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Design for Safety in Construction: A Study of Design Professionals in Kuwait

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ABSTRACT

Purpose: Design for Safety (DfS), also known as prevention through design (PtD), is a concept that mitigates accidents and hazards through considerations during the design stage of building projects. Literature provides much information on this concept, but such information is only limited to a few developed countries such as UK, USA, and Australia. There is limited insight into DfS implementation in the construction industry of several countries, including countries in the Gulf Cooperation Council such as Kuwait. Therefore, this study investigates DfS implementation among design professionals in the Kuwait construction industry.

Design/methodology/approach: The study used a questionnaire survey to obtain data from design professionals. The data were analysed using descriptive and inferential statistics (i.e., analysis of variance and t-test).

Findings: The results revealed that: DfS awareness among design professionals is very high; there is a very high willingness among design professionals to apply the concept, and design professionals generally view DfS implementation as important. Despite these, the frequency of implementation of DfS practices is generally moderate. In addition, the results revealed that though there is a high interest in DfS training among the design professionals, their actual engagement in training is low. The results also suggest some association between the frequency of engagement in the DfS practices and designers' DfS awareness, training, and education. DfS related regulations, industry guidance, formal education, and training are considered by design professionals to have the greatest influence on DfS implementation in Kuwait.

Originality/Value: These emerging findings both mirror and contradict aspects of the outcomes of previous DfS studies in other countries. . Furthermore, the findings from this study provide insights into a less investigated area regarding work-related health and safety in the Gulf Cooperation Council region. It offers new and additional information and insights into the current state-of-the-art DfS implementation in the construction industry in Kuwait. In view of the findings, joined-up efforts by government, industry, and academia are needed to enhance DfS implementation by design professionals in Kuwait.

Keywords: construction; design; design for safety; health and safety; survey

1.0 Introduction

Despite the importance of the construction sector towards the development of countries, a critical negative aspect is that it contributes significantly to occupational accidents and imposes a threat to the welfare and safety of the construction workforce (Awwad et al., 2016; Kim and Chi, 2019; Dogan et al., 2021). For instance, in the United States, the construction industry is responsible for the highest number of work-related fatalities (U.S. Bureau of Labor Statistics, 2017). In Kuwait, the construction industry is regarded as the most hazardous industry. The construction industry in Kuwait was responsible for 29% of all injuries reported in 2014, 28% of all injuries reported in 2015, and 34% of all injuries reported in 2016 (Almutairi, 2019).

One of the ways that accidents can be mitigated efficiently on construction sites is through design (Behm, 2005). Numerous studies have postulated a convergence between design decisions and accidents on construction sites (Behm, 2005; Manu et al., 2014). This issue has given rise to the concept of "Design for Safety (DfS)" or "Prevention through Design (PtD)".

DfS can be defined as "*Preventing and controlling occupational injuries, illness, and fatalities by designing out hazards and hazardous exposures from the workplace*" (Schulte et al., 2008, p. 116). A large and growing body of literature has investigated DfS in a few countries, especially the UK, other European countries (e.g., Spain), the USA, Australia, and Singapore (Manu et al., 2018; Manu et al., 2019). There is limited research regarding DfS awareness and implementation among design professionals in the construction industry in the Gulf Cooperation Council (GCC) countries. Against this backdrop, this study investigates the level of DfS awareness and its implementation amongst design professionals in a GCC country (i.e., Kuwait) construction industry. Knowing the level of awareness and implementation would inform efforts among designers (and other industry stakeholders, e.g., educators, professional bodies, and occupational safety and health regulatory agency) to raise the profile of DfS and improve its practice. The next section provides a literature review on the subject and further discusses the method used to carry out the study. Subsequently, the results, discussion, and concluding remarks are provided.

2.0 Literature review

This section reviews the literature on occupational health and safety in the construction industry within the GCC, and DfS. The section then concludes by establishing the knowledge gap that has given rise to the need for this study.

2.1 The status of occupational health and safety in the construction industry in the Gulf Cooperation Council (GCC) countries

The construction industry is considered one of the oldest industries in the Gulf Cooperation Council (GCC) countries. The GCC consists of six countries, i.e., the United Arab Emirates (UAE), Saudi Arabia, Qatar, Kuwait, Oman, and Bahrain. The construction industries of these countries were thriving until the COVID-19 pandemic hit them. Notwithstanding, as of June 2021, the total GCC construction market was worth US$ 3.2 trillion (messe frankfurt, 2021). Saudi Arabia and UAE are naturally at the forefront of the sector, and they are worth US$20.1 billion and US$11.4 billion, respectively (messe frankfurt, 2021). These countries are followed by Qatar (worth US$5.5 billion), Kuwait, Oman and Bahrain. Despite these developments, the number of safety lapses on construction sites in these countries is much higher than in other sectors (Umar et al., 2019).

Although accidents in the global construction industry lead to significant losses of lives yearly, occupational health and safety issues are still neglected because of competing social, economic and political barriers (Maliha et al., 2021). Literature reports that injuries and deaths caused by accidents in the construction industry have become alarming among GCC countries (Umar et al., 2019). Al-Bayati et al. (2017) report inadequate reliable data related to the number of fatalities in such countries. Notwithstanding the inadequate data, Umar et al. (2019) believe that attention must be paid to the speculations made in the media regarding some fatalities reported on the construction sites. For instance, Safety Media (SM) (2018) reported that the death toll of construction workers who worked on the stadia for the 2022 world cup in Qatar could reach 4,000 by the end of 2022 when the project would be completed. In other studies, it was confirmed that though there are no statistics in Oman regarding construction industry fatalities and injuries, over 3,500 construction workers received medical treatment due to construction work-related injuries (Umar and Wamuziri, 2016). In the United Arab Emirates, reports indicate that almost 70% of construction organisations do not pay serious attention to occupational health and safety (Umar et al., 2019). In a report by the General Organization for Social Insurance (2018), it was revealed that in the third quarter of 2018, occupational injuries in the construction industry constituted 47% of the total occupational injuries recorded in Saudi

Arabia. This case is not different from Kuwait's as the study of Al-Kandary and Al-Waheeb (2015), later iterated by Awwad et al. (2016), reported that the construction sector is the most hazardous. Designing out hazards has been identified as one of the most effective means to prevent occupational injuries, illnesses, and fatalities, especially, on construction sites. Notwithstanding this revelation, and despite the high rate of accidents reported in the construction industry in the GCC, there remain limited studies on design for safety in the GCC construction industry.

2.2 Design for Safety (DfS)

Design for safety or prevention through design (PtD) can be defined as the consideration of construction site safety in the design of a project. Specifically, this includes modifications to the permanent features of the construction project in such a way that construction site safety is considered; attention during the preparation of plans and specifications for construction in such a way that construction site safety is considered; the utilization of specific design for construction safety suggestions; and the communication of risks regarding the design in relation to the site and the work to be performed (Behm, 2005). The practice of anticipating and designing out work health and safety hazards associated with processes, structures, and plant and equipment has received considerable attention (Lingard et al., 2015).

The concept of DfS involves engineers and architects explicitly considering the safety of construction workers during the design process to eliminate or reduce hazards to construction workers (Manu et al., 2018). Designing for safety is a viable intervention in the construction industry to improve its safety performance. In construction, the argument that the opportunities to reduce work health and safety risks are highest at the pre-construction phase of projects and becomes less as the project progresses is linked to the time-safety influence curve (Lingard et al., 2015). This curve was proposed by Szymberski (1997). It describes the relationship between the progression of a project through its lifecycle phases and the ability to influence safety. The curve further indicates that the ability to influence safety at the project early/design phase is expected to be very high.

To test the time-safety influence curve, Lingard et al. (2015) adopted the prospective case study approach to examine the relationship between the timing of safety in design decisions and the effectiveness of work health and safety. The outcome of their study revealed a significant relationship between the quality of risk controls and the timing of risk control selection decisions. This implies that the greater the proportion of risk controls selected during a project's pre-construction stages, the better the risk control outcomes (Lingard et al., 2015). Their study highlighted the need for work health and safety risk to be integrated into decision making early in the life of construction projects. The study of Lingard et al. (2015) indicated that the pre-construction phase represents the highest opportunity to influence project work health and safety outcomes through the design phase. Hence, as the design of a project progresses in the pre-construction phase, there is a diminishing opportunity to influence health and safety risks through design. This finding was confirmed by Adaku et al. (2021).

Notwithstanding these revelations concerning the concept of DfS, several factors have been associated with its practical implementation in the literature (Poghosyan et al., 2018; Lingard et al., 2015). These factors are reported to include: designers' knowledge, awareness, and education; DfS implementation tools; the influence of clients and motivation; and legislation in DfS implementation. Gambatese et al. (2005) indicated that increasing the level of designer knowledge of the concept of DfS would lead to successful implementation in practice. The awareness of the concept can be raised through education by including DfS lessons as part of the engineering curriculum. A study by Behm et al. (2014) regarded the inclusion of DfS lessons as part of the engineering curriculum as the main source to influence the knowledge of safe design. Gambatese et al. (2005) suggested that the tools used in design and resources guide designers in addressing safety in their design. As an example of DfS tools, Zhang et al. (2013) proposed an automated safety rule checking tool to Building Information Models (BIM). Poghosyan et al. (2020) also developed a web-based tool for assessing the capability of design firms to implement DfS. Other digital tools for DfS are reported by Farghaly et al. (2021). Studies have shown that client involvement and influence in DfS affect the concept's implementation (Goh and Chua, 2016; Tymvios and Gambatese, 2016). This is mainly attributed to the clients being the funders and initiators of the construction project. Due to the established connection between the design phase and accidents that occur during construction, many countries have introduced legislation to encourage or require designers to take part in the safety of construction workers (Martínez Aires et al., 2010). An example of such legislation is the UK's Construction Design and Management Regulations 2015.

2.3 Towards investigating design for safety (DfS) in the construction industry in Kuwait: Knowledge gap

Most construction activities necessitate identifying and addressing the root causes of hazards in the construction industry to ensure the project life cycle's safety (Samsudin et al., 2022). Unfortunately, there is inadequate attention given to occupational safety and health in the construction industry in the GCC. Although the industry has proven to be the riskiest in terms of safety and health, there is still inadequate data on accidents and injuries recorded in the construction industry (Umar et al., 2019). Research has indicated that construction hazards and accidents are closely related to decisions made during projects' planning and design stages (Yuan et al., 2019). Many construction accidents are caused by inadequate safe design (Samsudin et al., 2022). Ensuring health and safety at the pre-construction stage of projects must be at the heart of both the client's and the designer's efforts to improve safety and safety. This means the concept of DfS must not be taken for granted among design professionals.

A review of the literature reveals that there have been studies conducted on occupational safety and health (OSH) within the context of Kuwait. These studies are summarized in Table 1 below. From Table 1, it is evident that there have been diverse views regarding OSH in the construction industry in Kuwait, and such studies have ranged from 1990 to date. The table also shows that most of these studies have focused on the views of clients, owners, and contractors regarding OSH. These studies have shown some usefulness in ascertaining these stakeholders' roles in occupational health and safety. However, there is inadequate information available on the evolving practice of DfS among design professionals in the GCC countries. This study pioneers this important subject by studying the context of the Kuwait construction industry. With the high rates of accidents and injuries recorded in Kuwait (Umar et al., 2019), there is the need to ascertain the extent of awareness and implementation of DfS among designers. This step would yield insights that could potentially stimulate efforts to educate various construction stakeholders on how OSH hazards could be mitigated throughout the design stage using the appropriate tools.

INSERT TABLE 1

3.0 Methodology

A quantitative research approach, particularly a questionnaire survey, was adopted to obtain a generic perspective of issues regarding DfS implementation among design professionals (Architects and Civil/Structural Engineers) in Kuwait. Bryman (2012), Naoum (2013) and Creswell (2014) have all indicated that the survey strategy is the most suitable where one seeks to obtain a generalized view of a phenomenon. Since this study sought to obtain a generic view of the level of awareness and implementation of DfS among design professionals in Kuwait, the survey approach was considered the most suitable. The survey approach has also been adopted in previous DfS studies in order to obtained a generalised view of the subject of inquiry (e.g., Goh and Chua, 2016; Ismail et al., 2021).

3.1 Design of survey instrument

The questionnaire items were adopted/adapted from previous DfS studies (Manu et al., 2018, 2019; Abueisheh et al., 2020) to suit the context of this study.

The questionnaire was divided into two parts. Part one sought general demographic information like profession, years of experience in construction and years of experience in their role, academic qualification, professional affiliation and finally, information relating to the participants work and the size of the organisation.

Part two captured respondents' DfS awareness and implementation and comprised six sub-questions. Sub-question 1 required the participants to determine their level of awareness of the concept of DfS. Sub-question 2 focused on DfS implementation. Respondents were required to indicate their frequency of engagement in 15 DfS practices using the five-point Likert scale (i.e., 1=never, 2=rarely, 3=sometimes, 4=often, 5=always). Sub-question 3 sought to assess the attitude of respondents towards the DfS concept. The respondents were required to rate the importance of implementing the concept based on the five-point Likert scale (i.e., 1=Not important, 2=Low importance, 3=Moderate importance, 4=High importance, 5=Very high importance). Sub-question 4 required the respondents to indicate if they would consider implementing DfS if given the opportunity. In sub-question 5, six factors that affect DfS implementation (drawn from literature; see section 2.2) were provided to the participants, and they were asked to determine to what extent these factors influence DfS implementation in the Kuwait construction industry using a 5-point Likert scale (1=Not at all, 2=Low, 3=Moderate, 4=High, 5= Very High). Sub-section 6 concerned DfS education and training. This section required respondents to specify whether they had received DfS lessons and training and were interested in receiving DfS training.

3.2 Survey administration

The population for the study comprised design professionals (i.e., Architects, Building and Civil Engineers) in Kuwait. This targeted population was compiled from Kuwait's construction and architectural firm directories (i.e., kuwaitlisting.com). Though there was a known sampling frame of the design professionals, it was still difficult to access such professionals. This problem made the authors resort to using two non-probability sampling approaches, i.e., purposive and snowball sampling. The purposive sampling assisted the researchers in identifying a prospective respondent from the list of potential respondents previously identified from the website. These respondents were then asked to forward the questionnaire to other design professionals within their professional networks through snowball sampling. These approaches enabled the researchers to obtain 73 useable responses. While a higher number of responses were reported in other construction DfS studies [e.g., 130 responses were reported by Manu et al. (2018) in a survey in Ghana and 161 responses were reported by Manu et al. (2019) in a survey in Nigeria], it is worth noting that the population of these countries [i.e., 30.5 million for Ghana and 200 million for Nigeria (World Population Review, 2019)] is significantly higher than the population of Kuwait (i.e., 4.271 million). Furthermore, other construction DfS studies (e.g., Goh and Chua's (2016) study in Singapore) reported fewer responses (i.e., 43 responses). Based on the foregoing discussion, the number of collected responses in this study (i.e., 73) can be deemed reasonable.

3.3 Data analyses

The data obtained were initially inputted into Microsoft Excel for screening and then exported to IBM Statistical Package for Social Sciences (SPSS) Statistics version 23. Descriptive statistical analyses (i.e., frequencies, means and standard deviations) and inferential statistical analyses (i.e., one-sample t-test, independent samples t-test, and one-way analysis of variance (ANOVA) were conducted. The one-sample *t*-test was used to assess the respondents' level of engagement in the 15 DfS practices. The independent samples *t*-tests and ANOVA were used to explore associations between respondents' characteristics (e.g., their DfS awareness, education, training, professional body membership, and work experience) and the implementation of DfS.

4.0 Results

This section presents the outcome of the data analyses within the following sub-sections.

4.1 Demographic information of respondents

Respondents' demographic information is presented in Table 2 below. Table 2 captured vital demographic information. Over 60% of the respondents are architects (63.0%). Most of the respondents are either bachelor's degree holders or master's degree holders with equal percentages of 46.6%. Approximately 80% of the respondents are members of a professional body. Architectural and engineering firms (28.8%) ranked the highest type of organisation the respondents work for. A majority (44%) of the respondents worked with large organisations. Most respondents have more than ten years of experience in their roles and industry. The average years of experience for the respondents in their role is 13.94 years (Standard deviation= 8.80). Similarly, the average years of experience in the industry are 15.07 years (Standard deviation= 10.16).

INSERT TABLE 2

4.2 Respondents' DfS profile

From Table 2, 82.2% of the respondents indicated that they are aware of the concept of DfS. Only 50.7% of the respondents were taught DfS as part of their formal education. Similarly, nearly only half of the respondents have participated in DfS training. Most respondents indicated an interest in participating in DfS training, and both attending seminars and receiving online courses were preferred by the respondents equally. Considering DfS importance, the vast majority of the respondents (i.e., approximately 92%) consider DfS implementation to be important or very important (Table 2). In addition, Table 2 shows that nearly all the participants are willing to apply DfS in their design.

4.3 Engagement in DfS practices

Table 3 shows the results of the frequency of engagement in the 15 DfS practices. The results indicate that more than 50% of the respondents undertake 10 out of the 15 practices often or always, while for the remaining five practices, less than 50% of the respondents engage in them often or always.

As previously discussed in the literature review, the linkage between design decisions and construction OSH is well established, and as such, DfS should be an essential component of the design process. Furthermore, the examined 15 practices are associated with major causes of construction illnesses and injuries, e.g., manual handling, work at height, and working with substances hazardous to health (Manu et al., 2018, 2019). Consequently, the view held by the study was that the level of engagement in the 15 DfS practices should be at least "often". Therefore, the one-sample *t*-test was conducted using a test value of 3.5 (i.e., p (1-tailed) ≤ 0.05), which approximates to "4" on the 5-point Likert scale, which corresponds to "often" on the Likert scale. Thus, from the one-sample t-test, a practice with a mean frequency of engagement that is significantly greater than 3.5 can be deemed to be implemented at least often by designers. Table 4 represents the outcome of the one-sample *t*-test. Eight out of fifteen practices are implemented at least often by the respondents.

INSERT TABLE 3

INSERT TABLE 4

4.4. Independent sample t-test results for the level of engagement in DfS practices

Drawing on previous DfS studies (e.g. Gambatese et al., 2005; Behm et al., 2014; Manu et al., 2019; Poghosyan et al. 2018), independent samples *t*-tests were carried out to explore whether there are statistically significant differences in the mean of the frequency of engagement in the 15 DfS practices by the following clusters:

1. Differences in the frequency of engagement in DfS practices based on the awareness of the DfS concept.
2. Differences in the frequency of engagement in DfS practices based on DfS training.
3. Differences in the frequency of engagement in DfS practices based on participants' education in DfS as part of their formal education.
4. Differences in the frequency of engagement in DfS practices based on professional body membership.

For conciseness, only the significant results (i.e., p (2-tailed) $\geq$ 0.05) are presented. The independent samples *t*-test revealed that nine out of fifteen practices had significant differences in the frequency of engagement when the group of respondents who are aware of the concept of DfS were compared with those who are unaware of DfS. The nine practices are listed in Table 5. In terms of DfS training, six out of fifteen practices had significant differences when respondents who participated in DfS training were compared with respondents who did not participate in DfS training. The results are provided in Table 6. Table 7 indicates seven out of fifteen DfS practices that had significant engagement differences when the groups of respondents who have been educated about DfS as part of their formal education are compared with the groups who have not been educated about DfS.

When the respondents who are members of a professional body are compared with the group of respondents who are not members of a professional body, only three out of fifteen DfS practices had a significant difference in engagement. The practices are: DfS.(P3) [t(71) = 2.236, *p* (2-tailed) = 0.029)]; DfS.(P6) [t(71) = 2.308, *p* (2-tailed) = 0.024)]; and DfS.(P7) [t(71) = 2.060, *p* (2-tailed) = 0.024)].

INSERT TABLE 5

INSERT TABLE 6

INSERT TABLE 7

4.5 One-way ANOVA results for the level of engagement in DfS practices

Drawing on previous DfS studies (e.g. Abueisheh et al., 2020) one-way ANOVA tests were carried out to explore whether there are statistically significant differences in the mean of the frequency of engagement in the 15 DfS practices by three clusters:

1. Experience in role (categorised as 1-5 years; 6-10 years and over 10 years).
2. Size of the organisation (categorised as 1-10 employees; 11-50 employees and over 50 employees).
3. Highest level of academic qualification (categorised as bachelor's degree; master's degree and PhD)

The outcome of the One-way ANOVA test for years of experience in role revealed three DfS practices that had a statistically significant difference in the frequency of engagement based on years of experience. The practices are: DfS.(P9) [F (2,70) = 5.108, *p* (2-tailed) = 0.008]; DfS.(P12) [F (2,70) = 3.783 , *p* (2-tailed) = 0.028]; and DfS.(P14) [F (2,70) = 3.525, *p* (2-tailed) = 0.035]. The One-way ANOVA test conducted based on the organisation's size did not show any significant differences in the frequency of engagement based on the size of the organisation.

4.6 Factors affecting DfS implementation

The respondents' views were further sought regarding six factors) that have the potential to affect DfS implementation in the construction industry in Kuwait. To determine the most significant factors, a one-sample *t*-test was carried out with a test value of 3.5. The result (shown by Table 8) of the one-sample *t*-test suggests that all the factors influence DfS implementation to a high extent except for F.1 (i.e. "availability of computer software applications regarding DfS") and F.5 (i.e. "client's influence").

INSERT TABLE 8

5. Discussion

The results from the data analyses offer valuable insight into the status of the concept of DfS in Kuwait. These results also provide indications about DfS characteristics and the factors which affect its implementation in Kuwait.

The results for the frequency of engagement in the 15 DfS practices (Table 3) and the one-sample *t*-test (Table 4) reveal an overall moderate level of engagement in DfS practices. The one-sample *t*-test indicates that only eight out of the fifteen practices are being implemented often or always by the participants. This corresponds to an approximately 50% level of engagement across the 15 DfS practices. This finding is not surprising because literature reports the poor status of work health and safety in the construction industry in Kuwait (Umar et al., 2019). This problem could be the outcome of this level of engagement in design for safety practices among design professionals in Kuwait. Notwithstanding, this outcome could be considered to be relatively better because compared to DfS studies in other contexts (Ghana, Nigeria, and Palestine), lower engagement levels in DfS practices were reported (Manu et al., 2018, 2019; Abueisheh et al., 2020).

The general picture emerging from the analyses is that there is a very high percentage of respondents who are aware of the concept of DfS (Table 2), and the attitude towards DfS is positive as nearly all the respondents are willing to apply this concept in their designs (Table 2). In addition, about 92% of respondents consider this concept to be important or very important (Table 2). Despite these results, the overall level of engagement in DfS practices was found to be moderate.

Furthermore, several other findings of this study warrant further discussion regarding the factors that affect DfS implementation in Kuwait. A study by Poghosyan et al. (2018) suggested that DfS education is a crucial factor that influences DfS implementation. The analyses revealed limited DfS lessons in formal education as only nearly 50% of the participants had been educated about DfS as part of their formal education. Consequently, the moderate DfS engagement could also be attributed to the limited DfS education as part of the formal education in Kuwait.

Regarding the independent samples t-test, the expectations held by the study were that: respondents who have previous DfS knowledge would tend to engage more in the concept than those who do not have any previous knowledge; respondents who have participated in DfS training would tend to engage more in DfS practice than those who have not; respondents who have been educated about DfS as part of their formal education would engage more in the concept than those who have not; and respondents' professional affiliation would increase the likelihood of engagement in DfS practice. These expectations were informed by previous DfS studies (Gambatese et al., 2005; Behm et al., 2014; Manu et al., 2018, 2019; Abueisheh et al., 2020). The independent samples *t*-test revealed that the professional body membership had very limited association with DfS implementation. In addition, contrary to the findings of Manu et al. (2018; 2019) and Abueisheh et al. (2020), in the case of Kuwait, the results yielded from the independent samples *t*-tests revealed that there was some level of association between the frequency of engaging in DfS practices and awareness of DfS, DfS training, and DfS education. Nonetheless, the association appears to be moderate given that only 6 to 9 (out of the 15 DfS practices) are associated with these demographic characteristics. This signals that there could be other factors that influence design for safety implementation in Kuwait, such as legislation and client influence (Tymvios and Gambatese, 2016; Goh and Chua, 2016) as revealed by Table 8.

Considering the one-way ANOVA tests conducted to determine differences in the mean of frequency of engagement in DfS practices by different categories of groups, previous DfS studies (Abueisheh et al., 2020) held expectations that firstly, there would be a discrepancy in the frequency of engagement in DfS practice between respondents with different educational backgrounds. Secondly, years of experience would influence DfS practice, and finally, the size of the respondents' organisation would also influence DfS practice. In this regard, the one-way ANOVA tests did not reflect any of the above expectations mirroring similar outcomes to the above-mentioned previous DfS studies. The outcome of the one-way ANOVA test showed either no or minimal association between frequency of engaging in DfS practices and experience in the role, size of the organisation, and level of education. These outcomes mirror previous DfS studies (Abueisheh et al., 2020).

The general picture emerging from the independent samples *t*-test and the one-way ANOVA tests is that previous knowledge of the concept of DfS, training, and education have some level of association with DfS engagement. However, other factors such as professional affiliation, level of education, years of experience, and size of an organisation have very limited influence on the frequency of engagement.

Finally, what seems to be counterintuitive is that the very high level of interest in DfS training (93.2%, as shown in Table 2) was coupled with a low level of engagement in DfS training (47.9% as shown in Table 2). Manu et al. (2018; 2019) argued that this phenomenon could be attributed to the presence of knowledge acquisition barriers and the lack of DfS training.

6.0 Conclusions

This study investigated the level of DfS awareness and its implementation amongst design professionals in the Kuwait construction industry. The main conclusions drawn from the research are the following:

- There is moderate engagement in DfS practices but a high level of DfS awareness among designers in the Kuwait construction industry.
- DfS is generally regarded as highly important among design professionals in the Kuwait construction industry, and the attitude towards implementing the concept is positive.
- There is high interest in undertaking DfS training but low levels of actual engagement in DfS training.
- There appear to be limited DfS lessons in formal education for design professions.
- There is some degree of association between designers' DfS awareness, training and education, and the level of engagement in DfS practices. However, other factors such as professional affiliation, level of education, years of experience, and organisation size have either no or very limited association with the implementation of DfS practices.
- In the view of design professionals in Kuwait, factors such as the inclusion of DfS in the formal education of design professionals, regulations regarding DfS, industry guidance regarding DfS, and availability of DfS training would greatly influence DfS implementation in Kuwait.

6.1 Theoretical and practical implication of findings

Theoretically, this study contributes to the ever-increasing studies on the DfS implementation in the construction industry. It extends the DfS literature in the construction context, particularly into the advancements towards creating awareness of DfS among design professionals. Furthermore, as a pioneering study on DfS awareness and implementation in the GCC region, the findings from this study should provide the research community with the state of DfS implementation in a typical GCC country, i.e., Kuwait. Practically, the results could create the needed awareness of the state of DfS implementation in the construction industry in Kuwait. DfS should be an industry-wide concern; the construction industry in Kuwait could collectively focus its attention on eliminating hazards and minimizing risks to workers in the construction industry as early as the design phase. With the DfS influencing factors identified, the construction industry (through multi-stakeholder collaboration) could institute appropriate measures that would raise the profile of DfS and its implementation among design professionals.

6.*2 Implication for practice*

Recommendations for practice include:

- The level of designers' engagement in DfS should increase. For this to be accomplished, the contribution from all stakeholders is required. Support from the government in legislation could be a useful stimulus to promote DfS practices.
- The study showed a high interest in DfS training amongst designers in the Kuwait construction industry coupled with low engagement in DfS training. Therefore, industry stakeholders and professional bodies in Kuwait could provide DfS training in the form of seminars, workshops, and online courses.
- The study showed that respondents who have been educated about DfS as part of their formal education tend to engage more often in DfS practices. Given that only about half of the respondents have received DfS lessons, higher education institutions should provide more mechanism for the inclusion of DfS teaching and learning activities as part of the construction design curriculum.

6.3 Study's limitation and implications for research

The limitation of the study and the potential areas for further research are presented below:

- The targeted professionals in this study were only design professionals, including civil/structural engineers and architects in the Kuwaiti construction industry. Therefore, the results of this study may not adequately reflect the DfS awareness and implementation by other design professionals in Kuwait, e.g., building services designers. Further research should also be dedicated to investigating DfS awareness and implementation among other design professionals in Kuwait.
- Further qualitative studies (e.g., using phenomenology) could be undertaken to shed light on aspects of the results of this study, e.g., why is there low engagement in DfS training despite a high level of interest in DfS training.
- This study only considered design professionals in Kuwait. DfS implementation in the construction industries of other GCC countries could be carried out to enable a much more generalisation to be made.

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Table 1: Construction OSH studies within the context of Kuwait

Author	Year	Summary
Din	1990	The study examined safety considerations at construction sites in Kuwait. The study was based on the premise that the idea of superintendents thinking that safety may obstruct productive work is not entirely true. That is, whenever job pressures increase, safety performance decreases. Following interviews with safety department personnel and superintendents of the National Housing Authority in Kuwait, it was revealed that the strongest motivation of the contractor to control job-site safety is the governmental sanctions on the contractor following severe accidents for the site.
Kartam et al.	2000	The study evaluated existing safety regulations, described safety procedures adopted by owners, designers, contractors, and insurance companies. It assessed the suitability of the regulations and procedures in Kuwait's environment and workforce. The findings revealed that management in government, owners, and contractors were all aware of the importance of safety in construction but did not effectively pursue active ways to maximize the achievement of the safety goal.
Robertson and Lamm	2008	The authors conducted an in-depth literature review on the issue of occupational health and safety in the Kuwait construction industry. The study answered several questions by examining the intersections between the literature on contingent workers and occupational health and safety in the Kuwait construction industry. It also examined the extent to which cultural factors shape employers' practices and attitudes towards employment relations and workplace health and safety.
Al-Humaidi and Tan	2009	The study examined construction safety laws and practices and accidents on construction sites in Kuwait. The findings revealed that the construction industry has safety issues in Kuwait and revealed the need to change current legislations and control strategies on construction and building sites to more rigorous and control strategies to enhance safety on such sites.
Al-Humaidi and Tan	2010	The study analysed construction-related accidents in Kuwait between 1996-2007 that impacted the safety of construction site workers. The study's findings revealed that the construction industry is the most hazardous of all industries in Kuwait. The major causes of accidents that impacted the safety of construction site workers were identified

		in the order of importance as falls, crushed or struck by a falling object, use or misuse of tools, among others.
Naseeb and Alawadhi	2014	The authors studied the preparedness and awareness of construction companies in Kuwait for hazards. This aim was based on the premise that one of the important stages in safety management is the identification of hazards. The findings revealed that there are several steps to follow to apply safety measures in construction projects. Unfortunately, these steps are not followed because of extensive use of foreign labour, extensive use of subcontractors, lack of reporting system and accident record keeping, among others.
Robertson	2018	This study examined the OHS experiences of vulnerable migrant workers in the Kuwait construction industry. The findings revealed that cultural indifferences that lead to power and control abuses within the low-bid tendering system severely compromised the OSH of the migrant construction workers.
Almutairi	2019	The study explored how the safety behaviours of construction workers were affected by the national culture within Kuwait's oil and gas sector. The findings revealed that six basic factors affect construction safety performance in Kuwait. The factors were identified as insufficient budgets, safety culture, work pressure, national culture, government role and allocation of safety personnel during tendering.

Table 2: Demographic information and DfS profile of respondents

Characteristic	Frequency	Percentage
Role		
Architect	46	63.00%
Civil/Structural engineers	27	36.90%
Highest level of academic qualification		
Diploma	2	2.70%
Bachelor’s degree	34	46.60%
Master’s Degree	34	46.60%
PhD degree	2	2.70%
Other	1	1.40%
Experience in role		
1-5 years	15	20.50%
6-10 years	14	19.10%
> 10 years	44	60.20%
Experience in industry		
1-5 years	14	19.10%
6-10 years	14	19.10%
> 10 years	45	61.60%
Professional body membership		
Yes	60	82.20%
No	13	17.80%
Type of organisation		
Architectural firm	12	16.40%
General building/civil engineering contractor	11	15.10%
Project management consultant	8	11.00%
Architectural & engineering firm	21	28.80%
Private engineering consultancy	6	8.20%
Other	15	20.50%
Size of organisation		
Micro	9	12%
Small	17	23%
Medium	15	21%
Large	32	44%
Design for safety awareness		
Yes	60	82.20%
No	13	17.80%
Participants’ education in DfS as part of their formal education		
Yes	37	50.70%
No	36	49.30%

Participations in design for safety training		
Yes	35	47.90%
No	38	52.10%
Participants' views regarding the importance of DfS implementation		
Very important	39	53.40%
Important	28	38.40%
Moderate importance	3	4.10%
Low importance	3	4.10%
Not important	0	0%
Participants' willingness to apply DfS		
Yes	70	95.90%
No	3	4.10%
Interest of participants in participating in design for safety training		
Yes	68	93.20%
No	5	6.80%
Participants' design for safety training preference		
Interest in attending Design for Safety seminar/workshop	44	47.80%
Interest in online course/ Study materials training	45	48.90%
Other design for safety training preference	3	3.30%

Table 3: Percentages of engagement in 15 DfS practices

DfS practice code	DfS Practices [a]	Percentage of frequency of engagement (%)					
		Never	Rarely	Sometimes	Often	Always	Often or always
DfS.(P1)	I design to avoid construction operations that create hazardous fumes, vapour and dust (e.g. disturbance of existing asbestos and cutting blockwork and concrete).	23.3	9.6	24.7	17.8	24.7	**42.5**
DfS.(P2)	I specify materials that require less frequent maintenance or replacement.	5.5	4.1	11.0	42.5	37.0	79.5
DfS.(P3)	I specify materials that are easier to handle, such, e.g. light weight blocks.	4.1	5.5	27.4	42.5	20.6	63.0
DfS.(P4)	I design to take into account the safe movement of site workers, plants, & equipment on a project site during construction.	6.9	9.6	21.9	13.7	48.0	61.7
DfS.(P5)	I specify materials that have less hazardous chemical constituents.	4.1	6.9	17.8	35.6	35.6	71.2
DfS.(P6)	I eliminate materials that could create a significant fire risk during construction.	4.1	2.7	11.0	34.3	48.0	82.2
DfS.(P7)	I design to position buildings/structures to minimise risks from buried services and overhead cables.	6.9	12.3	2.7	26.0	52.1	78.1
DfS.(P8)	I design to mitigate possible adverse impact a project could have on safe movement of the general public during construction.	5.5	8.2	16.4	24.7	45.2	69.9
DfS.(P9)	I design elements (e.g. walls, floors, etc.) so that they can be prefabricated offsite.	9.6	16.4	45.2	19.2	9.6	**28.8**

DfS.(P10)	I design to minimize or eliminate the need to work at height.	9.6	28.8	35.6	20.6	5.5	**26.0**
DfS.(P11)	I design to minimize or eliminate the need for workers to work in confined space.	8.2	20.6	28.8	32.9	9.6	**42.5**
DfS.(P12)	I highlight unusual construction considerations that have safety implications to the contractor e.g. key sequence of erecting/construction	6.9	17.8	15.1	32.9	27.4	60.3
DfS.(P13)	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.	9.6	19.2	11.0	27.4	32.9	60.3
DfS.(P14)	I produce designs that enable ease of building/constructing	2.7	6.9	23.3	24.7	42.5	67.1
DfS.(P15)	I prepare hazard identification drawings which show significant hazards that may not be obvious to a contractor.	26.0	20.6	23.3	13.7	16.4	**30.1**

[a]Note: DfS practices adopted from literature (Manu et al., 2018, 2019; Abueisheh et al., 2020)

Table 4: Outcome of the one-sample t-test for engagement in design for safety practice

						Test Value = 3.5						
											95% Confidence Interval of the Difference	
DfS Practice code	N	Mean	Rank of mean	Std. Deviation	Std. Error Mean	t	df	*p* (2-tailed)	*p* (1-tailed)	Mean Difference	Lower	Upper
DfS.(P6)	73	4.19	1	1.023	0.120	5.779	72	0.000	0.000	0.692	0.45	0.93
DfS.(P7)	73	4.04	2	1.296	0.152	3.568	72	0.001	0.001	0.541	0.24	0.84
DfS.(P2)	73	4.01	3	1.074	0.126	4.088	72	0.000	0.000	0.514	0.26	0.76
DfS.(P14)	73	3.97	4	1.093	0.128	3.696	72	0.000	0.000	0.473	0.22	0.73
DfS.(P8)	73	3.96	5	1.207	0.141	3.249	72	0.002	0.001	0.459	0.18	0.74
DfS.(P5)	73	3.92	6	1.090	0.128	3.276	72	0.002	0.001	0.418	0.16	0.67
DfS.(P4)	73	3.86	7	1.305	0.153	2.377	72	0.020	0.010	0.363	0.06	0.67
DfS.(P3)	73	3.7	8	0.996	0.117	1.705	72	0.093	0.047	0.199	-0.03	0.43
DfS.(P12)	73	3.56	9	1.258	0.147	0.419	72	0.677	0.339	0.062	-0.23	0.36
DfS.(P13)	73	3.55	10	1.375	0.161	0.298	72	0.767	0.384	0.048	-0.27	0.37
DfS.(P11)	73	3.15	11	1.114	0.130	-2.679	72	0.009	0.005	-0.349	-0.61	-0.09
DfS.(P1)	73	3.11	12	1.487	0.174	-2.244	72	0.028	0.014	-0.390	-0.74	-0.04
DfS.(P9)	73	3.03	13	1.067	0.125	-3.785	72	0.000	0.000	-0.473	-0.72	-0.22
DfS.(P10)	73	2.84	14	1.041	0.122	-5.453	72	0.000	0.000	-0.664	-0.91	-0.42
DfS.(P15)	73	2.74	15	1.414	0.166	-4.592	72	0.000	0.000	-0.760	-1.09	-0.43

Table 5: Differences in the frequency of engaging in DfS practices based on awareness of the DfS concept

DfS practice code	Design for safety awareness	N	Mean	Std. Dev.	Std. Error Mean	Independent Samples *t*-test: t	df	*p*(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
DfS.(P1)	Yes	60	3.28	1.462	0.189	2.202	71	0.031	0.976	0.443	0.092	1.859
	No	13	2.31	1.377	0.382		18.354					
DfS.(P2)	Yes	60	4.17	0.942	0.122	2.730	71	0.008	0.859	0.315	0.232	1.486
	No	13	3.31	1.377	0.382		14.524					
DfS.(P3)	Yes	60	3.82	0.873	0.113	2.236	71	0.029	0.663	0.296	0.072	1.254
	No	13	3.15	1.345	0.373		14.269					
DfS.(P4)	Yes	60	4.08	1.078	0.139	3.305	71	0.001	1.237	0.374	0.491	1.983
	No	13	2.85	1.772	0.492		13.983					
DfS.(P7)	Yes	60	4.18	1.142	0.147	2.060	71	0.043	0.799	0.388	0.026	1.572
	No	13	3.38	1.758	0.488		14.272					
DfS.(P8)	Yes	60	4.15	1.022	0.132	3.072	71	0.003	1.073	0.349	0.377	1.770
	No	13	3.08	1.605	0.445		14.179					
DfS.(P9)	Yes	60	3.15	1.022	0.132	2.163	71	0.034	0.688	0.318	0.054	1.323
	No	13	2.46	1.127	0.312		16.556					
DfS.(P11)	Yes	60	3.28	1.059	0.137	2.246	71	0.028	0.745	0.332	0.084	1.406
	No	13	2.54	1.198	0.332		16.311					
DfS.(P13)	Yes	60	3.70	1.331	0.172	2.076	71	0.041	0.854	0.411	0.034	1.674
	No	13	2.85	1.405	0.390		16.993					

Table 6: Differences in the frequency of engaging in DfS practices based on design for safety training

DfS practice code	Design for Safety training	N	Mean	Std. Dev.	Std. Error Mean	Independent Samples *t*-test: t	df	*p*(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
DfS.(P1)	Yes	35	3.51	1.358	0.230	2.298	71	0.025	0.777	0.338	0.103	1.452
	No	38	2.74	1.519	0.246		70.943					
DfS.(P4)	Yes	35	4.31	1.105	0.187	2.987	71	0.004	0.867	0.290	0.288	1.446
	No	38	3.45	1.350	0.219		70.072					
DfS.(P9)	Yes	35	3.37	1.060	0.179	2.763	71	0.007	0.661	0.239	0.184	1.138
	No	38	2.71	0.984	0.160		69.289					
DfS.(P12)	Yes	35	3.89	1.207	0.204	2.166	71	0.034	0.623	0.287	0.049	1.196
	No	38	3.26	1.245	0.202		70.806					
DfS.(P13)	Yes	35	4.06	1.136	0.192	3.230	71	0.002	0.978	0.303	0.374	1.582
	No	38	3.08	1.421	0.231		69.658					
DfS.(P15)	Yes	35	3.31	1.323	0.224	3.596	71	0.001	1.104	0.307	0.492	1.716
	No	38	2.21	1.298	0.211		70.256					

Table 7: Differences in the frequency of engaging in DfS practices based on participants' DfS education

						Independent Samples *t*-test						
											95% Confidence Interval of the Difference	
DfS practice code	Design for Safety education	N	Mean	Std. Dev.	Std. Error Mean	t	df	*p* (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
DfS.(P4)	Yes	37	4.46	0.836	0.138	4.444	71	0.000	1.209	0.272	0.667	1.752
	No	36	3.25	1.422	0.237		56.333					
DfS.(P9)	Yes	37	3.32	1.056	0.174	2.497	71	0.015	0.602	0.241	0.121	1.083
	No	36	2.72	1.003	0.167		70.962					
DfS.(P10)	Yes	37	3.14	1.032	0.170	2.589	71	0.012	0.607	0.235	0.140	1.075
	No	36	2.53	0.971	0.162		70.921					
DfS.(P11)	Yes	37	3.65	0.949	0.156	4.321	71	0.000	1.010	0.234	0.544	1.476
	No	36	2.64	1.046	0.174		69.914					
DfS.(P12)	Yes	37	4.08	0.983	0.162	3.916	71	0.000	1.053	0.269	0.517	1.590
	No	36	3.03	1.298	0.216		65.202					
DfS.(P13)	Yes	37	4.27	0.804	0.132	5.355	71	0.000	1.465	0.274	0.919	2.010
	No	36	2.81	1.451	0.242		54.351					
DfS.(P15)	Yes	37	3.46	1.325	0.218	5.122	71	0.000	1.459	0.285	0.891	2.028
	No	36	2.00	1.095	0.183		69.215					

Table 8: Factors that influence DfS implementation - one-sample *t*-test

DfS Influence factor code*	N	Mean	Std. Dev.	Std. Error Mean	Test Value = 3.5					
					t	df	*p* (1-tailed)	Mean Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(F.1)	73	3.38	1.209	0.142	-0.823	72	0.207	-0.116	-0.40	0.17
(F.2)	73	3.79	1.166	0.136	2.158	72	0.017	0.295	0.02	0.57
(F.3)	73	3.95	1.104	0.129	3.445	72	0.001	0.445	0.19	0.70
(F.4)	73	3.99	1.161	0.136	3.580	72	0.001	0.486	0.22	0.76
(F.5)	73	3.64	1.273	0.149	0.965	72	0.169	0.144	-0.15	0.44
(F.6)	73	3.81	1.174	0.137	2.242	72	0.014	0.308	0.03	0.58

Notes: F.1 = Availability of computer software applications regarding design for safety; F.2 = Availability of design for safety training; F.3 = Industry guidance regarding design for safety; F.4 = Regulation regarding design for safety; F.5 = Client's influence; F6 = Inclusion of design for safety in the formal education of design professional (e.g. degree programme for engineers and architects).