members that contribute to the success of the project (Msomba *et al*., 2018). Working in collaboration integrates relevant knowledge and skills from past work experience of project participants (Torneman, 2015: 23), increasing the project teams' competence and knowledge of construction H&S processes and enhancing their capability for delivering a successful project (Liu *et al*., 2017: 692). Developing competence in H&S management through training and adequate supervision (HSE, 2008: 31-32) gives project participants experience. Applying skills and knowledge helps them identify hazards on construction sites.

The **support of top management**, as a factor of collaboration critical for improving H&S performance in construction projects, is important for implementing a safety culture and safety standards (Charehzehi & Ahankoob, 2012: 306) and for establishing H&S policies and objectives in the CI (ISO, 2018: 9). This support is necessary to create a culture for collaborating between project participants (Faris *et al*., 2019: 5), in order to ensure that workers are safe (Charehzehi & Ahankoob, 2012: 304). Top management also provides resources or funds for creating a safe workplace (Mohammandi, Tavakolan & Khosravi, 2018).

As a factor of collaboration critical for improving H&S performance in construction projects, **early involvement of key participants** such as project managers, designers, contractors, subcontractors and other consultants had the greatest impact on project innovation and improvement of project efficiency (Hosseini *et al*., 2016: 248). Early involvement of key project team members in H&S management who have specialised

knowledge in project decision-making is linked to the adoption of higher work H&S risk controls (Emuze & Smallwood, 2014: 302).

Gain and pain sharing, as a factor of collaboration critical for improving H&S performance in construction projects, refers to shared profits or cost savings and shared losses, due to errors (for example, H&S) or cost increases between the parties in a construction project (Meng, 2012: 190). According to Faris *et al*. (2019: 2), in collaboration, risks and rewards are shared between all parties, but parties must find an effective way as to how to share risks and rewards between those involved, with a view to improving collaboration. One of the recommendations was to allocate risks and rewards fairly prior to tender. This will help improve project and H&S performance (Hasanzadeh *et al*., 2014: 816).

Although **continuous improvement** was rated the lowest factor of collaboration critical for improving H&S performance in construction projects, it is a key element in H&S management practice (Andreas & Ida, 2018), because it is characterised by non-ending improvements in products, services and processes (Pal *et al*., 2017: 1227). In H&S management, leading indicators such as audits, training, incident recalls (Hinze, Thurman & Wehle, 2013: 25; ISO, 2018: 23), percentage of accidents, frequency of H&S meetings, and the number of trained workers on H&S are used to ascertain if H&S performance is improving. Organisations with a "zero harm" policy will adopt the most effective leading indicators; that is, those that drive H&S management systems to continual improvement (Sinelnikov, Inouye & Kerper, 2015: 241).

5. CONCLUSION AND RECOMMENDATIONS

The review contributes to literature about collaboration in construction H&S and the factors that can be used to influence H&S performance. Findings show that there are 11 critical success factors of collaboration that can influence construction H&S performance: trust, communication, commitment, resource/information sharing, mutual goals, clear roles and responsibilities, culture, early involvement of key participants, competence, conflict resolution, and continual improvement. Based on reporting the number of included articles that mentioned or discussed the factor, the top three factors of collaboration critical for improving H&S performance in construction projects are trust (48); communication (47); resource/information sharing, (43) and mutual goals and commitment (43).

During 2014-2019, studies investigating collaboration have increased, but studies on collaboration in the CI were limited in developing countries such as Africa. Limited studies used a mixed method research design and most of the studies were based on surveys, literature reviews, and case

studies. The literature review revealed that few studies investigated factors of collaboration and barriers inhibiting collaboration in CI.

The limitation of this study is that the literature review and findings are based on studies done between 2010 and 2019 and that the unit of analysis was limited to studies obtained on Google scholar and Scopus databases. Searches in other search engines might have provided additional information on collaboration. The findings make way for future research into the impact of collaboration on H&S performance and provide an understanding that H&S performance can be improved by adopting collaboration.

The study presented in this article is based on work in progress and intermittent findings of an ongoing PhD research on a framework to improve H&S professionals' collaboration and value addition to H&S performance.

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