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Challenges for the Implementation of Sustainable Construction Practices in Libya

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Abstract

Sustainability is considered to be a central part of every global policy change because of the likelihood of negative effects of particular policies on the already endangered environment and on society. Whilst sustainability is receiving significant attention in construction sectors in developed countries, this seems to be less true for developing countries. Thus, this study explores the challenges faced by the construction sector in one such developing country, Libya, in integrating sustainability practices into its common scope of activities. The study adopted a mixed research approach consisting of a questionnaire survey and expert interviews. Completed questionnaires (134 No.) were analysed using statistical techniques. The findings from the survey informed the topics for the interviews with 10 experts where the collected data were analysed through content analysis. The outcomes of the research explained that the awareness of sustainability in construction was weak in the practice of the Libyan construction sector. Additionally, the failure of supporting institutions to create an effective application of sustainability guidelines, lack of stricter legislation, building codes or standards were also found to be major challenges. The study contributed to knowledge by providing a better understanding of sustainability and clarified the main challenges faced by the stakeholders and which they have to consider in order to improve sustainable construction in Libya. The practical

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implications of the study include the strategies identified to avoid or minimise the challenges and their consequences.

Keywords

Sustainable Construction; Challenges for Sustainable Construction; Libya; Construction Industry; Sustainability

Introduction

The later part of the 20th century has witnessed urgent calls for sustainable development like never before. This issue relates to social, economic and environmental sustainability and has become one of the topmost agenda items on government's policies globally. However, sustainable development faces the challenge of meeting growing human needs, yet at the same time, conserving and protecting environmental quality and natural resources that are crucial for future life and development. Sustainability, therefore, while meeting long-term human needs, will be impossible unless the conservation and protection of the planet, in terms of natural, physical, chemical, and biological systems, ae addressed (Berardi, 2013). According to Agyekum-Mensah, Knight and Coffey (2012), the idea of sustainable construction has changed over time, from the initial focus on the problem of insufficient resources, particularly energy, to technicalities such as raw materials, structural elements, building services and energy-related design principles referred to as "eco-build" and "green build." Nevertheless, Ndlangamandla and Combrinck (2019) insist that a robust and effective building sector is dedicated to social, environmental, and economic success. It is obvious that sustainable construction in a global context has concentrated on how building projects may conserve the ecosystem while also having an influence on the community's socioeconomic well-being (Willar, et al., 2020).

Unsustainable construction practices and their attendant degradation of the environment for construction purposes is a common phenomenon observed in most developing countries, of which Libya is no exemption (Karim 2017). Currently, in Libya, apart from the dissatisfaction towards the environmental issues caused by construction projects, the contribution of most construction organisations to sustainability objectives was considered to be mostly weak especially in terms of policy integration, environmental conservation and social responsibility (Schaltegger, Burritt and Petersen, 2017).This dissatisfaction drives the government and professional bodies in Libya to be more practical in alleviating the negative impacts on the environment caused by construction, without limiting the need for development (Elgadi et al., 2016). However, applying sustainable construction practices, influenced by the knowledge and involvement of all individuals involved in the industry, will require a more in-depth understanding of the sustainability concept for successful application (Omardin, Abidin and Ali, 2015). Thus, this study aimed at investigating the complexities associated with integrating sustainability in the construction sector in Libya, with a view to ranking the challenges that might be faced by its construction stakeholders.

Literature Review

THE CONCEPT OF SUSTAINABLE DEVELOPMENT

Sustainable Development has been defined differently in various disciplines and based on different assumptions (the concept embodied therein) about the basic relationship between society and nature (Keeys, 2012). The numerous definitions of this subject, according to Alshuwaikhat and Abubakar (2017) arise as a result of increasing recognition of the concept. Egbetokun, Osabuohien and Akinbobola (2018) described this developmental process in the definition above as involving institutions, people, natural resources and the environment, and which is to be implemented collectively and points towards the future.

However, as shown above, there is currently a plethora of sustainability definitions (Berardi, 2013). Among these is the rather succinct definition given by the Brundtland Report as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). In summary, the glut of sustainability definitions includes many which emphasise certain perspectives but most of which converge on issues of efficiency, equity, long and short-term analysis, intergenerational equity, values and ethics, economic, social and environmental aspects and local and global perspectives.

SUSTAINABILITY IN CONSTRUCTION

Liu et al. (2020) view sustainability in construction through performing the construction processes by incorporating the basic objectives of sustainable development. Accordingly, Du Plessis (2007) conceptualises sustainable construction as being a holistic process which reconciles the natural and built environments. Such construction should be such as would be affirmative of human dignity and not just serving economic interests. As both 'construction' and 'sustainability' are terms which have wide ranges of meanings, their combination only increases the difficulty of finding a concise meaning (Du Plessis, 2007). However, such noble aspirations are tempered by Berardi's (2013) underscoring of the constraints and uncertainty due to the time, scale, domain and social constraints confronting sustainable construction. A balance has to be struck between the competing demands of concerns for the environment and society alongside the economic imperatives of profitability (Akadiri, Olomolaiye and Chinyio, 2013). This balance is frequently referred to within the construction context as the 'triple bottom line of sustainability' (Elazabi, 2020).

CHALLENGES FOR THE IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION PRACTICES

The following sub-sections discuss the challenges for sustainable construction implementation.

Challenges related to regulations

The effects of regulatory challenges relating to the successful application of sustainable construction have been well recorded. Akadiri, Olomolaiye and Chinyio (2013) believes that government regulations and building code restrictions play a vital role in influencing sustainable practices amongst construction professionals. Whilst there are many recognized regulatory challenges, Rohracher (2001) argues that there is still a need for government regulations for the construction authorities and other public players in the construction sector to become more involved. For instance, Djokoto, Dadzie and Ohemeng-Ababio (2014) posit that the concept of sustainable construction could be more successful if stakeholders, including the government, were to set up legislation that requires the collaboration and cooperation of sustainability policies, as well as the development of numerous policy documents, thus resulting in the enforcement of sustainability in all parts of the development. This is because both the commitment and support of the government and the formation of legislation are vital for the accomplishment of sustainable construction practices. Moreover, due to the 'fragmentized nature' of the sector and the considerable number of players involved, this could cause a situation "where regulations are considered as the only possible way to proceed" (Femenias, 2005, p. 73–83). Nevertheless, rigid normative steering mechanisms could instigate the implementation of sustainable innovations.

Challenges related to finance

It is widely recognised that some of the most significant and influential challenges in the implementation of sustainable construction practices are financial in nature. According to Häkkinen and Belloni (2011), these challenges identify increased initial investment costs and financial resources as key components.

Besides, Hydes and Creech (2000) and Zhou and Lowe (2003) also maintain that core challenges in the execution of sustainable practices include the preconception of acquiring higher capital costs and insufficient market values. Tagaza and Wilson (2004) estimate that capital costs are from 1 to 25% higher for green projects. These increases are mainly due to design complexity, as well as the modelling costs required, to effectively incorporate green practices into projects (Zhang et al., 2014). Furthermore, higher costs are related to green materials and the use of green construction technologies (Hwang and Tan, 2012). As a result, Zhou and Lowe (2003) claim that the advancement of sustainable construction presents numerous economic challenges because of misunderstandings of the economic benefits available. Moreover, it is a well-known fact that sustainable construction projects do involve large investment costs, in comparison to more conventional building practices (Hakkinen and Belloni, 2011).

Challenges related to management

It is a well-established that the management and leadership of the construction industry and individual organisations play a vital role in accomplishing the effective application of innovative strategies (Nelms, Russell and Lence, 2005). Accordingly, possible management related challenges within a sustainable construction include "models of cooperation and networking, models of communication, roles of different actors, decision making and management processes, and scheduling" (Häkkinen and Belloni, 2011). In consideration of the significance of leadership, Mills and Glass (2012) highlight some of the skills needed to manage or lead the design of a sustainable building, including "awareness, communication, comprehension, experience, lateral thinking, leadership, negotiation, passion, and technical knowledge". Furthermore, Akadiri, Olomolaiye and Chinyio (2013) also refer to the importance of early adoption of sustainable construction objectives, along with the selection of an experienced design and construction team and effective communication and advise that haste should be avoided with team members who 'share the same goal'. Furthermore, Hong-Minh, Barker and Naim (2001) explain that the strong division of an organisation's departments hinders the possibility of sustainable practices being fully end-customer focused, because "there is no holistic view of the supply chain".

Challenges related to technology

Another key issue related to the implementation of sustainable construction practices is that of technical challenges which incorporate sustainable material information accessibility, easily available guidance and technical capability. These challenges are classified as technical as they have an immediate impact on the application of sustainable construction principles. (Hydes and Creech, 2000).

Markedly, Rydin et al. (2006) state that construction industry designers are often uncertain and less confident when confronted with sustainable construction design issues. This would point towards the need for built environment professionals to become more familiar with sustainable construction principles, to incorporate its practice. Moreover, another issue, according to Osaily (2010), is the availability of locally sourced 'green' building products, for instance, advanced glazing systems, which have proven to be problematic for many sustainable construction projects. As Osaily (2010) states, there is a necessity for technical data in the correct format to be readily available for design professionals, as well as for the contractors ultimately accountable for executing the design. The efficient and effective use of this data requires a method and procedure that facilitates its management and dissemination.

Furthermore, several studies have confirmed that the use of green technologies raises issues for developers, clients and contractors respectively. Egbetokun, Osabuohien and Akinbobola (2018) suggested two reasons for this, which are inadequate knowledge or technical expertise and inexperience with the products, materials, system or design. The principal issue is that green technologies appear to be more complex and dissimilar from traditional ones (Tagaza and Wilson, 2004). This challenge has also been affirmed by Zhang, et al. (2014).

Challenges related to awareness

Williams and Dair (2007) identified evidence that a lack of mutual understanding is an ordeal experienced by most stakeholder groups in the construction industry. Moreover, in several cases, stakeholders have admitted to being unaware or unknowledgeable about sustainable measures or alternatives that fell within their remit. Likewise, the installation of sustainable technologies and materials, requires new methods, competencies and knowledge. Indeed, it was apparent from the findings of their research that not all those with responsibilities in this area had the required experience or expertise to meet the challenge.

As mentioned previously, the construction industry consists of diverse actors with different opinions (clients, consultants and contractors); consequently, it is necessary that they come together and work as a team to guarantee the successful completion of a project (Williams and Dair, 2007). Additionally, as the demand and preferences of clients can eventually determine the development of sustainable buildings, they are interrelated to issues such as supply, knowledge, methods, costs, and value. Akadiri, Olomolaiye and Chinyio (2013) states that, few investors deliberately seek to invest in or have a desire to own sustainable buildings. As the wide context of sustainable construction increases, the difficulty of assessing the profitability or cost impacts of the buildings also increases (Stenberg, 2006). Therefore, a collective understanding of sustainable practices by the stakeholders could enhance collaboration and, in turn, improve the creation of innovative solutions.

SUSTAINABLE CONSTRUCTION IN LIBYA

In Libya, the concept of sustainability in construction is relatively new (Dania, Larsen and Ewart, 2014). Dahiru, Salau and Usman (2014) point out that the main culprit is the lack of knowledge and awareness of the construction of the green building and the adoption of sustainable practices accompanied by weak policies and legislation. Indeed, Adebayo (2002) shows how widespread such ignorance is due to the lack of information on sustainable construction issues and solutions, not only in Libya but in many developing countries.

Considering the research related to sustainable construction in Libya and its neighbouring region, Awaili, Uzunoglu and Özden (2020) and Abdausamea, Saaed and Ali (2018) investigated the importance of sustainable building developments to preserve the environment which has been greatly endangered by the high usage of resources by the building occupants. Meanwhile, Elazabi (2020) recognises the social responsibility in Libya towards sustainable construction through the establishment of new principles to protect and improve the environment and the rational use of natural resources. In the bigger picture, Aigbavboa, Ohiomah and Zwane (2017) criticise the 'lazy-view' of construction professionals in the African continent for not yet considering sustainable construction as an essential part of decision making. In Libya, lack of knowledge and awareness has significantly affected the application of sustainable practices. Consequently, Dania, Larsen and Ewart (2014) have pointed out that Libya was lagging behind other countries in adopting and applying sustainable practices within the construction industry. In most developing countries, the business case for sustainable construction is still weak. Although Libya is a signatory to the UN development objectives that include environmental sustainability, progress has been notoriously slow. The government of Libya promised to strengthen the Ecological Fund, Environmental Impact Assessment laws and National Environmental Standards and Regulations to advance sustainability. However, this effort has yielded only limited results, as evidence suggests that Libya continues to lose forest cover at an alarming rate of about 3.5% per annum. The UN Bureau for Statistics 2014 Report reveals that Libya performed at a rate of less than 50% in their attempts to achieve Millennium Development Goals. Brennan and Cotgrave (2014) state that construction clients are the main stakeholders to lead sustainable development practices but, in Libya, the main client in the construction industry is the Government (Tahir, 2015), and introducing change through demand by the client (Government) for sustainable practices

should be an effective approach to encouraging a transition from traditional practices. Du Plessis (2007) has drawn attention to the fact that the main development challenge facing countries such as Libya can be found in the web of poverty, rapid urbanisation, weak institutions, insecurity and resource scarcity. Therefore, in considering sustainable construction in Libya, it is significant to include its unique physical and social context.

Research Methodology

This study adopted a mixed research approach, which provided inferential and descriptive research findings. To achieve the aim of the study, a comprehensive literature review has been carried out in identifying the challenges confronting sustainable construction practices both in the global and Libyan contexts. Thereafter, primary data was collected from a two-stage process namely questionnaire survey (stage 1), analysed by using factor analysis, and semi-structured interviews (stage 2), analysed by content analysis.

STAGE 1: QUESTIONNAIRE SURVEY

The questionnaire survey was prepared in such a way that the answers received could be subjected to Factor Analysis by requesting respondents to tick only one of the challenges based on their perceptions of its importance. Their importance was assessed based on a 5-point Likert scale (1=Not at all, 2=Low, 3=Medium, 4=High, 5=Very high). Yong and Pearce (2013) state that the main purpose of factor analysis is to provide a structured pattern, which makes it easier for the researcher to understand the logic behind the relationship. Factor analysis is required for the empirical reduction and classification of the challenges into critical groups. The authors also state that factor analysis can be used for both exploratory factor analysis and confirmatory factor analysis. For this study, it was an exploratory factor analysis which was conducted because the study aimed at providing a sense of the significance of the main challenges to the implementation of sustainable construction practices in Libya.

Pallant (2013) opined that smaller samples with the good reliability of factor structures and the Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy should have an index of 0.6 or higher for reliable analysis. Accordingly, some variables were eliminated due to having KMO coefficient values less than 0.4. The principal component factor extractor was used for this study; this considers the most influential factors which reflect the comparison of the variables (Pallant, 2013). The extraction process is followed by a decision-making process which is based either on Kaizer's criterion, parallel analysis or a scree plot (Field, 2009). The scree plot was used for this investigation. The scree plot displays the eigenvalues of the factors. The factors above the turning point in the scree plot were retained. The factor rotation and interpretation were determined after the number of factors had been decided. This presents the pattern of loadings for easier interpretation. To check the reliability of data obtained from the respondents, Cronbach's Alpha was used as a measure of the reliability of data in this study. There were 134 responses of valid data for this analysis. This is 88.99% of the total of 150 responses and only 11.11% of the data was missing. For the data survey set to be reliable, its Cronbach's Alpha value of 0.7 or above is required (Tavakol, Mohagheghi and Dennick, 2008). The Cronbach Alpha of the data set used in the study obtained using the Statistical Package for Social Sciences (SPSS 24) was 0.96; this shows a very high internal consistency of the data.

The research sample frame in this study is within the construction organisations in Libya. The sample was based on the registered construction companies listed in the Ministry of Housing in Libya. However, this list is only an estimated number accompanied by the name of the construction companies. In this study, sixty-three construction companies responded out of one hundred and fifty companies contacted which accounts for 41% of the overall population of companies for data collection purposes; this is the company sample size. Two hundred and fifty persons in these companies were chosen as the broader sample size to cover the main challenges for the implementation of sustainable construction. Based on the purpose of this

study, the sampling frame consists of professionals who are involved in construction as Project Managers, Architects and Civil Engineers. These professionals were selected due to their active involvement in making strategic decisions related to sustainable construction practices in Libya. Overall, two hundred and fifty (250) questionnaires were distributed to the sixty-three (63) companies, but only one hundred and thirty-four (134) were completed and returned giving an approximate response rate of 54%.

STAGE 2: SEMI-STRUCTURED INTERVIEW

During this stage, the reasons behind the significant challenges derived from the factor analysis were evaluated by using semi-structured interviews. The primary data gathered from the semi-structured interviews were analysed using a manual content analysis method as described by Kulatunga, Amarathunga and Haigh (2007). Data collection involved ten (10) highly experienced senior staff having fifteen (15) to (25) twenty-five years of experience in the construction industry in Libya. Due to the data saturation, only ten (10) number of semi-structured interviews were required to be interviewed. The respondents also had various and diverse backgrounds in the construction field as listed in Table 1.

Table 1. Profile of the semi-structured interview respondents

ID	Job Role	Background
R1	Architect	Heavily involved in the practice of architects, designers, and engineers, and worked in various building types.
R2	Senior Civil Engineer	Specialist in engineering design: civil; structural and project management
R3	Senior Project Engineer	Experienced in construction management and Engineering
R4	Project Manager	Core expertise in a range of development management, project management and construction services. systems and processes
R5	Assistant Construction Project Manager	Construction project management assistance
R6	Senior Civil Engineer	Experienced in delivering construction projects, wide knowledge of managing various civil projects.
R7	Senior Project Manager	Experienced in delivering ambitious and innovative construction projects, delivering to both clients and the communities
R8	Site Manager	Specialist in working on several construction sites daily
R9	Senior Architect	Wide experience of architecture and building design in all major building types.
R10	Civil Engineer	Working in engineering design. Principle disciplines include civil; structural; services, such as highways engineering

The theoretical sampling method was used to select the interviewees for the second stage of the study by considering the expertise of the respondents.

Research Findings

FACTOR ANALYSIS OF CHALLENGES FOR SUSTAINABLE CONSTRUCTION PRACTICES IN LIBYA

To understand the challenges that affect sustainable construction in Libya, the questionnaire included 17 possible challenges identified using the review of focal literature. Respondents were asked to tick the challenges that they perceived as relevant to Libya. They included government commitment and support; government policies and legislation; building codes and regulations on sustainability; initial capital and investment costs; the additional cost in construction and services; availability of financial resources and incentives; life cycle cost assessment; cost of green materials and products; adoption and familiarity with the new technologies; accessibility to integrated design tools and methods; leadership ability and decision-making process; effective communication amongst project team members; technical ability and IT skills; common understanding and awareness by stakeholders on sustainability; professional capacity, knowledge & innovation in sustainability; education and training on sustainability; and cultural change resistance.

The criticality of challenges was tested using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to assess the adequacy of the data for factor analysis. This is based on the principal components. If the KMO is above 0.6, that indicates that the sampling is adequate, and data is reliable for the analysis. Ten factors (challenges) were eliminated to yield KMO and Barlett's test results in Table (2) which shows the KMO and Bartlett's test results after the final iteration.

Table 2. KMO and Bartlett's test

Cronbach's Alpha	N of Items
.958	17

Factors with a coefficient value below 0.4 in the correlation matrix were eliminated. An eigenvalue of 1 was used for the principal components. The findings of a scree plot for the seventeen factors which were

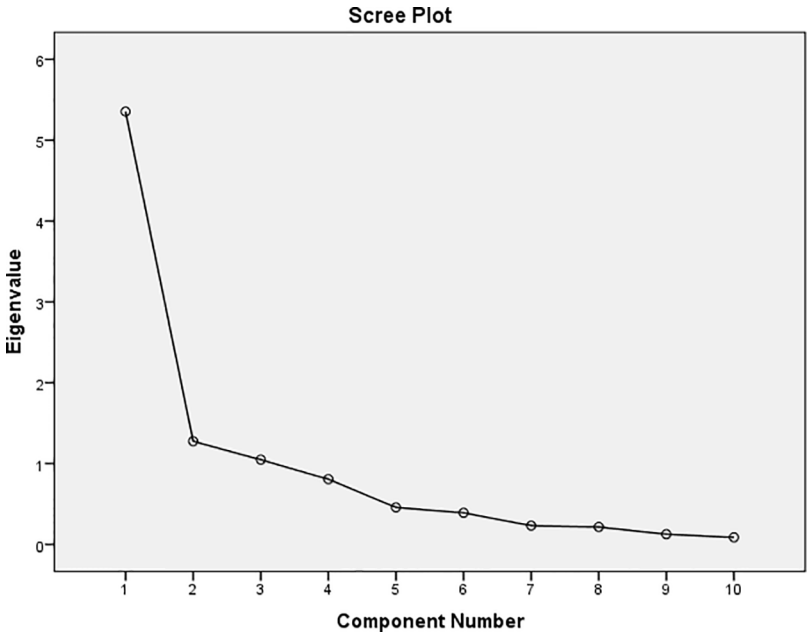

Figure 1. Scree plot with the eigenvalues

later reduced to 7 factors for KMO adequacy provided three major categories from the elbow of the curve. Figure (1) below shows the scree plot with the eigenvalues.

Three eigenvalues ≥1 were identified. The component transformation matrix was produced using the three identified challenges. Table (3) below shows the Component Transformation Matrix.

Table 3. Component Transformation Matrix

Component	1	2	3
1	.649	.629	.428
2	-.727	.679	.104
3	-.225	-.378	.898

The component transformation matrix from the principal component extraction also made use of the Varimax with Kaiser Normalisation Rotation Method. The method extracts the 3 major components. The three components identified from the scree plot extraction method were correlated with each other for further analysis to prove their correction. The rotated matrix provided the coefficients of the factors, which are categorised into three categories. These are presented in Table 4 below which is the Rotated matrix table for the factors analysis.

Table 4. The Rotated matrix for the factor analysis

	Component		
	1	2	3
Awareness of Stakeholders about Sustainability	.908		
Government policies, and legislation	.867		
Adoption with the new technologies		.827	
Capital and investment costs		.816	.
Cost of green materials and products		.749	
Leadership and decision-making process			.903
Technical ability and IT skills			.740

The extraction method was based on the principal component analysis. The rotation method employed Varimax with Kaiser Normalization. The rotation converged in 12 iterations. The three factors extracted with an eigenvalue greater than 1.0 were used to re-categorize the challenges into three major components, as listed in the table above. The values of the factors which appeared in different components were selected based on the highest value. The overall categorization of the challenges is named and presented in the table below. Table (5) below shows the categorisation of the factors under the heading of challenges.

The seven sub-challenges have been allocated to the critical challenges based on the pattern matrix. The names given to the categories were based on the similarities between the challenges. The most important challenges in each category were now tested for their level of importance using Kendall's test for concordance. The three main challenges were Steering and Knowledge, Technological and Cost and, finally, Organisational and Technical challenges. These are presented in Table 6:

Table 5. The categorisation of the factors into challenges

Challenges in	Knowledge & steering	Technology & Costs	Organisation& Technical
Sub- Challenge	Awareness of stakeholders about sustainability	Familiarity with the new technologies Capital and investment costs	Leadership and decision-making process
	Government policies, legislation	Cost of green materials and products	Technical ability and IT skills

Table 6. Significance and mean values for challenges

Challenge	Sub-challenges	Asymp Sig.	Mean	Rank
Knowledge and steering	Awareness of stakeholders about sustainability	0.004	4.14	1
	Government policies, legislation	0.018	4.12	2
Technology & Costs	Familiarity with the new technologies	0.001	3.89	1
	Capital and investment costs	0.006	3.83	2
	Cost of green materials and products	0.018	3.79	3
Organisation & Technical	Leadership and decision-making process	0.047	4.12	1
	Technical ability and IT skills	0.011	3.64	2

QUALITATIVE ANALYSIS OF CHALLENGES FOR SUSTAINABLE CONSTRUCTION PRACTICES IN LIBYA

As pointed out in the previous section and in Section 3, following the survey, it was important to recognise and understand the existing challenges for sustainability in the Libyan construction sector. To do so, interviews were carried out to gain a more in-depth understanding of how sustainability in construction was hindered during the practice within the organization, following a content analysis of the three main challenges which included the seven sub-challenges resulting from the questionnaire factor analysis

Knowledge and steering challenges

Steering and knowledge refer to regulatory and awareness matters which influence the implementation of sustainable construction practices in Libya. Participants were interviewed about identifying these challenges related to steering and knowledge in detail, and what recommendations could be considered to overcome these challenges.

- Unawareness of sustainability

The majority of participants viewed unawareness of sustainability and its importance by the stakeholders as the main challenge for the implementation of sustainability practices. Several participants thought that changing the current situation in education in Libya required raising awareness about sustainability. According to R2: "…unawareness or a weak knowledge of professionals is the key matter, awareness on sustainability needs to be raised among all construction organisations in Libya". Furthermore, R8 concurred with R2 and R5 adding that "…there is a lack of awareness of the majority of the stakeholders in the industry as such the clients, especially their knowledge on benefits and misunderstanding of sustainability". To sum up, the level of awareness by the stakeholders seems to appear as a key challenge to applying sustainable practices in the construction organisation in Libya.

- Inadequacy of government policies and legislation

Concerning the challenges for implementing sustainable construction practices in Libya, it appears that weakness in government policies and legislation is considered to be a major challenge which was referred to by most participants. R4 highlighted some difficulties related to the regulation and standardisation applied in the industry: "… government regulations and rules to help sustainable construction are not fully applied, which allows qualified designers to conduct their practice in ways that do not consider the principles of sustainability". R5 stressed in relation to building codes and standards used in Libya, that "….there is no strong building codes and standards that consider sustainability in construction in Libya, therefore experts had to tolerate with a wide variation of ideals across the industry". Thus, the success of the implementation of sustainable construction in Libya requires a consideration of the regulations and policies correlated with sustainability. However, implementation of sustainability-related regulatory policies appears to be a major challenge to embedding sustainable practices in Libya's construction industry. Currently there are several laws and regulations to protect the environment and promote sustainable construction practices in Libya, including The Environmental Impact Assessment Policy, Health and Safety Laws, the Central Environmental Protection Agency Act and the Ministry of Environment Regulations. However, there are further elements that shape the implementation of sustainable construction if stakeholders, especially government officers, put in place legislation that will need cooperative sustainability policies and similarly the development of various policy forms to implement sustainability in all aspects within the industry.

Technological and cost challenges

Technological and Cost challenges referred to the use of technology and finance aspects that influenced implementing sustainable construction practices in Libya. Participants were interviewed in detail on challenges of technology and costs, and what recommendations could be made to overcome these challenges.

- Unfamiliarity with new technologies

Based on the findings from the interviews concerning the main challenges of implementing sustainable construction practices in Libya, unfamiliarity with the new technologies was considered a major challenge according to the majority of participants. The participants agreed that there was a fear of adopting and using new technologies which was a challenge for implementing sustainable construction practices in Libya. Indeed, R2 stated: "using new technologies in the Libyan construction industry is still at an early stage of the application, which is complicated and different from conventional technologies that we know. Besides, it appears in the industry that there's a lack of wide knowledge and unfamiliarity with the green products, materials, and design".

In terms of the experience of using new technologies by the building designers, R6 highlighted that: "… in Libya, professionals have kind of lack of experience in using new technologies and uncertainty of the success of the construction process, this is considered as an important challenge for the implementation of sustainable strategies and specifications. Also, there is a clear unfamiliarity of the designers and contractors with sustainable design approaches, and a lack of knowledge and understanding of using green technologies effectively. According to all the above comments, it has been shown that green technologies appear to hold certain challenges for the clients and contractors; the main challenge is that green technologies are usually more complicated and are different from conventional technologies, unfamiliarity with the performance of green technologies may affect the performance outcomes.

- Capital and investment costs

About the main challenges of implementing sustainable construction practices in Libya, the high capital and investment costs were considered a challenge according to the majority of the participants. According to participants R2: "… sustainable buildings usually have higher initial capital costs than any other conventional buildings, which means there's sort of hesitation and uncertainty of higher investment costs by the clients and investors".

Furthermore, respondents R4 explained the main interest of clients and their concerns: "… Client's main concern and interest is making profits without long pay-back period which causes doubts about profitability so that can be a major challenge". Moreover, participants R4 and R9 both mentioned a useful insight about the current status of investment in construction in Libya relevant to sustainability. This was spelt out by R4: "…. additional investments in the Libyan construction industry more likely come from cost increases on new materials, use of technologies, fees and high expenses for the professional development of the contractors, managers, consultants and design team". In the light of these comments, the long-term benefit is worth the initial increase in investment; the expected long-term benefits are normally not expressed in terms of financial return but focused instead on the environmental and social benefits that the client believes the technology or practice could provide, but that might be too costly.

- Cost of green materials and products

R1 and R5 raised their thoughts about the cost of green materials and products that can be used in the Libyan construction industry; R1 emphasised that: "there is a shortage of imported green materials and equipment in the Libyan market, as those are difficult to find especially in urban areas where preserving the environment is not the people's first option". Additionally, in the same context, R8 raised a similar point that: "there is a hesitation in adoption of green material and equipment, where there is a noteworthy resistance among specialists due to the possible fall of conventional construction materials demand despite improved productivity".

Organisational and technical challenges

Organisational and technical challenges refer to managerial and technical skills matters which influence implementing sustainable construction practices in Libya. Participants were interviewed about these challenges related to organisational and technical details.

- Leadership and decision-making process

The relationship between leadership and the application of sustainable construction practices is reflected in the statement of R4: "… good management skills have a big effect on implementing sustainable

construction practices, the main challenges that we face are lack of effective leadership and decision making, which is important for the adoption of sustainability aspects"

Also, R1 expressed views about the leadership role in achieving sustainable strategies in organisations: "...industry, therefore, needs leaders that can develop a culture that supports, promotes and rewards organisational strategy towards sustainability. The leadership of individuals in Libyan organisations are required to change the way of operation towards paying more attention to the associated economic, social and environmental effects". Furthermore, R5's opinion on the decision-making process and sustainability was expressed as follows: "… construction organisations in Libya need high skilled decision-makers who deliver the direction, shared vision, strategy towards the common aim of a sustainable future"

Summing up, from the participants' perceptions, leadership within construction organisations faces challenges in an attempt to effectively implement sustainable construction practices in Libya. Common challenges include poor leadership processes within organisations and project teams and lack of decision-maker's ability.

- Technical ability and IT skills

According to the participants, the role of technical ability and IT skills should be aimed at supporting the implementation of sustainable construction projects in Libya. R3 stated his opinion about the design skills of the designers in his company that: "…there's a lack of technical ability of the staff in organisations, chronic in design skills are a major challenge". Another challenge concerning technical ability was mentioned from the perspective of R1: "…Libya suffers difficulties from not having exemplary projects which consider technical difficulties; also, Libyan designers are not confident enough when the matters of sustainable design issues appear". In the same context, R3 further explained about green technologies and the function of technical skills in delivering their projects successfully in Libya that: "…, green technologies require complicated techniques and construction processes. If complexities in the aspects of the technique are not addressed well, that might affect the performance of project delivery".

Summing up, technical skills are the abilities and knowledge needed to perform specific green design issues. They are often related to IT skills that include knowledge of tools and technical skills. Technical skills are often most important to overcome complexities in some aspects of the technique in construction projects in Libya.

Discussion of Findings

The following section discusses the key findings from the analysis of data derived from the questionnaire survey and expert interview which were presented in the previous section with reference to the literature.

STEERING AND KNOWLEDGE CHALLENGES

The following issues emerged under this key factor.

Unawareness of sustainability

Experience and information about sustainability by the stakeholders such as professionals and clients can have a significant influence on the implementation of sustainable practices in the industry (Kiesnere and Baumgartner, 2019). In this research, the questionnaire results showed that the respondents paid considerable attention to the level of awareness by stakeholders of sustainable construction, which can be seen from assessing Steering and knowledge challenges. It indicates that awareness by stakeholders on sustainable construction was ranked highest and seen to be highly significant. The awareness seems to be of high value and reaches high agreement between stakeholders. This high level of agreement indicates that

educating the public is paramount to the successful development and application of sustainability within the construction industry in Libya. Furthermore, the finding of the interview showed that unawareness and poor knowledge of professionals was the key factor and suggested that awareness of the importance of sustainability needed to be raised among all construction organisations in Libya.

The above finding, derived from the questionnaire survey and confirmed by the interview narratives was consistent with the findings of Kiesnere and Baumgartner (2019) which indicated that a lack of common understanding was an experience shared by many stakeholders in the construction industry, while, it has also been reported that several stakeholders have acknowledged unawareness or inadequate knowledge of 'sustainable measures' or their alternatives

Inadequacy of government policies and legislation

For the success of the implementation of sustainable construction practices, strong policies are required to enforce sustainability in all aspects of government development. Therefore, the achievement of sustainable construction is highly reliant on the commitment of government and the formation of legislation (Nelms, Russell and Lence, 2005).

Based on the findings of questionnaire survey results, the challenges related to regulations, and policies are of crucial importance for Libya, as a result of assessing steering and knowledge challenges. Government policies and legislation was ranked second. The mean ranks are also compared to the asymptotic significance value that was less than 0.05 for a level of significance. This was substantiated by the primary findings of the semi-structured interviews. The majority of the interviewees agreed that weak policies regarding sustainability presented significant challenges to the Libyan construction industry. It was noted that government regulations to support sustainable construction were required.

Similarly, Akadiri, Olomolaiye and Chinyio (2013) suggested that the sustainable construction concept would be effective if stakeholders, particularly the Government, established legislation that would mandate sustainability policies and building codes and also the development of various policy documents to implement sustainability in all aspects of their development.

TECHNOLOGY AND COST CHALLENGES

Adoption to new technologies

The findings from the analysis of the questionnaire survey showed that the adoption of new technologies was a challenge that was ranked with the highest mean value and was significant. Furthermore, the interviewees' opinions were consistent with the primary data findings from the questionnaire respondents. In the Libyan context, using new technologies in the construction industry are still at an early stage of application, where technologies are often more complicated and are different from conventional technologies that they use in the construction industry.

This agrees with the literature where Tagaza and Wilson (2004) identified the main challenge presented by green technologies was their complexity and diversity in comparison with conventional technologies. Furthermore, Zhang, et al. (2014) noted that a project manager was required to deliver the project with the required performance, and that lack of familiarity with green technologies might adversely affect such performance.

High initial capital and investment costs

It is widely recognised that the most influential challenges for the implementation of sustainable construction practices are financial in nature which increased initial investment costs for sustainable projects compared with traditional buildings (Häkkinen and Belloni, 2011).

In this study, the findings of the questionnaire survey indicated that the challenge of high initial capital and investment costs was significant; the assessment of this challenge was ranked second.

Moreover, the effect of cost challenges on the implementation of sustainable construction has been well discussed by the interviewees from the interview primary data; their opinions showed that sustainable projects usually had higher initial capital costs than any other conventional buildings, which means that there was often some hesitation about undertaking these higher investment costs by clients and investors in Libya.

In the support of the above findings, Häkkinen and Belloni (2011) identified initial costs and financial resources as a major challenge to providing measures of sustainability. These increases are mainly due to design complexity as well as the modelling costs required, to effectively incorporate green practices into projects (Zhang, et al., 2014). Furthermore, Hwang and Tan (2012) noted that higher costs were related to green materials and the use of green construction technologies.

High cost of green materials and products

The questionnaire results showed that the cost of green materials and products was ranked third in terms of mean and significance values. Likewise, from the perspective of the respondents in the interview, interviewees have identified design tools and method as a challenge to implementing sustainable construction practices in Libya; the findings showed that there is a shortage of imported green material and equipment in the Libyan market. The materials required for use for such buildings can be difficult to find especially in urban areas where preserving the environment is not the people's first priority; therefore, there is some hesitation about adopting the use of green material and equipment. The industry is facing resistance from practitioners to support the change from conventional building materials.

As mentioned in the findings of the literature review, the use of green materials can be significantly higher than conventional construction ones. According to Zhang, et al. (2014), green materials were calculated to cost between 3% and 4% more. Some green materials cost significantly more, for instance, "compressed wheat board costs about 10 times more than ordinary plywood" (Hwang and Tan, 2012).

ORGANISATIONAL AND TECHNICAL CHALLENGES

Poor leadership and decision-making process

The leadership process within construction organisations has a key impact on achieving the successful implementation of sustainability. This can be substantiated by the findings of the questionnaire survey, which was ranked highest and had the highest significance value.

Furthermore, poor management and leadership were recognised as a hindrance to the success of sustainable construction in Libya, according to the interviewees' perceptions. It indicated that the success of sustainable construction implementation in Libya lay in the commitment of managers and leaders in developing and implementing an effective plan and adequately providing the required resources and support to manage changes arising from the implementation.

The above-mentioned key findings uphold the findings in the literature review. According to Osaily (2010), the management and leadership of the construction industry and individual organisations had a major role to play in achieving the successful implementation of innovative strategies.

Lack of technical ability and IT skills

Lack of technical ability and chronic lack of skills by the designers had a direct impact on the success of the implementation of sustainable construction principles; this assumes that experts within the industry

need to be fully aware of sustainable construction principles to implement its practice (Hydes and Creech, 2000).

By viewing the primary findings of the questionnaire survey, it appears from assessing the challenges, that lack of technical ability and IT skills challenge had the second highest mean score of 3.64 and a significance of 0.011. Furthermore, this was consistent with the finding of the semi-structured interviews, where the interviewees indicated that there were some difficulties in not having exemplary projects which considered technical difficulties; also, it was found that the building designers usually were not confident enough when issues of sustainable design issues appeared.

This confirms the findings of Rydin et al. (2006) who asserted that designers in the construction industry were not confident when the issues of sustainable construction design arose. This presupposes that professionals within the built environment needed to be fully acquainted with sustainable construction principles in order to implement its practice.

Conclusion

This study aimed at investigating the challenges of implementing sustainable construction practices in Libya. The identified challenges were related to knowledge and steering, technological and costs, organisational and technical issues. Under those three main challenges, seven sub challenges were identified as highly significant for a successful implementation of sustainable construction practices. Within this context, strategies to improve the implementation of sustainable construction practices need to be targeted at different levels of the organisation (i.e., decision-maker level to improve leadership; operational level to improve the technical know-how and willingness to embrace the practices). Further, as a construction industry key stakeholder the government has to play an important role by imposing standards, regulations and policies to govern construction organisations in order to ensure that they complied with and agreed to sustainable construction practices. Findings further indicate that sustainability is more closely associated with financial constraints. Hence providing concessions/intensives for incorporating green materials, products and systems could motivate the stakeholders. This would strengthen the economic significance of socio-environmental practices and further incentivise companies towards the uptake of sustainable construction practices.

The data collection of the study was limited to sixty-three construction companies and carried out in two stages: firstly, by surveying a large population of the construction organisations in Libya and, secondly, by interviewing key actors in the construction sector. Hence, the findings of the study are not limited to the organisations that were involved in the study but can be generalised to the Libyan construction industry as a whole. Further, going beyond that, the findings can be generalised to the construction industry in other developing countries with similar educational, political and economic conditions.

Even though sustainable construction is not a novel concept, limited studies have so far been conducted within the Libyan construction industry. Hence, this study makes an original contribution to the corpus of knowledge and practice through the identification of challenges in implementing sustainable construction practices in Libya. The identification of such challenges should lead to advancement of theory and practice on the strategies that are required to address these challenges in the Libyan and global construction industry contexts. Furthermore, the findings of this study can be extended to investigate the implementation of sustainable construction integrated with lean concept, as its intentionality is to reduce energy consumption, environmental pollution, and optimise waste generation based on sustainability principles. Similarly, this research has provided a solid platform for future research that aims to expand knowledge in this field. It also delivered an in-depth understanding of the complexities related to integrating sustainability in the Libyan construction industry.

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