Design for Occupational Safety and Health of Workers in Construction in Developing Countries: A Study of Architects in Nigeria

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Abstract

Purpose: Design for safety (DfS) of workers is amongst the prominent ways of tackling poor occupational safety and health (OSH) performance in construction. However, in developing countries there is an extremely limited research on DfS. This study thus makes an important contribution to the subject of DfS in developing countries by specifically examining the awareness and practice of DfS amongst architects within the construction sector of Nigeria.

Materials and methods: A survey of architects, yielding 161 valid responses, was conducted.

Results: While there is a high awareness of the concept of DfS, the actual practice is low. Additionally, although there is high interest in DfS training, the engagement in DfS training is low. Significantly, awareness of DfS, training and education related to DfS, and membership of a design professional body have very limited bearing on the practice of DfS by architects.

Conclusions: The findings are thus symptomatic of the prevalence of influential DfS implementation barriers within the construction sector. Industry stakeholders should seek to raise the profile of DfS practice within the sector. Furthermore, similar empirical studies in the construction sector of other developing countries would be useful in shedding light on the status of DfS in these countries.

Keywords: construction; design for safety; prevention through design; developing country; survey.

1. Introduction

The construction sector accounts for numerous deaths, injuries and illnesses. For instance, in the United States of America (USA), construction accounted for the highest number of fatalities in 2016 (i.e., 991 out of 5190) [1]. Similarly, in the United Kingdom (UK), the construction sector accounted for the highest number of fatalities in 2016/2017 (i.e., 30 out of 137) [2]. The cost arising from construction occupational injuries and illnesses can be colossal. In the UK, this is estimated to be about GBP 1.1 billion in 2012/13 [3]. While occupational injuries and illnesses are commonplace in construction worldwide, in developing countries the situation seems worse in comparison with developed countries. For instance, while in the UK 30 worker fatalities were recorded in 2016/2017 [2], in Malaysia, out of the 239 occupational fatalities recorded in 2016, the construction sector accounted for 106 fatalities which is the highest [4]. With global construction output predicted to increase by over 70% to USD 15 trillion by 2025 [5], the current poor occupational safety and health (OSH) outlook in developing countries could get even worse if appropriate action is not taken. While construction accident causation is multi-faceted and complex, it has been established that design is one of the major contributors to accidents and injuries [6,7]. Consequently, design for safety (DfS) is one of the prominent ways of mitigating the occurrence of injuries and illnesses in construction. However, the bulk of research on DfS has focussed on developed countries and therefore very limited research on the subject exist on developing countries [5,8-14]. Considering that in developing countries, significant investment is needed to address infrastructure and housing deficits [see 15], which implies more construction activity, it is important that DfS inquiries are conducted in these contexts in order to ascertain the awareness of the concept as well as its practice. This could help guide efforts to promote DfS amongst designers in these countries. This study particularly focuses on Nigeria (a lower middle-income country [16]), and investigates the awareness of DfS concept and the practice of DfS amongst architects.

In the next section, an overview of the status of construction OSH in Nigeria is presented, followed by a review of DfS literature. Subsequently, the research strategy applied in the study, the ensuing findings, discussion, implications and concluding remarks are given.

2. Construction health and safety in Nigeria: an overview

Nigeria is Africa's largest economy, although it is a lower middle-income economy [16,17]. Like many other countries, the Nigerian construction sector plays an important socio-economic role in the nation's development. In 2012 the sector contributed about 3.05% to the nation's gross domestic product and it also employed close to seven million workers [18]. Despite the sector's socio-economic importance, its image is dented by its enviable reputation regarding OSH. Occupational injury and illness estimates in low and lower middle-income economies like Nigeria are generally considered to be higher than in the high-income countries [see 19,20]. While Nigeria has been a signatory to the Geneva Occupational Safety and Health Convention 1981, for over three decades, OSH in Nigeria is still considered to be poor and at its infancy [21-23]. According to a survey by Idoro [24] even larger contractors that are expected to have better OSH performance still record high numbers and rates of injuries on their sites. The survey by Idoro [24] which involved 42 Nigerian contractors (comprising local, regional, national and multinational contractors) revealed poor OSH performance such as five injuries per 100 workers and two accidents per 100 workers. According to Ezenwa [25] these figures tend often to be worse in practice as a result of a culture of under-reporting and concealment.

While there have been OSH legislation governing work and work environments in Nigeria (e.g., Employee's Compensation Act 2010), some have attributed the poor OSH performance to dysfunctional OSH legislation [21]. Compliance with and enforcement of OSH legislation have generally been described as poor [26-29] and this has been linked to factors such as corruption and bribery [28]. Regarding DfS, unlike countries such as UK, Australia and Singapore where there are DfS legislation that cover construction, there are no such legislation in Nigeria. As legislation can be powerful stimuli for change, the absence of construction DfS legislation in Nigeria could potentially have implications for the awareness, knowledge and practice of DfS.

3. Design for safety

Traditionally the role of the designer in construction has been to design a structure (building, facility, dwelling, etc.) that would comply with established engineering practices, rules, local building codes, and would be safe for the occupants. The safety of construction workers was often left up to the contractors. However, the gravity of the link between design and the occurrence of accidents and injuries shown by several studies [6,7,30,31] is increasingly giving impetus for the integration of OSH into the delivery of construction projects from the design stages. For instance, in the USA, Behm [6] studied 224 construction fatality cases and found that 42% of the cases were linked to design.

DfS in construction can be described as the integration of hazard identification and risk assessment in the design process to eliminate or minimise the risks of injury and illness to workers [32]. DfS (also referred to as prevention through design (PtD)) is a concept that encourages design professionals to explicitly take into consideration the OSH of construction and maintenance workers during the design phase in order to eliminate or reduce the likelihood of occurrence of harm to these workers. DfS is a rapidly developing area of practice in construction and in some countries it is supported by legislation (e.g., the Construction Design and Management Regulations 2015 in the UK, the Workplace Safety and Health (Design for Safety) Regulations 2015 of Singapore, and the Work Health and Safety Acts and Regulations in Australia).

Since the early 1990s there has been a growing number of studies on various aspects of DfS including designers' attitude towards DfS, awareness, education and training regarding DfS, and the development of DfS tools to facilitate DfS practice. Regarding DfS implementation by designers, Hinze and Wiegand [33] surveyed design firms and contractors in the USA and found that one-third of the designers take into consideration the safety of construction workers in design. Respondents from the contractors also provided examples of design modifications that designers might consider in order to improve the safety of construction workers. On the aspect of designers' attitudes to DfS, Gambatese et al. [10], in a subsequent inquiry in the USA, reported that a large percentage of the design professionals in their study were willing to implement DfS in practice, making it a viable intervention in construction. The authors also presented factors that affect the practice of DfS and these include: designer knowledge of the concept; DfS education and training; and the availability of DfS tools.

Other DfS studies have also focussed on education and training, and the development of various tools and methods to facilitate the implementation of DfS. Concerning DfS tools, one of the earlier computer-based tools to support DfS was implemented by Gambatese et al. [34]. The tool linked the design and construction phases and assisted designers in recognising project-specific hazards and implementing design suggestions into a project's design. Furthermore, following rapid advance of computer-aided design in the 2000s several computer-based tools and methodologies were suggested for integrating OSH in early stages of construction and providing decision support [8,9,11,12]. For instance, Cooke et al. [12]) developed an information and decision support tool to help designers to integrate the management of OSH risk into the design process. Regarding DfS education and training, various studies have been conducted and they mainly emphasise the importance of DfS education to the practice of DfS [10,13,14]. For instance, López-Arquillos et al. [14] reported an insufficient coverage of PtD in design and construction courses taught as part of engineering and architecture degrees in Spain. Consequently, they argued that improved knowledge of PtD would be beneficial to construction industry stakeholders who ought to launch initiatives to promote PtD in university degrees.

In general, all of the above studies on DfS attest to the increasing recognition of the importance of DfS to securing better OSH performance in construction. However, a critical examination of the DfS literature in construction (since the 1990s to 2016) by country/location of study (illustrated by Appendix A) reveals that the vast majority of DfS studies have been conducted within the context of developed countries (i.e., high-income countries) particularly Australia, UK, and USA. In terms of developing countries (i.e., low-income economies and lower middle-income economies), very limited research exists. This creates a fertile ground for more empirical studies regarding DfS in these countries. As a step in this direction, this study focusses on examining DfS (i.e., awareness of the concept and its practice) amongst architects in the Nigeria construction sector with the view to gauging the extent of awareness of the concept of DfS and the extent of DfS practice amongst this group of design professionals. It was deemed important to examine architects as they often play a leading role in the design and procurement of built assets.

4. Research design

In line with the study's interest in obtaining a generic/snapshot view of a phenomenon, in this case the awareness of the concept of DfS and its practice by architects in Nigeria, a quantitative research strategy of inquiry, particularly a survey, was adopted [35,36]. A survey instrument (i.e., questionnaire) was thus designed as described below.

4.1 Questionnaire design

The questionnaire was structured into two main sections to capture respondents' demographic information, awareness of the concept of DfS, education and training related to DfS and the practice of DfS.

Section 1: This captured respondents' information including professional role, years of experience in role, years of experience in construction industry, and professional body membership.

Section 2: This captured respondents' awareness of the concept of DfS, education and training undertaken by respondents related to DfS, and the practice of DfS. Concerning awareness of the concept, respondents were asked to indicate whether or not they were aware of the concept of DfS prior to participating in the research. A preamble statement explaining the concept was included in an information sheet on the front cover of the questionnaire. The statement was: The concept of design for safety can be described as the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury and ill health throughout the life of a building or structure being designed.

Regarding the practice of DfS, respondents were asked to indicate the extent of frequency to which they engage in several DfS practices [37]. While DfS involves many practices, the survey focused on a selection of DfS practices (15 practices) that are related to prominent causes of occupational injuries and illnesses in construction such as working at height, working in confined space, congestion on site, manual handling and the presence of substances hazardous to health [see 7,38-41]. The rationale for this was that it would give a reasonable indication of the extent of engagement in the practice of DfS considering that those practices are related to prominent causes of occupational injuries and illnesses in construction. Regarding the frequency of practice of DfS, a 5-point Likert scale (i.e., *1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always*) was used.

While architects in Nigeria constituted the population, it was not possible to precisely gauge the size of this population due to the lack of information. However, being mindful of the potential difficulty in obtaining participation in construction OSH research due to the legal sensitivity of OSH [40] and also the difficulty in obtaining accessible information records to facilitate research work especially in developing countries [42], a pragmatic approach was thus taken in order to reach the potential respondents (i.e., architects) and to obtain an appreciable response. This involved drawing a list of architectural firms using Yellow Pages Nigeria online business directory and a list of registered members of the Nigerian Institute of Architects (NIA). Additionally, industry contacts known to the researchers were used as points of contacts for further administration of the questionnaire. The questionnaires were distributed via email to the registered architects and firms (where an email address was obtained) in order for the architects within the firms to complete. The industry contacts known to the researchers were also sent the questionnaire via email for them to complete and to forward to architects within their network of professionals. Overall, a total of 535 questionnaires were sent and 161 valid questionnaires were received, resulting in an effective response rate of 30%.

4.2 Data analysis

The questionnaires were screened and coded in Microsoft Excel version 2013 and subsequently exported into IBM SPSS Statistics version 23 for analysis. SPSS was used to undertake descriptive statistical analysis including determining frequencies, mean and standard deviation.

Given that design has a significant impact on workers' OSH, the practice of DfS ought to be an inherent part of design process. Therefore, a reasonable expectation taken by the study was that the DfS practices examined should at least be often (if not always) practiced by architects especially given that the practices are associated with prominent causes of injuries and illnesses in construction. Aligned to this, a one-sample *t*-test was conducted to ascertain whether the frequencies of engagement in the DfS practices by the architects could be considered as being at least often. DfS practices with mean scores that are statistically significantly greater than the test value of 3.5 (i.e., with 1-tailed $p \leq 0.050$) were thus deemed to be practiced at least often [43].

Additionally, in order to explore associations between awareness of the concept of DfS, DfS education and training, and the practice of DfS as mentioned in the literature [see 10], independent samples *t*-tests were conducted. The tests were conducted to compare the mean scores of frequency of engaging in DfS practices between the following groups of respondents: (1) those aware of the concept of DfS and those who were not aware of the concept; (2) those who have attended DfS training course and those who have not; (3) those who have received DfS lessons as part of their formal education and those who have not; and (4) those who are members of a professional body and those who are not. Independent samples *t*-test was used due to its suitability for group mean comparison, especially where there are two groups with different participants in each group [44].

5. Results

The results are presented below under three main headings: demographic information; DfS awareness, education and professional development training; and DfS practice.

5.1 Demographic information

Table 1 provides the respondents' demographic information. The table shows that all the respondents are architects. About 62% and 67% of the respondents have over 5 years of experience in their role and in construction industry respectively. The respondents' mean years of experience in role and in construction are M = 8.79 years (SD = 5.881) and M = 12.25 years (SD = 8.698). Over half of the respondents are members of a professional body. Amongst these respondents, a large majority (i.e., 87.2%) are affiliated to the Nigerian Institute of Architects and/or the Architects Registration Council of Nigeria. Overall, the demographic information shows that the respondents have reasonable experience in design role as architects.

5.2 DfS awareness, education and professional development training

Table 2 provides the results on the respondents' DfS awareness, education and professional development training. The table shows that an overwhelming majority (89.4%) of the respondents indicated an awareness of the DfS concept and 60.9% of the respondents have received DfS related lessons as part of their formal education. Meanwhile, a lower proportion of the respondents (i.e., 38.5%) have undertaken DfS professional development training although interest in undertaking DfS professional development training is very high (i.e., 96.3 % of respondents indicated interest).

[Insert Table 1 approximately here]

[Insert Table 2 approximately here]

In terms of preferred method of undertaking DfS professional development training, 74.5% of respondents prefer attending seminar/workshop and 60.2% prefer online course/study.

5.3 DfS practice

Table 3 provides the frequency of engagement in DfS practice by the respondents based on the 15 practices examined in the study. For eight out of the 15 DfS practices, less than 50% of the respondents undertake them often or always. These include: specifying materials that are easier to handle; specifying materials that have less hazardous chemical constituents; designing elements so that they can be prefabricated offsite; designing to minimise or eliminate the need to work at height;

and highlighting unusual construction considerations that have safety implications to a contractor.

[Insert Table 3 approximately here]

5.3.1 One-sample *t*-test

Results of the one-sample *t*-test to ascertain whether the mean frequencies of engagement in the DfS practices by the respondents can be considered as being at least often (based on a test value of 3.5) are shown by Table 4.

[Insert Table 4 approximately here]

The table shows that only six out of the 15 practices (i.e., 40% of the DfS practices) can be considered as being undertaken at least often by the respondents based on 1-tailed $p \leq 0.050$. The majority of the practices (i.e., 60%) are thus not undertaken often or always. These include: designing to minimise or eliminate the need for workers to work in confined space; designing to minimise or eliminate the need to work at height; and designing to avoid construction operations that create hazardous fumes, vapour and dust. Amongst the least practised DfS practices (which are outside the often or always category) are: specifying materials that have less hazardous chemical constituents; preparing hazard identification drawings which show significant hazards that may not be obvious to a contractor; designing elements (e.g., walls, floors, etc.) so that they can be prefabricated offsite; and following a structured/systematic procedure for undertaking design health and safety risk assessment.

5.3.2 Independent samples *t*-test

The results of the independent samples *t*-test conducted to compare the mean scores of frequency of engaging in DfS practices between various groups of respondents are presented in Tables 5 to 8. For the sake of brevity, only the practices with significant outcomes (i.e., $p \leq 0.050$) are summarised in the tables. Except for only one DfS practice (i.e., DfS. C), there was no significant difference in the frequency of engagement in the DfS practices when those who are aware of the concept of DfS are compared with those who are unaware. In terms of group comparison by DfS professional development training (i.e., those who have undertaken DfS professional development training and those who have not), there was significant difference in the mean frequency of engagement for only three (i.e., DfS. E, DfS. J and DfS. M) of the 15 practices. Regarding group comparison by receipt of DfS lessons as part of formal education (i.e., those who have received DfS lessons as part of their formal design education and those who have not), there was significant difference in the mean frequency of engagement for only two (i.e., DfS. C and DfS. E) of the 15 practices. In terms of group comparison by membership of a professional body (i.e., those who are members of a professional body and those who are not), there was a significant difference in the mean frequency of engagement for six (i.e., DfS. B, DfS. E, DfS. F, DfS. H, DfS. J, and DfS. N) of the 15 practices.

[Insert Table 5 approximately here]

[Insert Table 6 approximately here]

[Insert Table 7 approximately here]

[Insert Table 8 approximately here]

6. Discussion

The data analyses revealed some intriguing findings which are the focus of discussion.

Overall, the frequency of engaging in DfS practices (shown by Table 3) and the one-sample *t*-test results (shown by Table 4) reveal a low level of engagement in DfS practice amongst the architects. This is generally in accord with the status of construction OSH in Nigeria (discussed above) as well as the hints given by previous studies [e.g., 20]. Takala et al. [20], in their study on global estimates of injury and illness, reported an inverse relationship between competitiveness of countries and rate of occupational fatalities. This implies that countries with better competitiveness would have better OSH performance and by inference have better approaches to mitigating the occurrence of injuries and illnesses, which in the case of construction could include DfS practice.

Nevertheless, the low level of engagement in DfS practice amongst the architects is out of sync with the very high level of awareness of the concept of DfS (i.e., 89.4%) amongst the respondents. Although Gambatese et al. [10] reported that awareness of DfS is important for DfS practice, the results of the study do not show this. While this does not imply that DfS awareness amongst designers is irrelevant for DfS practice, it shows that other factors which affect implementation of DfS could be at play. These factors include designers' acceptance of the concept/attitude towards the concept, limited or no construction experience by designers, and DfS education and training [10,45]. The existence and enforcement of DfS legislation as well as clients' motivation in respect of DfS are also amongst the reported stimuli for DfS implementation [see 45-47]. The discord between the level of awareness of the concept of DfS and engagement in DfS practices could be symptomatic of the effect of any of the above factors. For instance, at present there is no construction DfS legislation in Nigeria.

Overall, the independent samples *t*-test revealed surprising results since it is reasonable to expect that there would be significant difference in the mean scores for the various group comparisons as follows: (1) respondents who are aware of the concept would frequently engage in DfS practice than those who are unaware; (2) those who have undertaken DfS professional development training would frequently engage in DfS practice than those who have not; (3) those who have received DfS lesson as part of their formal design education would frequently engage in DfS practice than those who have not; and (4) those who are members of a professional body would frequently engage in DfS practice than those who are not.

Expectations 1, 2 and 3 are aligned to various literature that highlight the importance of DfS knowledge, education and training to the implementation of DfS [see

10,13,14,37,45]. Expectation 4 is based on the rationale that professional bodies are commonly expected to promote professionalism and best practices amongst their members, which in the case of construction design professional bodies should reasonably include encouraging members to take into consideration OSH issues in design [see 48]. Importantly, the independent samples *t*-test results provide insights that potentially help to shed light on the low engagement in DfS practice recorded by this study. The results suggest that amongst architects in Nigeria, knowledge of DfS, DfS training and education, and design professional body membership do not seem to matter in terms of engagement in DfS practice. These by no means imply that knowledge of DfS, DfS training and education, and design professional body membership are not important for DfS practice in Nigeria. However, these results are symptomatic of the existence of more influential barriers to DfS practice in Nigeria that may be related to the attitude of designers and other industry stakeholders (e.g., clients) towards the importance of DfS, and the absence of a DfS legislation in Nigeria. For instance, in the DfS study by Goh and Chua [37] in Singapore, designers' mind-set towards safety and DfS legislation were perceived by civil and structural engineers to be critical to the success of DfS practice while knowledge-related factors were deemed to be less important. Earlier, in the USA, Gambatese et al. [10] also reported designers' acceptance of DfS concept as a factor crucial to DfS implementation. More recent work by Tymvious and Gambatese [47] in the USA has also reported that clients have the greatest influence to generate interest in DfS.

The very high interest in undertaking DfS training juxtaposed with the low engagement in DfS training is also quite revealing in that it is suggestive of potential DfS knowledge acquisition barriers which may be related to designers' attitude, the adequacy and availability of DfS training courses, or other individual or organisational barriers (e.g., the availability of resources to support practitioners' engagement in DfS training). In terms of preferred method of DfS professional development training, while there is higher preference for attending seminar/workshop, there is also moderate preference for online course/study.

7. Implications of findings

The following implications based on the research findings are offered.

1. The low engagement in DfS practice is unhealthy for the improvement of construction OSH in Nigeria. Therefore the profile of DfS ought to be raised amongst industry stakeholders including architects, clients and legislators. Clients being the initiators of construction works have a key role to play, and government, often being the major procurer of construction works ought to take the leading role. While legislation can be a very powerful stimulus for change in DfS practice and attitude across the industry, it is important to acknowledge that without effective enforcement, legislation lose their potency. Weak enforcement of legislation aligned with corruption is often reported in construction studies and other reports on Nigeria [see 28,29]. Therefore, any intentions by policy makers to introduce DfS regulations in Nigeria should be carefully considered. Considerations regarding the introduction of DfS regulations could be facilitated by further studies to explore strategies for effective enforcement in the midst of corruption.

2. The high interest in DfS training amongst architects shown by this study should be viewed as an important opportunity which ought to be leveraged by the professional bodies and other industry associations by designing and providing adequate training courses.

3. The disconnect between the awareness of DfS and the practice of DfS, as well as the intriguing results emerging from the group comparison analyses, should trigger a keen interest amongst construction OSH researchers in general and construction industry stakeholders in Nigeria, particularly designers, clients, and policy makers, in gaining a better understanding of the critical success factors/barriers for DfS implementation in Nigeria and developing countries. Further research by the DfS research community in this direction would be invaluable towards raising the profile of DfS amongst designers in Nigeria, and more broadly in developing countries.

8. Conclusions

DfS is a prominent mechanism for improving OSH performance in construction. However, very limited research have inquired into DfS in developing countries. Contributing towards closing this research gap, this study has examined DfS awareness and practice amongst architects in the Nigerian construction sector. Based on the data collected and analysed in the study, there is an indication that DfS practice amongst architects is low despite a high level of awareness of the concept of DfS. Also engagement in DfS training is low in spite of a very high interest in undertaking DfS professional development training. Additionally, awareness of DfS, DfS related training and education, and membership of a design professional body have very limited bearing on the implementation of DfS. These are symptomatic of influential barriers that are undermining DfS practice and knowledge acquisition by architects in Nigeria's construction sector. While concerted efforts by industry stakeholders, particularly clients, designers, design professional bodies, and legislators, are required to raise the profile of DfS in Nigeria, it is also very important that further empirical studies are undertaken to unravel the critical success factors/barriers of DfS implementation in Nigeria and, more broadly, other developing countries.

A limitation of this study is that it has only captured the responses of architects and therefore does not necessarily reflect the views of all the professional groups of designers in Nigeria.

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[Insert Appendix A approximately here]

Table 1. Respondents' (role = architect) demographic information. (*N* =161)

Respondents' profile	*n*	%
Experience in role (years)		
1-5	51	31.7
6-10	57	35.4
>10	43	26.7
Non-response	10	6.2
M = 8.79. *SD* = 5.881		
Experience in construction industry (years)		
1-5	43	26.7
6-10	31	19.3
>10	77	47.8
Non-response	10	6.2
M = 12.25. *SD* = 8.698		
Professional body membership		
Yes	94	58.4
No	64	39.8
Non-response	3	1.9

Table 2. Design for safety awareness, education and training. (N = 161)

Extent of awareness, education and training	*n*	%
Awareness of concept of design for safety		
Yes	144	89.4
No	15	9.3
Non-response	2	1.2
Received design for safety lessons as part of formal education		
Yes	98	60.9
No	60	37.3
Non-response	3	1.9
Engagement in design for safety professional development training		
Yes	62	38.5
No	97	60.2
Non-response	2	1.2
Interest in undertaking design for safety professional development training		
Yes	155	96.3
No	5	3.1
Non-response	1	0.6
Preferred method of design for safety professional development training[a]		
Online course/study	97	60.2
Attending seminar/workshop	120	74.5
Other preference	5	3.1

Note: [a]total % is greater than 100% due to multiple preferences by some respondents.

Table 3. Frequency of engaging in design for safety practices.

Design for safety (DfS) practice code[a]	Design for safety practice	Frequency of engagement in design for safety Practice (%)[b]					
		Never	Rarely	Sometimes	Often	Always	Often or always
DfS. A[c]	I design to avoid construction operations that create hazardous fumes, vapour and dust (e.g., disturbance of existing asbestos and cutting blockwork and concrete).	7.5	13.7	32.3	30.4	15.5	45.9
DfS. B	I specify materials that require less frequent maintenance or replacement.	0.0	11.2	34.2	32.9	21.7	54.6
DfS. C[c]	I specify materials that are easier to handle e.g., lightweight blocks.	9.3	24.2	32.3	16.8	16.8	33.6
DfS. D	I design to take into account safe movement of site workers, plants, and equipment on a project site during construction.	0.6	11.2	16.8	32.9	38.5	71.4
DfS. E[c]	I specify materials that have less hazardous chemical constituents.	16.1	21.7	26.1	21.1	13.7	34.8
DfS. F	I eliminate materials that could create a significant fire risk during construction.	2.5	9.9	29.8	33.5	24.2	57.7
DfS. G	I design to position buildings/structures to minimise risks from buried services and overhead cables.	0.6	2.5	19.9	32.3	44.7	77.0
DfS. H	I design to mitigate possible adverse impact a project could have on safe movement of the general public during construction.	1.2	6.8	22.4	37.3	31.7	69.0
DfS. I[c]	I design elements (e.g., walls, floors, etc.) so that they can be prefabricated offsite.	21.7	30.4	21.1	15.5	9.3	24.8
DfS. J[c]	I design to minimise or eliminate the need to work at height.	2.5	13.0	35.4	31.1	17.4	48.5
DfS. K	I design to minimise or eliminate the need for workers to work in confined space.	3.1	11.2	29.8	35.4	19.9	55.3
DfS. L[c]	I highlight unusual construction considerations that have safety implications to the contractor e.g., key sequence of erecting/construction.	6.8	16.8	29.2	33.5	13.0	46.5
DfS. M[c]	I follow a structured/systematic procedure for undertaking design health and safety risk assessment e.g. using a tool, template or form for design health and safety risk assessment.	9.9	19.3	23.6	28.0	17.4	45.4
DfS. N	I produce designs that enable ease of building/constructing.	0.0	1.9	13.0	39.8	44.7	84.5
DfS. O[c]	I prepare hazard identification drawings that show significant hazards that may not be obvious to a contractor.	18.6	24.8	24.8	17.4	13.7	31.1

Note: [a]DfS. A to DfS. O are codes representing their corresponding design for safety practices; [b]Due to non-responses by some respondents, total % may not be 100% for some practices; [c]design for safety practices for which less than 50% of the respondents undertake often or always.

Table 4. One-sample *t*-test results on frequency of engaging in design for safety practices.

Design for safety (DfS) practice code[a]	*n*	*M*	Rank of mean	*SD*	*SEM*	Test value = 3.5					
						t	*df*	*p* (2-tailed)	*p* (1-tailed)	Mean difference	Confidence interval
DfS. N	160	4.28	1	0.762	0.060	12.967	159	<0.001	<0.001	0.781	95% CI [0.66, 0.90]
DfS. G	161	4.18	2	0.880	0.069	9.812	160	<0.001	<0.001	0.680	95% CI [0.54, 0.82]
DfS. D	161	3.98	3	1.030	0.081	5.851	160	<0.001	<0.001	0.475	95% CI [0.31, 0.64]
DfS. H	160	3.92	4	0.965	0.076	5.491	159	<0.001	<0.001	0.419	95% CI [0.2, 0.57]
DfS. F	161	3.67	5	1.029	0.081	2.105	160	0.037	0.018	0.171	95% CI [0.0, 0.33]
DfS. B	161	3.65	6	0.944	0.074	2.046	160	0.042	0.021	0.152	95% CI [0.0, 0.30]
DfS. K	160	3.58	7	1.031	0.081	0.997	159	0.320	0.160	0.081	95% CI [-0.08, 0.24]
DfS. J	160	3.48	8	1.009	0.080	-0.235	159	0.815	0.407	-0.019	95% CI [-0.18, 0.14]
DfS. A	160	3.33	9	1.126	0.089	-1.896	159	0.060	0.030	-0.169	95% CI [-0.34, 0.01]
DfS. L	160	3.29	10	1.108	0.088	-2.355	159	0.020	0.010	-0.206	95% CI [-0.38, -0.03]
DfS. M	158	3.24	11	1.244	0.099	-2.623	157	0.010	0.005	-0.259	95% CI [-0.45, -0.06]
DfS. C	160	3.08	12	1.211	0.096	-4.440	159	<0.001	<0.001	-0.425	95% CI [-0.61, -0.24]
DfS. E	159	2.94	13	1.284	0.102	-5.466	158	<0.001	<0.001	-0.557	95% CI [-0.76, -0.36]
DfS. O	160	2.83	14	1.306	0.103	-6.539	159	<0.001	<0.001	-0.675	95% CI [-0.88, -0.47]
DfS. I	158	2.59	15	1.257	0.100	-9.050	157	<0.001	<0.001	-0.905	95% CI [-1.10, -0.71]

Note: [a]DfS. A to DfS. O are codes representing design for safety practices as indicated in Table 3.

Table 5. Differences in frequency of engaging in design for safety (DfS) practices - by awareness of DfS concept

Design for safety (DfS) practice code[a]	Awareness of design for safety concept	*n*	*M*	*SD*	*SEM*	Independent samples *t*-test					
						t	*df*	p (2-tailed)	Mean difference	Standard error difference	Confidence interval
DfS. C	Yes	143	3.11	1.187	0.099	2.002	156	0.047	0.645	0.322	95% CI [0.009, 1.282]
	No	15	2.47	1.187	0.307						

Note: [a]DfS. C represents design for safety practice as indicated in Table 3.

Table 6. Differences in frequency of engaging in design for safety (DfS) practices - by DfS professional development training.

Design for safety (DfS) practice code[a]	Design for safety professional development training	*n*	*M*	*SD*	*SEM*	Independent samples *t*-test					
						t	*df*	*p* (2-tailed)	Mean difference	Standard error difference	Confidence interval
DfS. E	Yes	61	3.20	1.249	0.160	2.101	156	0.037	0.434	0.207	95% CI [0.026, 0.842]
	No	97	2.76	1.273	0.129						
DfS. J	Yes	61	3.79	0.985	0.126	3.246	156	0.001	0.519	0.160	95% CI [0.203, 0.835]
	No	97	3.27	0.974	0.099						
DfS. M	Yes	61	3.66	1.078	0.138	3.499	154	0.001	0.687	0.196	95% CI [0.299, 1.075]
	No	95	2.97	1.267	0.130						

Note: [a]DfS. E, DfS. J and DfS. M represents design for safety practice as indicated in Table 3.

Table 7. Differences in frequency of engaging in design for safety (DfS) practices - by receipt of DfS lessons in formal education.

Design for safety (DfS) practice code[a]	Design for safety lessons in formal education	*n*	*M*	*SD*	*SEM*	Independent samples *t*-test					
						t	*df*	*p* (2-tailed)	Mean difference	Standard error difference	Confidence interval
DfS. C	Yes	97	3.23	1.262	0.128	1.978	155	0.050	0.393	0.199	95% CI [0.001, 0.786]
	No	60	2.83	1.122	0.145						
DfS. E	Yes	97	3.11	1.249	0.127	2.501	155	0.013	0.513	0.205	95% CI [0.108, 0.786]
	No	60	2.60	1.251	0.162						

Note: [a]DfS. C and DfS. E represent design for safety practices as indicated in Table 3.

Table 8. Differences in frequency of engaging in design for safety (DfS) practices - by professional body membership.

Design for safety (DfS) practice code[a]	Professional body membership	*n*	*M*	*SD*	*SEM*	Independent samples *t*-test					
						t	*df*	*p* (2-tailed)	Mean difference	Standard error difference	Confidence interval
DfS. B	Yes	94	3.46	0.947	0.098	-3.232	156	0.002	-0.480	0.149	95% CI [-0.773, -0.187]
	No	64	3.94	0.871	0.109						
DfS. E	Yes	93	2.67	1.280	0.133	-3.144	154	0.002	-0.635	0.202	95% CI [-1.034, -0.236]
	No	63	3.30	1.173	0.148						
DfS. F	Yes	94	3.52	1.002	0.103	-2.166	156	0.032	-0.354	0.163	95% CI [-0.676, -0.031]
	No	64	3.88	1.016	0.127						
DfS. H	Yes	94	4.05	0.896	0.092	2.079	155	0.039	0.323	0.155	95% CI [0.016, 0.630]
	No	63	3.73	1.035	0.130						
DfS. J	Yes	94	3.65	1.013	0.104	2.567	156	0.011	0.415	0.161	95% CI [0.096, 0.734]
	No	64	3.23	0.972	0.121						
DfS. N	Yes	94	4.41	0.679	0.070	2.744	155	0.007	0.336	0.122	95% CI [0.094, 0.577]
	No	63	4.08	0.848	0.107						

Note: [a]DfS. B, DfS. E, DfS. F, DfS. H, DfS. J and DfS. N represent design for safety practices as indicated in Table 3.

Appendix A. Design for safety in construction studies (in journals).

Author	Year	Journal[a]	Digital object identifier (DOI)	Location of study[b]	The World Bank income group [16][c]
Alarcón LF, Acuña D, Diethelm S, et al.	2016	AAP	http://dx.doi.org/10.1016/j.aap.2016.05.021	Chile	HI
Wang J, Zou PXW, Li PP.	2016	AAP	http://dx.doi.org/10.1016/j.aap.2015.11.027	China	UMI
Goh YM, Chua S.	2016	AAP	http://dx.doi.org/10.1016/j.aap.2015.09.023	Singapore	HI
Edirisinghe R, Stranieri A, Blismas N.	2016	AEDM	http://dx.doi.org/10.1080/17452007.2016.1182890	Australia	HI
Teizer J.	2016	CI	http://dx.doi.org/10.1108/CI-10-2015-0049	Germany	HI
Morrow S, Hare B, Cameron I.	2016	ECAM	http://dx.doi.org/10.1108/ECAM-01-2013-0009	UK	HI
Tymvios N, Gambatese JA.	2016	JCEM	http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0001134	USA	HI
Tymvios N, Gambatese JA.	2016	JCEM	https://doi.org/10.1061/(ASCE)CO.1943-7862.0001067	USA	HI
Martínez-Aires MD, Rubio Gámez MC, Gibb A.	2016	W	https://dx.doi.org/10.3233/WOR-152148	UK/Spain	HI/HI
Hallowell MR, Hansen D.	2016	SS	https://doi.org/10.1016/j.ssci.2015.09.005	USA	HI
Sacks R, Whyte J, Swiss D, et al.	2015	CME	http://dx.doi.org/10.1080/01446193.2015.1029504	Israel/UK	HI/HI
Bong S, Rameezdeen R, Zuo J, et al.	2015	IJCM	http://dx.doi.org/10.1080/15623599.2015.1094850	Australia	HI
Dharmapalan V, Gambatese J A, Fradella J, et al.	2015	JCEM	http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000952	USA	HI
Sadeghi L, Mathieu L, Tricot N, et al.	2015	SS	http://dx.doi.org/10.1016/j.ssci.2015.08.006	France	HI
López-Arquillos A, Rubio-Romero JC, Martinez-Aires MD.	2015	SS	http://dx.doi.org/10.1016/j.ssci.2014.11.006	Spain	HI
Hallowell MR, Hansen D.	2015	SS	http://dx.doi.org/10.1016/j.ssci.2015.09.005	USA	HI
Zhang S, Sulankivi K, Kiviniemi M, et al.	2015	SS	https://doi.org/10.1016/j.ssci.2014.08.001	Finland	HI
Simanaviciene R, Liaudanskiene R, Ustinovichius L.	2014	AC	http://dx.doi.org/10.1016/j.autcon.2013.11.008	n/a	n/a

Appendix A. continued.

Author	Year	Journal[a]	Digital object identifier (DOI)	Location of study[b]	The World Bank income group [16][c]
Öney-Yazıcı E, Dulaimi MF.	2015	AEDM	http://dx.doi.org/10.1080/17452007.2014.895697	UAE	HI
Morrow S, Cameron I, Hare B.	2015	AEDM	http://dx.doi.org/10.1080/17452007.2014.915512	UK	HI
Almén L, Larsson TJ.	2014	BEPAM	http://dx.doi.org/10.1108/BEPAM-05-2013-0012	Sweden	HI
Gibb A. Lingard H, Behm M, et al.	2014	CME	http://dx.doi.org/10.1080/01446193.2014.907498	Australia/UK/USA	HI
Qi J. Issa RRA, Olbina S, et al.	2014	JCCE	http://dx.doi.org/10.1061/(ASCE)CP.1943-5487.0000365	USA	HI
Forsythe P.	2014	PICEMPL	http://dx.doi.org/10.1680/mpal.13.00055	n/a	n/a
Mahmoudi S, Ghasemi F, Mohammadfam I, et al.	2014	SHW	https://dx.doi.org/10.1016%2Fj.shaw.2014.05.005	Iran	UMI
Ganah A, John GA.	2015	SHW	https://dx.doi.org/10.1016%2Fj.shaw.2014.10.002	UK	HI
Fonseca ED, Lima FPA, Duarte F.	2014	SS	http://dx.doi.org/10.1016/j.ssci.2014.07.006	Brazil	UMI
Zou PXW, Sunindijo R Y, Dainty ARJ.	2014	SS	http://dx.doi.org/10.1016/j.ssci.2014.07.005	n/a	n/a
Behm M, Culvenor J, Dixon G.	2014	SS	https://doi.org/10.1016/j.ssci.2013.10.018	USA	HI
Zhang S, Teizer J, Lee J-K, et al.	2013	AC	https://doi.org/10.1016/j.autcon.2012.05.006	USA	HI
Lingard H, Cooke T, Blismas N, et al.	2013	BEPAM	http://dx.doi.org/10.1108/BEPAM-06-2012-0036	Australia	HI
Larsen GD, Whyte J.	2013	CME	http://dx.doi.org/10.1080/01446193.2013.798424	UK	HI
del Puerto CL, Strong K, Miller M.	2013	IJCER	http://dx.doi.org/10.1080/15578771.2012.756436	USA	HI
Toole T, Carpenter G.	2013	JAE	http://dx.doi.org/10.1061/(ASCE)AE.1943-5568.0000107	USA	HI
Kaskutas V, Dale AM, Lipscomb H, et al.	2013	JSR	http://dx.doi.org/10.1016/j.jsr.2012.08.020	USA	HI
Lingard H, Wakefield R.	2013	PICEMPL	http://dx.doi.org/10.1680/mpal.12.00014	Australia	HI
Rajendran S, Gambatese JA.	2013	PPSDC	http://dx.doi.org/10.1061/(ASCE)SC.1943-5576.0000129	USA	HI
Spillane J, Oyedele L.	2013	TAJCEB	http://dx.doi.org/10.5130/AJCEB.v13i4.3619	UK	HI
Zhou W, Whyte J, Sacks R.	2012	AC	http://dx.doi.org/10.1016/j.autcon.2011.07.005	UK-Israel	HI/HI

Appendix A. continued.

Author	Year	Journal[a]	Digital object identifier (DOI)	Location of study[b]	The World Bank income group [16][c]
Chun CK, Li H, Skitmore M.	2012	CI	http://dx.doi.org/10.1108/14714171211197481	Hong Kong	HI
Lingard HC, Cooke T, Blismas N.	2012	CME	http://dx.doi.org/10.1080/01446193.2012.667569	Australia	HI
Dewlaney KS, Hallowell M.	2012	CME	http://dx.doi.org/10.1080/01446193.2011.654232	USA	HI
Behm M.	2012	JCEM	http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000500	USA	HI
Chileshe N, Dzisi E.	2012	JEDT	http://dx.doi.org/10.1108/17260531211241220	UK	HI
Emuze F, Smallwood JJ.	2012	PICEMPL	http://dx.doi.org/10.1680/mpal.2012.165.1.27	South Africa	UMI
Yang H, Chew DAS, Wu W, et al.	2012	AAP	http://dx.doi.org/10.1016/j.aap.2011.06.017	China/USA	UMI/HI
Al-Jibouri S, Ogink G.	2009	AEDM	http://dx.doi.org/10.3763/aedm.2008.0100	Netherlands	HI
Valdes-Vasquez R, Klotz L.	2011	JPIEEP	http://dx.doi.org/10.1061/(ASCE)EI.1943-5541.0000066	USA	HI
Aneziris ON, Topali E, Papazoglou IA.	2012	RESS	http://dx.doi.org/10.1016/j.ress.2011.11.003	Greece/Netherlands	HI
Pinto A, Nunes IL, Ribeiro RA.	2011	SS	http://dx.doi.org/10.1016/j.ssci.2011.01.003	Portugal	HI
Pérez-Alonso J, Carreño-Ortega Á, Callejón-Ferrea ÁJ, et al.	2011	SS	https://doi.org/10.1016/j.ssci.2010.09.013	Spain	HI
Rwamamara R, Norberg H, Olofsson T, et al.	2010	CI	http://dx.doi.org/10.1108/14714171011060060	Sweden	HI
Atkinson AR, Westall R.	2010	CME	http://dx.doi.org/10.1080/01446193.2010.504214	UK	HI
Lopez R, Love PED, Edwards DJ, et al.	2010	JPCF	http://dx.doi.org/10.1061/(ASCE)CF.1943-5509.0000116	n/a	n/a
Gangolells M, Casals M, Forcada N, et al.	2010	JSR	http://dx.doi.org/10.1016/j.jsr.2009.10.007	Spain	HI
Martinez-Aires MD, Rubio-Gamez MC, Gibb A.	2010	SS	http://dx.doi.org/10.1016/j.ssci.2009.09.004	EU	n/a
Hallowell MR, Gambatese JA.	2009	JCEM	http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000107	USA	HI
Rajendran S, Gambatese JA, Behm MG.	2009	JCEM	http://dx.doi.org/10.1061/(ASCE)0733-9364(2009)135:10(1058)	USA	HI

Appendix A. continued.

Author	Year	Journal[a]	Digital object identifier (DOI)	Location of study[b]	The World Bank income group [16][c]
Megri AC.	2009	PPSDC	http://dx.doi.org/10.1061/(ASCE)1084-0680(2009)14:4(181)	USA	HI
Cameron I, Hare B.	2008	CME	http://dx.doi.org/10.1080/01446190802175660	UK	HI
Cooke T, Lingard H, Blismas N, et al.	2008	ECAM	http://dx.doi.org/10.1108/09699980810886847	Australia	HI
Creaser W.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.018	Australia	HI
Mann JA.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.009	USA	HI
Schulte PA, Rinehart R, Okun A, et al.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.021	USA	HI
Howe J.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.010	USA	HI
Lin M-L.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.011	USA	HI
Manuele FA.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.019	USA	HI
Gambatese JA.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.012	USA	HI
Toole TM, Gambatese JA.	2008	JSR	http://dx.doi.org/10.1016/j.jsr.2008.02.026	USA	HI
Behm M.	2008	JSR	https://doi.org/10.1016/j.jsr.2008.02.007	USA	HI
Evans M.	2008	PICECE	http://dx.doi.org/10.1680/cien.2007.161.5.16	UK	HI
Khudeira S.	2008	PPSDC	http://dx.doi.org/10.1061/(ASCE)1084-0680(2008)13:3(109)	USA	HI
Gambatese JA, Behm M, Rajendran S.	2008	SS	http://dx.doi.org/10.1016/j.ssci.2007.06.010	USA	HI
Frijters ACP, Swuste PHJJ.	2008	SS	https://doi.org/10.1016/j.ssci.2007.06.032	Netherland	HI
Slater R, Radford A.	2008	TAJCEB	http://dx.doi.org/10.5130/AJCEB.v8i1.2995	Australia	HI
Al-Homoud MS, Abdou AA, Khan MM.	2004	BRI	http://dx.doi.org/10.1080/0961321042000221034	Saudi Arabia	HI
Gibb AGF, Haslam RA, Pavitt TC, et al.	2007	CIQ	https://dspace.lboro.ac.uk/2134/8719	UK	HI
van Gorp A.	2007	DS	http://dx.doi.org/10.1016/j.destud.2006.11.002	Netherlands	HI
Greenwood JP.	2007	TAJCEB	http://dx.doi.org/10.5130/AJCEB.v7i1.2976	Australia	HI
Hare B, Cameron I, Duff AR.	2006	ECAM	http://dx.doi.org/10.1108/09699980610690729	UK	HI
Huang X, Hinze J.	2006	JCEM	http://dx.doi.org/10.1061/(ASCE)0733-9364(2006)132:2(174)	USA	HI

Appendix A. continued.

Author	Year	Journal[a]	Digital object identifier (DOI)	Location of study[b]	The World Bank income group [16][c]
Gambatese JA, Behm M, Hinze JW.	2005	JCEM	https://doi.org/10.1061/(ASCE)0733-9364(2005)131:9(1029)	USA	HI
Weinstein M, Gambatese J, Hecker S.	2005	JCEM	http://dx.doi.org/10.1061/(ASCE)0733-9364(2005)131:10(1125)	USA	HI
Hadikusumo BHW, Rowlinson S.	2004	JCEM	http://dx.doi.org/10.1061/(ASCE)0733-9364(2004)130:2(281)	Hong Kong	HI
Hecker S, Gambatese JA.	2003	AOEH	http://dx.doi.org/10.1080/10473220301369	USA	HI
Anderson J.	2003	PICEME	http://dx.doi.org/10.1680/muen.2003.156.3.175	UK	HI
Hadikusumo BHW, Rowlinson S.	2002	AC	http://dx.doi.org/10.1016/S0926-5805(01)00061-9	Hong Kong	HI
Toole TM, Gambatese JA.	2002	PPSDC	http://dx.doi.org/10.1061/(ASCE)1084-0680(2002)7:2(56)	USA	HI
Hinze J.	2002	PPSDC	http://dx.doi.org/10.1061/(ASCE)1084-0680(2002)7:2(81)	USA	HI
Baxendale T, Jones O.	2000	IJPM	http://dx.doi.org/10.1016/S0263-7863(98)00066-0	UK	HI
Gambatese J, Hinze J.	1999	AC	http://dx.doi.org/10.1016/S0926-5805(98)00109-5	USA	HI
Coble R, Blatter R.	1999	JAE	http://dx.doi.org/10.1061/(ASCE)1076-0431(1999)5:2(44)	n/a	n/a
Arditi D, Nawakorawit M.	1999	JAE	http://dx.doi.org/10.1061/(ASCE)1076-0431(1999)5:4(107)	USA	HI
Gambatese JA.	1998	JAE	http://dx.doi.org/10.1061/(ASCE)1076-0431(1998)4:3(107)	USA	HI
Gambatese JA, Hinze J, Haas C.	1997	JAE	http://dx.doi.org/10.1061/(ASCE)1076-0431(1997)3:1(32)	USA	HI
Heger FJ.	1996	PPSDC	http://dx.doi.org/10.1061/(ASCE)1084-0680(1996)1:4(113)	USA	HI
Hinze J, Wiegand F.	1992	JCEM	http://dx.doi.org/10.1061/(ASCE)0733-9364(1992)118:4(677)	USA	HI

Note: [a]AAP = Accident Analysis and Prevention, AC = Automation in Construction, AEDM = Architectural Engineering and Design Management, AOEH = Applied Occupational and Environmental Hygiene, BEPAM = Built Environment Project and Asset Management, BRI = Building Research and Information, CI = Construction Innovation, CIQ = Construction Information Quarterly, CME = Construction Management and Economics, DS = Design Studies, ECAM = Engineering, Construction and Architectural Management, IJCER = International Journal of Construction Education and Research, IJCM = International Journal of Construction Management, IJPM = International Journal of Project Management, JAE = Journal of Architectural Engineering, JCCE = Journal of Computing in Civil Engineering, JCEM = Journal of Construction Engineering and Management, JEDT = Journal of Engineering, Design and Technology, JPCF = Journal of Performance of Constructed Facilities, JPIEEP = Journal of Professional Issues in Engineering Education and Practice, JSR = Journal of Safety Research, PICECE = Proceedings of ICE Civil Engineering, PICEME = Proceedings of ICE Municipal Engineer, PICEMPL = Proceedings of ICE Management, Procurement and Law, PPSDC = Practice Periodical on Structural Design and Construction, RESS = Reliability Engineering and System Safety, SHW = Safety and Health at Work, SS = Safety Science, TAJCEB = The Australian Journal of Construction Economics and Building, W = Work; [b]EU = European Union, n/a= not available, UAE = United Arab Emirates, UK = United Kingdom, USA = United States of America; [c]HI = high-income country, n/a = not available, UMI = upper middle-income country.