SUSTAINABILITY AWARENESS FOR ARCHITECTURAL, ENGINEERING AND CONSTRUCTION PROFESSIONALS IN ZIMBABWE

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ABSTRACT

Sustainability-related challenges, are evident in the construction industries. Therefore, a contextual interrogation of sustainability awareness for the determination of knowledge-based improvement strategies is supported. This article pursued the sustainability awareness needs for construction professionals and evaluated statistically significant variances due to gender, designation, educational levels, and experience of respondents. A web-based questionnaire survey was administered to built environment professionals, and the collected numerical data was analysed through descriptive and non-parametric statistical methods. Factor analysis determined six significant components, with the most important being cultural diversity and evolution and futures thinking. These were the broad learning objectives within which sustainability instruction should be implemented. Significant variances, due to the selected demographic variables, were non-existent, indicating consensus on the required sustainability learning objectives. However, a few individual sustainability learning objectives had statistically significant differences that required intervention for Architects and Engineers as well as for those with degrees and MSc educational levels. The determination of sustainability learning objectives established the knowledge for curriculum re-design, continuous professional development, and improvement for built environment professionals. However, due to the exploratory nature of the study, the insights of clients were not considered. Further studies should aim to establish the context-specific sustainability learning objectives for each designation. The derivation of sustainability awareness needs for architectural, engineering and construction professionals enabled operationalisation of remedial strategies within the construction companies and professionals' bodies.

Keywords: Construction, Professionals, Awareness, Sustainability

INTRODUCTION

Sustainability concerns have dominated construction industries in recent years. Despite the construction industry contributing significantly to national economies, it has developed to be a major contributor to economic, social and environmental sustainability challenges. Performance inefficiencies (Chigara & Moyo, 2014a), construction on wetlands and sustainability challenges (Mhlanga, 2018), infrastructure inadequacies (Mhlanga, 2019), and construction workers' well-being shortcomings (Moyo *et al.,* 2021), have been widespread. In addition, health and safety insufficiencies (Chigara & Moyo, 2014b; Chirazeni & Chigonda, 2018), corporate social responsibility insufficiencies (Uzhenyu & Marisa, 2017; Moyo, Crafford & Emuze, 2019a), and decent work concerns (Moyo Crafford & Emuze, 2019b), have inundated the construction industry. Amongst other contributing causes, the lack of sustainability awareness amongst the built environment professionals and a resulting necessity to raise sustainability literacy levels has been identified as being critical (Cotgrave & Kokkarinen, 2010; Brennan & Cotgrave, 2014; Higham & Thomson, 2015). More-so for developing countries like Zimbabwe, realisation of sustainability in construction has been hampered by lack of knowledge. Thus, any effective resolutions to these challenges require the provision of adequate sustainability knowledge and skills. Viertel (2010), bemoans arguments on widespread inequalities, environmental damage, climate change and dwindling resources and the consequent need for stronger education on sustainable development.

The United Nations Education Science and Cultural Organization (UNESCO, 2017), advocates for strengthening Education for Sustainable Development (ESD) through implementing substantial changes in training which entail incorporating critical issues such as climate change, biodiversity, disaster risk reduction and sustainable consumption and production. However, Blewitt (2010), justifies the lack of mainstreaming of sustainability within the training curriculum because of suspicion that the concept is inexact, unique to different situations and the general lack of knowledge. Despotovic, Cvetanovic, Nedic, and Despotovic (2015), also assert that economic competitiveness should be amply assimilated with environmental and social sustainability, however, clarity lacks in explaining the complex phenomenon of these mechanisms.

Therefore, this study aims to determine the sustainability awareness for construction professionals in Zimbabwe through factor analysis. The Government of Zimbabwe's (2014), prerogative is "the provision of relevant skills to individuals for sustainable economic development and self-fulfillment through a system which is accessible, equitable, inclusive, financially sustainable, responsive to technological developments, and includes entrepreneurship and involves all stakeholders". Therefore, resolutions can be achieved through developing sustainability literacy which informs our behaviour and attitude to technological advancements in the industry. Further to this, an examination of any significant variances in perceptions due to gender, designation, educational levels and experience was undertaken. Wan and Ng (2016), emphasise that construction sustainability approaches by developed and developing countries are not mutually adaptable hence a country-specific approach is inevitable. The next section of the study presents the theoretical and conceptual framework of the study.

SUSTAINABILITY IN CONSTRUCTION

World Commission on Environment and Development (WCED, 1987: 24), defines sustainability as humanity's ability to "ensure that it meets the needs of the present without compromising the ability of future generations to meet their own". It is concerned with issues of continuity and endurance and sets a methodology to remedy social, economic and environmental challenges that face mankind (Murray & Cotgrave, 2007). However, the execution of sustainable development is inundated with complexities and conflicts the world over. Ratiu and Anderson (2015) decry that clear understanding of sustainability continues to elude academics though there is an upsurge in attention and use of this notion. Sustainability in the built environment focuses on ways the sector can add to the earth's sustainability (Halliday, 2008). Sustainable construction concerns construction projects that promote environmental, social and economic gains today and tomorrow (Suliman & Abdelnaser, 2009). Since the built environment has a significant impact on the community, it faces scrutiny from various stakeholders (Siew, Balatbat & Carmichael 2013).

Innovative sustainability solutions are dependent on firms fostering 'sustainability cultures' to produce evident objectives for the environment and society (Galpin, Whittington & Bell, 2015). As such, construction should enhance social, economic and environmental sustainability through motivating for considerable sustainability literacy (Murray & Cotgrave, 2007).This is due to sustainability having transformed into a considered authority (Galpin et al., 2015). Several academics including Murray and Cotgrave (2007); El-Zein, Airey, Bowden and Clarkeburn (2008), Blewit (2010), agree that education is essential to making changes to the industry to improve sustainability. However, Kagawa (2007), relays that academics have agreed that there is no single context and acceptance of sustainability hence there is a need for alignment to country-specific challenges. Training is crucial in promoting attitudinal change (Cotgrave & Kokkarinen, 2010). Therefore, realisation of how sustainability can be incorporated into curricula is pertinent (Wyness, Jones & Klapper, 2015). Changing the thought process and perceptions of the workforce is vital to achieving sustainable development (Brennan & Cotgrave, 2014). Suffice to say sustainable construction principles are achievable if and when construction professionals attain the expected levels of sustainability literacy (Kibert, 2002).

Demographic variables are pertinent in effectively resolving sustainability challenges. Limitations of women in the Zimbabwean construction industry are likely to be significant (Infrastructure development bank of Zimbabwe, 2019). Alkhaddar, Woode, Sertyesilisik, and Tunstall (2012), expose the deep learning approach effectiveness on sustainability improvement differences between office-based and site-based construction workers. Robotham (2003), interprets the importance of level of education by highlighting that an effective training, to achieve competent learners, is borne out of consideration of their learning ability. Desha and Hargroves (2014) intimate that key professionals lack critical knowledge and skills to bring about sustainable solutions. Also, differences in professional roles were found to be significant towards how sustainable construction could be enshrined in projects. Cumulatively, Viertel (2010) concurs that competent transition to achieving sustainability is vital and can be realised through general awareness and applied research. Achievement of sustainable development is entrenched in equipping professionals, and skilled individuals in its literacy (Murray & Cotgrave, 2007).

Sustainability Literacy

Literacy involves a wide range of knowledge to empower people to achieve their objectives, to advance their awareness, and to contribute in their societies (UNESCO, 2017). Achieving sustainability literacy is the ability to understand global macro-problems, and to tackle these problems at all societal levels within irregular settings (Dale & Newman, 2005). Sustainability literacy is foundational and is based on construction professionals being instructed in sustainability learning that enables them to advance the sustainability development drive. As construction professionals are the drivers of construction projects, they can best lead towards sustainability attainment through adequate learning objectives. However, to accomplish this, they need to be equipped with the relevant knowledge during their training or and as part of their professional development. Competencies in sustainability permit effective job performance associated with sustainability risks. With key competences of sustainable development goals being envisioning, systemic thinking, critical thinking and reflection, participation in decision making and building partnerships (Osman, Ladhani, Findlater & McKay, 2017), most of the learning objectives are captured within these. Rieckmann (2012), determined key competencies of sustainable development as being analysis and responsibility, management of processes, cooperation and communication, handling of differences and conflicts, critical reflection on and involvement with the world, and handling of complexity and future developments. Steiner (2013) also developed competencies to resolve difficulties and these included personal competence, socio-cultural (collaborative) competence, professional domain competence, creativity competence and systemic competence. Related to these, this study considered converging competencies of systems thinking, strategic thinking (or action-oriented), values thinking (or normative), futures thinking (or anticipatory) and collaboration (or interpersonal) as suggested by various authors (Wiek Withycombe, & Redman, 2011; Frisk & Larson 2011). However, Glasser's competencies of affinity for life, state of the planet knowledge, wise decision making, modelling sustainable behaviour and transformative social change had greater agreement than those proposed by Wiek, Bernstein, and Foley (2016) (Glasser & Hirsch, 2016). Therefore, the sustainability learning objectives emphasised hereafter, as suggested by Glasser and Hirsch (2016), were subjectively selected with consideration of the infancy of sustainability within the study area. This is due to the suggested competences not being as explicit as learning objectives, as these accentuate the context within which advances are to be incorporated. Dale and Newman (2005), argue that learning objectives for sustainable development education are processed-based in addition to facts-based, in which the structures under study are composite, dynamic, and varied. Further, gaining a set of skills and the ability to implement those skills in a dynamic environment is pertinent. Hence, the learning objectives within these competencies were interrogated, as shown in Table 1.

Table 1: Conceptual Framework for the Study.

Key competence	Sustainability learning objectives
Affinity for life	SL01- Biophilia Integration SL02- Understanding of how life on planet Earth coevolved SL03- Cultural diversity appreciation SL04- Biological diversity appreciation
State of the planet knowledge	SL05- Deep understanding of how nature sustains life SL06- Understanding current, widely-held state of the planet perceptions and their limits SL07- Understanding of climate change SL08- Understanding of biological and cultural diversity loss rates SL09- Facility to foster state of the planet knowledge recalibration SL10- Understanding linear and non-linear growth rates and consequences
Modelling sustainable behaviour	SL11- Being the change one wants to see in the world SL12- Incorporating deep understanding of the state of the planet into policies and actions SL13- Acting in accordance with long-term goals (Sustainability Development Goals) SL14- Responding to maladaptive forces effectively SL15- Creating policy incentives to encourage the behavior we seek SL16- Prioritizing high-level values when tradeoffs arise
Transformative social change	SL17- Social learning for sustainability leadership and collaboration SL18- Recognition of motivational variables and consequences of action SL19- Facility to inspire collective change for sustainability SL20- Openness to the views and concerns of others SL21- Facility to perform action research

Learning objectives associated with affinity for life include biophilia integration

(Niu Jiang & Li, 2010; Dmochowski, Garofalo, Ficher, Greene, & Gambogi 2016), understanding of how life on planet earth co-evolved (Dmochowski *et al.,* 2016), cultural diversity appreciation (Du Plessis, 2007; Svanstrom *et al.,* 2008; Dmochowski *et al.,* 2016; Hill & Wang, 2018) and biological diversity appreciation (Svanstrom, Lozano-Garcia & Rowe 2008; Dmochowski *et al.,* 2016). Obiozo and Smallwood (2014), support the "green" interventions on construction sites as a tactic to improve workers well-being and performance. Goldswain and Smallwood (2013), also mention health, safety and ergonomics being caused by inadequacies in designs. The state of the planet knowledge include deep understanding of how nature sustains life (Wiek, *et al.,* 2011; Hill & Wang, 2018), understanding current, widely-held state of the planet perceptions and their limits (Hill & Wang, 2018), understanding of climate change (Du Plessis, 2007; Blewitt, 2010; Dmochowski *et al.,* 2016; Osman *et al.,* 2017), understanding of biological and cultural diversity loss rates (Du Plessis, 2007; Svanstrom *et al.,* 2008; Blewitt, 2010; Hill & Wang, 2018), facility to foster state of the planet knowledge recalibration (Hill & Wang, 2018), and understanding linear and non-linear growth rates and consequences (Du Plessis, 2007; Hill & Wang, 2018).Will (2008), suggests that corporate sustainability potentially enhances the competitiveness of companies by exploiting opportunities and reducing risks associated with current global trends like climate change. Cruickshank and Fenner (2012), supports instruction in climate change as pertinent for transforming current working conditions regime.

The competence of modelling sustainable behaviour, includes being the change one wants to see in the world (Murray & Cotgrave, 2007; Gaard *et al.,* 2017), incorporating deep understanding of the state of the planet into policies and actions (Du Plessis, 2007; Sivapalan, 2017), acting in accordance with long-term goals (Murray & Cotgrave, 2007; Osman *et al.,* 2017), responding to maladaptive forces effectively (Svanstrom *et al.,* 2008; Niu *et al.,* 2010; Osman *et al.,* 2017), creating policy incentives to encourage the behaviour we seek (Murray & Cotgrave, 2007; Niu *et al.,* 2010; Kokkarinen & Cotgrave, 2013), prioritising high-level values when tradeoffs arise (Du Plessis, 2007; Murray & Cotgrave, 2007; Kokkarinen & Cotgrave, 2013; Sivapalan, 2017). UNESCO (2017), remarks that ESD can develop learning objectives that are specific to a particular Sustainability Development Goal (SDGs) and relevant to all seventeen sustainability development goals. To improve the efficiency of the built environment, key construction players need to be trained on drivers of such sustainability objectives (Sfakianski, 2015). Learning objectives associated with transformative social change include social learning for sustainability leadership and collaboration (Steiner & Posch, 2006; Murray & Cotgrave, 2007; Svanstrom *et al.,* 2008; Niu *et al.,* 2010; Gaard et al., 2017; Sivapalan, 2017), recognition of motivational variables and consequences of action (Gaard *et al.,* 2017) , facility to inspire collective change for sustainability (Svanstrom et al., 2008; Gaard *et al.,* 2017) , openness to the views and concerns of others (Dmochowski et al., 2016) and facility to perform action research (Steiner & Posch, 2006; Du Plessis, 2007; Svanstrom et al., 2008; Niu et al., 2010; Osman *et al.,* 2017; Hill & Wang, 2018). Priest (2008), support the social capital concept comprising linkages, shared principles and considerations that enable clusters and entities to depend on each other and work together.

The focus of this study, on sustainability learning objectives for construction professionals in Zimbabwe, was predicated on the demographic background of respondents as alluded to in the previous section. Twenty-one sustainability learning objectives from Table 1 were selected for the survey. The methodology is outlined in the next section.

METHODOLOGY

The exploratory nature of the study utilised a web-based questionnaire survey strategy as supported by Cotgrave and Kokkarinen (2011) and Gaard *et al.,* (2017). Although Cotgrave and Kokkarinen (2011) utilised built environment students to establish sustainability learning objectives, this study involved the collection of numerical data from construction professionals for promoting awareness of sustainability learning. All the eighty-three construction companies', situated in Harare and Bulawayo and registered with the Construction Industry Federation of Zimbabwe, were considered for the built environment professional's selection. Harare and Bulawayo are inhabited by 90 per cent of construction and consultancy firms (Mhlanga, 2019) with a total of 202 firms eligible for participation in the study.

The web-based questionnaires included of two sections. The first section invited demographic data on age, designation, educational levels, experience, gender and profession. The second section requested the respondents to score on the importance of sustainability learning objectives where: 1- not important, 2- of little importance, 3- somewhat important, 4- important and 5- very important. The Statistical Package for Social Science (SPSS) version 25 was utilised to aid in the determination of important learning objectives within demographic variables considerations. Reliability of the data collection instrument was ensured through a Cronbach-alpha reliability test. Taherdoost (2016), defines this test as the degree to which the instrument provides constant and dependable results, and it showed very good reliability of 0.897. Normality was determined by the Shapiro-Wilk test, which is reliable for samples of more than fifty, and this had a significant value of 0.000 which is less than 0.05 indicating abnormally distributed data (Ghasemi & Zahediasl, 2012) and consequent use of non-parametric tests.

Importance was evaluated through the Relative Importance Index (RII). As adapted from Perera *et al.*(2007), the response evaluation scales were ordered as follows: 'not important' < 0.2; $0.2<$ 'of little importance' ≤ 0.4; $0.4<$ 'somewhat important' ≤ 0.6; $0.6<$ 'important' ≤ 0.8; $0.8<$ 'very important' ≤ 1. Importance was considered from RII ≥ 0.6. Statistically significant variances, due to demographic variables, were evaluated utilising the Mann-Whitney U test and the Kruskal-Wallis test where the significance level was $p < 0.05$. The Mann-Whitney U test was used for matching the central tendency of the two (2) gender independent samples (Blumberg, Cooper and Schindler, 2008). The Kruskal-Wallis test was used to test the null hypothesis that more than two independent random samples (in the case of designation, educational levels and experience) come from undistinguishable populations against the alternative hypothesis that their means are not equal (Kothari, 2009). A post-hoc Mann-Whitney U test analysis was used, where individual learning objectives had statistically significant variances, where the effect size scale to measure the strength of the relationship; $r = 0.10$ (small effect); $r = 0.30$ (medium effect); $r = 0.50$ (large effect) was used to determine practical significance (Field, 2014).

Factor analysis was utilised to expose sets of underlying factors through considering the interrelationship among the variables (Field, 2014). The Kaiser-Meyer-Olkin (KMO) was used to measure the sampling adequacy for validity, with a measured value of 0.820 being acceptable for conducting factor analysis as it was > 0.5 (George & Mallery, 2003). The Bartlett's test for Sphericity had a significant value of 0.000, which was < 0.05, signifying a suitably multivariate normal and acceptable data for factor analysis (Field, 2014). Components from the analysis were extracted using the principal component analysis with varimax rotation due to its advantage in maximising variance for each factor (Kaiser, 1958; Benson & Nasser, 1998), with those with eigenvalues greater-than-one being noteworthy. Those with values being < 1 were disregarded as supported by Ather and Balasundaram (2009). The base line for loadings was set at 0.4 and this was considered stable for utilization (Guadagnoli & Velicer, 1988). The components were titled from consideration of their constituent factors as held by Rieckmann (2012). Factor scores were used to rank the components learning objectives (Ather & Balasundaram, 2009).

RESULTS AND DISCUSSION

This segment elucidates on the demographics of respondents, the importance of the learning objectives, statistically significant variances due demographic variables and factor analysis.

Demographics of Respondents

The response rate was 54.5 per cent, represented by one hundred and ten respondents from a population size of two hundred and two, and this was adequate. It conforms to Baruch (1999)'s recommended 60 per cent (+/- 20%) response rate for populaces of professionals. The designations were represented as follows; Quantity surveyors (34%), Project Managers (31%), Engineers (21%) and Architects (14%). Table 2 shows the other demographics of respondents.

Table 2- Demographics of Respondents

Respondent group	Architects' Firms	Construction companies	Civil engineering firms	Quantity surveying Firms
Population	54	83	43	22
Responses	19	59	23	14
Response rate	35%	71%	54%	64%
Gender	**Males**	**Females**		
Response rate	83%	17%		
Educational levels	**Diplomas**	**Degrees**	**Post-graduate degree**	
Response rate	7%	45%	47%	
Experience	**0-5 years**	**6-10 years**	**11-15 years**	**More than 15 years**
Response rate	41%	25%	21%	13%

The gender-biased nature of the construction industry is evident with a skew in favour of males (Infrastructure Development Bank of Zimbabwe, 2019). All the educational levels are well embodied representing acceptable aptitude levels. Also, the work experience results indicate a slight skew towards the less experienced, however, the more experienced professionals also had their insights included.

Relative Importance of Sustainability Learning Objectives

Respondents contributed their insights on sustainability learning objectives for construction professionals are as shown in Table 3. The results of this analysis show the importance of the individual sustainability learning objectives for construction professionals for directed corrective action. According to the evaluation scale, for overall ranking and that of engineers, project managers and quantity surveyors, all twenty-one sustainability learning objectives for construction professionals were measured as being important with RII $\geq$ 0.6 (Perera *et al.*, 2007). This supports the need to enrich all the construction professionals with sustainability learning. However, the learning objectives of 'facility to foster state of the planet knowledge recalibration' and 'understanding linear and non-linear growth rates and consequences' were considered not important by architects. The top three overall important sustainability learning objectives for construction professionals include: Understanding climate change (RII= 0,867), Acting in accordance with long-term goals (SDGs) (RII= 0,860) and Openness to perform to the views and concerns of others (RII= 0,840). All these learning objectives are fundamental towards enhancing sustainable construction principles through addressing the social, economic, environmental, technical, and cultural aspects of construction-related activities (Steiner & Posch, 2006; Du Plessis, 2007; Murray & Cotgrave, 2007; Svanstrom *et al.,* 2008; Niu *et al.,* 2010; Svanstrom *et al.,* 2008; Dmochowski *et al.,* 2016; Gaard *et al.*, 2017; Sivapalan, 2017; Hill & Wang, 2018). Climate change is topical the world over, and has also affected the construction sector. More-so, where a need for resilient infrastructure and adequate health and safety of workers are fundamental. Construction professionals have the prerogative to ensure that all aspects of design and execution of construction projects align with the requirements of climate change as supported by Will (2008) and Cruickshank and Fenner (2012). Acting in accordance with long term goals (SDGs) is also relevant. With most countries ratifying the Sustainable development agenda, it is inevitable that construction professionals act towards its achievement. However, a clear understanding of sustainability continues to elude academics and professionals (Ratiu and Anderson, 2015). This is reflected by the construction professionals' insights and supports integration of sustainability learning in undergraduate, post graduate and continuous professional development programmes.

Table 3: Ranking of Sustainability Learning Objectives

Sustainability learning objectives	Overall		Project Managers		Architects		Engineers		Quantity Surveyors	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
SL07- Understanding of climate change	0,867	1	0,859	2	0.863	1	0,861	1	0,881	1
SL13- Acting in accordance with long-term goals	0,860	2	0,865	1	0.850	3	0,835	2	0,881	1
SL20- Openness to the views and concerns of others	0,840	3	0,853	3	0.863	1	0,774	9	0,859	3
SL05- Deep understanding of how nature sustains life	0,815	4	0,812	6	0.775	7	0,791	5	0,849	5
SL03- Cultural diversity appreciation	0,811	5	0,818	5	0.763	8	0,835	2	0,811	7
SL19- Facility to inspire collective change for sustainability	0,798	6	0,800	8	0.663	16	0,791	5	0,859	3
SL17- Social learning for sustainability leadership and collaboration	0,796	7	0,847	4	0.725	11	0,757	12	0,805	9
SL21- Facility to perform action research	0,796	7	0,812	6	0.825	5	0,765	11	0,805	9

SL12- Incorporating deep understanding of the state of the planet into policies and actions	0,789	9	0,782	10	0.725	11	0,826	4	0,800	11
SL15- Creating policy incentives to encourage the behavior we seek	0,787	10	0,759	12	0.725	11	0,791	5	0,838	6
SL11- Being the change one wants to see in the world	0,760	11	0,741	14	0.763	8	0,774	9	0,784	13
SL04- Biological diversity appreciation	0,758	12	0,776	11	0.738	10	0,783	8	0,741	16
SL18- Recognition of motivational variables and consequences of action	0,758	12	0,794	9	0.838	4	0,730	15	0,789	12
SL16- Prioritizing high-level values when tradeoffs arise	0,753	14	0,735	17	0.663	16	0,748	13	0,811	7
SL08- Understanding of biological and cultural diversity loss rates	0,751	15	0,741	14	0.713	14	0,739	14	0,784	13
SL06- Understanding current, widely-held state of the planet perceptions and their limits	0,738	16	0,747	13	0.800	6	0,696	17	0,730	18
SL14- Responding to maladaptive forces effectively	0,698	17	0,741	14	0.638	18	0,678	18	0,697	20
SL01- Biophilia Integration	0,691	18	0,688	18	0.613	19	0,722	16	0,724	19
SL02- Understanding of how life on planet Earth coevolved	0,685	19	0,671	20	0.675	15	0,626	19	0,741	16
SL09- Facility to foster state of the planet knowledge recalibration	0,660	20	0,688	18	0.563	20	0,626	19	0,697	20
SL10- Understanding linear and non-linear growth rates and consequences	0,658	21	0,635	21	0.550	21	0,609	21	0,757	15

Statistically Significant Variances due to Demographic Variables

As shown in Table 4, the Mann-Whitney U and Kruskal-Wallis tests show that there was no statistically significant variance in the aggregated sustainability learning objectives concerning gender (0.305), designation (0.120), educational levels (0.09) and experience (0.668) since their p-values were > 0.05.

Table 4: Summary of Results for Sustainability Learning Objectives

Sustainability learning objectives	**Gender (sig.)**	**Designation (Sig.)**	**Educational level (Sig.)**	**Experience (Sig.)**
SL01- Biophilia Integration	0.227	0.279	0.119	0.165
SL02- Understanding of how life on planet Earth coevolved	0.760	0.344	0.364	0.726
SL03- Cultural diversity appreciation	0.282	0.908	0.203	0.860
SL04- Biological diversity appreciation	0.262	0.664	0.071	0.408
SL05- Deep understanding of how nature sustains life	0.635	0.364	0.033*	0.819
SL06- Understanding current, widely-held state of the planet perceptions and their limits	0.388	0.612	0.468	0.554
SL07- Understanding of climate change	0.708	0.810	0.751	0.778
SL08- Understanding of biological and cultural diversity loss rates	0.960	0.763	0.538	0.838
SL09- Facility to foster state of the planet knowledge recalibration	0.215	0.252	0.401	0.803
SL10- Understanding linear and non-linear growth rates and consequences	0.420	0.040*	0.028*	0.846
SL11- Being the change one wants to see in the world	0.386	0.708	0.127	0.148
SL12- Incorporating deep understanding of the state of the planet into policies and actions	0.360	0.298	0.467	0.743
SL13- Acting in accordance with long-term goals (Sustainability Development Goals)	0.696	0.407	0.165	0.288
SL14- Responding to maladaptive forces effectively	0.344	0.555	0.483	0.814
SL15- Creating policy incentives to encourage the behaviour we seek	0.916	0.244	0.031*	0.520
SL16- Prioritizing high-level values when trade-offs arise	0.587	0.024*	0.106	0.901
SL17- Social learning for sustainability leadership and collaboration	0.095	0.112	0.601	0.828
SL18- Recognition of motivational variables and consequences of action	0.234	0.075	0.017*	0.950

SL19- Facility to inspire collective change for sustainability	0.384	0.011*	0.108	0.539
SL20- Openness to the views and concerns of others	0.195	0.466	0.692	0.409
SL21- Facility to perform action research	0.395	0.870	0.728	0.828
Aggregated	**0.305**	**0.120**	**0.090**	**0.668**

Holistic resolutions are reinforced by the results, showing consistent perceptions from respondents regardless of their demographic variances. Despite sustainability being in its early stages in the Zimbabwean construction industry, all the construction professionals generally show consensus in its appreciation.

The gender imbalance and experience of professionals, in the construction industry, has not shown any significant differences, even in the individual learning objectives. However, individual learning objectives have shown significant differences with p-values of < 0.05, for the demographic variables of designation and educational levels. These are discussed hereafter with consideration of post hoc Mann Whitney U test to ascertain the existence of the actual statistically significant differences as shown in Tables 5.

Table 5: Post-hoc Mann-Whitney U test Results for Designations

Learning objectives	Designation Groups	Mann-Whitney U	Wilcoxon W	Z	r	Asymp. Sig. (2-tailed)
Understanding linear and non-linear growth rates and consequences	Architects and Quantity surveyors	172.00	308.00	-2.509	0.119	0.012
	Engineers and Quantity surveyors	292.500	568.500	-2.100	0.099	0.036
Prioritising high-level values when tradeoffs arise	Architects and Quantity surveyors	174.00	310.00	-2.503	0.247	0.012
	Engineer and Quantity surveyors	287.000	563.000	-2.252	0.157	0.024
	Project managers and Quantity Surveyors	458.500	1053.500	-2.077	0.076	0.038
Facility to inspire collective change for sustainability	Architects and Quantity surveyors	146.00	282.00	-3.122	0.193	0.002
	Architects and Project managers	182.00	318.00	-2.097	0.312	0.036

For designation, as shown in Table 5 and 6, the post-hoc tests showed results for the learning objectives of understanding linear and non-linear growth rates and consequences, prioritising high-level values when tradeoffs arise and facility to inspire collective change for sustainability. However, the practical significance of these differences is low expect for that which exists for Architects and Project managers for the facility to inspire collective change for sustainability learning objective. Table 6 shows that quantity surveyors and project managers perceive these learning objectives as being more important as compared to architects and engineers and this is opposed to views by Du Plessis, (2007), Murray & Cotgrave (2007), Kokkarinen and Cotgrave (2013), Gaard *et al.*(2017), and Sivapalan (2017).

The views of Viertel (2010), and Desha and Hargroves (2014), on key professionals' lack in critical knowledge and skills is evident in these learning objectives and also that competent transition to achieving sustainability is vital and can be realised through general awareness and applied research. From the results, engineers and architects should value these learning objectives more since they are the originators of designs which are supposed to initiate sustainable provisions. This difference likely emanates from deficiencies in sustainability learning within the curricula of these two professions.

Table 6: Ranking of Learning Objectives

Learning objectives	Designation	N	Mean Rank	Sum of Ranks
Understanding linear and non-linear growth rates and consequences	Engineers	23	24.72	568.50
	Quantity surveyors	37	34.09	1261.50
	Total	60		
	Architects	16	19.25	308.00
	Quantity surveyors	37	30.35	1123.00
	Total	53		
Prioritizing high-level values when trade-offs arise	Architects	16	19.38	210.00
	Quantity surveyors	37	30.30	1121.00
	Total	53		
	Engineers	23	24.48	563.00
	Quantity surveyors	37	34.24	1267.00
	Total	60		

	Project managers	34	30.99	1053.50
	Quantity surveyors	37	40.61	1502.50
	Total	71		
	Architects	16	17.63	282.00
Facility to inspire collective change for sustainability	Quantity surveyors	37	31.05	1149.00
	Total	53		
	Architects	16	19.88	318.00
	Project managers	34	28.15	957.00
	Total	50		

For educational levels, as shown in Table 7 and 8, the post-hoc tests showed results for the learning objectives of Deep understanding of how nature sustains life, understanding linear and non-linear growth rates and consequences, Creating policy incentives to encourage the behaviour we seek and recognition of motivational variables and consequences of action. These showed significant differences since the p-values were < 0.05. However, the practical significance of these differences is low expect for that which exists for Diploma & Degree professionals for the Recognition of motivational variables and consequences of action.

Table 7: Post-hoc Mann-Whitney U test results for Educational Levels

Learning objectives	Education Groups	Mann-Whitney U	Wilcoxon W	Z	r	Asymp. Sig. (2-tailed)
Deep understanding of how nature sustains life	Diploma & MSc	101.500	1479.500	-2.462	0.068	0.014
	Diploma & Degree	111.500	1386.500	-2.170	0.229	0.030
Understanding linear and non-linear growth rates and consequences	Diploma & MSc	100.000	1478.000	-2.450	0.087	0.014
	Diploma & Degree	86.000	1361.000	-2.689	0.143	0.007
Creating policy incentives to encourage the behavior we seek	Diploma & MSc	122.000	1500.000	-1.959	0.029	0.049
Recognition of motivational variables and consequences of action	Diploma & MSc	91.500	1469.500	-2.754	0.188	0.006
	Diploma & Degree	91.500	1366.500	-2.684	0.331	0.007

Table 8 shows that those with diplomas perceive these learning objectives as being more important as compared to those with degrees and MSc educational levels. Diploma graduates' value on these learning objectives is evidence of a gap that requires remedial action through both academic and professional interventions. These interventions can include curricula re-designs and professional short courses for integration of these learning objectives. These results support Wan and Ng (2016)'s assertion on the need for country-specific interventions. Further, Robotham (2003)'s consideration on abilities of various educational levels needs critical analysis for sustainable resolutions. However, sustainability has become pertinent such that all professionals of various educational levels need its instruction. More so on issues of deep understanding of how nature sustains life, understanding linear and non-linear growth rates and consequences, creating policy incentives to encourage the behaviour that is sought and recognition of motivational variables and consequences of action.

Table 8: Ranking of Learning Objectives

Learning objectives	Educational groups	N	Mean Rank	Sum of Ranks
Deep understanding of how nature sustains life	Diploma	8	43.81	350.50
	MSc	52	28.45	1479.50
	Total	60		
	Diploma	8	40.56	324.50
	Degree	50	27.73	1386.50
	Total	58		
Understanding linear and non-linear growth rates and consequences	Diploma	8	44.00	352.00
	MSc	52	28.42	1478.00
	Total	60		
	Diploma	8	43.75	350.00
	Degree	50	27.22	1361.00
	Total	58		
Creating policy incentives to encourage the behavior we seek	Diploma	8	41.25	330.00
	MSc	52	28.85	1500.00
	Total	60		
	Diploma	8	45.06	360.50
Recognition of motivational variables and consequences of action	MSc	52	28.26	1469.50
	Total	60		
	Diploma	8	43.06	344.50
	Degree	50	27.33	1366.50
	Total	58		

Relationships Amongst Sustainability Learning Objectives

Six groups of learning objectives were reveled from the factor analysis having eigenvalues of ≥ 1, which explained 67.017 per cent of the total variance with factor loadings ranging from 0.799 to 0.473. Each group of learning objectives was discussed here-after and named according to the constituent learning objectives, as shown in Table 9.

Table 9: Factor analysis results

Factor score and (Rank)	**Sustainability learning objectives**	**Components**					
		1	**2**	**3**	**4**	**5**	**6**
1,945	SL17- Social learning for sustainability leadership and collaboration	0.728					
	SL18- Recognition of motivational variables and consequences of action	0.713					
	SL19- Facility to inspire collective change for sustainability	0.701					
	SL08- Understanding of biological and cultural diversity loss rates	0.671					
	SL15- Creating policy incentives to encourage the behaviour we seek	0.657					
	SL16- Prioritizing high-level values when trade-offs arise	0.581					
	SL04- Biological diversity appreciation	0.537					
2,340	SL09- Facility to foster state of the planet knowledge recalibration		0.799				
	SL10- Understanding linear and non-linear growth rates and consequences		0.709				
	SL01- Biophilia integration		0.626				
	SL14- Responding to maladaptive forces effectively		0.501				
	SL12- Incorporating deep understanding of the state of the planet into policies and actions		0.473				
2,781	SL05- Deep understanding of how nature sustains life			0.795			

	SL06- Understanding current, widely-held state of the planet perceptions and their limits			0.658			
	SL11- Being the change one wants to see in the world			0.640			
3,010	SL20- Openness to the views and concerns of others				0.791		
	SL21- Facility to perform action research				0.741		
3,540	SL07- Understanding of climate change					0.759	
	SL13- Acting in accordance with long-term goals					0.499	
3,800	SL03- Cultural diversity appreciation						0.759
	SL02- Understanding of how life on planet Earth coevolved						0.617
	Eigen value	7.317	1.730	1.347	1.318	1.229	1.132
	Proportion of variance (%)	34.843	8.238	6.415	6.276	5.854	5.391
	Cumulative variance (%)	34.843	43.081	49.496	55.772	61.626	67.017
	Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 10 iterations.						

Component 1- Sustainability Leadership and Value Prioritisation

The first component was named "sustainability leadership and value prioritisation" and accounted for 7.317 eigenvalues with a variance of 34.843 per cent. The sustainability learning objectives included in this component were Social learning for sustainability leadership and collaboration (sig.= 0.728), Recognition of motivational variables and consequences of action (sig.= 0.713), Facility to inspire collective change for sustainability (sig.= 0.701), Understanding of biological and cultural diversity loss rates (sig.= 0.671), Creating policy incentives to encourage the behavour that is sought (sig.= 0.657), Prioritising high-level values when trade-offs arise (sig.= 0.581), and Biological diversity appreciation (sig.= 0.537). This component was ranked sixth with a factor score of 1.945. This component has diverse learning objectives, however, they all resolve towards effective sustainability leadership and adding value to the sustainability development drive. Objectives of social learning, motivational variables, collective change, understanding loss rates, policy incentives, prioritizing high-level values and appreciation of biological diversity all enrich the construction professionals towards improving their focus on sustainability. As supported by Galpin *et al.* (2015), sustainability cultures that seek to enhance value thinking are paramount. As such, construction professionals need to be equipped with these learning objectives through continuous professional development and curricula re-development for undergraduate and post graduate programmes.

Component 2- Strategic Planning for Co-existence

The second component was titled "strategic planning for co-existence" and accounts for 1.730 eigenvalues with a variance of 8.238 per cent. The sustainability learning objectives incorporated in this component were: Facility to foster state of the planet knowledge recalibration (sig. = 0.799), Understanding linear and non-linear growth rates and consequences (sig. = 0.709), Biophilia integration (the urge to affiliate with other forms of life) (sig. = 0.626), Responding to maladaptive forces effectively (sig. = 0.501), and Incorporating deep understanding of the state of the planet into policies and actions (sig. = 0.473). This component was ranked fifth with a factor score of 2.340. Strategic thinking allows for long-term objectives that will bring about the required change in the construction industry. The learning objectives within this component enable the construction professionals to act towards achieving or implementing sustainable development within and through their designations. Objectives of planetary knowledge recalibration, understanding growth rates and consequences, biophilia integration, responding to maladaptive forces and enacting appropriate policies and actions are all paramount products of essentially equipped professionals as supported by Svanstrom *et al.*(2008), Niu *et al.* (2010), and Osman *et al.* (2017). However, equipping constructional professionals on these objectives requires complimentary efforts from instructors situated in other professions and industries. This implies the need to integrate sustainability learning objectives as multi-disciplinary functions.

Component 3- Planetary Knowledge and Behaviour

The third component was titled "planetary knowledge and behaviour" and accounts for 1.347 eigenvalues with a variance of 6.415 per cent. The sustainability learning objectives incorporated in this component are Deep understanding of how nature sustains life (sig. = 0.795), Understanding current, widely-held state of the planet perception and their limits (sig. = 0.658) and Being the change, one wants to see in the world (sig. = 0.640). This component was the ranked forth, with a factor score of 2.781. Critical thinkers are important for the attainment of the sustainability development agenda. The deep understanding of the relationship between nature and life, and the state and limits of the planet (Dmochowski et al., 2016) are fundamental objectives of critical thinkers. These are supported by the resolve to be the change that one would want to see in the world. For construction professionals to achieve these objectives, it is imperative that they be exposed to the broader planetary issues and how they can affect the change that is required from a holistic perspective.

Component 4- Social Inclusivity and Evidence-based Problem-solving

The fourth component was titled "social inclusivity and evidence-based problem-solving" accounts for 1.318 eigenvalues with a variance of 5.854 per cent. The sustainability learning objectives incorporated in this component are openness to perform to the views and concerns of others (sig. = 0.791) and Facility to perform action research (sig. = 0.741). This component was ranked third, with a factor score of 3.010. The learning objectives within this component are concerned with the ability and capacity of construction professionals to solve problems in the construction industry. The objectives of 'openness to perform to the views and concerns of others' and 'facility to perform action research' enable construction professionals to identify sustainability inadequacies within their construction projects and broader communities. Consequent to identification, the construction professionals can undertake competent enquiries that will culminate in viable solutions and can also be exported to similar communities. Failure to equip construction professionals in this regard will have disastrous consequences as opined by Viertel (2010) and Alkhaddar *et al.* (2012).

C*omponent 5- Futures Thinking*

The fifth component was titled "futures thinking", accounts for 1.229 eigenvalues with a variance of 4.446 per cent. The sustainability learning objectives incorporated in this component are: Understanding climate change (sig. = 0.759) and acting in accordance with long-term goals (SDGs) (sig. = 0.499). This component ranked second, with a factor score of 3.540. Issues of climate change, and acting in accordance with the long term goals (SDGs), are universal and are a real threat to the future of mankind. Thus, the title of the component is appropriate as it highlights the learning needs that will assist to secure the existence of future generations. However, the attention on these pertinent objectives has not been equally met with sufficient instruction in tertiary institutions (Kokkarinen & Cotgrave, 2013) and professional bodies have not adequately taken remedial action towards its incorporation in construction-related policies. The existent gap needs redress if the tenets of sustainability development agenda are to be achieved (Despotovic et al., 2015). It is incumbent upon the construction industry organisations, academics and associated professional bodies to enhance the knowledge of construction professionals in these aspects.

Component 6- Cultural Diversity and Evolution

The sixth component was titled "Cultural diversity and evolution", accounts for 1.132 eigenvalues with a variance of 5.391 per cent. The sustainability learning objectives incorporated in this component are cultural diversity appreciation (sig. = 0.759) and understanding of how life on planet Earth co-evolved (sig. = 0.617). This component was ranked highest, with a factor score of 3.800. Globalisation has contributed to opening up of borders and this has brought about considerable advantages and disadvantages. Multinational construction companies have a strong presence in the Zimbabwean construction industry, and this has inevitably brought about cultural variances on social and environmental aspects. Decent work and workers' well-being concerns are borne from lack of cultural diversity appreciation (Moyo *et al.,* 2019; Moyo *et al.,* 2021). Thus, as construction professionals are effectively instructed in such apprehensions, they will ably administer construction projects sustainably. As supported by Dmochowski *et al.* (2016), 'understanding how life on planet earth co-evolved' is an important learning objective. Long term future planning needs an in-depth understanding of how the planet has co-evolved. This enables an understanding of how evolution will likely progress and enable effective strategic planning and policy formulation by construction professionals. Issues of construction on wetlands (Mhlanga, 2018) and infrastructure inadequacies (Mhlanga, 2019) can be efficiently dealt with if construction professionals attain such instruction.

The six significant groups of sustainability learning objectives show the depth of construction professionals' current knowledge. It is apparent that much needs to be done to improve the learning of construction professionals with respect to cultural, social and environmental concerns. Contrariwise, economic concerns are inconspicuous. The results are supported by Wiek *et al.* (2015) and Glasser and Hirsch (2016), although the thrust of the broader learning objectives' groups are different. Hence, the implementation, in accordance to the importance of the learning groups, also differs. The results have various implications. There is a need to enhance sustainability education in the construction industry for both those in training and those already in professional capacities. Ratifying global initiatives is not enough if this is not supported by remedial action within the training of professionals. Enacting sustainability policies should be supported by knowledge enhancement within the construction industry, and appropriate performance measures should be operationalised.

CONCLUSION

Sustainability-related challenges of performance, workers well-being and social responsibility issues are common in Zimbabwe. While advocating for sustainable construction seems a worthy resolution, however, sustainability instruction of architectural, engineering and construction professionals is inadequate. This research aimed to determine sustainability awareness needs for construction professionals and evaluate statistically significant variances due to gender, designation, educational levels and experience of respondents concerning their ranking. The relative importance analysis results show that all sustainability learning objectives are important with understanding climate change, acting in accordance with long-term goals (SDGs), and openness to perform to the views and concerns of others being the top three learning objectives. The dearth in construction professionals' sustainability learning is confirmed by the results. Construction professionals need the support from universities and relevant professional bodies to bridge the evident gap. The need for policies that support sustainable construction is emphasised. There were no statistically significant variances of aggregated sustainability learning objectives due to gender, designations, educational levels and experience signifying uniformity in perceptions. However, interventions for architects, engineers and those with degrees and MSc educational levels are supported for individual sustainability learning objectives although the practical significance of these differences were generally low. There is consensus from the construction professionals on the sustainability learning needs.

Factor analysis exposed related and significant components of sustainability learning objectives. It generated six important groups. These comprised, from highest importance: cultural diversity and evolution, futures thinking, social inclusivity and evidence-based problem-solving, planetary knowledge and behaviour, strategic planning for co-existence and sustainability leadership and value prioritization. These sustainability learning objectives will inevitably resolve the sustainability-related challenges affecting the construction industry. However, the major challenge is potentially in equipping construction professionals with this knowledge. An integrative and multi-disciplinary approach is most suited. This entails an extensive sustainability education drive through academic institutions and professional bodies. Regulatory authorities can also be proactive in shaping the sustainability agenda by insisting on adherence to sustainability enhancement proposals. The study had limitations on failing to incorporate the views of clients as initiators of built environment projects, however, project managers represented their views to a great extent. Future studies can consider the derivation and contextualisation of sustainability learning objectives for development of continuous professional development programmes within the various construction-related professions.

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