Barriers to Sustainable Practices in Indonesian Construction Industry

The adoption of sustainable practices is essential to mitigating negative impacts associated with the global construction industry. This study investigates barriers inhibiting the transition to sustainable practices in the Indonesian construction industry. Using questionnaire as a means of data collection, relevant data was analyzed using reliability and exploratory factor analysis. Based on the analysis, the findings suggest that there were eight underlying factors responsible for the poor awareness of sustainability and the current low level of sustainable construction practices in the Indonesian construction industry. The three most significant barriers towards sustainable practices in Indonesia are lack of knowledge and standards, poor design practices, and financial constraints. The sustainable standards practice in Indonesia is still in its infancy and immature compared to developed countries. The findings of this study are expected to provide guidance and knowledge to construction players related to barriers in sustainability practices within the Indonesian construction industry.

Keywords: Sustainable Construction; environmental impacts; Indonesia; sustainable practices; environment

1.0. Introduction

The concept of sustainability was first introduced in 1989 by the United Nations of the World Commission on Environment and Development and has proved to be of utmost importance for the construction industry (Berardi, 2012). The need to build eco-friendly and smart infrastructure to support economic development requires careful considerations from all stakeholders, due to the industry's adverse impacts on the natural environment and human well-being (Akhanova *et al.*, 2019). The construction industry is charged with planning, designing, building, and maintaining the built environment for infrastructure development (Baloi, 2003), without threatening natural life and ecological functioning. Compared to other industries, construction is one of the most vigorous, risky and stimulating industry sectors (Bal *et al.*, 2013), and plays a substantial role not only in the economic and social factors conditioning countries' growth but also in a country's environmental integrity.

Due to the complexity and unique nature of the construction industry, construction processes and activities consume over 30% of natural resources used as raw materials,

25% of water, and yield 30% of global waste (Kucukvar *et al.*, 2013; Rode *et al.*, 2011). Moreover, construction activities contribute approximately 38% to total worldwide energy consumption and GHG emissions (UNEP, 2020). Like in other nations, the Indonesian construction industry significantly impacts economic growth and infrastructure development. It is also known that construction activities are one of the main sources of green-house gas emissions (GHG) in Indonesia (Surahman *et al.*, 2014).

As a foremost contributor to environmental degradation globally, the construction industry is required to compensate for its environmental impacts (Glass, 2012), by promoting sustainable practices throughout its project lifecycles, i.e., sustainable design, sustainable planning, and sustainable infrastructure. Due to these concerns, it is important to take environmental issues into consideration when planning and designing project infrastructures to generate paybacks and protect the environment (Chan & Lee, 2009). Therefore, there is an urgent call for increased sustainability practices in the delivery of construction projects across nations, indicating all countries share common challenges such as climate change, pollution-related health impacts, and biodiversity loss.

Notwithstanding the universal nature of this challenge, developed countries make more substantial progress in driving sustainable construction compared to developing countries (Rwelamila and Ogunlana, 2015; Yin *et al.*, 2018; Martek *et al.*, 2019). However, developing countries such as Indonesia, Brazil, Thailand, Venezuela, Philippines, Turkey, Mexico and South Africa are exceeding the developed nations in terms of their negative environmental impacts as evident by a recent analysis of the top polluting nations across the globe (Wei *et al*., 2021). Moreover, it is predicted that several developing nations such as Indonesia, China, and India will be leaders in the international construction market by 2030 due to their growing construction projects producing carbon emissions (PBC Today, 2019). This suggests that there is a need for developing nations

to meet sustainability goals and incorporate the sustainability agenda into the core of their construction activities.

Due to the need to tackle the challenges to sustainable practices within the construction industry, some research has attempted to explore barriers to implementing sustainable construction throughout project life cycles. For example, Aghimien *et al.* (2018) studied barriers to adopting sustainable construction practices in Zambia and found that the most significant barriers are high investment costs, unavailability of local green certification, and lack of government support and financial incentives. The study suggested the need for client and stakeholder education related to the benefits of implementing sustainability practices throughout the project life-cycle. Abidin (2010) explored the level of awareness and application of sustainable practices among Malaysian developers and found that there was a concern about the higher cost of sustainability practices as well as a tendency to be reluctant to pursue sustainability in their projects. The paper also argued that awareness and knowledge about sustainability should come first, followed by the interest, demand and implementation from clients and other stakeholders.

Studies have shown that the adoption of sustainability practices in developing countries is still very low, mostly caused by lack of understanding of their benefits (Aghimien *et al.*, 2018). Studies concerning the identification of barriers to sustainable practices especially in developing countries like Indonesia are still very limited. The shortage of studies identifying barriers to the adoption of sustainability practices in Indonesia needs to be elaborated, especially as sustainable practices are driven by the local context, including policies, regulations and professional practices (Ajayi and Oyedele, 2017). Consequently, this study investigates obstacles towards implementing sustainability practices in the Indonesian construction industry with a view to informing

progress towards sustainable construction. Significantly, exploring professional perspectives regarding hurdles hindering the adopting of sustainable principles will help decision makers tailor interventions to incorporate sustainability practices into the core of the industry that is known to contribute the highest portion of CO_2 (Ajayi and Oyedele, 2017).

To provide the conceptual background for the study, the next section of the paper reviews present literature on the concept of sustainability practices along with barriers within the construction industry. The findings will serve as a reference for establishing sustainability-related issues and help policymakers define assessment tools related to environmental, economic and social matters in the construction areas.

2.0. Sustainable Construction

In the construction sector, sustainability tends to focus on the term 'sustainable construction' as a subsection of sustainable development (Ashworth *et al.*, 2019). Sustainable construction (SC) was defined as an approach for creating construction practices which include project processes and activities to be more economically, socially, and environmentally responsible (Abidin, 2010). Sustainable construction aims to deliver constructions that provide to users enduring value, affordability, quality and efficiency as well as decrease their environmental impacts. Plessis (2007) described sustainable construction as the practices sustaining the harmony of the built and natural environment to affirm human dignity and economic parity, indicating the needs of people's awareness and knowledge about how to be prepared.

2.1 Barriers to and Drivers of Sustainable Construction Implementation

Many researchers have discussed barriers to and drivers of sustainability practices (Häkkinen & Belloni, 2011; Tunji-Olayeni *et al.*, 2018; Baloi, 2003). For example, Onososen *et al.* (2019) studied the major barriers to the adoption of green building in Nigeria, mostly caused by fear of high risk and increased costs to the project, lack of awareness, lack of green products and poor government support. Similarly, Pham *et al.* (2020) studied key barriers to sustainable practices at firm and project levels within the Vietnamese construction industry and identified the most important hurdles as including lack of project manager's competence, lack of sustainable material and technologies, poor government incentives, and low level of sustainability practices. Dahiru (2019) investigated the barriers to sustainable procurement practices in Nigeria and showed that the environmental assessment criteria during tendering and environmental planning were still poor, specifying optimal solutions needed to improve the integration of environmental issues into project requirements.

According to Häkkinen & Belloni (2011), the most significant barriers to sustainable approaches are organizational and procedural problems due to the acceptance of new methods, necessitating process changes which have direct effects to risks and costs. There is a resistance to the adoption of new technologies due to the reluctance to apply changes within the organization; therefore, there is a need to apply new effective processes by focusing on the roles and tasks of all stakeholders. However, in order to fully adopt sustainability building, there are three main components that should be fulfilled, such as the accessibility of sustainable technologies, accessibility of sustainable knowledge and methods, and accessibility of sustainable processes and adoption of new technologies (Häkkinen & Belloni, 2011). Nduka & Ogunsanmi (2015) evaluated factors and constraints influencing the adoption of green building practices based on stakeholders' perceptions in Nigeria using a questionnaire survey for environmental

professionals. It was found that higher costs and lack of awareness and expertise were the main barriers to implementing green building practices, suggesting action and policy from the Green Building Council of Nigeria to fully establish public awareness and develop best practices. Tunji-Olayeni *et al.* (2018) explored obstacles for driving sustainability practices within the Nigerian construction industry. The study showed that lack of awareness of sustainability issues among project players, lack of government support and leadership are the main factors that militate against the execution of its practices, indicating insufficient information about sustainability practices. While these sets of studies further reinforced the need for enhancing sustainable practices within the construction industry, the findings show the plurality of recognized barriers that can be used as benchmarks under different case studies and countries. Table 1 summarizes the barriers to sustainable construction practices as established in the literature.

Studies have also investigated attitudes towards sustainability practices within the construction industry, as well as their major drivers. For instance, Manoliadis (2006) found that the most essential factors influencing sustainability were cost savings associated with energy and resource conservation measures as well as waste reduction. A similar study by Myers (2005) suggests that sustainable construction practices are linked to corporate social responsibility, allowing firms to inform the public about their responsible environmental, economic, and social behaviours. The studies' findings suggest that while a major motivation for adopting sustainable approaches could be linked to financial benefits, such as the cost associated with waste reduction and energy reduction over the entire building lifecycle, sustainability is also an essential tool for brand promotion in the corporate world.

Although emerging relatively slowly, there are a number of studies on sustainable construction practices within the Indonesian context. Berawi *et al.* (2019), as an example,

investigated stakeholders' participation towards green building practices and found that few building owners have fully adopted green building certification. The study of Wirahadikusumah & Ario (2015) into contractors' readiness paints a similar picture in terms of the willingness, awareness and preparedness of Indonesian contractors for sustainable construction practices. With both the clients and contractors having problems with the adoption and implementation of sustainable construction practices, it is not surprising that it is challenging to implement such practices during the procurement stage for construction works as found by Wirahadikusumah *et al.* (2019).

Based on the understanding that the concept of sustainability has yet to be widely adopted in Indonesia, Suprayoga *et al.* (2019) developed a framework that could assist stakeholders by stating problems and solutions integrated with sustainability practices to streamline decision making. Zhabrinna *et al.* (2018) also argued that sustainable construction could also be achieved with the help of BIM adoption as an innovative technology in the construction industry. While the different studies focussing on sustainability practices within the Indonesian construction industry have clearly established the poor awareness and implementation of sustainability practices, there has been no study that focused on understanding the barriers towards achieving sustainable construction in the Indonesian context. However, an understanding of such barriers and challenges is essential for tailoring solutions to addressing them. Therefore, this study fills gaps in research by addressing hurdles to sustainability practices within the Indonesian construction industry.

Table 1. Summary of previous studies

No	Barriers	Source
1	Lack of awareness about sustainability issues	Tunji-Olayeni *et al.* (2018), Davies *et al.* (2017), Esezobor (2016), Szydlik (2014), Durdyev *et al.* (2018), Aghimien *et al.* (2018)
2	Lack of business case understanding	Toriola-Coker *et al.* (2021)

3	No professional role for initializing and leading sustainability	Toriola-Coker *et al.* (2021)
4	Lack of resources to supervise the realization of sustainability	Toriola-Coker *et al.* (2021)
5	Lack of leadership and professional support institut	Tunji-Olayeni *et al.* (2018), Gan *et al.* (2015), Pham *et al.* (2020), Aghimien *et al.* (2018)
6	Long payback periods of sustainable practices	Durdyev *et al.* (2018), Gan *et al.* (2015), Aghimien *et al.* (2018)
7	Lack of sustainable building materials	Dzokoto &Dadzie (2013), Davies *et al.* (2017), Gan *et al.* (2015), Pham *et al.* (2020), Aghimien *et al.* (2018)
8	Lack of capacity for execution of sustainable construction projects	Davies *et al.* (2017), Pham, *et al.* (2020),
9	Lack of incentives for designers to facilitate sustainable design	Davies *et al.* (2017), Hwang & Tan (2012), Gan *et al.* (2015), Aghimien *et al.* (2018)
10	Operational and end of life stages are not considered in design	Toriola-Coker *et al.* (2021)
11	Lack of design and construction team	Davies *et al.* (2017)
12	Lack of building codes, laws, legal, and regulation	Davies *et al.* (2017), Tunji-Olayeni *et al.* 2018, Esezobor (2016), Durdyev *et al.* (2018), Gan *et al.* (2015), Pham *et al.* (2020), Aghimien *et al.* (2018)
13	Fear of higher investment cost	Davies *et al.* (2017), Tunji-Olayeni *et al.* (2018), Hwang, B. G., & Tan, J. S. (2012), Durdyev *et al.* (2018), Gan *et al.* (2015), Pham *et al.* (2020), Aghimien *et al.* (2018)
14	Lack of strategy to promote sustainability	Davies *et al.* (2017)
15	Lack of database and information	Davies *et al.* (2017)
16	Lack of government support	Davies *et al.* (2017), Tunji-Olayeni *et al.* 2018, Hwang & Tan (2012), Durdyev *et al.* (2018), Pham *et al.* (2020), Aghimien *et al.* (2018)
17	Lack of sustainability measurement tools, standards and certification	Davies *et al.* (2017), Aghimien *et al.* (2018)
18	Increased documentation	Davies *et al.* (2017)
19	Extensive pre-contract planning	Davies *et al.* (2017)
20	Lack of training on sustainability	Davies *et al.* (2017), Durdyev *et al.* (2018), Gan *et al.* (2015)
21	Lack of education and research	Esezobor (2016), Gan *et al.* (2015), Aghimien *et al.* (2018)
22	Lack of knowledge about sustainability principles	Hwang & Tan (2012), Gan *et al.* (2015), Pham *et al.* (2020)
23	Client worries on profitability	Szydlik (2014), Aghimien *et al.* (2018)
24	Lack of financial resources	Szydlik (2014), Pham *et al.* (2020)
25	Different views and conflicts of interest among project players	Adetunji *et al.* (2005)
26	Lack of support from financial institution	Gan *et al.* (2015)
27	Lack of accessible guidance about sustainability	Gan *et al.* (2015), Aghimien *et al.* (2018)
28	Poor project organization structure	Gan *et al.* (2015)
29	Poor project procurement system	Gan *et al.* (2015)
30	Low understanding of economic benefits	Pham *et al.* (2020)
31	Lack of competence of project managers	Pham *et al.* (2020)
32	Lack of government commitment	Aghimien *et al.* (2018)
33	Lack of motivation and aspiration values of managers	Aghimien *et al.* (2018)
34	General perception that sustainability means more expensive buildings	Toriola-Coker *et al.* (2021)

2.2 Benchmarking and Assessment Tools for Sustainable Construction

To facilitate sustainability within the construction industry, there is a need to develop and establish benchmarking and assessment tools towards achieving a sustainability agenda. This is especially as Ding (2008), Halliday (2008) and other authors established that sustainable design appraisal tools play a major role in motivating, encouraging and driving sustainable practices by providing tools for benchmarking. Sustainability assessment is the process of identifying, estimating and assessing the potential impacts of construction products and processes, and is required to improve the low dispersion of sustainable buildings in the construction sector. Moreover, the assessment tools can also be used by practitioners to stimulate building sustainability to prioritize goals and environmental performance (Akhanova *et al.*, 2019) as well as evaluate performance measures. Akhanova *et al.* (2019) developed a framework of sustainability assessment tools for commercial buildings for local prerequisites in Kazakhstan using a combination of different international standards such as LEED, BREEAM, CASBEE, and SBTool. The built standard was used as a benchmark to establish a regional sustainability assessment that can help policymakers elucidate problems related to sustainability practices.

Berardi (2012) evaluated the rating systems assessment for buildings and found that building energy performance is the major criterion used for sustainability assessment. However, the high rate of success in sustainability rating systems was shown by the criteria of water efficiency and indoor air quality. It was estimated approximately 6 Gt per year of the total CO_2 emissions reduced in the upcoming years if sustainability is implemented in the building sector (Berardi, 2012), highlighting the need for sustainable construction to be prioritized for sustainable development. Ding (2008) discussed the role of environmental valuation tools and stated that it is inadequate for attaining the

sustainable development goal and decreasing environmental impact to implement environmental friendly project design at the design stage only, but more than that it is essential to apply the concept design at the early stage of project feasibility study.

2.3 Roles of and Collaboration among Construction Players towards Sustainable Construction

Construction practitioners are playing an important role in implementing sustainable construction within construction projects. As the study of Gan *et al.* (2015) which highlighted the importance of owner's roles in achieving sustainable construction found that the critical factors related to sustainable construction included economic feasibility, owner's awareness, stakeholder's support, laws and regulation, operability, resource risks, and project management models. A study by Pero *et al.* (2017) emphasized that the success of sustainability practices greatly depends on environmental collaboration among supply chain players. The study investigated multiple case-studies within construction companies in Italy by identifying different approaches used. Meanwhile, Ikediashi *et al.* (2012) noted that sustainable practices can only be made possible by executives at the top strategic level of management. In addition, Plessis (2007) emphasized the urgency of dialogue among different levels of stakeholders involved within the construction industry such as government, industry practitioners, universities and research centres to strengthen the understanding of achieving sustainability goals for broader practices. It was mentioned that many stakeholders in the construction industry do not have sufficient information about sustainability practices. Bal *et al.* (2013) stressed the importance of stakeholder engagement as a fundamental element in every sector to better manage project delivery in a more sustainable way in terms of economic, social and environmental concerns. On the other hand, Yuan and Zuo (2013) investigated the role of students of

higher education in China. The university students were very concerned about sustainability issues and emphasized the importance for social factors such as safety on campus and access for the disabled to be included as critical dimensions of sustainable development. Students also perceived the importance of research into sustainable practices. Therefore, there is urgency for enhancing students' awareness of how to better achieve sustainable development goals at the university level.

Given issues and lessons based on previous studies, and with the need for engaging stakeholders being important, none of the existing studies have engaged Indonesian construction professionals. Therefore, it is important to further investigate the underlying barriers that hinder the adoption of sustainability practices within the Indonesian construction industry, in order to understand approaches for promoting sustainability practices in the emerging economy.

3.0. Research Method

This study adopted quantitative methods of data collection and analysis by operationalizing a questionnaire incorporating relevant factors established from extant literature and brainstorming sessions with industry experts, which Field (2013) suggest as an effective approach for generating items for measuring constructs. This approach is considered suitable for this study, as it is the best approach when a study seeks quantifiable data for which statistical analysis could be employed to establish a conclusion that is applicable to a larger audience (Flannery *et al*., 2019). This section explains and justifies the approaches used for the study.

3.1. Quantitative Data Collection

A questionnaire was selected as the means of data collection, as questionnaires provide an opportunity to reach out to a larger audience using a standardized instrument for data collection (Walliman, 2019). Using factors operationalized from an initial review of literature and brainstorming sessions, the questionnaire consists of two main sections, one for the participants' information, and one posing questions about potential barriers to sustainable construction practices. The factors identified from literature and through brainstorming sessions were rephrased to fit the rating scales, as recommended by Field (2013), with duplicate measures eliminated from the list. To identify factors hindering sustainable construction practices in the Indonesian construction industry, the questionnaire was put on a five-point Likert scale, where 1 represents strongly disagree and 5 represents strongly agree. This, according to Nunnally and Bernstein (2007) ensures that the responses could be summarized for each of the factors based on all participants' responses, thereby determining the contributory impacts of the individual measures on the questionnaire.

To confirm the suitability of the questionnaire as a measure of the intended construct, a pilot study was carried out in order to evaluate the clarity of language, logic of its questions, and degree of depth, and in order to carry out a preliminary check of the proposed statistical analysis as recommended by Field (2013). Thereafter, some factors were rephrased to ensure clarity and the efficacy of the internal construct was evaluated and validated through cross tab analysis and frequency test. Using a Google Form questionnaire design, an online questionnaire administration was preferred in this instance, as it enables researchers to reach out to a larger audience over a short period of time by sending the questionnaire links to the prospective participants (Flannery *et al.*, 2019). The use of Google Form means that the responses could be easily downloaded into an Excel sheet for a convenient export into SPSS that was used for data analysis.

Following Couper's (2000) list-based sample of high-coverage populations, a probability-based survey involving a list-based sampling frame was adopted. LinkedIn messages, emails and other professional platforms were used to contact about 1,000 construction professionals. Overall, 487 responses were received from the participants, with 482 used for further analysis after removal of responses with excessive missing data that are considered unsuitable for further analysis. Table 2 shows the demographic distribution of the respondents.

Table 2. Overview of the respondents

	Sample size	**% of Respondents**
Job roles		
Architect	29	6.0
Faculty/Professor	55	11.4
Builder	4	.8
Civil/Structural Engineer	129	26.8
Construction Manager	8	1.7
M&E Engineer	20	4.1
Project Manager	39	8.1
Quantity Surveying	22	4.6
Site Manager	15	3.1
Material Supplier	9	1.9
Staff Officer	102	21.2
Environmental Engineer	22	4.6
Others	28	5.8
Total	**482**	**100.0**
Types of Organization		
Government Officer	74	15.4
Architectural Firm	10	2.1
Engineering Consultancy	70	14.5
Contractor	132	27.4
Project Management Firm	9	1.9
Material Supplier	10	2.1
University	56	11.6
State-owned Enterprises (BUMN)	49	10.2
Ministry of Public works	51	10.6
Others	21	4.4
Total	482	100.0
Size of Organization		
Fewer than 20 employees	74	15.4
21 to 100 employees	146	30.3
101 to 500 employees	109	22.6
501 to 1000 employees	51	10.6
1001 or more employees	102	21.2
Total	482	100.0

3.1. Quantitative Data Screening and Reliability Analysis

A visual screening of the data shows that five respondents were largely unengaged. Their data, which also contained excessive missing values, were excluded from further analysis as recommended by Nunnally and Bernstein (2007). Yockey (2010) suggests that it is essential that the reliability of the research instrument is tested using a Cronbach alpha coefficient when the study involves the use of a Likert scaled questionnaire. In line with this, SPSS 26 was used to estimate the internal consistency of the questionnaire data through Cronbach Alpha, which retuned a value of 0.917 for the 74 items on the questionnaire. With the value being above 0.8, which George and Mallery (2019) suggests as a mark of an excellent internal consistency, it shows a very high level of internal consistency. As recommended by Field (2013), Cronbach Alpha if item deleted was estimated to identify factors that were not contributing to the overall internal consistency. Through this, seven items with their individual *Cronbach Alpha if item deleted* about 0.917 were removed from the lists of 74 items with the Cronbach alpha increasing to 0.974.

3.2. Exploratory Factor Analysis

Consistent with the aim of this study, which is to understand the underlying barriers hindering the adoption of sustainable construction practices, it was important to determine the underlying factors hindering the practices. As a result, confirmatory factor analysis was carried out to substitute the remaining 67 factors with a few uncorrelated factors undermining sustainability in the Indonesian construction industry. According to Field (2013), this process involves three steps, which are confirmation of data suitability, factor extraction and factor rotation, respectively. Kaiser Meyer Olkins (KMO), Bartlett's test of sphericity and Determinant of Coefficient Matrix tests were carried out to

determine suitability of the data for factor analysis. While the KMO and Bartlett's test coefficient meet the required thresholds by achieving values of 0.940 and 0.0001 respectively, which meets the required minimum of 0.5 for KMO and p-value below 0.05 for the Bartlett's test (Field, 2013), the determinant of coefficient initially failed to meet the threshold. This is because it achieved an initial value of 1.270E-10, which is below the minimum value of 0.00001 (Field, 2013). As further recommended by Field (2013), the determinant of correlation matrix and the diagonal of anti-image correlation matrix were checked to eliminate variables with values below 0.5. Through this, 16 variables were excluded to achieve a Determinant of Coefficient Matrix of 2.549 E-5, which meets the required threshold.

Factor extraction and rotation were carried out using Principal Component Analysis (PCA) and Varimax with Kaiser Normalisation, respectively. Using this approach, a minimum Eigen value of 1 was retained, resulting into eight component solutions which accounted for 62% of total variance. As recommended by Tabachnick and Fidell (2013), factors that loaded significantly in two components were excluded, and the resulting variables and their underlying latent factors are as presented in Table 3. Taking the Eigen value and percentage of variance as a measure of significance, the eight barriers to sustainable construction practices, which are discussed in the next section, are: lack of knowledge and standards, poor design practices, financial constraints, project management constraints, lack of leadership, weak political will, economic barriers and documentation constraints.

Table 3. Results of Factor Analysis

NO.	Extracted and Rotated Components	Eigen Value	%of Variance	Factor loading
COMP 1	**Lack of knowledge and standards**	7.382	17.465	
	Lack of knowledge about sustainability principles			.694
	Lack of training on sustainability			.661
	Lack of database and information			.635

	Lack of education and research			.628
	Lack of sustainability measurement tools, standards and certification			.581
	Lack of accessible guidance about sustainability			.575
	Lack of strategy to promote sustainability			.561
	Lack of building codes, laws, legal, and regulation			.528
COMP 2	**Poor design practices**	4.404	9.908	
	Lack of design and construction team			.684
	Lack of sustainable building materials			.570
	Operational and end of life stages are not considered in design			.560
	Long payback periods of sustainable practices			.535
	Lack of incentives for designers to facilitate sustainable design			.526
	Lack of capacity for execution of sustainable construction projects			.509
COMP 3	**Financial constraints**	4.158	8.317	
	Client worries about profitability			.683
	Lack of financial resources			.604
	Lack of support from financial institution			.596
	Different views and conflicts of interest among project players			.548
COMP 4	**Project management constraints**	3.403	6.806	
	Lack of motivation and aspiration values of managers			.675
	Poor project organization structure			.674
	Poor project procurement system			.627
	Lack of competence of project managers			.567
COMP 5	**Lack of Project Leadership for Sustainability Practices**	3.011	6.023	
	No professional role for initializing and leading sustainability			.732
	Lack of leadership and professional support institutions			.633
	Lack of awareness about sustainability issues			.625
	Lack of resources to supervise the realization of sustainability			.537
	Lack of business case understanding			.531
COMP 6	**Weak political will for sustainability**	2.577	5.155	
	Lack of government commitment			.724
	Lack of government support			.671
COMP 7	**Economic barriers**	2.232	4.463	
	Low understanding of economic benefits			.594
	Fear of higher investment cost			.575
	General perception that sustainability means more expensive buildings			.509
COMP 8	**Documentation Constraints**	1.961	3.923	
	Increased documentation			.688
	Extensive pre-contract planning			.647

4.0. Discussion of Findings

Based on the findings in the previous section, this section presents the underlying factors that are hindering the sustainable construction practices in Indonesia.

4.1 Lack of knowledge and standards

Based on the factor analysis, the first component with a total variance of 17.465% was labelled as 'lack of knowledge and standards'. With the component having the highest percentage of variance, this suggests that Indonesian construction players acknowledge that there is a lack of sustainability knowledge and standards for driving sustainable construction practices. The knowledge deficit in this instance is considered to be responsible for the lack of sustainable construction practices among the professionals that are expected to motivate hesitant clients. It is, therefore, essential that knowledge of sustainability is enhanced in order to drive behavioural change towards sustainability practices (Heeren *et al.*, 2016).

Similar studies from developing countries arrived at the same conclusion, namely, that a lack of knowledge and awareness is the most significant factor impeding sustainability implementation and eventually leads to insufficient sustainability practices (Rock *et al.*, 2019; Bonsu *et al.*, 2019). Furthermore, the study of Amiril *et al.* (2017) found lack of training and education to be the second major barrier to sustainability practices in a Malaysian railway project, leading to slow implementation of sustainable construction practices. As a result, there exists an urgent need to address the skills and knowledge gap by facilitating relevant training and professional development (Zalina & Soebarto, 2014). Educational programs should be enhanced to increase general education among stakeholders as they are the primary decision-makers who can impact achieving sustainable practices.

According to GBCI report (IFC, 2019), it has been known that almost 90% of existing buildings in big cities such as Jakarta do not comply with green regulations as they were built before green conventions were released. Additionally, there was an

increasing awareness about environmental issues, thus far there has been little done to educate the public.

4.2 Poor design practices

The second component, with a total variance of 9.908%, was named ‘poor design practices’, suggesting that there is a need for a fundamental change in what should be considered as design quality in the Indonesian construction industry. The European Union (EU) estimated that the early design stage could influence about 80% of the total environmental impacts of products and services. An effectively planned design provides opportunities for selecting materials with low embodied energy, low U-value and high end of life residual values. According to Blutstein & Rodger (2001), a sustainable building is not only diagnosing solutions about certain problems, but also changing approaches, exemplars, processes and schemes to deliver the project. It is important to adopt the concept and principles of sustainability at the early design stage to avoid problems in the future, as it could be too late to fix what has been built. The future of building construction and its environment highly depends on the level of adoption of the sustainability concept and principles at the design stage to decrease the negative impacts on building and surrounding environment (McLennan, 2004).

According to the MacLeamy Curve, which is a graphical representation of how changes become increasingly difficult as a project develops (AIA, 2007), the decisions made at earlier design stage are more cost effective, since this stage could significantly influence outcomes and produce minimal cost change. Thus, it is essential to focus on the need for designers to lead the sustainability agenda by providing effective design strategies and approaches such as incorporating sustainability into design briefs, and procuring sustainable design processes and services. Wang & Adeli (2014) affirmed that

sustainable building design enables construction practitioners to transform structural development into more eco-friendly building design which eventually could increase quality of life. It is undeniable that numerous designers are not aware of their roles in promoting sustainable practices especially in developing countries (Bonsu *et al.*, 2019). The study of Mitchell (2012) in Africa stated that there were only a few design companies that incorporated sustainability principles into their projects even though the design practitioners can apply their practices in different ways. Consequently, raising the awareness of sustainability among the designers is requisite for enhancing sustainable construction practices in Indonesia.

4.3 Financial constraints

The third significant component labelled as 'financial constraints', had a total variance of 8.317% and consisted of 4 variables. This component indicates that finance is hindering sustainability practices due to the clients' perceptions about gaining profitability and poor support from financial institutions. Clients have the capability of wielding pressure within the construction industry (Blayse & Manley, 2004). Clients can also affect and shift the approaches, performances and paradigms that other construction experts addressed and play significant roles in achieving the success of construction projects. The clients' perception about profits may occur because there was a concern about additional investment costs such as equipment, machinery, or technology costs that clients should pay-off to comply with the standards practices (Zalina & Soebarto, 2014).

Although it is widely believed that sustainable buildings have a shorter payback period when compared to conventional ones, poor awareness of such benefits among the clients could be counterproductive, as the initial cost could be slightly higher. The clients' knowledge of profitability if practicing sustainability concepts can be enhanced by using

the analysis of a payback period in which investments costs are divided by annual savings. In the case of green building retrofitting, some clients believe that the benefits of investing according to green principles will not automatically give direct impact to the owners of buildings, but mostly will provide saving to a building's tenants. This makes owners reluctant to bear the cost of increasing building energy efficiency for sustainable practices at a project's early stage. Consequently, it is important to increase the clients' awareness and understanding about the importance of adopting sustainable construction.

4.4 Project management constraints

Component 4, named 'project management constraints,' had a total variance of 6.806% and comprised 4 variables. This factor suggests that the construction practitioners considered project management as one of the major barriers hindering sustainability practices. Project management plays significant roles in creating project values in terms of planning, monitoring, and controlling project goals involving stakeholders' participation within the specified constraints (Nikolić *et al.*, 2020). The objective of project management is to deliver a project that conforms to a client's objectives. The application of project management principles can be enhanced by introducing the concept of sustainable project management as a change model towards sustainability practice, involving environmental, economic, and social aspects (Peter & Lucas, 2017).

The success or failure in implementing sustainable construction practices strongly depends on its project management. Maijo (2020) explored the success factors of project management towards sustainable project implementation and found that the project managers' performance and the project organizations considerably influenced the success of sustainability practices. It is known that poor project organization structure and poor procurement systems will lead to unsuccessful implementation of a sustainable project.

According to Kim and Park (2006), an organization's top management plays a vital role ensuring that a project's entire life cycle, from design and construction to operation and management, is suffused with sustainable practices. Michaelides *et al.* (2014) pointed out important enablers of sustainability covering 5 factors, such as the culture of an organization, transfer of knowledge, management commitment, project managers' experience, and perceived success about sustainability practices. Project managers are responsible for managing projects and the use of resources to achieve sustainable project management practices adopted into their programs, policy, and portfolios (Michaelides *et al.*, 2014). Therefore, poor project organization cultures and poor procurement systems make a significant negative impact on business processes and organizational performance. Aghaegbuna *et al.* (2020) also mentioned that there are some challenges faced by project managers as they apply sustainability principles, which include planning-related challenges, project and client related challenges, project team, labor and external-related challenges.

4.5 Lack of project leadership for sustainability practices

Component 5, labelled 'lack of project leadership for sustainability practices,' had a total variance of 6.023% and comprised 5 variables. This factor reinforced the importance of project leadership for tackling sustainability barriers by leading a team to achieve successful project completion. This aligns with the study of Ametepey *et al.* (2015), which indicated that one of the most significant barriers towards sustainability practices was project leadership, since effective leadership plays a major role in determining whether an organization will achieve its goal. The leaders are expected to be able to develop a system or culture that promotes and supports an organizational strategy for sustainability implementation. Moreover, leaders are required to have the ability and

knowledge to effectively guide a project and organization towards sustainability (Opoku and Fortune, 2011). Opoku *et al.* (2015) suggested that the role of organizational leadership in delivering sustainable construction projects that should be supported by the commitment and encouragement of leadership. There is an urgency to promote a constructive culture of effective leadership within an organization that shows the level of ethical performance necessary to substitute the conventional paradigm with more sustainable practices (Toor and Ofori, 2006). Likewise, strong collaboration among stakeholders who are knowledgeable and experienced about sustainable construction implementation is strongly required in order to tackle obstacles hindering sustainable building acceptance (Griffin *et al.*, 2010). Aghaegbuna *et al.* (2020) also argued that the experience and competence of project managers significantly affected the implementation of sustainability. Meanwhile, the failures of project managers in addressing sustainability issues in their projects were often caused by a lack of managerial competence, which made it difficult to apply sustainability to a project's business process. One of the examples is that project managers should be familiar with sustainable standards to be able to set sustainable objectives at the design stage. Moreover, project managers should also understand sustainable green designs to justify environmental performance criteria and knowledge about choosing suitable construction methods for achieving sustainable construction.

4.6 Weak political will for sustainability

Government plays a vital role as regulator, policymaker, and driver of sustainability practices. Therefore, the government should be fully committed to sustainable practices by introducing and enhancing legislation and policy guidance. Furthermore, the government is expected to drive transparency by enhancing regulations and policies as

well as share information widely to raise public involvement, awareness, and commitment to sustainable programs. In the case of developed countries, for example, Germany has successfully established an energy policy using renewable energy for sustainable development. The USA has led and developed some strategies in every sector to achieve energy savings such as establishing building energy performance criteria. On the other side, the UK government implemented European Union (EU) law as a legal policy requiring it to consume 20% of energy from renewable energy sources by 2020 and to reach zero carbon emissions by 2050 (Lu *et al.*, 2020). In order to fulfil this condition, the UK government has amended several policy instruments and improved construction and design criteria such as building control regulation and mandatory energy labelling (Lu *et al.*, 2020). As a result, the UK government has been promoting sustainable construction by establishing a report about strategies for sustainable construction to be adopted in their construction industry. This signifies that the government takes the lead and makes a firm commitment towards enabling a sustainable construction industry to reduce its carbon footprint and energy consumption.

Unlike some developed nations, the Indonesian government has made a slow progress in emissions reductions in the field of built environment since there were few policies and regulations supporting green goals during the year of 2009-2014 (Wiryomartono, 2015). The Jakarta Governor's decree No 38/2012 provided green building criteria for new building permits in Jakarta only. However, policies governing green building regulations have not been fully implemented nationally throughout Indonesia but are limited to few cities only.

The application of sustainability in Indonesia is still in an early stage compared to neighbouring countries (Wiryomartono, 2015). Green concept development in Indonesia was initiated in 2008 by the Green Building Council Indonesia (GBCI), a non-

governmental and non-profit institution. GBCI aims to assist the sustainable revolution of the building industry, facilitating the adoption of green building principles and increasing public education to support implementing environmental best practices (GBCI, 2021). GBCI also collaborates with many stakeholders such as construction professionals, professional associations, building developers, government, educational and research institutions to disseminate and facilitate green construction practices. GBCI published GREENSHIP in 2011 as a rating tool and best practice for building construction standards. However, the adoption of its practices is still low, as is evident by limited legal support given by the government and the fact that they are not integrated into the national government policy (Wiryomartono, 2015).

The Indonesian government has issued several regulations and policies related to sustainable building construction, such as the Ministerial Regulation No 2/2015, that should be adopted by construction practitioners; however, the adoption of a broader orientation towards sustainability is still very limited and lagged behind compared to other Asian countries (IFC, 2019). The Indonesian government has targeted a 29% carbon emission reduction by 2030. Therefore, it is important to make mandatory regulations requiring a full adoption of green building practices. The government should also emphasize an environmental care program and commit to real action rather than just publishing laws and regulations by collaborating with non-governmental institutions such as GBCI.

4.7 Economic barriers

Based on the factor analysis, the seventh component, ‘economic barriers,’ had a total variance of 4.463%. Lack of understanding of their economic benefits and high investment costs result in slow implementation of sustainability practices. In line with the

study of Griffin *et al.* (2010), the cost increase during initial investment was considered to be one of the most significant barriers hindering the practice of sustainability. However, it was said that even though the sustainability practices could raise initial costs, that initial outlay can be recovered through economic benefits such as operational cost savings and life-cycle cost reduction throughout building cycles (Baiden *et al.*, 2006). This is especially as the green concepts implementation may reduce operating costs by 8-9%, increase total building rate by 7.5% and improve occupancy rates by 3.5% (USGBC, 2006).

The majority of practitioners tend to eliminate the use of sustainable concepts in the early stages due to perceived higher investment costs (Griffin *et al.,* 2010). This suggests there is ignorance about the payback that clients could obtain in future by implementing the sustainability concepts. The barrier of high investment costs can be mitigated by providing financial incentives to clients so that they can increase capital access as well as reduce initial costs. The financial incentives given by the government can be in form of tax abatements, loan programs, guarantees, rebates, low-interest financing and other incentive programs to make clients more receptive to sustainability practices (Rana *et al.*, 2021). The stigma connected with the clients' idea that adopting sustainability means more costs and expensive buildings could be diminished if clients are convinced about the benefits of fully implementing sustainability concepts within their organizations.

4.8 Documentation constraints

The last component, named 'documentation constraints,' has a total variance of 3.923%. This component suggests that there is a belief that adopting sustainable construction practices means that there would be increased documentation and extensive pre-contract planning. While it is possible that there would be a documentation

requirement for team members, which may consume more time and efforts to finalize, especially when applying for sustainable design appraisal systems such as BREAAM, sustainable construction projects do not necessarily require more extensive documentation. In traditional projects, documentation can be equally difficult to collect from different sources, whereas advanced construction management could make gathering and submitting documentation more efficient in terms of project schedules and budgets (Robichaud & Anantatmula, 2011). Adoption and implementation of such techniques as the Building Information Modelling (BIM) would enhance coordination among project teams, thereby reducing stress and difficulties associated with project documentation (Ajayi *et al.*, 2019). Thus, complementing sustainable construction practices with advanced and collaborative techniques would facilitate seamless implementation of sustainability within the Indonesian construction industry.

5.0 Conclusion and Recommendations

The need for increased sustainability in the global construction industry is well established in the literature. In line with this, there has been a significant improvement in sustainable construction practices in most developed nations, while many developing nations are lagging. To understand this challenge from the Indonesian context, this study investigates barriers to sustainable practices based on professional perspectives within the Indonesian construction industry. Using a questionnaire as a means of data collection, data was analyzed using reliability and exploratory factor analysis.

Based on the analysis, the finding suggests that there were eight underlying factors responsible for the poor awareness of sustainability and the current low level of implementation of sustainable construction practices in the Indonesian construction industry. The three most significant barriers towards sustainability practices in Indonesia

are lack of knowledge and standards, poor design practices, and financial constraints, making the nation to remain in its infancy with regards to sustainability practices compared to developed countries.

The lack of knowledge and standards became the most important barrier hindering sustainability, indicating an urgency to address knowledge and standards gaps among key players. Thus, educational programs should be developed to enhance stakeholders' knowledge, as they are the primary decision-makers regarding achieving sustainable practices. Universities and colleges should educate their students by developing sustainability curricula and education programs to guide and influence behavior towards sustainability.

Building design plays an important role in delivering the whole building performance, as the early design stage contributes around 80% of total environmental impact of products and services. It is, therefore, important to adopt the concept and principles of sustainability at the early design stage, and then ensure that sustainable design principles are adequately implemented through a sustainable project management approach.. However, this study shows that there is poor design practice in the Indonesian construction industry. Similarly, poor project management practices and lack of leadership for motivating and driving sustainability practices are established. This implies that there is an urgency for designers and project management professionals to commit themselves to utilizing more sustainable processes from design through to the projects' end of life stages.

Capital costs of sustainability practices are usually higher than conventional approaches, but the lifespan payback is much greater compared to traditional practices due to the savings in operational costs, emissions reduction, and energy efficiency. One approach that has been successfully adopted in developed nations such as the US and UK,

for instance, is the concept of a green subsidy, which involves the government providing market subsidies to drive down the cost of sustainability. If implemented, this could help reduce the cost of sustainable construction materials and technologies, thereby motivating their adoption. While this could result in a financial burden on the government, practices in developed nations showed that such cost of subsidising sustainability could be offset by the financial penalties from poor sustainability practices, such as the landfill tax in the UK.

The low level of government support that currently hinders sustainability practices in Indonesia should be enhanced. It is expected that the government should be fully committed to sustainability practices by introducing and enhancing legislation and policy guidance, which have been instrumental to driving sustainability in most developed nations. Furthermore, the government should also promote transparency by enhancing regulations and policies as well as providing information widely to raise public awareness, involvement and enhance commitment to sustainable programs. These measures would drive industry professionals towards adopting sustainable alternatives in design, materials use, construction and building operation.

The implementation of sustainability practices among project members should be seen as a way to increase value as well as a way to protect all from global warming and other environmental disasters. This study has contributed to the understanding of key barriers towards implementing sustainable construction practices in Indonesia by recognizing the most testified barriers in the literature. The outcomes are significant due to the information offered on the foremost barriers in sustainable construction practices, indicating to a better understanding in the context of challenges and hurdles of global sustainability adoption. Therefore, it is important to actively pursue effective strategies and actions to that are consequently suggested towards enhancing sustainability practices.

The findings of this study are expected to provide guidance and knowledge to construction players related to barriers to sustainable practices within the Indonesian construction industry. This study also offers valuable information that presents the challenges to and potential for improving sustainability implementation in the construction sector. However, notwithstanding that the findings of this paper uncovered many factors that bear similarities to the current situations in many other developing nations, it is limited to the Indonesian context only with findings emanating from Indonesian construction professionals. Further research could explore its applicability to other nations.

References

Abidin, N.Z. (2010). Investigating the awareness and application of sustainable construction concept by Malaysian developers. Habitat International, 34(4), 421-426.

Adetunji, I., Price, A., Fleming, P., & Kemp, P. (2005). The barriers and possible solution to achieve sustainable development. *Proceedings of 2005 2nd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment (PRoBE 2005)*, 611–622. https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/23679/1/C108 Adetunji %282005%29 The barriers and possible solution to achieve sustainable development.pdf

Aghaegbuna, O., Tasmiyah, C., Zanoxolo, B., & Nikiwe, M. (2020). Sustainability in Project Management Practice. *MATEC Web of Conferences*, *312*, 02015.

Aghimien, D. O., Aigbavboa, C. O., Oke, A. E., & Musenga, C. (2018). Barriers to sustainable construction practices in the Zambian construction industry. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, *2018*(JUL), 2383–2392.

AIA. (2007). Integrated project delivery: A guide. New York: The American Institute of Architects.

Ajayi, S.O., Jones, W. & Unuigbe, M. (2019). Occupational stress management for UK construction professionals. *Journal of Engineering, Design and Technology*, 17(4), 819-832.

Ajayi, S.O. and Oyedele, L.O. (2017). Policy imperatives for diverting construction waste from landfill: Experts' recommendations for UK policy expansion. *Journal of cleaner production*, *147*, pp.57-65.

Akhanova, G., Nadeem, A., Kim, J. R., & Azhar, S. (2019). A framework of building sustainability assessment system for the commercial buildings in Kazakhstan. *Sustainability (Switzerland)*, *11*(17), 1–24.

Ametepey, O., Aigbavboa, C., & Ansah, K. (2015). Barriers to Successful Implementation of Sustainable Construction in the Ghanaian Construction Industry. *Procedia Manufacturing*, *3*(December), 1682–1689.

Amiril, A., Nawawi, A. H., Takim, R., & Ab-Latif, S.N.F. (2017). The barriers to sustainable railway infrastructure projects in Malaysia. The Social Sciences 12(5): 769-775. ISNN: 1818-5800.

Ashworth, A., Perera, S., Ashworth, A., & Perera, S. (2019). Sustainable development and construction. *Contractual Procedures in the Construction Industry*, 285–300.

Baiden, B.K., Price, A.D.F., & Dainty, A.R.J. (2006). The extent of team integration within construction projects", International Journal of Project Management, vol. 2, no. 24, 13 – 23.

Bal, M., Bryde, D., Fearon, D., & Ochieng, E. (2013). Stakeholder Engagement: Achieving Sustainability in the Construction Sector. *Sustainability, 5(2), 695–710.*

Baloi, D. (2003). Sustainable construction: challenges and opportunities. Association of Researchers in Construction Management, 289- 297.

Berardi, U. (2012). Sustainability Assessment in the Construction Sector: Rating Systems and Rated Buildings. *Sustainable Development*, *20*(6), 411–424.

Berawi, M. A., Miraj, P., Windrayani, R., & Berawi, A. R. B. (2019). Stakeholders' perspectives on green building rating: A case study in Indonesia. *Heliyon*, *5*(3), e01328. https://doi.org/10.1016/j.heliyon.2019.e01328

Blayse, A. M. & Manley, K. (2004). Key influences on construction innovation. Construction Innovation, 4 (3).

Blutstein, H & Rodger, A. (2001). The sustainable tall building of the third millennium, in Proc. of the CTBUH 6th World Congress, 26 February–2 March, 2001, Melbourne, Australia, 131–142.

Bonsu, G. A., Chisin, A. V., & Cronjé, J. (2019). Challenges to Sustainability in the Graphic Design

Chan, E. H. W., & Lee, G. K. L. (2009). Design considerations for environmental sustainability in high density development: A case study of Hong Kong. *Environment, Development and Sustainability*, *11*(2), 359–374.

Couper, M.P. (2000), “Review: web surveys: a review of issues and approaches”, Public Opinion Quarterly, Vol. 64 No. 4, pp. 464-494

Dahiru (2019). Investigating Barriers and Drivers of Sustainable Construction Procurement Practice in Kano State. *Environmental Technology & science Journal*, 10(1).

Davies, O. O. A., Davies, I. O. E., Davies, O O A and Davies, I. O. E., Davies, O. O. A., & Davies, I. O. E. (2017). Barriers to Implementation of Sustainable Construction Techniques. *MAYFEB Journal of Environmental Science*, *2*, 1–9.

Ding, G. K. C. (2008). Sustainable construction-The role of environmental assessment tools. *Journal of Environmental Management*, *86*(3), 451–464. https://doi.org/10.1016/j.jenvman.2006.12.025

Durdyev, S., Zavadskas, E. K., Thurnell, D., Banaitis, A., & Ihtiyar, A. (2018). Sustainable construction industry in Cambodia: Awareness, drivers and barriers. *Sustainability (Switzerland)*, *10*(2), 1–19. https://doi.org/10.3390/su10020392

Dzokoto S. D. &Dadzie J. (2013). Barriers to sustainable construction in the Ghanaian construction industry: consultants perspectives In: Laryea, S. and Agyepong, S. (Eds) Procs 5th West Africa Built Environment Research (WABER) Conference, 12-14 August 2013, Accra, Ghana, 223-234.

Esezobor, E. L. (2016). *Sustainability and construction: a study of the transition to sustainable construction practices in Nigeria*. *June*, 1–224. Thesis submitted in partial fulfilment of the requirements of Birmingham City University, UK, for the degree of Doctor of Philosophy

Field A. (2013). Discovering Statistics using IM SPSS Statistics. London: SAGE

Flannery, J., Ajayi, S.O. & Oyegoke, A.S. (2019). Alcohol and substance misuse in the construction industry. *International journal of occupational safety and ergonomics*, *27*(2), 472-487.

Gan, X., Zuo, J., Ye, K., Skitmore, M., & Xiong, B. (2015). Why sustainable construction? Why not? An owner's perspective. *Habitat International*, *47*, 61–68. https://doi.org/10.1016/j.habitatint.2015.01.005

GBCI. (2021). https://gbcindonesia.org/

George, D. & Mallery, P. (2019). IBM SPSS statistics 26 step by step: A simple guide and reference, *16th edition*. New York: Routledge.

Glass, J. (2012). The state of sustainability reporting in the construction sector. Smart and Sustainable Built Environment, 1(1), 87–104.

Griffin, C. T., Knowles, C., Theodoropoulos, C., & Allen, J. H. (2010). Barriers to the implementation of sustainable structural materials in green buildings. *Structures and Architecture - Proceedings of the 1st International Conference on Structures and Architecture, ICSA 2010*, 1349–1357.

Halliday, S. (2008). *Sustainable construction*. Routledge.

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research and Information*, *39*(3), 239–255.

Heeren, A. J., Singh, A. S., Zwickle, A., Koontz, T. M., Slagle, K. M., & McCreery, A. C. (2016). Is sustainability knowledge half the battle? An examination of sustainability knowledge, attitudes, norms, and efficacy to understand sustainable behaviours. *International Journal of Sustainability in Higher Education*, *17*(5), 613–632.

Hwang, B. G., & Tan, J. S. (2012). Green building project management: Obstacles and solutions for sustainable development. *Sustainable Development*, *20*(5), 335–349. https://doi.org/10.1002/sd.492

IFC (2019). Indonesia makes good progress in green building (online). Available at: https://ifc-org.medium.com/indonesia-makes-good-progress-in-green-building-9a3165842cc1 [Accessed: March, 2021].

Ikediashi, D.I., Ogunlana,S.O., Oladokun, M.G and Adewuyi, T. (2012). Assessing the level of commitment and barriers to sustainable facilities management practice: A case of Nigeria. International Journal of Sustainable Built Environment. 1(2), 167–176

Kim, D. & Park, H.S. (2006). Innovative construction management method: Assessment of lean construction implementation, KSCE Journal of Civil Engineering, Vol. 10, No. 6, 381-388.

Kucukvar, M.; Tatari, O. (2013). Towards a triple bottom-line sustainability assessment of the U.S. construction industry. Int. J. Life Cycle Assess, 18, 958–972.

Lu, Y., Khan, Z. A., Alvarez-Alvarado, M. S., Zhang, Y., Huang, Z., & Imran, M. (2020). A critical review of sustainable energy policies for the promotion of renewable energy sources. *Sustainability (Switzerland)*, *12*(12), 1–30.

Maijo, S. N. (2020). Project Management Success Factors for Sustainability of Community Projects in Tanzania : A Critical Review. *5*, 183–189.

Manoliadis, O., Tsolas, I., & Nakou, A. (2006). Sustainable construction and drivers of change in Greece: A Delphi study. *Construction Management and Economics*, *24*(2), 113–120.

Martek, I., Hosseini, M. R., Shrestha, A., Edwards, D. J., & Durdyev, S. (2019). Barriers inhibiting the transition to sustainability within the Australian construction industry: An investigation of technical and social interactions. *Journal of Cleaner Production*, *211*, 281–292. https://doi.org/10.1016/j.jclepro.2018.11.166

McLennan, J.F. (2004). The Philosophy of Sustainable Design, first Ed. Ecotone publishing, Canada.

Michaelides, R., Bryde, D., & Ohaeri, U. (2014). Sustainability from a project management perspective: are oil and gas supply chains ready to embed sustainability in their projects? Paper presented at Project Management Institute Research and Education Conference, Phoenix, AZ. Newtown Square, PA: Project Management Institute.

Mitchell, G. (2012). Where Graphic Design Is Failing: Sustainability and the Future of Our Profession j Modern Species. (Online). Available at: https://modernspecies.com/blog/post/where-graphic-design-is-failing [Accessed: March, 2021].

Myers, D. (2005). A Review of Construction Companies' Attitudes to Sustainability. Construction Management and Economics 23, 781-785.

Nduka, D. O. & Ogunsanmi, O.E. (2015). Stakeholders Perception of Factors Determining the Adoptability of Green Building Practices In Construction Projects In Nigeria. *Journal of Environment and Earth Science*. ISSM 224-3216. *5*(2), 5(2), 188–197.

Nikolić, D.T., Todorović, M., Dobrota, M., Obradović, T., & Obradović, V. (2020). Project management and sustainability: Playing trick or treat with the planet. *Sustainability (Switzerland)*, *12*(20), 1–20.

Nunnally, J.C. & Bernstein, I.H. (2007). Psychometric Theory, 3rd Edition. New York: McGraw-Hill.

Onososen, A. O., Osanyin, O., Adeyemo, M. O. (2019). Drivers and Barriers to the Implementation of Green Building Development. PM World Journal *VIII* (Ix), 1–15.

Opoku, A., & Fortune, C. (2011). The implementation of sustainable practices through leadership in construction organizations. *Association of Researchers in Construction Management, ARCOM 2011 - Proceedings of the 27th Annual Conference*, *2*(January 2011), 1145–1154.

Opoku, A., Cruickshank, H., & Ahmed, V. (2015). Organizational leadership role in the delivery of sustainable construction projects in UK. *Built Environment Project and Asset Management*, *5*(2), 154–169.

PBC Today (2019). Which countries are investing the most in construction? (online). Available through: https://www.pbctoday.co.uk/news/planning-construction-news/countries-investing-construction/54507/. Last accessed: 9th August 2021.

Pero, M., Moretto, A., Bottani, E., & Bigliardi, B. (2017). Environmental collaboration for sustainability in the construction industry: An exploratory study in Italy. *Sustainability (Switzerland)*, *9*(1), 1–25.

Peter, S., & Lucas, E. (2017). Evaluating the Role of Project Management on Sustainable Development. *Pakistan Research Journal of Management Sciences*, *1*(1), 64–69.

Pham, H., Kim, S. Y., & Luu, T. Van. (2020). Managerial perceptions on barriers to sustainable construction in developing countries: Vietnam case. *Environment, Development and Sustainability*, *22*(4), 2979–3003. https://doi.org/10.1007/s10668-019-00331-6

Plessis, C. Du. (2007). A strategic framework for sustainable construction in developing countries. *Construction Management and Economics*, *25*(1), 67–76.

Rana, A., Sadiq, R., Alam, M. S., Karunathilake, H., & Hewage, K. (2021). Evaluation of financial incentives for green buildings in Canadian landscape. Renewable and Sustainable Energy Reviews, 135, 110-199.

Robichaud, L. B., & Anantatmula, V. S. (2011). Greening Project Management Practices for Sustainable Construction. *Journal of Management in Engineering*, *27*(1), 48–57.

Rock, S., Hosseini, Nikmehr, B., Martek, I., Abrishami, S., & Durdyev, S. (2019). Barriers to 'green opera- tion' of commercial office buildings: Perspectives of Australian facilities managers. Facilities.

Rode, P., Burdett, R., Soares G., & Joana C. (2011). Buildings: investing in energy and resource efficiency. In Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. United Nations Environment Programme, 331–373.

Rwelamila P. D, & Ogunlana, S. (2015). *W107 - Construction in Developing Countries*: Research Roadmap Report for Construction. International Council for Research and Innovation in Building and Construction.

Surahman, U., Higashi, O., & Kubota, T. (2014). Embodied energy and CO2 emissions of building materials for residential buildings in Jakarta and Bandung, Indonesia. *30th International PLEA Conference: Sustainable Habitat for Developing Societies: Choosing the Way Forward - Proceedings*, *2*(December), 221–228.

Suprayoga, G. B., Witte, P., & Spit, T. (2019). Coping with strategic ambiguity in planning sustainable road development: balancing economic and environmental

interests in two highway projects in Indonesia. *Impact Assessment and Project Appraisal*, *38*(3), 233–244. https://doi.org/10.1080/14615517.2019.1695462

Szydlik, C. C. (2014). Identifying and overcoming the barriers to sustainable construction. *ProQuest Dissertations and Theses*, *10*(4), 177. https://search.proquest.com/docview/1622146310?accountid=26642%0Ahttp://link.periodicos.capes.gov.br/sfxlcl41?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+Globa

Tabachnick, B. G. & Fidell, L.S. (2013). Using Multivariate Statistics, 6th Edition. Pearson.

Toor, S. R. and Ofori, G. (2006). An antecedental model of leadership development. Proceedings of joint international symposium of CIB working commissions W55/W65/W86, October, Rome, Italy.

Toriola-Coker, LO and Alaka, H and Bello, WA and Ajayi, S and Adeniyi, A and Olopade, SO (2021) Sustainability Barriers in Nigeria Construction Practice. IOP Conference Series: Materials Science and Engineering, 1036 (1). 012023-012023. ISSN 1757-8981 DOI: https://doi.org/10.1088/1757- 899x/1036/1/012023

Tunji-Olayeni, P. F., Mosaku, T. O., Oyeyipo, O. O., & Afolabi, A. O. (2018). Sustainability strategies in the construction industry: Implications on Green Growth in Nigeria. *IOP Conference Series: Earth and Environmental Science*, *146*(1). https://doi.org/10.1088/1755-1315/146/1/012004

U.S. Green Building Council. (2006). Building a greener future. Special advertising section in partnership with Fortune. Fortune, March 20, S2–S14.

United Nations Environment Programme (2020). 2020 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. Nairobi https://globalabc.org/news/launched-2020-global-status-report-buildings-and-construction

Walliman, N. (2019). Your Research Project: Designing, Planning, and Getting Started, 4th edition. London: SAGE.

Wang, N., & Adeli, H. (2014). Sustainable building design. *Journal of Civil Engineering and Management*, *20*(1), 1–10.

Wei, T., Wu, J. & Chen, S. (2021). Keeping track of greenhouse gas emission reduction progress and targets in 167 cities worldwide. *Frontiers in Sustainable Cities*, *3*, p.64.

Wirahadikusumah, R., Abduh, M., Messah, Y., & Aulia, M. (2019). Introducing sustainability principles into the procurement of construction works–case of Indonesian developers. *International Journal of Construction Management*, *0*(0), 1–13. https://doi.org/10.1080/15623599.2019.1599559

Wirahadikusumah, R. D., & Ario, D. (2015). A readiness assessment model for Indonesian contractors in implementing sustainability principles. *International Journal of Construction Management*, *15*(2), 126–136. https://doi.org/10.1080/15623599.2015.1033817

Wiryomartono, B. (2015). Green building' and sustainable development policy in Indonesia since 2004. *International Journal of Sustainable Building Technology and Urban Development*, *6*(2), 82–89.

Yin, B. C. L., Laing, R., Leon, M., & Mabon, L. (2018). An evaluation of sustainable construction perceptions and practices in Singapore. *Sustainable Cities and Society*, *39*, 613–620. https://doi.org/10.1016/j.scs.2018.03.024

Yockey, R. D. (2010). SPSS demystified: A step by Step Approach, 2nd edition. Upper Saddle River, NJ: Prentice Hall Press

Yuan, X., & Zuo, J. (2013). A critical assessment of the Higher Education for Sustainable Development from students' perspectives - A Chinese study. *Journal of Cleaner Production*, *48*, 108–115.

Zalina Shari & Soebarto, V. (2014). Delivering sustainable building strategies in Malaysia : Stakeholders' barriers and inspirations. Alam Cipta vol *5(2).*

Zhabrinna, Davies, R. J., Abdillah Pratama, M. M., & Yusuf, M. (2018). BIM adoption towards the sustainability of construction industry in Indonesia. *MATEC Web of Conferences*, *195*(August). https://doi.org/10.1051/matecconf/201819506003