Acta Structilia 2022 29(1): 112-140

Sambo Zulu

Dr Sambo Lyson Zulu, School of Built Environment, Engineering and Computing, Leeds Beckett University, Leeds, UK. Phone: +44 01138127644, Email: <s.zulu@leedsbeckett.ac.uk>, ORCID: https://orcid.org/0000-0002-2724-1192.

Ephraim Zulu

Dr Ephraim Zulu, School of Built Environment, Construction Economics and Management, Copperbelt University, Kitwe, Zambia. Email: <ephraimzulu2000@yahoo.co.uk>, ORCID: https://orcid.org/0000-0002-5999-7808.

Mwansa Chabala

Dr Mwansa Chabala, School of Business, Department of Operations and Supply Chain Management, Copperbelt University, Kitwe, Zambia. Email: <chabalam1@cbu.ac.zm>, ORCID: https://orcid.org/0000-0002-5036-7631.

ISSN: 1023-0564 • e-ISSN: 2415-0487

OPEN ACCESS

Received: January 2022
Peer reviewed and revised: April 2022
Published: June 2022

KEYWORDS: Sustainable construction, sustainable buildings, sustainability practices, Zambian construction industry

HOW TO CITE: Zulu, S., Zulu, E. & Chabala, M. 2022. Sustainability awareness and practices in the Zambian construction industry. *Acta Structilia*, 29(1), pp. 112-140.

Published by the UFS
http://journals.ufs.ac.za/index.php/as

SUSTAINABILITY AWARENESS AND PRACTICES IN THE ZAMBIAN CONSTRUCTION INDUSTRY

RESEARCH ARTICLE[1]

DOI: http://dx.doi.org/10.18820/24150487/as29i1.5

ABSTRACT

The construction industry makes a significant contribution to the global green-house gas emission. It is, therefore, critical that construction industry professionals should be aware of and practise sustainable construction. However, there is a paucity of studies on the awareness of sustainability and their practices in developing countries, with some results seemingly contradicting. This article explored the awareness and practices of sustainability in the Zambian construction industry. Data was collected from construction industry professionals through a questionnaire survey and a total of 112 responses were received. The relative importance index (RII) and a series of linear regression analyses were used to analyse the data. The participants' perception of sustainability was primarily enviro-centric as opposed to the economic or social context. However, social and economic sustainability practices ranked highest, while environmental sustainability practices ranked in the bottom five of the 16 practices. While the participants perceived the environmental context as more critical in their understanding of sustainability, their practice reflected a focus on the social and economic sustainability context. The findings imply that merely increasing the level of knowledge and awareness of environmental

1 DECLARATION: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

sustainability may not lead to gross improvements in environmental sustainability practices. Therefore, studies that recommended increasing knowledge and awareness, in order to increase the implementation of environmentally sustainable construction, may have neglected the effect of the other barriers to sustainable construction which may be more critical. Studies with multivariate analyses such as structural equation modelling are needed to establish the contributory effect of the various barriers to environmental sustainability practices and so establish the extent to which knowledge and awareness alone, and other factors, can improve environmental sustainability practices.

ABSTRAK

Die konstruksiebedryf lewer ’n beduidende bydrae tot wêreldwye kweekhuisgasvrystelling. Dit is dus van kritieke belang dat professionele mense in die konstruksiebedryf bewus moet wees van en volhoubare konstruksie moet beoefen. Daar is egter min studies oor die bewustheid van volhoubaarheid en volhoubaarheidpraktyke in ontwikkelende lande met sommige resultate wat oënskynlik teenstrydig is. Daarom het hierdie artikel die bewustheid en praktyke van volhoubaarheid in die Zambiese konstruksiebedryf ondersoek. Data is van professionele persone in die konstruksiebedryf ingesamel deur middel van ’n vraelysopname en ’n totaal van 112 antwoorde is ontvang. Die relatiewe belangrikheidsindeks (RII) en ’n reeks lineêre regressie-ontledings is gebruik om die data te ontleed. Die deelnemers se persepsie van volhoubaarheid was primêr enviro-sentries in teenstelling met die ekonomiese of sosiale konteks. Sosiale en ekonomiese volhoubaarheidspraktyke is egter die hoogste gelys terwyl omgewingsvolhoubaarheidspraktyke onder die laagste vyf van die 16 praktyke gelys was. Dus, terwyl die deelnemers die omgewingskonteks as meer krities in hul begrip van volhoubaarheid beskou het, weerspieël hulle in praktyk ’n fokus op die sosiale en ekonomiese volhoubaarheidskonteks. Die bevindinge impliseer dat deur bloot die vlak van kennis en bewustheid van omgewingsvolhoubaarheid te verhoog, dit nie noodwendig lei tot verbeterings in omgewingsvolhoubaarheidspraktyke nie. Studies wat die verhoging van kennis en bewustheid aanbeveel het om die implementering van omgewingsvolhoubare konstruksie te verhoog, het moontlik die effek van die ander hindernisse tot volhoubare konstruksie, wat meer krities kan wees, verwaarloos. Daarom is studies met meerveranderlike ontledings soos strukturele vergelykingsmodellering nodig om die bydraende effek van die verskillende hindernisse tot omgewingsvolhoubaarheidspraktyke vas te stel en so vas te stel tot watter mate kennis en bewustheid alleen, en ander faktore, omgewingsvolhoubaarheidspraktyke kan verbeter.

Sleutelwoorde: Volhoubare konstruksie, volhoubare geboue, volhoubaarheidspraktyke, Zambiese konstruksiebedryf

1. INTRODUCTION

The construction industry is a key player in delivering sustainable development, as its products and processes have a significant impact on the environment. It contributes roughly 33% of greenhouse gas (GHG) emissions, 30% of global raw material use, 25% of water use, 25% of solid waste generation, and 12% of land use (Phillips *et al*., 2020: 181). From a stakeholder perspective, Li *et al*. (2018: 160) suggest that sustainable construction projects impact on different stakeholders with different social, environmental, and economic interests. However, its products such as infrastructure are critical to achieving sustainable development goals (Thacker *et al*., 2018).

In Zambia, the construction industry has noted a significant increase in its output over the past thirty years, with a contribution to the country's GDP of 3.6% in 1995 to 10.9% in 2000 and a marginal decline to 10.3% contribution in 2017 (Cheelo & Liebenthal, 2018: 6). While the growth in the industry is to be celebrated, its impact on environmental degradation is an essential factor that the government and industry stakeholders should address. It is essential that, as the Zambian construction industry continues to develop, it must deliver technically sound projects and still respond to the social, economic, environmental and governance challenges.

While there is a push for sustainability in the construction industry, its uptake is affected by factors such as the perceived high cost of sustainable construction (Hwang & Tan, 2012: 343) and lack of awareness (Shafii, Ali & Othman, 2006: 41; Dosumu & Aigbavboa, 2018: 86), education and training (Zulu & Muleya, 2017: 495; Jacobs, 2015:110), and inadequate client demand (Yin *et al*., 2018: 617). However, other studies on sustainability in the construction industry in Zambia have reported that the level of knowledge and awareness are reasonably fine (Oke *et al*., 2019: 3249). Studies on sustainability in the Zambian construction industry appear to be contradictory in the sense that some present knowledge and awareness as barriers needing remediation (Zulu & Muleya, 2017) while others present them as being reasonably sufficient (Oke *et al*., 2019: 3429). The paucity of studies in Zambia on the matter leaves an evidence gap on the level of sustainability awareness and practices among stakeholders in the construction industry. An understanding of the level of awareness and practices of sustainability could lead to a better understanding of why some studies found a mismatch between sustainability awareness and practices in the construction industry in developing countries (Kibwami & Tutesigensi, 2016; 76-79). Because the concepts of sustainability are the same across all climes, findings from this study have implications for developing countries with a contextual background similar to Zambia, notwithstanding that the current study is country specific.

Besides, while the worldwide construction industry is developing sustainability solutions, developing countries such as Zambia should also strive to deliver sustainable construction projects. This article thus aims to explore the stakeholders' awareness and practice of sustainability in the Zambian construction industry. In addition, it explores the extent to which the conceptualisation of sustainability is reflected in the sustainability practices among the various stakeholders in the construction industry. Previous studies in other countries evaluated the level of awareness and sustainability practices in the construction industry in different country-specific contexts, including, for example, Malaysia (Abidin, 2010), Kuwait (AlSanad, 2015), Chile (Serpell, Kort & Vera, 2013), Cambodia (Durdyev, Zavadskas *et al*., 2018), Australia (Khalfan *et al*., 2015), Khazakstan

(Tokbolat *et al*., 2020), Ghana (Ghansah, 2021; Owusu-Mensah, 2021), and Singapore (Shan *et al*., 2020).

It should be noted that the evaluation and significance of the studies are interpreted within the country-specific context, reflecting the idea that the approach to sustainability is not a “one-size-fits-all” (OECD, 2001: 2). In their studies on sustainability measures in the Nigerian context, Unuigbe, Zulu and Johnston (2020) identified factors that were particularly unique to their study, as they had not been identified in previous studies in other countries. This study, therefore, extends the understanding of sustainability within different country contexts. This study is timely and joins other country-specific studies in understanding sustainable construction practices. This is important as it is expected that, as the level of awareness increases, there will be a greater emphasis on the inclusion of sustainability solutions in construction projects. The findings have both practical and theoretical implications on sustainability awareness and how it affects environmental sustainability practices.

2. LITERATURE REVIEW

2.1 Sustainable construction

Sustainability has become an issue at the forefront of discussion in many sectors of society. The World Commission on Environment and Development (WECD) report defines sustainable development as “integrating the economic, social and environmental objectives of society, in order to maximise human well-being in the present without compromising the ability of future generations to meet their needs” (WCED, 1987: 2). It is generally accepted that this definition is broad and encompasses three strands, namely environmental, social and economic sustainability (Zwickle *et al.*, 2014: 377-380; Zeegers & Clark, 2014: 247). This three-pillar context of sustainability of environmental, economic and social sustainability is often referred to as the triple bottom line (TBL) of sustainability (Elkington, 1998: 18; Slaper & Hall, 2011: 4). Organisations can use this criterion to measure their sustainability performance. In distinguishing between the three, Slaper and Hall (2011: 5) considered that environmental sustainability reflects natural resource measures and potential influences on its viability. In this instance, issues such as air and water quality, energy consumption, waste water, and land use are considered.

Sustainable and resilient projects refer to projects that integrate environmental, social and governance (ESG) aspects into a project’s planning, building, and operating, while ensuring resilience in the face of climate change or shocks (Hebb, 2019: 252-259). Phillips *et al*. (2020: 1) suggest that green buildings (or sustainable construction) design should aim to improve building performance and conditions across a suite of environmental, economic, and social sustainability measures.

Economic sustainability focuses on money flow and reflects issues such as income and expenditure, business climate factors, employment, and revenue. Social sustainability reflects community or regional dimensions and addresses issues such as education, equality, access to social services, health and safety, labour relations, and poverty. Abidin and Pasquire (2007: 277) distinguished between the three from a value management perspective:

- Economic sustainability – increasing profitability through efficient use of resources (human, material, financial), effective design and good management, planning and control.
- Environmental sustainability – preventing harmful and irreversible effects on the environment by efficiently using natural resources, encouraging renewable resources, protecting the soil, water, and air from contaminations, etc.
- Social sustainability – responding to society's needs, including users, neighbours, community, workers, and other project stakeholders.

McMahon and Bhamra (2015: 368) suggest that, in the past, the emphasis on sustainability research tended to be on environmental and economic sustainability and less on social sustainability as the former, environmental and economic sustainabilities, are tangible and can be quantified. This may be due to the difficulty in getting tangible outcomes or the unquantifiable nature of social sustainability measures (McMahon & Bhamra, 2015: 368), making it complex to measure social sustainability. Goh *et al*. (2020: 7) suggest that the social dimension is often regarded as the most challenging pillar of sustainable construction, since the construction project has multiple stakeholders with different objectives and priorities. It is, therefore, essential that an organisation's sustainability strategy considers the TBL, which simultaneously reflects the balance between its environmental, economic, and social performance (Elkington, 2006: 523-524).

In the context of the construction industry, the concept of sustainable construction has generated interest. Some view sustainable construction as a subset of sustainable development (Kibert, 2012: 6-7) that should be regarded as a contribution of construction to sustainable development (Abidin, 2010: 422). The terms 'green construction' or 'sustainable construction' have been used interchangeably to refer to sustainability in the construction industry (Li *et al*., 2018: 161-163; Albino & Berardi, 2012: 388). A review of literature suggests a number of studies that have examined perceptions and awareness of the TBL of sustainability among construction industry stakeholders. For instance, Govindan, Khodaverdi and Jafarian (2013), Hutchins and Sutherland (2008), among others, considered the TBL in their studies. The TBL has demonstrated to provide a common basis to compare and understand sustainability practices in the construction industry.

The construction industry has shown a myriad of practices that enhance its sustainability credentials. Kibwami and Tutesigensi (2016: 65-66) identified 23 sustainability practices which they grouped under the three sustainability pillars (environmental, economic, and social sustainability). Similarly, Araújo, Bragança and Almeida (2013: 511) grouped 19 sustainability indicators under the three pillars. Considering the plethora of sustainability practices, following guiding principles can help construction stakeholders decide on specific sustainability practices. This is important, considering that project priorities differ between projects. Kibert (2012: 8) presented seven principles of sustainable construction to provide guidelines for sustainability practices in the design and construction phase. These include reducing resource consumption; reusing resources; using recyclable resources; protecting nature; eliminating toxic materials; applying life-cycle costing, and focusing on quality. Masia, Kajimo-Shakantu and Opawole (2020: 603-606) grouped green building practices into five categories, namely energy efficiency, water efficiency, resource efficiency, occupant health and well-being, as well as sustainable site development. Zhang, Platten and Shen (2011: 2155) also classified sustainability practices under six categories, namely energy efficiency, water efficiency, materials efficiency, indoor environmental, quality enhancement, operations, and maintenance optimisation.

2.2 Sustainable principles

Ainger and Fenner (2014, cited in Green, Yates & Hope, 2015: 13) identified five sustainability principles that they suggested to derive practical, realistic sustainability practices to apply to infrastructure planning and delivery. These include environmental sustainability, socio-economic sustainability, intergenerational stewardship, and complex systems. Their classification can also be aligned with the TBL system. Indeed, example practices under each of the four principles include factors that have been classified under the TBL pillars in other literature.

Ainger and Fenner (2014, cited in Green *et al.*, 2015: 13) perceive environmental sustainability as reflecting issues such as the need to minimise the operational energy consumption of buildings, the carbon footprint of buildings, solutions that have the lowest practical life-cycle impact, reduction of waste through careful design and construction, careful land use, use of water and other resources, and the impact of development on ecosystems. They also include development that seeks to benefit society, enhance community health and well-being, minimise the risk of flooding, enhance skills and employment through design, and construct and use contractors/sub-contractors/suppliers who demonstrate sustainable practices (Ainger & Fenner, 2014, cited in Green *et al.*, 2015: 13). These issues are addressed in other literature and include minimising solid waste materials, dust emissions, materials waste, water use, noise, and energy use (Serpell *et al.*, 2013: 279). Literature addresses practices that reflect the environmental context, including energy efficiency (Kylili & Fokaides, 2017: 2010-2011), efficient resource use (Oyebanji, Liyanage & Akintoye, 2017: 220), construction waste (Akinade *et al.*, 2017: 6-9), land use (Doan *et al.*, 2017: 245-246), use of sustainable materials (Camara *et al.*, 2017; 256), consumption of materials, and reduction in carbon emissions/pollution (Tsai *et al.*, 2011: 3023).

On the other hand, socio-economic sustainability practices should seek to meet basic human needs for shelter, comfort, health, and social interaction (Ainger & Fenner, 2014, cited in Green *et al.*, 2015: 13). The social sustainability principles reflect practices that reveal the social and economic sustainability pillars of the TBL. Kibwami and Tutesigensi (2016: 71-74) identified issues such as health and safety at the workplace, developing capacity and skills, as well as corporate social responsibility (CSR) as social sustainability measures. Factors or practices such as the impact on health and community (Chen, Okudan & Riley, 2010: 236-244; Jagarajan *et al.*, 2017: 1362-1364; Oyebanji *et al.*, 2017: 222), health and safety, access to services, equality and diversity (Goh, 2017: 2, 5), quality of life (Oyebanji *et al.*, 2017: 222), and stakeholder participation (Oyebanji *et al.*, 2017: 222) are recognised as social sustainability factors.

Practices that reflect the economic sustainability context include life-cycle costs (Araújo *et al.*, 2013: 507-511; Da Rocha & Sattler, 2009: 104-105; Tripathy, Sadhu & Panda, 2016: 455), affordability (Chen *et al.*, 2010: 238-239; Tsai *et al.*, 2011: 3028), and consideration of initial construction costs (Chen *et al.*, 2010: 239; Tsai *et al.*, 2011: 3024-3028; Tripathy *et al.*, 2016: 452-453). Others include employment creation such as intensive labour construction, environmentally responsible suppliers/contractors who demonstrate environmental performance, and use of local resources in construction (Kibwami & Tutesigensi, 2016: 71, 74), as well as financial gains for project stakeholders (Abidin, 2010: 422) are addressed in literature as economic sustainability.

Practices under Ainger and Fenner's (2014, cited in Green *et al.*, 2015: 13) intergenerational stewardship would include those that seek to use whole-life principles in the design, construction, and management of built assets; design for adaptability in function, technology and climate, as well as application of whole-life costs is a vital part of the decision-making process. Compared to other studies, these issues can be aligned to at least one of the pillars of sustainability. For example, whole-life costing is an economic sustainability practice (Kibwami & Tutesigensi, 2016: 69-73), while the design for adaptability can be conceived as encompassing the environmental, social and economic sustainability contexts. Studies on the adaptation and re-use of buildings argue that such practices have a social sustainability value (Dehbashisharif, 2017: 350-353). Misirlihsoy and Gunce (20162: 92) suggested that "successful adaptive reuse of heritage buildings should be economically, socially and physically sustainable".

On the other hand, whole-life principles can be considered an environmental sustainability issue as they considers energy efficiency in the building's whole life (Ibn-Mohammed *et al*., 2013: 235-237). Practices under complex systems would include considering sustainability holistically to avoid unforeseen consequences and limitations; considering building as a part of a broader system in terms of infrastructure and community, and identifying the appropriate design life to minimise life-cycle impacts and costs (Ainger & Fenner, 2014, cited in Green *et al*., 2015: 13). However, it is evident that considering the complex systems perspective can also relate to the TBL context.

Table 1 shows the possible alignment of Ainger and Fenners (2014, cited in Green *et al*., 2015: 13) principles with specific practices identified in other literature. The subthemes' groupings have been arranged under three categories to reflect the three sustainability pillars (environmental, social and economic sustainability).

Table 1: Summary of broad sustainability practices

Category	*Practice*	*Example practice*	*Example reference*
Social	Meeting basic human needs for shelter, comfort, health, and social interaction	Showing concern for people by ensuring that they live in a healthy, safe, and productive built environment and in harmony with nature	Ashley *et al*. (2003)
Social	Development that seeks to benefit society	Corporate social responsibility (CSR)	Kibwami and Tutesigensi (2016)
Social	Enhancing community health and well-being	Health and safety at the workplace	Kibwami and Tutesigensi (2016)
Social	Designing for adaptability in function, technology, and climate.	Health and safety at the workplace	Kibwami and Tutesigensi (2016)
Economic	Enhancing skills and employment through design and construction	Employment creation such as using labour-intensive construction.	Kibwami and Tutesigensi (2016)

Category	*Practice*	*Example practice*	*Example reference*
Economic	Using whole-life costing as a critical criterion in the decision-making process	Life-cycle costs	Araújo *et al.* (2013)
Economic	Use of contractors/sub-contractors/suppliers who demonstrate sustainable practices	Enable choosing suppliers or contractors that demonstrate environmental performance	Pearce *et al.* (2010)
Environmental	Reducing waste through careful design and construction	Reduce the use of resources such as energy, water, and materials during construction	Kibwami and Tutesigensi (2016)
Environmental	Careful land use, including protecting green spaces and re-use of land	Sustainable site	Sarkis, Presle and Meade (2010)
Environmental	Minimising the risk of flooding	Sustainable site	Sarkis, Presley and Meade (2010)
Environmental	Minimising operational energy consumption of buildings	Reduction in ordinary Portland cement for all concrete used in the construction of the building	Masia *et al.* (2020)
Environmental	Minimising the impact of development on ecosystems	Minimise pollutants that cause environmental degradation	Kibwami and Tutesigensi (2016)
Environmental	Use of whole-life principles in the design, construction, and management of built assets.	Life-cycle assessment	Oke *et al.* (2019)
Environmental	Choosing solutions that have the lowest practical life-cycle impact	Responsible sourcing materials	Araújo *et al.* (2013)
Environmental	Reducing the use of water and other resources	Water consumption	Araújo *et al.* (2013)
Environmental	Minimising the carbon footprint of buildings	Use of environment-friendly materials for HVAC systems	Zhang *et al.* (2011)

2.3 Sustainability in the Zambian construction industry

Like in the vast majority of developing countries, practitioners in the Zambian construction industry (ZCI) are fairly knowledgeable about environmental sustainability (Oke *et al.*, 2019: 3249). Oke *et al.* (2019: 3249) classified the level of awareness of sustainable construction practices as average. However, notwithstanding the fairly high level of knowledge about sustainable construction in the ZCI, Zulu *et al.* (2022) found that environmental sustainability is not an important consideration during the design stage of building infrastructure projects. It was found that the primary focus of the design teams was to achieve design functionality that is aesthetically pleasing and meets the technical requirements of the needs of the clients. Environmental design considerations were only made in an *ad hoc* manner when they were cost effective. This resonates with findings by Phiri and Matipa (2004: 1364) that professionals in Zambia have an indifferent attitude towards sustainable construction, with hardly anything being done to apply sustainable construction principles.

While it appears that the professionals in Zambia have some fairly reasonable knowledge about sustainability in the construction industry, a number of challenges hamper the implementation of sustainable practices. For example, Zulu *et al.* (2022) found that the implementation of sustainable construction in Zambia was hindered by several barriers that clustered into three groups, namely awareness and knowledge-related factors, regulatory and industry-related factors, and economy and cost-related factors. Aghimien *et al.* (2018: 2387-2389) found that some of the challenges affecting the implementation of sustainability practices are fear of higher investment cost, no local green certification, lack of government policies or support, and lack of financial incentives.

While studies have found that the level of knowledge and awareness about sustainability in Zambia is fairly reasonable (Oke *et al.*, 2019: 3250; Phiri & Matipa, 2004: 1361), others have highlighted knowledge and awareness as barriers to the implementation of sustainability principles (Zulu *et al.,* 2022: 7-9). Knowledge and awareness as a barrier to the implementation of sustainability principles in the construction industry have been reported in a number of studies (Durdyev *et al.*, 2018: 7-8; Tokbolat *et al.*, 2020: 4373-4374). Therefore, it is unclear what the level of knowledge and awareness of sustainability and its practices are in Zambia among the different stakeholders in the construction industry.

3. METHODOLOGY

3.1 Research design

The study used a quantitative research design in an online questionnaire survey to assess sustainable construction awareness and interpretation in the Zambian construction industry. As stated by Cooper and Schindler (1998: 21), a questionnaire survey assists with the standardisation of data-gathering, decreases non-response errors, and increases response rates. Quantitative design allows for the use of descriptive indexes to analyse data. The Relative Importance Index was used as this approach enabled the comparison of rankings of items/factors across different demographic groups.

3.2 Population, sample, and response rate

The study targeted stakeholders in the Zambian construction industry, including contractors, consultants (architects, quantity surveyors, as well as construction and project managers), and clients. The study participants were contacted via e-mail and the WhatsApp social media platform. A list of 350 e-mail addresses for contractors registered with the Zambian National Council for Construction (NCC) were obtained from their database and contacted. Two reminder emails were sent to the contractors urging those who had not completed the questionnaire to do so. Consultants were contacted through the professional WhatsApp© groups for both the Zambia Institute of Architects and the Surveyors Institute of Zambia (SIZ). Quantity Surveyors, as well as Construction and Project Managers subscribe to the same professional body (the SIZ).

Both WhatsApp© groups had the maximum allowable number of members to the group of 256, meaning that there was a total of 256 potential respondents from each of the two groups. This also means that professionals who were not members of the WhatsApp© groups were omitted from the population of interest. This is one limitation of the use of social media platforms, in that only active users of the platforms make up the sample. Therefore, a total of 905 potential respondents were contacted. A total of 112 completed questionnaires were received, representing a response rate of 12.4%. A sample size of this magnitude is not uncommon in construction management research, including samples of less than 100 participants (Muleya, Zulu & Nanchengwa, 2020). Difficulties in accessing the target population is one of the factors that contribute to small sample sizes (Muleya, Zulu & Nanchengwa, 2020). Table 2 shows details of the target population, sample, and response rate.

Table 2: Population, sample, and response

Respondents	*Potential respondents*	*Responses returned*	*Response rate (%)*
Architects	256	45	17.6
Quantity surveyors and construction managers	256	25	9.8
Contractors	350	33	9.4
Clients	43	11	25.5
Total	905	112	12.4

3.3 Data collection

The data was collected between 26 November and 24 December 2020 from the self-administering structured questionnaire that was distributed to a total sample of 905 consultants, contractors, and clients involved in building construction projects in Zambia. The questionnaire was created in Google Forms© and sent to the study participants by email and the WhatsApp© social media platform. Using an online self-administering questionnaire was the most feasible approach, given the restrictions on movement and contact due to the COVID-19 pandemic. Using social media to collect data in social science research has become common because of the low cost, ease of use, and convenience associated with them and has proved to be effective (Zulu, Zulu & Chabala, 2021; Dodds & Hess, 2020; Torrentira, 2020). The study explored the participants' conceptualisation of sustainability. Sustainability is considered a three-pronged concept, including environmental, social, and economic sustainability.

The questionnaire was divided into three sections. The first section, on the respondents' profile, obtained general demographics about the respondents, including education level, sector (private or public), type and size of organisation for which the respondents work, and the professional experience of each respondent. Section two had seven Likert-scale statements on 'sustainability awareness' (see Table 5), and section three on 'sustainability practices' with 16 Likert-scale statements (see Table 6), where participants were asked to indicate their agreement level with the statements that reflected the three sustainability contexts. Closed-ended questions were prefeered to reduce the respondent's bias and facilitate coding of the questionnaire (Akintoye & Main, 2007: 601).

3.4 Data analysis and interpretation of the findings

Descriptive analysis was used to summarise the respondents' profiles, where the frequency and percentage were calculated and reported. The Relative Importance Index (RII) approach was used to determine the ranking of the awareness and practices of sustainability in the Zambian construction industry and how the conceptualisation of sustainability was reflected in the sustainability practices. The RII is used to weigh attributes and as a basis for determining their relative ranking (Shah *et al*., 2021: 5). The RII is one of the extensively used data-analysing tools to identify and rank a set of attributes based on their weighted average values and has high reliability in predicting the most important variables from a list of variables (Singh & Kumar, 2021: 7; Amarkhil, Elwakil & Hubbard, 2021: 1505).

The formula below represents the approach taken in calculating the RII (Akadiri & Olomolaiye, 2012: 669; Muleya *et al*., 2020: 9)

$$RII = \frac{\sum W}{AN}$$

Where W = score; A = highest possible score, and N = number of participants

The values generated would range from 0 to 1, with a higher value representing a higher ranking and a lower score representing a lower ranking. The generated values are interpreted as low (L) (0 ≤ RI ≤ 0.2), medium-low (M-L) (0.2 ≤ RII ≤ 0.4), medium (M) (0.4 ≤ RII ≤ 0.6), high-medium (H–M) (0.6 ≤ RII ≤ 0.8), and high (H) (0.8 ≤ RII ≤ 1) (Akadiri, 2012: 670).

3.5 Limitations of the study

The study had a sample size limitation that was influenced by many factors, including the impact of the COVID-19 pandemic, which meant that some potential participants could not be reached. While there have been studies with smaller sample sizes, future studies could benefit from a triangulation methodological approach that would aid a broader understanding of sustainable construction practices in the Zambian construction industry.

4. FINDINGS AND DISCUSSION

4.1 Respondents' characteristics

Table 3 summarises the respondents' profiles. Most (93%) of the respondents had at least an undergraduate degree, while 30% had a postgraduate qualification. The respondents were from both the private (69%) and public (31%) sectors. Most (48%) of the respondents worked in consulting organisations, followed by contractor organisations (22%). The respondents also had varying levels of experience. Roughly 50% had been working in their current position for at least six years, while 76% had worked in the construction industry for at least six years. The sample data shows that the participants had the necessary knowledge and experience (Bernard, 2002: 186), a requirement for participation in this study.

Table 3: Respondents' demographics

Demographic	*Category*	*Frequency (n=112)*	*%*
Education	Up to undergraduate qualification	78	70
	Secondary education	2	2
	College diploma	6	5
	University degree	70	63
	Postgraduate qualification	34	30
	Master's degree	33	29
	Ph.D.	1	1
Sector	Private	77	68.8
	Public	35	31.3

Demographic	*Category*	*Frequency (n=112)*	*%*
Organisation	Consulting organisations	54	48.2
	Contractor	25	22.3
	Client organisation	11	9.8
	Other	22	19.6
Experience (years) in current job	Less than 1 year	7	6.3
	1-2 years	18	16.1
	3-5 years	30	26.8
	6-10 years	38	33.9
	More than 10 years	19	17.0
Experience (years) in AEC industry	Less than 1 year	1	0.9
	1-2 years	8	7.1
	3-5 years	18	16.1
	6-10 years	47	42.0
	More than 10 years	38	33.9
Organisation size (employees)	Less than 5	20	17.9
	Between 6 and 50	37	33.0
	Between 51 and 100	23	20.5
	Above 100	32	28.6

4.2 Instrument reliability

The measurement instrument was assessed for reliability using inter-item correlations and Cronbach's *alpha*. Table 4 shows the statistics The Cronbach's *alpha* for all the constructs ranged between 0.705 and 0.932, and all the constructs exceeded the threshold of 0.70 recommended by Hair *et al*. (1998: 124). The item-correlations exceeded the threshold of 0.3, as recommended by Carmines and Zeller (1974: 79). Therefore, based on the Cronbach's *alpha* and the item-correlations, the study constructs exhibit good reliability.

Table 4: Instruments reliability

Research constructs		*Mean*	*Std. Dev.*	*Cronbach's alpha*	*Item-correlations*
Environmental awareness					
1	Aware1	3.80	1.184	0.874	0.438
2	Aware2	4.33	1.102		0.660
3	Aware3	4.29	0.972		0.618
4	Aware4	3.91	0.935		0.704
5	Aware5	3.96	0.939		0.733
6	Aware6	3.99	1.127		0.711
7	Aware7	4.30	0.919		0.789

Research constructs		*Mean*	*Std. Dev.*	*Cronbach's alpha*	*Item-correlations*
Environmental practices					
1	EnvP1	3.44	1.229	0.932	0.783
2	EnvP2	3.29	1.196		0.778
3	EnvP3	3.36	1.169		0.716
4	EnvP4	3.70	1.153		0.743
5	EnvP5	3.68	1.224		0.726
6	EnvP6	3.35	1.198		0.655
7	EnvP7	3.44	1.161		0.765
8	EnvP8	3.54	1.130		0.647
9	EnvP9	3.22	1.206		0.693
10	EnvP10	3.42	1.235		0.802
Social practice					
1	SocP1	4.03	0.895	0.871	0.701
2	SocP2	3.96	0.986		0.797
3	SocP3	3.91	1.018		0.832
4	SocP4	3.62	1.164		0.607
Economic practices					
1	EcoP1	3.74	1.097	0.705	0.547
2	EcoP2	3.50	1.208		0.547

The data was assessed for homogeneity, using the Kruskal-Wallis analysis of ranks because it came from several distinct demographic groupings within the construction industry. Education, private or public sector, and type of organisation (consulting, contractor, and client) were specifically assessed. These characteristics were assessed because literature has shown that there may be differences in perceptions based on these. The results in Table 5 show that there are no statistically significant differences among the responses based on education and type of organisation ($p>0.05$). A statistically significant difference was found on the level of awareness of sustainability by sector ($p=0.018$), indicating that there is a difference in the level of awareness between the public sector and the private sector in the Zambian construction industry. The environmental, social and economic sustainability practices were all homogenous across both sectors. Therefore, the data was aggregated and analysed at the aggregate level. Because the level of sustainability awareness was statistically different at the sector level, the ranking of awareness by sector is also provided with a brief discussion.

Table 5: Kruskal-Wallis analysis of ranks

	Awareness	*Environmental*	*Social*	*Economic*
Kruskal-Wallis H	5.603	1.643	1.427	0.980
Asymp. Sig.[a]	0.018*	0.200	0.232	0.322
Kruskal-Wallis H	0.915	0.473	0.333	0.898

	Awareness	*Environmental*	*Social*	*Economic*
Asymp. Sig.[b]	0.633	0.790	0.847	0.638
Kruskal-Wallis H	3.314	6.838	7.845	7.987
Asymp. Sig.[c]	0.507	0.145	0.097	0.092

[a]. Grouping variable: Sector
[b]. Grouping Variable: Type of organisation
[c]. Grouping variable: Education

4.3 Awareness and conceptualisation of sustainability

Table 6 shows a complete set of the survey results illustrating the RII as well as the ranking order, where 1 shows the items contributing the most to sustainability. An initial inspection of the results shows that the RII ranged from High-Medium ($0.6 \leq RI \leq 0.8$) to High ($0.8 \leq RI \leq 1$). The data indicate that the survey participants took an enviro-centric view as the top three environmental sustainability statements were ranked highest.

The three environment-related statements ranked the top three in six out of seven categories. The social and economic sustainability statements shared the last four ranking positions. At an aggregate level, 'generating profit without compromising future need' [economic] and 'social progress for everyone' [social] were ranked seventh and sixth, respectively. While clients expect that the supply chains they engage will make a profit on the project, it is expected that this will not compromise future needs. It is not 'profit at all costs'. This may be reflected in the construction industry's current push for increased attention to social responsibility. An example of this is the Zambian government's initiative to ensure that large foreign contractors engage local subcontractors for 20% of the contract value (Sikombe & Phiri, 2021: 2).

Overall, the perception of sustainability takes an enviro-centric view. This is a similar finding to a study in Uganda, where Kibwami and Tutesigensi (2016: 70) found that the concept of sustainable construction was interpreted mainly from an environmental sustainability context. While the data shows an enviro-centric view of sustainability, it provides evidence of the overall appreciation of the broader context of sustainability in the construction industry that the critical context should not only be on the environmental sustainability, but also on the social and economic sustainability. This reflects the TBL sustainability context espoused by Slaper and Hall (2011: 1-5). The fact that the RII for all the focus areas was above 0.7, representing a High-Medium ($0.6 \leq RI \leq 0.8$) or High ($0.8 \leq RI \leq 1$) rating, demonstrated the perceived importance of the three sustainability contexts, although environmental sustainability seems to take a prominent position.

At the sector demographic level, there appears to be major differences in the perception of sustainability awareness related to the 'quality of life and customer satisfaction' and 'generating profit without compromising future needs'. The private sector ranked 'quality of life and customer satisfaction' higher than 'generating profit without compromising future needs'. This may be attributed to the fact that the private sector in the construction industry is more focused on generating profit by ensuring client satisfaction. Therefore, they are very likely to favour generating profit with less regard for the long-term effect of their actions. The public sector, on the other hand, is unlikely to take a position favouring profit maximisation over the long-term effects because their work is never profit centred.

Table 6: Sustainability awareness: Focus areas

Sustainability focus area	*Aggregate (overall)*		*Sector*			
			Private		*Public*	
	RII	*Rank*	*RII*	*Rank*	*RII*	*Rank*
Protection of the environment [environmental]	0.866	1	0.844	1	0.914	1
Environmental planning, management and control [environmental]	0.861	2	0.839	3	0.909	2
Prudent use of natural resources [environmental]	0.857	3	0.839	2	0.897	3
Quality of life and customer satisfaction [social]	0.798	4	0.790	4	0.817	5
Maintaining economic growth [economic]	0.793	5	0.782	5	0.817	6
Social progress for everyone [social]	0.782	6	0.771	6	0.806	7
Generating profit without compromising future need [economic]	0.761	7	0.727	7	0.834	4

Table 7: Sustainability practices

Item	*Aggregate (overall)*	
	RII	*Rank*
Meeting basic human needs for shelter, comfort, health and social interaction [social]	0.805	1
Development that seeks to benefit society [social]	0.793	2
Enhancing community health and well-being [social]	0.782	3
Enhancing skills and employment through design and construction [economic]	0.748	4
Reducing waste through careful design and construction [environmental]	0.739	5
Careful land use including protecting green spaces and re-use of land [environmental]	0.736	6
Designing for adaptability in function, technology, and climate [social]	0.723	7

Item	*Aggregate (overall)*	
	RII	*Rank*
Minimising the risk of flooding [environmental]	0.709	8
Using whole-life costing as a key criterion in the decision-making process [economic]	0.700	9
Minimising operational energy consumption of buildings [environmental]	0.688	10
Minimising the impact of development on ecosystems [environmental]	0.688	11
Use of whole-life principles in the design, construction, and management of built assets [environmental]	0.684	12
Choosing solutions that have the lowest practical life-cycle impact [environmental]	0.671	13
Reducing the use of water and other resources [environmental]	0.670	14
Minimising the carbon footprint of a building [environmental]	0.657	15
Use of contractors/sub-contractors/suppliers who demonstrate sustainable practices [environmental]	0.645	16

4.3 Sustainability practices

Table 7 shows the relative importance index and ranking of a range of generic sustainability practices. These practices represent those identified in the literature and presented in Table 1. Owing to the plethora of actual sustainability practices, a decision was made to provide participants with a generic list representing specific practices. Participants were asked to indicate the extent to which the sustainability practices were considered necessary on projects they had worked on in the last three years. The statements represented the three levels of sustainability, (environmental, economic, and social). Results are presented in Table 6.

The sustainability practices that ranked among the top five included practices that met 'basic human needs for shelter, comfort, health and social interaction' [social]; focused on 'development that seeks to benefit society' [social], enhanced 'community health and well-being' [social]; focused on 'enhancing skills and employment through design and construction' [economic], and designed to reduce 'waste through careful design and construction' [economic]. All the top five practices reflected the social and economic sustainability context. The table shows that the bottom five practices relate to environmental sustainability. These included 'use of whole-life principles in the design, construction, and management of built assets' [environmental]; 'choosing solutions that have the lowest practical life-cycle impact' [environmental]; 'reducing the use of water and other resources' [environmental]; 'minimising the carbon footprint of a building' [environmental], and 'engagement of contractors/sub-contractors/suppliers who demonstrate sustainable practices' [environmental] ranked twelfth, thirteenth, fourteenth, fifteenth and sixteenth, respectively.

Section 4.3 focused on the participants' conceptualisation of sustainability. However, in this section, the focus was on the broader sustainability practices they had considered on their projects. While it is expected that a predominant enviro-centric perspective of sustainable construction would encourage construction industry professionals to adopt sustainability measures that highly promote environmental sustainability (Kibwami & Tutesigensi, 2016: 69), this data showed that this may not always be the case. The data shows an interesting finding in that, while the participants perceived the environmental context as more critical in their understanding of sustainability, their practice reflected a focus on the social and economic sustainability context. Kibwami and Tutesigensi (2016: 69) also observed this mismatch between the perception of sustainability and practice in Uganda by. The scope of this study did not include an evaluation of the reasons for the differences in perceptions. Future research should consider this as an area for further development.

4.4 Regression analysis

A series of three separate linear regression analyses were run in order to establish the relationships between each of the three aspects of sustainability practices and sustainability awareness. The regression models assessed whether sustainability awareness significantly influenced the environmental, social, and economic sustainability practices. This was done to provide a better understanding of the finding that social and economic sustainability practices were ranked higher even when the respondents showed an enviro-centric view of sustainability.

Table 8 shows the results of the regression analysis. The results show that sustainability awareness significantly influences environmental (R^2=0.102, p=0.001), social (R^2=0.219, p<0.001), and economic (R^2=0.108, p<0.001) sustainability practices. This means that sustainability awareness influences social sustainability practices more than either environmental or economic sustainability practices because sustainability awareness accounted for 21.90% variation in social sustainability practices while environmental and economic practices accounted for 10.20% and 10.80%, respectively.

Table 8: Regression model summary

Model	*R*	*R Square*	*Sig.*
1	0.319	0.102	0.001
2	0.468	0.219	0.000
3	0.329	0.108	0.000

1. Constant and sustainability awareness predicting environmental practices
2. Constant and sustainability awareness predicting social practices
3. Constant and sustainability awareness predicting economic practices

The results show that social sustainability practices are influenced more by sustainability awareness than both environmental and economic practices. This means that, when construction practitioners are aware about sustainability, they will engage in more socially sustainable practices as compared to environmental and economic sustainability. This is in line with the findings from the RII, where it was shown that, even though the participants showed an enviro-centric view of sustainability, their practices mostly reflected social sustainability. This finding suggests that, while increasing the level of sustainability awareness among practitioners will result in increased levels of environmental sustainability practices, the level of social sustainability practices will be more than environmental sustainability practices. This result further highlights the mismatch between the level of awareness of sustainability and the ensuing environmental sustainability practices in tandem with findings by Kibwami and Tutesigensi (2016: 69-70).

It is surprising that environmental awareness does not increase the level of sustainable environmental practices as much as it does social sustainability practices, considering that the understanding of sustainability among the respondents was more focused on the environmental sustainability context of the TBL. It would be expected that an understanding skewed towards environmental sustainability would also reflect in the sustainability practices by leading to more environmental sustainability practices compared to the other aspects of sustainability. The expectation is supported by studies concluding that deficiencies in the level of awareness of sustainability were a barrier to the implementation of environmental sustainability practices. The studies recommended that increasing the level of understanding and awareness of environmental sustainability would lead to more environmentally sustainable construction practices (Zulu *et al*., 2022; Aghimien *et al*., 2018; Akadiri, 2015). Considering that there are many barriers to the implementation of sustainable construction practices in developing countries, it may be that merely increasing the level of knowledge and awareness of environmentally sustainable construction would not necessarily lead to major improvements in sustainable construction practices because of the other barriers that may be more cumbersome. This could explain the mismatch between the perception of sustainability and the practices, as also reported by Kibwami and Tutesigensi (2016: 69-70).

5. CONCLUSION

The study aimed to evaluate the awareness and practices of sustainable construction in the Zambian construction industry. Sustainable construction should encompass the three strands of environmental, economic, and social sustainability. While there have been studies on sustainability in the Zambian construction industry, this study shed light on the context of sustainability awareness and how the various broader sustainability practices are considered on construction projects. The data shows that the survey participants took an enviro-centric view in defining the focus areas of sustainability. Regarding sustainability practices, practices related to social and economic sustainability ranked higher than those related to environmental sustainability. The data shows an interesting finding in that, while the participants perceived the environmental context as more critical in their understanding of sustainability, their practice reflected a focus on the social and economic sustainability context. This finding shows that there is a missmatch between the understanding of sustainability and the sustainability practices in the industry. That is, while the awareness context favours an enviro-centric view, the actual practice focuses more on sustainability's social and economic aspects.

The practical implication of the findings is that merely increasing the level of knowledge and awareness of environmental sustainability may not lead to gross improvements in sustainability practices. This is in contrast to other studies that concluded that knowledge and awareness were barriers to the implementation of environmental sustainability and, therefore, suggested that increasing the levels of knowledge and awareness could lead to improvements in sustainability practices. These studies may have neglected the effect of the other critical barriers to the implementation of environmental sustainability practices which may still hinder the adoption of sustainable practices, even when knowledge and awareness increase. Therefore, studies with multivariate analyses such as structural equation modelling are needed to establish the contributory effect of the various barriers to environmental sustainability practices and so establish the extent to which knowledge and awareness alone, and other factors, can improve environmentally sustainable practices.

REFERENCES

Abidin, N.Z. 2010. Investigating the awareness and application of sustainable construction concept by Malaysian developers. *Habitat International*, 34(4), pp. 421-426. https://doi.org/10.1016/j.habitatint.2009.11.011

Abidin, N.Z. & Pasquire, C.L. 2007. Revolutionize value management: A mode towards sustainability. *International Journal of Project Management*, 25(3), pp. 275-282. DOI: 10.1016/j.ijproman.2006.10.005

Aghimien, D., Aigbavboa, C., Oke, A. & Musenga, C. 2018. Barriers to sustainable construction practices in the Zambian construction industry. In: *Proceedings of the International Conference on Industrial Engineering* *and Operations Management*, 26-27 July, Paris, France. IEOM Society International, pp. 2383-2392.

Ainger, C.M. & Fenner, R.A. 2014. *Sustainable infrastructure: Principles into practice*. London, UK: ICE publishing.

Akadiri, P.O. & Olomolaiye, P.O. 2012. Development of sustainable assessment criteria for building materials selection. *Engineering, Construction and Architectural Management*, 19(6), pp. 666-687. https://doi.org/10.1108/09699981211277568

Akinade, O.O., Oyedele, L.O., Ajayi, S.O., Bilal, M. & Alaka, H.A. 2017. Design for deconstruction (DfD): Critical success factors for diverting end-of-life waste from landfills. *Waste Management*, 60, pp. 3-13. https://doi.org/10.1016/j.wasman.2016.08.017

Akintoye, A. & Main, J. 2007. Collaborative relationships in construction: The UK contractors' perception. *Engineering, Construction and Architectural Management Journal*, 14(6), pp. 597-617. https://doi.org/10.1108/09699980710829049

Albino, V. & Berardi, U. 2012. Green buildings and organizational changes in Italian case studies. *Business Strategy and the Environment*, 21(6), pp. 387-400. https://doi.org/10.1002/bse.1728

AlSanad, S. 2015. Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. *Procedia Engineering*, 118, pp. 969-983. https://doi.org/10.1016/j.proeng.2015.08.538

Amarkhil, Q., Elwakil, E. & Hubbard, B. 2021. A meta-analysis of critical causes of project delay using Spearman's rank and relative importance index integrated approach. *Canadian Journal of Civil Engineering*, 48(11), pp. 1498-1507. https://doi.org/10.1139/cjce-2020-0527

Araújo, C., Bragança, L. & Almeida, M.G.D. 2013. Sustainable construction key indicators building sustainability assessment tools. In: Bragança, L. & Pinheiro, M. (Eds). Portugal SB13: Contribution of sustainable building to meet EU 20-20-20 targets. Ricardo Mateus, Braga, Portugal: Universidade do Minho, pp. 505-512.

Ashley, R., Blackwood, D., Butler, D., Davies, J., Jowitt, P. & Smith, H. 2003. Sustainable decision-making for the UK water industry. In: *Proceedings of the Institution of Civil Engineers-Engineering Sustainability,* 156(1), pp. 41-49. https://doi.org/10.1680/ensu.2003.156.1.41

Bernard, H. 2002. *Research methods in anthropology: Qualitative and quantitative approaches*. 3rd edition. Walnut Creek, CA: Alta Mira Press.

Camara, T., Kamsu-Foguem, B., Diourte, B., Maiga, A.I. & Habbadi, A. 2017. Management and assessment of performance risks for bioclimatic buildings. *Journal of Cleaner Production*, 147, pp. 654-667. https://doi.org/10.1016/j.jclepro.2017.01.063

Carmines, E.G. & Zeller. R.A. 1974. On establishing the empirical dimensionality of theoretical terms: Analytic example. *Political Methodology*, 1(4), pp. 75-96.

Cheelo, C. & Liebenthal, R. 2018. The role of the construction sector in influencing natural resource use, structural change, and industrial development in Zambia (No. 2018/172). WIDER Working Paper. https://doi.org/10.35188/UNU-WIDER/2018/614-2

Chen, Y., Okudan, G.E. & Riley, D.R. 2010. Sustainable performance criteria for construction method selection in concrete buildings. *Automation in Construction*, 19(2), pp. 235-244. https://doi.org/10.1016/j.autcon.2009.10.004

Cooper, D.R. & Schindler, P.S. 1998. *Business research methods.* 6th edition. New York: Irwin/McGraw-Hill.

Da Rocha, C.G. & Sattler, M.A. 2009. A discussion on the reuse of building components in Brazil: An analysis of major social, economic and legal factors. *Resources, Conservation and Recycling*, 54(2), pp. 104-112. https://doi.org/10.1016/j.resconrec.2009.07.004

Dehbashisharif, M. 2017. The impact of social sustainability on culture buildings located in historical context. *International Journal of Current Engineering and Technology*, 7(2), pp. 350-353.

Doan, D.T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A. & Tookey, J. 2017. A critical comparison of green building rating systems. *Building and Environment*, 123, pp. 243-260. https://doi.org/10.1016/j.buildenv.2017.07.007

Dodds, S. & Hess, A. 2020. Adapting research methodology during COVID-19: Lessons for transformative service research. *Journal of Service Management*, 32(2), pp. 203-217. https://doi.org/10.1108/JOSM-05-2020-0153

Dosumu, O. & Aigbavboa, C. 2018. Drivers and effects of sustainable construction in the South African construction industry. *Acta Structilia*, 28(2), pp. 78-107. https://doi.org/10.18820/24150487/as28i2.4

Durdyev, S., Ismail, S., Ihtiyar, A., Bakar, N.F.S.A. & Darko, A. 2018. A partial least squares structural equation modeling (PLS-SEM) of barriers to sustainable construction in Malaysia. *Journal of Cleaner Production*, 204, pp. 564-572. https://doi.org/10.1016/j.jclepro.2018.08.304

Durdyev, S., Zavadskas, E.K., Thurnell, D., Banaitis, A. & Ihtiyar, A. 2018. Sustainable construction industry in Cambodia: Awareness, drivers and barriers. *Sustainability*, 10(2), article number 392. https://doi.org/10.3390/su10020392

Elkington, J. 1998. Accounting for the triple bottom line. *Measuring Business Excellence*, 2(3), pp. 18-22. https://doi.org/10.1108/eb025539

Elkington, J. 2006. Governance for sustainability. *Corporate Governance: An International Review*, 14(6), pp. 522-529. https://doi.org/10.1111/j.1467-8683.2006.00527.x

Ghansah, F.A., Owusu-Manu, D.G., Ayarkwa, J., Edwards, D.J. & Hosseini, M.R. 2021. Assessing the level of awareness of smart building technologies (SBTs) in the developing countries. *Journal of Engineering, Design and Technology*. Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JEDT-11-2020-0465

Goh, C.S. 2017. Towards an integrated approach for assessing triple bottom line in the built environment. In: Amoêda, R. & Pinheiro, C. (Eds). *SB-LAB 2017: Proceedings of the International Conference on Advances in Sustainable Cities and Buildings Development*, 15-17 November, Porto, Portugal. Green Lines Institute.

Goh, C.S., Chong, H.Y., Jack, L. & Faris, A.F.M. 2020. Revisiting triple bottom line within the context of sustainable construction: A systematic review. *Journal of Cleaner Production*, 252, 119884. https://doi.org/10.1016/j.jclepro.2019.119884

Govindan, K., Khodaverdi, R. & Jafarian, A. 2013. A fuzzy multi-criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach. *Journal of Cleaner Production*, 47, pp. 345-354. https://doi.org/10.1016/j.jclepro.2012.04.014

Green, E., Yates, A. & Hope, T. 2015. *Sustainable buildings – Delivering sustainable infrastructure*. Johannesburg, South Africa: ICE Publishing.

Hair, J.F., Anderson, R.E., Tatham, R.L. & Black, W.C. 1998. *Multivariate data analysis*. Upper Saddle River, NJ: Prentice-Hall.

Hebb, T. 2019. Investing in sustainable infrastructure. In: Arvidsson, S. (Ed.). *Challenges in managing sustainable business.* Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-319-93266-8_11

Hutchins, M.J. & Sutherland, J.W. 2008. An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production*, 16(15), pp. 1688-1698. https://doi.org/10.1016/j.jclepro.2008.06.001

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

Ibn-Mohammed, T., Greenough, R., Taylor, S., Ozawa-Meida, L. & Acquaye, A. 2013. Operational vs. embodied emissions in buildings - A review of current trends. *Energy and Buildings*, 66, pp. 232-245. https://doi.org/10.1016/j.enbuild.2013.07.026

Jacobs, E. 2015. The status quo of green-building education in South Africa. *Acta Structilia*, 22(2), pp. 110-133.

Jagarajan, R., Asmoni, M.N.A.M., Mohammed, A.H., Jaafar, M.N., Mei, J.L.Y. & Baba, M. 2017. Green retrofitting – A review of current status, implementations and challenges. *Renewable and Sustainable Energy Reviews*, 67, pp. 1360-1368. https://doi.org/10.1016/j.rser.2016.09.091

Khalfan, M., Noor, M.A., Maqsood, T., Alshanbri, N. & Sagoo, A. 2015. Perceptions towards sustainable construction amongst construction contractors in state of Victoria, Australia. *Journal of Economics, Business and Management,* 3(10), pp. 940-947. https://doi.org/10.7763/JOEBM.2015.V3.313

Kibert, C.J. 2012. *Sustainable construction – Green building design and delivery*. 3rd edition. Hoboken, NJ: Wiley.

Kibwami, N. & Tutesigensi, A. 2016. Enhancing sustainable construction in the building sector in Uganda. *Habitat International*, 57, pp. 64-73. https://doi.org/10.1016/j.habitatint.2016.06.011

Kylili, A. & Fokaides, P.A. 2017. Policy trends for the sustainability assessment of construction: A review. *Sustainable Cities and Society*, 35, pp. 208-288. https://doi.org/10.1016/j.scs.2017.08.013

Li, H., Zhang, X., Ng, S.T. & Skitmore, M. 2018. Quantifying stakeholder influence in decision/evaluations relating to sustainable construction in China – A Delphi approach. *Journal of Cleaner Production,* 173, pp. 160-170. https://doi.org/10.1016/j.jclepro.2017.04.151

Masia, T., Kajimo-Shakantu, K. & Opawole, A. 2020. A case study on the implementation of green building construction in Gauteng province, South Africa. *Management of Environmental Quality,* 31(3), pp. 602-623. https://doi.org/10.1108/MEQ-04-2019-0085

McMahon, M. & Bhamra, T. 2015. Social sustainability in design: Moving the discussions forward. *The Design Journal*, 18(3), pp. 367-391. https://doi.org/10.1080/14606925.2015.1059604

Mısırlısoy, D. & Günçe, K. 2016. Adaptive reuse strategies for heritage buildings: A holistic approach. *Sustainable Cities and Society*, 26, pp. 91-98. https://doi.org/10.1016/j.scs.2016.05.017

Muleya, F., Zulu, S. & Nanchengwa, P. 2020. Investigating the role of the public private partnership act on private sector participation in PPP projects: A case of Zambia. *International Journal of Construction Management*, 20(6), pp. 598-612. DOI: 10.1080/15623599.2019.1703088

Oke, A., Aghimien, D., Aigbavboa, C. & Musenga, C. 2019. Drivers of sustainable construction practices in the Zambian construction industry. *Energy Procedia,* 158, pp. 3246-3252. doi:10.1016/j.egypro.2019.01.995

OECD (Organisation for Economic Co-operation and Development). 2001. Sustainable development strategies – What are they and how can development cooperation agencies support them? [Online]. Available at: <https://www.oecd.org/dac/environment-development/1899857.pdf> [Accessed: 3 June 2018].

Owusu-Mensah, R. 2021. Investigating knowledge and awareness level of sustainable construction practices on university campuses in Ghana, Unpublished Ph.D. dissertation, Kwame Nkrumah University of Science and Technology, Ghana.

Oyebanji, O.O., Liyanage, C. & Akintoye, A. 2017. Critical success factors (CSFs) for achieving sustainable social housing (SSH). *International Journal of Sustainable Built Environment,* 6(1), pp. 216-227. https://doi.org/10.1016/j.ijsbe.2017.03.006

Pearce, A.R., Shenoy, S., Fiori, C.M. & Winters, Z. 2010. The state of sustainability best practices in construction: A benchmark study. *Journal of Green Building*, 5(3), pp. 116-130. https://doi.org/10.3992/jgb.5.3.116

Phillips, R., Troup, L., Fannon, D. & Eckelman, M.J. 2020. Triple bottom line sustainability assessment of window-to-wall ratio in US office buildings. *Building and Environment*, 182, Article 107057. https://doi.org/10.1016/j.buildenv.2020.107057

Phiri, J. & Matipa, W.M. 2004. Sustainable construction in a developing country: An assessment of how the professionals' practice impacts on the environment. Paper presented at the 20th Annual ARCOM Conference, 1-3 September, Edinburgh, United Kingdom, Heriot Watt University.

Sarkis, J., Presley, A. & Meade, L. 2010. Benchmarking for sustainability: An application to the sustainable construction industry. *Benchmarking: An International Journal*, 17(3), pp. 435-451. https://doi.org/10.1108/14635771011049380

Serpell, A., Kort, J. & Vera, S. 2013. Awareness, actions, drivers and barriers of sustainable construction in Chile. *Technological and Economic Development of Economy,* 19(2), pp. 272-288. https://doi.org/10.3846/20294913.2013.798597

Shafii, F., Ali, Z.A. & Othman, M.Z. 2006. Achieving sustainable construction in the developing countries of Southeast Asia. *Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006)*, 5-6 September, Kuala Lumpur, Malaysia, pp. C29-C44.

Shah, M.N., Dixit, S., Kumar, R., Jain, R. & Anand, K. 2021. Causes of delays in slum reconstruction projects in India. *International Journal of Construction management*, 21(5), pp. 452-467. https://doi.org/10.1080/15623599.2018.1560546

Shan, M., Liu, W.Q., Hwang, B.G. & Lye, J.M. 2020. Critical success factors for small contractors to conduct green building construction projects in Singapore: Identification and comparison with large contractors. *Environmental Science and Pollution Research*, 27(8), pp. 8310-8322. https://doi.org/10.1007/s11356-019-06646-1

Sikombe, S. & Phiri, M. 2021. How do institutionalized supplier development initiatives affect knowledge transfer and operational performance? Evidence from SME construction companies in Zambia. *African Journal of Science, Technology, Innovation and Development*, 1(14), pp. 1-14. DOI: 10.1080/20421338.2021.1889757

Singh, S. & Kumar, K. 2021. A study of lean construction and visual management tools through cluster analysis. *Ain Shams Engineering Journal,* 12(1), pp. 1153-1162. https://doi.org/10.1016/j.asej.2020.04.019

Slaper, T.F. & Hall, T.J. 2011. The triple bottom line: What is it and how does it work. *Indiana Business Review*, 86(1), pp. 4-8.

Thacker, S., Adshead, D., Morgan, G., Crosskey, S., Bajpai, A., Ceppi, P. & O'Regan, N. 2018. Infrastructure: Underpinning sustainable development. Copenhagen, Denmark: UNOPS.

Tokbolat, S., Karaca, F., Durdyev, S. & Calay, R.K. 2020. Construction professionals' perspectives on drivers and barriers of sustainable construction. *Environment, Development and Sustainability,* 22(5), pp. 4361-4378. https://doi.org/10.1007/s10668-019-00388-3

Torrentira, M. 2020. Combating COVID-19 pandemic: The best management practices of a designated hospital in Southern Philippines. *Journal of Business and Management Studies*, 2(2), pp. 11-15.

Tripathy, M., Sadhu, P.K. & Panda, S.K. 2016. A critical review on building integrated photovoltaic products and their applications. *Renewable and Sustainable Energy Reviews*, 61, pp. 451-465. https://doi.org/10.1016/j.rser.2016.04.008

Tsai, W.-H., Lin, S.-J., Liu, J.-Y., Lin, W.-R. & Lee, K.-C. 2011. Incorporating life cycle assessments into building project decision-making: An energy consumption and CO2 emission perspective. *Energy,* 36(5), pp. 3022-3029. https://doi.org/10.1016/j.energy.2011.02.046

Unuigbe, M., Zulu, S. & Johnston, D. 2020. Renewable energy sources and technologies in commercial buildings – Understanding the Nigerian experience. *Built Environment Project and Asset Management Journal,* 10(2), pp. 231-245. https://doi.org/10.1108/BEPAM-11-2018-0151

WCED (World Commission on Environment and Development). 1987. Report of the World Commission on Environment and Development: Our common future. United Nations.

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, pp. 613-620. https://doi.org/10.1016/j.scs.2018.03.024

Zeegers, Y. & Francis Clark, I. 2014. Students' perceptions of education for sustainable development. *International Journal of Sustainability in Higher Education*, 15(2), pp. 242-253. https://doi.org/10.1108/IJSHE-09-2012-0079

Zhang, X., Platten, A. & Shen, L. 2011. Green property development practice in China: Costs and barriers. *Building and Environment,* 46(11), pp. 2153-2160. https://doi.org/10.1016/j.buildenv.2011.04.031

Zulu, E., Zulu, S.L., Chabala, M., Kavishe, N., Chifunda, C. & Musonda, I. 2022. Infrastructure design stage considerations for environmental sustainability in Zambia. *Journal of Engineering, Design and Technology*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JEDT-12-2021-0742

Zulu, S. & Muleya, F. 2017. Exploring student perceptions on sustainability considerations in construction procurement decisions in Zambia. In: Emuze, F. & Behm, M. (Eds). *Proceedings of the Joint CIB W099 and TG59 International Safety, Health, and People in Construction Conference, Cape Town, South Africa*, 11-13 June 2017, Bloemfontein: CUT, pp. 488-498.

Zulu, S.L., Zulu, E., Chabala, M. & Chunda, N. 2022. Drivers and barriers to sustainability practices in the Zambian construction industry. *International Journal of Construction Management*, 1-10. DOI: https://doi.org/10.1080/15623599.2022.2045425

Zulu, S., Zulu, E. & Chabala, M. 2021. Factors influencing households' intention to adopt solar energy solutions in Zambia: Insights from the theory of planned behaviour. *Smart and Sustainable Built Environment,* ahead-of-print. DOI: 10.1108/SASBE-01-2021-0008

Zwickle, A., Koontz, T.M., Slagle, K.M. & Bruskotter, J.T. 2014. Assessing sustainability knowledge of a student population: Developing a tool to measure knowledge in the environmental, economic and social domains. *International Journal of Sustainability in Higher Education*, 15(4), pp. 375-389. https://doi.org/10.1108/IJSHE-01-2013-0008