DESIGN FOR SAFETY ORGANISATIONAL CAPABILITY IN MALAYSIA: A MULTI-STAKEHOLDER PERSPECTIVE

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Since the introduction of Occupational Safety and Health in Construction Industry (Management) (OSHCI(M)) in Malaysia, little effort has been made to capture the current state of construction organisations' Design for Safety (DfS) capability towards fulfilling the stipulated requirements. Therefore, this paper aims to discuss the current state of six DfS organisational capability elements (i.e., competency, corporate experience, collaboration, infrastructure, strategy, and system) among key construction stakeholders in Malaysia. Based on the online questionnaire survey, the findings indicated that all 18 attributes under the six main elements are important in determining an organisation's ability to practise DfS. Additional initiatives such as incentivisation, early education; practical guidance, professional training, and enforcement were also required to enhance the existing DfS frameworks. The findings from this study have salient implications in enhancing the ability of construction organisations in Malaysia to instil DfS practices from the upstream stages of typical projects lifecycles.

Keywords: design for safety; safety and health; organisational capability; Malaysia

INTRODUCTION

The construction industry has long been suffered from the organisational inability to manage workplace safety and health as a collective endeavour. The fact that managing occupational safety and health (OSH) is a traditional concern in the construction industry, continuous efforts by governments worldwide have led to the introduction of innovative OSH practices. These efforts are reflected in the establishment of the Design for Safety (DfS) concept which is known as Safe Design in Australia and New Zealand, Prevention through Design (PtD) in the United States and Construction Design and Management (CDM) in the UK. The DfS concept has been promoted via different forms of frameworks, for instance as a legislation (where DfS is legally enforceable) such as the CDM regulations in UK and as a guideline (non-mandatory or voluntary basis) such as the Occupational Safety and Health in

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Construction Industry (Management) (OSHCIM) in Malaysia and the Guidelines for addressing occupational hazards and risks in design and redesign processes in the United States. The DfS concept is often seen as a preventive practice, where OSH risks and hazards are mitigated or eliminated in the early phases of project lifecycle. While DfS practices promote the collective prevention practice among project stakeholders (Che Ibrahim *et al.,* 2022), design organisations have specific responsibilities which is, as far as practicable in the design phase, to mitigate OSH hazards during the construction, operation and occupation phase of a building or structure (Schulte, 2008).

LITERATURE REVIEW

Although the role of organisations has been highlighted in DfS-related legislations in reducing accident occurrences (Health and Safety Executive, 2015; Gambatese *et al.,* 2017), there are still limitations and challenges that continually emerge in various contexts (e.g., concept, processes, legislation, regulatory requirements, collaboration, technologies, early and continuous education etc) that affect the organisational capability in DfS implementation. The ambiguity associated with regulatory prescriptions of competence and its assessment, have contributed to the inability of design organisations to fulfil their duties under the DfS-related legislative / guideline framework (Manu *et al.,* 2019; Che Ibrahim and Belayutham, 2020; Adaku *et al.,* 2021). The lack of clarity on the required DfS capabilities, coupled with the misconceptions, mindset, and ownership among design organisations (Behm *et al.,* 2014; Manu *et al.,* 2021), as well as the lack of competence (knowledge, skills and experience) among designers in addressing the OSH issues during the design phase (Morrow *et al.,* 2016; Che Ibrahim *et al.,* 2021) could further impede the progress of DfS diffusion.

A review of related literature has highlighted that there is a growing body of DfS research in developed countries especially UK, USA, and several countries within the European Union (Manu *et al.,* 2021), and it is still a growing area of research and practice in many developing countries including Malaysia, whereby DfS concepts remain underdeveloped. Against this backdrop, there's been significant upgrades to the existing OSH guideline in Malaysia, to better encapsulate DfS principles and practices (Che Ibrahim *et al.,* 2020). Specifically, the OSHCIM has been introduced in 2017 as part of DfS practice to enhance the capability of construction stakeholders in improving the safety performance of the construction industry. The fact that OSHCIM is relatively new to the industry, most players within the industry are still unclear about the DfS subject (Che Ibrahim *et al.,* 2020; Ismail *et al.,* 2021; Che Ibrahim *et al.,* 2022). Thus, the need to capture the state of DfS capability of Malaysian organisations in fulfilling the OSHCIM requirements highlighted in Sections 3.1 and 3.2 of the guidelines.

Although there have been several studies related to DfS in construction studies, empirical studies related to DfS capability at the organisational level is still limited. This limitation could hinder the actual capabilities in relation to DfS practices as different disciplines of professional might influence the level of specificity (i.e., task, project, programme, and portfolio) of organisational capability (Adaku *et al.,* 2021). Also, different geographical contexts (e.g., legislations, safety requirements, public procurement) might influence the dynamism of organisation to undertake OSH exercises (Oney-Yazici and Dulaimi, 2015; Goh and Chua, 2016). Although existing DfS studies on organisational capabilities (e.g., Manu *et al.,* 2019; Poghosyan *et al.,*

2020) provide a useful insight into the organisational capability landscape, the findings in these studies were mostly framed based on responses from the UK (where DfS practise is well established in CDM regulations) and, thus, these studies were limited in terms of responses from those countries where DfS legislations are non-existent or have recently been developed. Thus, to fill the identified gap within the existing body of DfS knowledge, the aim of this study is to investigate the DfS organisational capability among the key stakeholders in Malaysia.

The key elements of OSHCIM are as follows, where OSHCIM: Applies to design, construction, maintenance, and demolition phases (full cycle); Focuses on planning, design and management of construction projects; Sets the standard/objective to achieve, but not how; and Main responsibility to the client/developer, principal designer and principal contractor. OSHCIM has similar characteristics to the CDM in the UK, owing to its adaptation of CDM regulations 2015 (CIDB, 2019). This study has adopted a theoretical framework based on empirical organisational DfS capability related studies (see Manu *et al.,* 2019; Adaku *et al.,* 2021) as a foundation to construct an OSHCI(M) organisational maturity framework. A recent study by Manu *et al.,* (2019) identified six key elements related to organisational DfS capability (see Fig. 1): 1) Competence; 2) Strategy; 3) Infrastructure; 4) System; 5) Collaboration and 6) Corporate Experience. These elements went through an extensive process of validation and verification through three focus group sessions with eight UK construction and OSH professionals, as well as three rounds of Delphi survey involving 28 - 32 experts. As the UK has been implementing CDM regulations for the past two decades and has demonstrated a significant reduction in risk at the source (CIDB, 2019), the elements identified and verified by Manu *et al.,* (2019) would be a useful foundation for this DfS study.

Table 1 depicts the alignment of the key elements of DfS organisational capability with the OSHCIM principles (as stipulated in section 1.2 of the Guidelines on OSHCIM 2017) to ensure the validity of these elements on the principle of OSHCIM. All six elements can address the five OSHCIM principles.

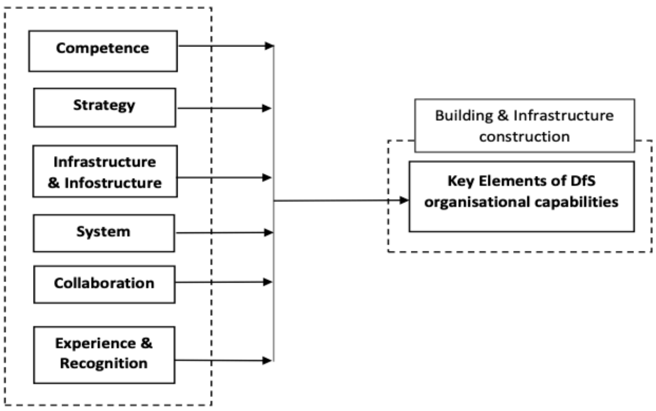

Figure 1: Key elements of DfS capability within an organisation (adapted from Manu et al., 2019 and Adaku et al., 2021)

METHOD

In view of the research aim to obtain a generic understanding of context pertaining to the knowledge gap on the current state of DfS organisational capability in Malaysia, a quantitative approach using questionnaire survey was adopted for this study. Such approach is deemed suitable because it able to elicit the perception of stakeholders against specific attributes (Fellow and Lui, 2015). An online questionnaire survey was developed and administered through SurveyMonkey platform to multiple stakeholders, using a purposive sampling approach.

Table 1: Mapping between key elements of DfS organisational capability and OSHCIM principles

Key Elements of DfS Organisational Capability	OSHCIM Principles (As stipulated in section 1.2 in Guidelines on OSHCIM 2017)				
	Risk management approach and general principles of prevention	Appointing the right organisations and people	Supervision, instruction, and information	Cooperating, communicating, and coordinating	Consulting and engaging with workers
1. Competence i.e., the competence of organisation's designer in respect of DfS	√		√	√	
2. Corporate Experience i.e., Organisation's experience in implementing DfS on projects		√	√	√	√
3. Multidimensional Collaboration i.e., inter and intra organisational collaboration within the project				√	√
4. System i.e., organisation's systems, processes and procedures required for DfS	√		√	√	
5. Infrastructure i.e., organisation's physical and dynamic information and communication technology (ICT) resources required for DfS	√			√	
6. Strategy i.e., the consideration of PtD practice in organisation's vision as well as the top management support for DfS		√			√

The first section of the questionnaire was designed to identify the demographic characteristics of the respondents, while the second section included descriptions on the extent to which the respondents consider the organisational capability attributes (adopted from Manu *et al.,* 2019) as important towards DfS practice in the Malaysian construction industry in the form of a five-point Likert-scale (1 = not at all important, 2 = least important, 3 = important, 4 = very important and 5 = extremely important). In the third section, the respondents were asked to rate their level of agreement regarding the influence of each of the described factors for DfS implementation.

The initial invitation was sent to over 150 potential respondents through an industrial network of experts that have previously attended OSHCIM workshops and seminars. Out of the 150 potential respondents, 90 responses were received and 82 were useable responses. The number of useable responses is considered appropriate when compared to the number of responses from other DfS studies (e.g., 73 responses reported in DfS studies in Kuwait (Sharar *et al.,* 2022) and 46 responses reported in DfS studies in Singapore (Goh and Chua, 2016)).

The responses, collected in Excel format, were then exported to IBM SPSS Statistic 26 Software to conduct descriptive statistical analysis (e.g., frequency, mean, percentages, and standard deviation) and inferential analysis to ascertain variations in DfS attributes across organisations.

From the 82 responses received, 58.5% and 41.5% of the respondents were male and female respectively. The response also depicted that respondent possessed an average of 13 years' experience within the construction industry. The respondents have described their organisations as contractor (42.7%), government agencies (24.4%), consultant (20.7%) and developer/owner (12.2%). It is worth noting that 42% of the respondents were registered as a professional (e.g., professional engineer, architect, surveyor, and technologist) under their respective professional bodies.

FINDINGS

Key elements of DfS organisational capability

Table 2 presents the results of the questionnaire survey on the key elements of DfS organisational capability. To demonstrate variations between designers, the mean values were divided into four key stakeholders in the construction industry: G1 (Contractor), G2 (Consultant), G3 (Government Agencies), and G4 (Developer/Owner). Based on this analysis it should be noted that the top five elements of DfS organisational attributes were dominated by top management commitment, design risk management and competency-related elements. From the analysis, commitment from top management (mean = 4.402) is the most important capability. It is acknowledged that the commitment from top management is one of the most important attributes for driving DfS related initiatives (Gambatese *et al.,* 2017). Such commitment in terms of proactive leadership and higher expectation for worker safety and health could positively impact the culture of DfS practice within the organisation.

The need for an organisation to ensure that their designers are fully equipped with such knowledge, experience, and skills (identified as second, third and fourth most important capability, respectively) has been explicitly highlighted in several DfS legislative / guideline frameworks. For example, in Regulation 8 within the Construction Design and Management (CDM) regulations 2015 in the UK; Section 3 on OSHCI(M) guideline in Malaysia; Part 3 - Duties of Designer and Contractor (regulation 9) under the WSH (DfS) Regulations in Singapore; and Part 2 - Health and Safety Duties (Section 22) of Work Health and Safety Act 2011 in Australia. A recent study by Che Ibrahim *et al.,* (2020) emphasised that DfS practice requires diverse capabilities (including design, constructability, organisational, human, technologies, and life cycle management), a wider range of competencies related to construction, design, hazard and risk, as well as other factors (e.g., procurement strategy, regulations, economic and social impacts, and management practices) in order to facilitate organisational DfS implementation (Che Ibrahim *et al.,* 2022).

The capability of having proper design management system (mean = 4.293) was fifth position from the list. Researchers (e.g., Che Ibrahim and Belayutham, 2020; Manu *et al.,* 2021) have emphasised that the lack of sufficient knowledge and skills among the design professionals is significant. This evidence has led to the need to have access to prescribed design management system in managing the DfS. Such a system could act as a foundational platform for designers to follow a structured and systematic risk identification and assessment process during the design phase with a high level of constructability (Toole *et al.,* 2017). Moreover, ability to integrate such systems in the activities could provide long-term positive impacts on project cost and duration (Gambatese *et al.,* 2017). It should also be noted that the two elements of least importance are corporate experience and research and innovation. The former could be because DfS is still relatively new and real-life impact case studies from Malaysia are scarce, making it challenging for organisations in Malaysia to quantify DfS values.

Upon further analysis with ANOVA test to examine the differences in perceived importance of the DfS organisational capability elements across the four groups of organisations (see Table 2), it was found that there was no statistical difference between the 18 sub-elements ($p>0.05$). However, some notable findings (mean value less than 4.000) are worth mentioning, particularly those from government agencies, where intra and inter-organisational collaboration elements received lower responses. This suggests that those working in government-related organisations are having slightly different views regarding the significance of inter-organisational collaboration to DfS implementation, owing to their fragmented experience managing projects through traditional procurement. On the other hand, the mean value for sub-element of physical work resources for consultant is 3.647 which are slightly lower than those of the other organisations and the overall values of 4.049. Such results may imply that professionals working in design organisations may not require a physical workspace/workstation and equipment in the office to support DfS, owing to less face-to face interaction and working from home policies due to the recent COVID-19 pandemic.

Factors influencing DfS implementation

Having identified the DfS organisational capability, this study also sought to understand the factors influencing DfS implementation. The results indicated that the first key factor is the "Government should provide incentive (e.g., tax deduction, subsidise DfS training) for companies that meet the requirements" (mean =4.146). The findings indicated that having external economic incentives can motivate further the interest of organisation to practice the DfS. Such incentives could be provided not only at the national level but also through local authorities as intermediaries to stimulate further efforts in DfS (Karakhan *et al.,* 2017). The second key factor on the list is the "Inclusion of DfS lessons in the formal education of design professional" (mean = 4.085). The importance of having early DfS learning has been highlighted by scholars (Abueisheh *et al.,* 2020; Che Ibrahim *et al.,* 2021; Adaku *et al.,* 2021) as a mechanism to improve the cognitive, psychomotor, and affective development towards enhancing the DfS principles.

The need for "Industry guidelines / practical guidance or codes for DfS implementation" (mean =4.073) comes third on the list. Previous studies (e.g., Abueisheh *et al.,* 2020; Sharar *et al.,* 2022) in different geographical locations have indicated the availability of DfS guidelines as being influential to DfS implementation. The fourth key factor is the "Professional development training relating to DfS for potential duty holder" (mean = 4.049). As DfS practice is relatively new concept is most countries, such training is critical for organisations to ensure the DfS sustainability and effectiveness. Also, continuous training, whether in-house or external, could provide newly graduated or experienced professionals with a better understanding of their role in fulfilling the requirements as a DfS duty holder (Ismail *et al.,* 2021). The fifth key factor is the need for "introduction of legislation relating to DfS (e.g., mandated legislation and DfS is one of the criteria in tendering)" (mean = 3.963). Such institutional pressure is viewed as a necessary mechanism to augment the country's DfS implementation. It is argued that ignoring the legal mechanism may result in DfS diffusion failing to perform its intended function of improving safety at the beginning of the project lifecycle. It is worth noting that the ANOVA test results showed no statistical difference between 12 factors across four different organisations (p>0.05).

Table 2: The responses on the key elements of DfS organisational capability

Element	*Overall Mean* (n=82)	*Mean values for each organisation* *G1* (n=35)	*G2* (n=17)	*G3* (n=20)	*G4* (n=10)	*Standard Deviation*	*Significant p*
Competency							
DfS skills of designer	4.293	4.371	4.000	4.400	4.300	0.762	0.355
DfS knowledge of designer	4.390	4.371	4.294	4.350	4.700	0.733	0.547
DfS experience of designer	4.329	4.343	4.235	4.300	4.500	0.755	0.850
DfS continuous professional development	4.120	4.114	4.471	3.800	4.100	0.754	0.060
Designer access to competent advice	4.159	4.086	4.235	4.150	4.300	0.711	0.816
Designer recruitment and role definition	4.110	4.057	4.059	4.050	4.500	0.754	0.389
Corporate Experience							
Company/design office experience	3.927	4.057	4.118	3.500	4.000	0.953	0.143
Collaboration							
Intra-organisational collaboration	4.098	4.114	4.235	3.800	4.400	0.747	0.143
Inter-organisational collaboration	3.976	4.029	4.118	3.550	4.400	0.889	0.056
Infrastructure & Infostructure							
Information communication technology	4.085	4.143	4.000	4.000	4.200	0.773	0.839
Physical work resources	4.049	4.314	3.647	3.900	4.100	0.967	0.106
Strategy							
Company policy in relation to DfS	4.183	4.314	4.000	3.900	4.600	0.862	0.106
Top management commitment to DfS	4.402	4.486	4.294	4.150	4.800	0.799	0.160
Research and innovation	3.914	4.059	3.765	3.750	4.000	0.883	0.543
System							
Design quality management	4.159	4.200	4.235	3.950	4.300	0.761	0.555
Design risk management	4.293	4.286	4.294	4.200	4.500	0.745	0.787
Project review	4.195	4.314	4.235	4.000	4.100	0.823	0.574
Management of outsourcing/subcontracting	3.963	4.171	4.000	3.650	3.800	0.974	0.267

CONCLUSIONS

This study has provided an overview of the attributes of organisational capability for DfS implementation from a Malaysian construction organisation's point of view. This study assessed the importance of DfS organisational capability attributes and provided insight into factors influencing DfS implementation using online questionnaire surveys with four different types of construction-related organisations. The findings indicate that all 18 attributes under six main elements are important in determining an organisation's ability to practise DfS. The findings also suggest that despite the perceived DfS benefits, the government and related authorities should consider factors such as incentivisation, early education, practical guidance, professional training, and enforcement in order to further facilitate the development of construction organisations capability towards fulfilling their role as duty holders, as specified in Section 3 of the OSHCIM guideline.

Overall, the consistency of the responses suggests that the nature of the organisations may not have an impact on the capability required for DfS practise. Thus, this study contributed to corroborating the constituents of DfS organisational capability reported in literature the previous research on. It is proposed that any countries with DfS legislation that embed similar characteristics with CDM legislation could adapt this capability framework. Despite some limitations (e.g., locality, balance distribution of sampling size), further research could expand the current study to larger scales with different disciplines of organisations (e.g., architecture, civil and structural, mechanical, electrical quantity surveyor) as well as focusing on qualitative methodologies to facilitate more in-depth findings regarding the DfS organisational capability.

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REFERENCES

Abueisheh, Q, Manu, P, Mahamadu, AM and Cheung, C (2020) Design for Safety Implementation Among Design Professionals in Construction: The Context of Palestine, *Safety Science*, **128**, 104742.

Adaku, E, Ankrah, N A, Ndekugri, I E (2021) Design for occupational safety and health: a theoretical framework for organisational capability, *Safety Science*, **133**, 105005.

Behm, M, Culvenor, J and Dixon, G (2014) Development of safe design thinking among engineering students, *Safety Science*, **63**, 1-7.

Che Ibrahim, C K I and Belayutham, S (2020) A Knowledge, Attitude and Practices (KAP) Study on Prevention through Design: A Dynamic insight into Civil and Structural Engineers in Malaysia, *Architectural Engineering and Design Management*, **16**(2), 131-149.

Che Ibrahim, C K I, Belayutham, S, Manu, P and Mahamadu, A-M (2020) Key attributes of designers' competency for prevention through design (PtD) practices in construction: a review, *Engineering, Construction and Architectural Management*, **28**(4), 908-933.

Che Ibrahim, C K I, Manu, P, Belayutham S, Mahamadu A-M and Antwi-Afari, M F (2022) Design for safety (DfS) practice in construction engineering and management research: A review of current trends and future directions*, Journal of Building Engineering*, **52**, 104352.

CIDB (2019) *Securing Improvement in the Health and Safety Performance of Malaysia's Construction Industry*, CIDB Technical Publication No 183, (ISBN 978-967-0997-31-5).

Fellow, R and Lui, A (2015) *Research Methods for Construction, 4th Edition*, Chichester, UK: Wiley.

Gambatese, J A, Gibb, A G, Brace, C and Tymvios, N (2017) Motivation for prevention through design: Experiential perspectives and practice, special collection on construction safety, *Practice Periodical on Structural Design and Construction,* **22**(4), 04017017.

Goh, Y M and Chua, S (2016) Knowledge, attitude and practices for design for safety: A study on civil and structural engineers, *Accident Analysis & Prevention,* 93, 260-266.

Health and Safety Executive (2015) *Managing Health and Safety in Construction: Construction (Design and Management) Regulations 2015-Guidance on Regulations L153*, Norwich, UK: HSE Books.

Karakhan, A A and Gambatese, J A (2017) Integrating worker health and safety into sustainable design and construction: Designer and constructor perspectives, *Journal of Construction Engineering and Management*, **143**(9), 04017069.

Manu, P, Poghosyan, A M, Agyei, G, Mahamadu, A M and Dziekonski, K (2021) Design for safety in construction in sub-Saharan Africa: A study of architects in Ghana, *International Journal of Construction Management*, **21**(4), 382-394.

Manu, P, Poghosyan, A M, Mahamadu, A-M, Mahdjoubi, L, Gibb, A, Behm, M and Akinade, O O (2019) Design for occupational safety and health: Key attributes for organisational capability*, Engineering, Construction and Architectural Management*, **26**(11), 2614-2636.

Morrow, S, Hare, B and Cameron, I (2016) Design engineers' perception of health and safety and its impact in the design process, *Engineering, Construction and Architectural Management*, **23**(1), 40-59.

Oney-Yazıcı, E and Dulaimi, M F (2015) Understanding designing for construction safety: The interaction between confidence and attitude of designers and safety culture, *Architectural Engineering and Design Management*, **11**(5), 325-337.

Poghosyan, A, Manu, P, Mahamadu, A-M, Akinade, O, Mahdjoubi, L, Gibb, A and Behm, M (2020) A web-based design for occupational safety and health capability maturity indicator, *Safety Science,* **122**, 104516.

Schulte PA, Rinehart R, Okun A, Geraci CL, Heidel DS (2008) National prevention through design (PtD) initiative, *Journal of safety research*, **39**(2), 115-121.

Sharar, M, Agyekum, K, Manu, P, Che Ibrahim C K I, Mahamadu, A-M, Antwi-Afari, M F and Owusu Danso, F (2022) Design for safety in construction: A study of design professionals in Kuwait, *International Journal of Building Pathology and Adaptation*, [In press].

Toole, T M, Gambatese, J A and Abowitz, D A (2017) Owners' role in facilitating prevention through design, *Journal of Professional Issues in Engineering Education and Practice*, **143**(1), 04016012.