

Assessing Barriers and Facilitators to Adoption of Design for Safety by Construction Organisations in Nigeria

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Abstract:

Reactive construction safety measures are becoming increasingly criticised for their poor bearings on construction accident hazards. Conversely, Design for Safety (DfS) is a proactive measure, proven to have improved on the state of construction Health and Safety performances. Studies, however, show that the adoption of DfS in developing countries to be poor. This study thus assessed the barriers and facilitators to the successful adoption of DfS by construction organizations in Nigeria. A quantitative research approach was used, collecting data via structured questionnaires administered to construction organisations. The data was analysed using descriptive statistics (mean and standard deviation). The study found 'Client interest in the use of DfS in their projects', 'Top Management support and commitment' and 'Government policy via legislation' to be the most important facilitators for adopting Design for Safety in the Nigerian construction industry. While 'More satisfied clients', 'Shorter construction periods' and, 'Better construction and maintenance safety' were the most important benefits of adopting Design for Safety in the Nigerian construction industry. With regards to barriers, the study found 'Other project objectives given higher priority by project stakeholders', 'The predominant use of the traditional project delivery method' and 'Absence of collaboration between designers and contractors' to be the essential contractual related barriers to the adoption of Design for Safety in the Nigerian construction industry. The study concludes that barriers that hamper the successful adoption of the DfS practice pose as risks that will continue to prevent successful adoption of DfS through the effective use of the facilitators for the adoption of Design for Safety in the Nigerian construction industry. The study recommends that government should also provide a more enabling environment by enacting policies and legislation that will guide and ease the implementation of Design for Safety and focus attention on client interest, top management commitment and support, and government policy via legislation.

Keywords: Construction, design for Safety, Health and Safety performance, Nigeria

1 Introduction

Inadequate Health and Safety (H&S) activities have resulted in accidents and injuries that sometimes result in death or permanent deformity to victims in the construction industry. This, therefore, hampers the success on the delivery of projects by being responsible for projects overrunning their budgeted costs and time, disputes within and outside organisations, organisations losing their reputation, and bad image for the construction business (Kheni, Gibb and dainty, 2010; and Project Management Institute, PMI, 2017).

To ensure apt H&S and thus facilitate successful delivery of projects, strategies have been recommended by various studies, which include the use of personal protective equipment (PPE), consistent training on safety, adequate supervision of works, regulatory laws, creating behavioural health awareness, and building safety environment at construction sites. (Lingard and Turner, 2016; Diugwu, and Occupational Safety and Health Administration, OSHA, 2016). However, although these strategies resulted in considerable improvement of H&S performance, they have been termed reactive as findings have revealed a gap in safety performance (Bureau of Labor Statistics, 2009).

These findings from researchers coined the roots for consideration of safety at the design stage (Hinze and Wiegand, 1992), which has been a proactive approach referred to as Design for Safety (DfS). Since its adoption, the approach yielded benefits that include reducing construction accidents, improving efficiency in cost, time and productivity, because it takes into account the project lifecycle completely (Gambates, Hinze and Haas, 1997; and Institute for Safety through Design, 2003). These benefits have long-term effects due to reduced construction costs and enhanced safety at the operation and maintenance phase. However, even with the identified benefits of this proactive approach, its adoption is still being troubled by numerous factors, consisting of the absence of adequate regulatory requirements, heightened designers' cost, designers resisting in fear of lawsuits by accident victims (Toole and Erger, 2019).

Manu et al. (2018a) acknowledged studies on DfS focusing on developed countries, including Australia, the United Kingdom, and the United States of America with limited attention to the developing countries. In a step towards bridging that wide gap, Manu et al. (2018a) and Manu et al. (2018b) studied the awareness and practice of DfS among architects in the Nigerian construction industry and that of Ghana. They found them to be aware of the concept of DfS. However, even with the efforts above, the adoption is still low. This study assessed the barriers and facilitators to the successful adoption of DfS in the Nigerian construction industry to bridge this gap. Developing countries have been found to experience poorer H&S performance (Umeokafor, 2015), requiring the adoption of proven measures like DfS (Manu et al., 2018b). Furthermore, to improve the practice of novel measures, the establishment of essential requirements is needed (Combe, 2014), and the absence of such would hamper the effective adoption of these measures. The study will benefit designers, clients, and contractors in the successful execution of projects by bringing about improved health and safety performance and, hence, improved success on the delivery of projects.

The aim of this study, which is to assess the barriers and facilitators of DfS adoption by Nigerian construction organisations, was achieved by identifying the barriers and facilitators for DfS adoption. The identified factors were then assessed. The scope of the study considered clients, contractors and consultants in the construction mainstream. This is because they are deemed to hold the fundamental key for DfS practice (Manu et al., 2018a).

2 Literature Review

2.1 Design for Safety (DfS)

This has to do with approaching construction safety right from the design stage. Many terms have been used over the years to refer to the approach which include "Design for Construction Safety (DfCS)", "Construction Hazard Prevention through Design (CHPtD)", "Prevention through Design (PtD)" and "Safety in Design (SiD)". Several authors have given various

definitions for DfS. Behm (2005) referred to DfS as considering the safety of the construction site during a project's design. Toole (1997) gave its definition as safety constructability, while Schulte et al. (2008) defined it as the approach of expecting and designing out probable occupational safety and health hazards and risks related to new procedures, structure, equipment, tools and the organisation of works in a way which puts into account the construction, maintenance, decomposition disposal/recycling of waste materials while identifying the economic and social benefits of doing so.

2.2 Benefits of DfS Implementation

Implementing DfS has the primary goal of the construction worker's safety on site (Toole and Gambatese, 2008). DfS, a proactive method of identifying and eliminating construction hazards, has been safer and has better cost-effectiveness than reactive hazard management (Toole and Gambatese, 2008). Another issue which the DfS tackles is the high rate of injuries and casualties resulting from accidents (Gambatese 1998; Hagan et al., 2009). Manuele (1997) also stressed that through the application of DfS notions, more output could be realised and a decrease in the cost of operation and retrofitting.

Some benefits also found from the implementation of DfS by Gambatese et al. (1997) include improved collaboration among the various distinct project participants, healthier client approval, construction projects executed in shorter times, improved construction and maintenance safety, greater end-user safety, better design, greater health and safety performance for the industry, higher certainty, and augmented status of organisation.

2.3 Barriers to DfS Implementation

Implementing the DfS concept did not come without some barriers hindering its successful implementation. These barriers serve as a bottleneck to the success of DfS implementation. The barriers have been identified and generally grouped into four (Toole, 2005; Gambatese et al., 2017b; Tymvios, 2013; and Toole and Erger, 2019): regulatory and legal which include lack of regulatory requirements, potential resistance from professional bodies to implement the measure, increased number of lawsuits against designers, increased number of lawsuits against owners, potential designer resistance to implement the measure, and risk of liability for post construction activities; contractual barriers which encompass other project objectives given higher priority by project stakeholders, the predominant use of the traditional project delivery method, absence of collaboration between designers and contractors, poor understanding of contract terms and scopes of work, increased design duration, long implementation period, poor client trust on designers competence to practice DfS; economic barriers which consist of high short term project costs to the owner, higher fee demands from designers, increases direct and overhead costs for designers, and lack of incentives and motivation; and educational barriers to include inadequate exposure to requirements for DfS implementation, designer lacking requisite knowledge and skills, DfS construction means and methods not generally known during design, lack of DfS awareness and education programmes, misconceptions about DfS practice, and DfS seen as too complex and alien.

2.4 Facilitators for DfS implementation

Even though barriers have been identified to hamper the successful implementation of DfS, those barriers can be overcome. This can be achieved via some factors which facilitate DfS implementation. These facilitators refer to some key modifications can be done at the industry level. Tymvios and Gambatese (2016) found some factors as facilitators to the successful

implementation of DfS. Some these factors have also been stressed by Gambatese et al. (2017a), Toole et al. (2017), and Atkinson and Westall (2010). They found DfS to be facilitated through factors that include client interest in the use of DfS on their project, government policy via legislation, commitment and cooperation of professional bodies, top management support and commitment, education and skills development, availability of trained professionals and attitudinal change.

3 Research Methodology

A survey strategy was adopted to accomplish the set goal of the study (Collis and Hussey, 2013). After careful literature review, the factors identified based on the context were used to draft a close-ended questionnaire to collect data for the study. The study was conducted in Kaduna, Abuja, and Lagos states of Nigeria. This was done to collect data from different country's geo-political zones to do away with bias and because these locations are the centers of construction activities in the country.

For a fair representation and coverage as this study requires, a stratified sampling technique was adopted. Ogunbameru and Ogunbameru (2010) identified stratified sampling as a sampling method used when the population is made up of sub populations with different features known as strata. Therefore, a stratified sampling technique was adopted since the population cuts across distinct strata.

The client organisations considered were experienced public client organisations (Federal ministries) and private client organisations (Property developers). The respective sample frames used were a list of federal ministries in the country and a list of property developers registered with the Real Estate Developers Association of Nigeria (REDAN). The population of these organisations were 26 and 967, respectively. The consultant organisations considered were Architectural consultancy firms, Civil Engineering consultancy firms, Project Management consultancy firms, Quantity Surveying consultancy firms, Mechanical and Electrical (M&E) consultancy firms and Building consultancy firms. The sample frames used were registers of these firms from their respective professional bodies viz; Architects Registration Council of Nigeria (ARCON), Council for the Regulation of Engineering in Nigeria (COREN), Quantity Surveyors Registration Board of Nigeria (QSRBN) and Council of Registered Builders of Nigeria (CORBON). However, there is no sampling frame identified for project management firms in Nigeria as at the time of this study. The population of these organisations were 1095, 1236, 340, 42, and 763 for the Architectural consultancy firms, Civil Engineering consultancy firms, Quantity Surveying consultancy firms, Building consultancy firms and Mechanical and Electrical (M&E) consultancy firms, respectively. The Contractor organisations considered were building contractors and heavy engineering contractors. The sample frames used were registers of these firms from their respective professional bodies viz; Council of Registered Builders of Nigeria (CORON) and Council for the Regulation of Engineering in Nigeria (COREN). The population of these organisations were respectively 61 and 411. The individual populations were summed up to get the population size for this study which was 4941.

Since all the population size cannot be studied, a sample of the population was focused on. Making use of the formula for calculating sample size proposed by Yamane (1986),

$$n = \frac{N}{1 + N(e)^2}$$

Where; n = required sample size; N = the population size (4941); e = level of precision (0.050)

The sample size for this study was calculated to be approximately 382.

The study targeted a total of 382 respondents, where the researchers recovered 188 (49%) of the questionnaires. The amount of feedback was deemed fitting as Moser and Kalton (1979) regarded the survey's response rate to be categorised as important when it has a return percentage of 30-40%.

The data collection instrument was divided into two parts: with the first part covering the respondents' area of expertise, and the other part capturing questions on the facilitators, benefits, and barriers of DfS adoption on a Likert of 1-5. On the scale 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat agree, 4 = Agree and 5 = Strongly agree. The responses were evaluated using mean and standard deviation descriptive statistics. For analysis, version 25 of the Statistical Package for Social Science (SPSS) was adopted. Where 0-1.49 represent very low, 1.50-2.49 represent low, 2.50-3.49 represent moderate, 3.50-4.49 represent high and 4.50-5.00 represent very high in the table after analysis.

4 Results and Discussion

4.1 Introduction

The results of the study show that 34 of the respondents, which make 18.1% of the total respondents, were organisations engaged in architectural consultancy, property developers with 31 respondents, representing 16.5% of the total respondents, and 27 civil engineers with 14.4% of the total make up the top three respondents.

4.2 Facilitators and Potential Benefits for Adopting Design for Safety

Table 1 shows the extent of agreement of the respondents with factors that could be termed facilitators for adopting Design for Safety in the Nigerian construction industry. As shown in the table, the respondents ranked Client interest in the use of DfS in their project, Top Management support and commitment and Government Policy via legislation as the three most important facilitators for adopting Design for Safety in the Nigeria construction industry, while Commitment and cooperation of Professional bodies, Availability of trained professionals and Education and skills development were the least ranked factors. However, all the factors were significant because the mean score of the factors ranged between 4.69 to 4.33.

Table 1. Facilitators for Adopting Design for Safety

Facilitators	Respondents' assessment					Mean	SD	Rank
	1	2	3	4	5			
Client interest in the use of DfS in their project.	0	0	6	47	135	4.69	0.53	1
Top Management support and commitment	0	0	5	52	131	4.67	0.53	2
Government Policy via legislation	0	0	22	43	123	4.54	0.70	3
Attitudinal change	0	1	9	68	110	4.53	0.62	4
Commitment and cooperation of Professional bodies	0	0	15	67	106	4.48	0.64	5
Availability of trained professionals	0	1	15	86	86	4.37	0.65	6
Education and skills development	0	2	12	94	80	4.33	0.69	7

Source: Field Survey, 2020

4.3 Benefits of Adopting Design for Safety in the Nigerian Construction Industry

Similarly, Table 2 shows the respondents' extent of agreement with factors that could be termed as Potential Benefits for adopting Design for Safety. As shown in the table, the respondents ranked, More satisfied clients, Shorter construction periods and Better construction and maintenance safety as the three most essential benefits for adopting Design for Safety in the Nigeria construction industry. At the same time, Productivity gains, Greater predictability and Increased organisation's reputation were the least ranked factors. This is in line with the work of Toole and Erger (2019) where they identified reduced injuries and fatalities, reduced total design and construction costs for clients and faster construction durations to be among the crucial benefits of adopting DfS. However, all the factors were significant because the mean score of the factors ranged between 4.75 for the top-ranked and 3.69 for the least ranked factors.

Table 2. Potential Benefits for adopting Design for Safety

Benefits	Respondents' assessment					Mean	SD	Rank
	1	2	3	4	5			
More satisfied clients	0	0	2	43	143	4.75	0.46	1
Shorter construction periods	0	0	2	46	140	4.73	0.47	2
Better construction and maintenance safety	0	0	5	66	117	4.60	0.54	3
Better end-user safety	0	0	4	81	103	4.53	0.54	4
Improved design	0	0	13	73	102	4.47	0.62	5
Reduced costs	0	1	29	104	54	4.12	0.67	6
Less waste	0	0	48	90	50	4.01	0.72	7
Improved safety and health for the industry	0	1	58	107	22	3.80	0.64	8
Improved quality	0	5	50	112	21	3.79	0.67	10
Productivity gains	0	1	61	103	23	3.79	0.65	10
Greater predictability	0	0	70	90	28	3.78	0.69	11
Increased firm/organisation's reputation	0	0	80	86	22	3.69	0.67	12

Source: Field Survey, 2020

4.4 Barriers to Adopting Design for Safety in the Nigerian Construction Industry

Table 3 shows the extent of agreement of the respondents with factors that could be termed as barriers militating against the adoption of Design for Safety in the Nigerian construction industry. As the table depicts, the respondents ranked, 'Other project objectives given higher priority by project stakeholders', 'Predominant use of the traditional project delivery method' and 'Absence of collaboration between designers and contractors' as the three most significant barriers against the adoption of Design for Safety in the Nigeria construction industry, while 'Increased number of lawsuits against owners', 'Potential designer resistance to implement the measure' and 'Risk of liability for post-construction activities' were the least ranked factors. This differs from what Toole and Erger (2019) found, as they found major barriers to DfS adoption to be enhanced risks of inappropriate lawsuits, owner's resistance to increased design fees, and lack of support for the DfS process. However, all the factors were significant because the mean score of the factors ranged between 4.75 and 3.69.

Table 3. Barriers to adopting Design for Safety

Barriers	Respondents' assessment					Mean	SD	Rank
	1	2	3	4	5			
Other project objectives given higher priority by project stakeholders	0	0	2	33	153	4.80	0.42	1
The predominant use of the traditional project delivery method	0	0	3	39	146	4.76	0.46	2
Absence of collaboration between designers and contractors	0	0	5	41	142	4.73	0.50	3
Lack of regulatory requirements	0	1	12	35	140	4.67	0.62	4
High short term project costs to the owner	0	6	14	67	101	4.40	0.76	5
Inadequate exposure to requirements for DfS implementation	0	0	40	67	81	4.22	0.77	6
Higher fee demands from designers	0	4	26	93	65	4.16	0.74	7
Designer lacking requisite knowledge and skills	0	1	37	90	60	4.11	0.73	8
DfS construction means and methods not generally known during design	0	0	31	110	47	4.09	0.64	9
Poor understanding of contract terms and scopes of work	0	4	45	85	54	4.01	0.78	10
Increases direct and overhead costs for designers	0	5	38	99	46	3.99	0.75	11
Potential resistance from professional bodies to implement the measure	0	7	25	124	32	3.96	0.67	12
Increased design duration	0	6	41	99	42	3.94	0.75	13
Lack of DfS awareness and education programmes	0	0	56	93	39	3.91	0.71	14
Long implementation period	0	2	62	78	46	3.89	0.78	15
Poor Client trust on Designers competence to practice DfS	0	12	53	92	31	3.76	0.80	16
Misconceptions about DfS practice	0	7	76	62	43	3.75	0.85	17
Lack of incentives and motivation	0	11	83	41	53	3.72	0.94	18
Increased number of lawsuits against designers	0	25	56	62	645	3.68	0.98	19
Seen as too complex and alien	0	6	91	55	36	3.64	0.82	20
Increased number of lawsuits against owners	0	12	76	80	20	3.57	0.77	21
Potential designer resistance to implement the measure	1	0	68	89	17	3.55	0.81	22
Risk of liability for post-construction activities	1	23	63	75	26	3.54	0.90	23

Source: Field Survey, 2020

5 Conclusion

After analysing the results, the study found that 'Client interest in the use of DfS in their projects', 'Top Management support and commitment' and 'Government policy via legislation' are the most important facilitators for adopting Design for Safety in the Nigerian construction industry. While 'More satisfied clients', 'Shorter construction periods' and 'Better construction and maintenance safety' were the most important benefits of adopting Design for Safety in the Nigerian construction industry. With regards to barriers, the study found 'Other project objectives given higher priority by project stakeholders', 'The predominant use of the traditional project delivery method' and 'Absence of collaboration between designers and contractors' to be the most important contractual related barriers to the adoption of Design for Safety in the Nigerian construction industry.

Based on the findings from this research, benefits for the adoption of DfS exists which will yield positive outcomes in the health and safety practice of the Nigerian construction industry. Barriers that hamper the successful adoption of the DfS practice pose risks that will continue to prevent successful adoption of DfS. The threats the barriers pose can be addressed through effective use of the facilitators for adoption of Design for Safety in the Nigerian construction industry. The study has revealed the key benefits, barriers, and facilitators to the successful adoption of DfS.

The study recommends that government should also provide a more enabling environment by enacting policies and legislation that will guide and ease the implementation of Design for Safety and focus attention on client interest, top management commitment and support, and government policy via legislation.

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