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Training methods for effective development and transfer of sustainability knowledge in the construction industry

Samuel Ekung [1*], Timothy Adewuyi [2]

[1] *Department of Quantity Surveying, Faculty of Environmental Studies, University of Uyo, Uyo, Nigeria*
[2] *Department of Building, Faculty of Environmental Studies, University of Uyo, Uyo, Nigeria*

Abstract

Many methods are deployed to train and embed sustainability principles in the construction industry. Insignificant empirical evidence however exists about the effectiveness of these training methods and why they have seen such widespread application is not theorised. This study determined preferred methods for sustainable construction (SC) skills training and their impact on knowledge development and transfer. The causal relationship was hypothesised using training method's ability to enhance individual learning (IL) as correlates of sustainability knowledge transfer performance (SKTP). A survey data obtained from 200 built environment professionals in South-South and South-East, Nigeria were analysed using Kruskal Wallis test and Canonical Correlation Analysis. The result of the study revealed that stakeholders' preferred training method is project site-based; although, workshops, seminars, conferences and web-based approaches are more dispersed. Project site-based training method correlated theoretical individual learning in support of SKTP. Training method therefore moderates the effectiveness of sustainability knowledge transfer in the construction industry. The implication is that, training method maximises sustainable construction pedagogies by enhancing its content, stimulate motivation to learn, and promotes favourable organisation climate development to embed learned skills. Project site-based training method is therefore recommended to stakeholders for optimal sustainability knowledge development and transfer to practice.

Keywords: Canonical Correlation; Knowledge Development; Knowledge Transfer; Sustainable Construction; Training Methods

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* Corresponding author. *E-mail address:* elbason6@gmail.com

1. Introduction

The competencies of relevant stakeholders are critical success factor to embed sustainability practices in the construction industry (Shen et al., 2017). This awareness has not assisted to stimulate actions towards skills development in sustainable construction (SC). Literature is replete with evidences of global construction sector skills gap and dearth of capacity to implement sustainable construction practices (SCP) (Nduka and Ogunsami, 2015; Simpeh and Smallwood, 2015; Tramontin and Moodley, 2016). Amidst the skills' gap, stakeholders in the construction in many places are also laggard to develop skills in SC. Studies by Bejide and Iyagba (2015) and Saliu and Achimugu (2016) revealed that SC skills are not prioritised among built environment professionals' training in Nigeria. Academic curricula of the various built environment professions in Nigeria also stop short at tackling these lapses at structured education learning level (Ameh et al., 2010; Ekung and Odesola, 2017). The implementation of SCP in the built environment across global perspective therefore suffers skills mismatch (Kok et al., 2012; Kukoyi, 2014). To bridge the skills gap, Choi (2009) held that training, education and increase stakeholders' knowledge are fundamental.

Training means efforts aimed at skills and knowledge improvement. Loosemore et al. (2003) observed that a trained workforce is equipped to apply learned skills in resolving system's problems, adapt creative innovations, and facilitate innovation transfer. Training therefore enhances the application of sustainability standards in project delivery (Kokkanen and Cotgrate, 2010); and contributes to construction business performance (Abdel-Wahab et al., 2009). Based on these benefits therefore, the performance of training has emerged a front-end project management concern that construction stakeholders must consider. Matar et al. (2008) recognised the role of training in the dissemination of learning, and attributed knowledge gap in the development and transfer of sustainable construction skills to inappropriate training model. In addition, stakeholders' dissatisfaction with the performance of trained workforce in the construction industry is also alarming (Heffernan et al., 2012; Higham and Fortune, 2012; Chindo et al., 2015; Oni and Crafford, 2017). However, limited literature narratives exist about the optimal training models to adopt in order to effectively embed sustainability practices in the construction industry. This study therefore tackles dearth of empirical data on the performance of training models in the development and transfer of sustainable construction knowledge in the construction industry.

The need to develop appropriate models for training in sustainable construction (SC) has reached deep (Mile-Shenton et al., 2010; Pan and Gramston, 2012). But the performance of developed and applied models has continued to witness limited literature space. Ene et al. (2014) argued that important training models have been advanced as exemplar solutions in the construction industry, but dearth of empirical data prevents comparative evaluation of their appropriateness. The World Green Building Trend [WGBT] report (2016) revealed that only marginal improvement is achieved in stakeholder's perception about the cost of sustainable construction methods after many decades of concerted dissemination efforts. The report exposes ineffectiveness of current advocacy, education, and training dissemination parameters adopted. Many have studies have explored construction training improvement methodologies across the globe, but plethora of studies incline to developing framework for training (Gorse *et al.,* 2009; Thomson and Gleeson, 2012; Lee et al., 2014; Kukoyi, 2014; Ene et al., 2014; Higham and Gleeson, 2015). This study evaluates the performance of

training methods in the development and transfer of sustainable construction knowledge. The objectives were to determine preferred methods for training and embedding SC skills in the industry, and their impact on knowledge development and transfer performance. The study is important to the exigent drive to close knowledge gap in the implementation of sustainability standards in the construction industry. Achieving the research goal will therefore position inferred stakeholders to adopt appropriate training model(s) that would ensure that learned skills are transferred to practice.

2. Literature reviews

2.1. Knowledge domains in sustainable construction

The term sustainable construction (SC) is recognised as the most appropriate term to describe sustainable development agenda in the construction industry. It is defined as '*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*' (Kibert, 2008). Whenever knowledge development is mention, stakeholders understanding tend to dilate towards craft skills and artisanship domain. However, literatures on skills gap in the construction sector portray prevailing problems cuts across high and low skill levels. Skills in SC therefore refer to knowledge needed to propel the development and application of sustainable practices in the built environment (Bauer et al., 2011). Such skills include managerial, professional and associate professional and technical occupations (UKCES, 2013). Although, SC paradigm tends to aggregate the roles of distinct professionals in certain areas, Hansmann (2010) believes the prime knowledge concern of SC is to shape professionals to understand their skills and roles in the delivery process. Expanding responsibilities have emerged for the built environment professionals to increase their participation in sustainable infrastructure delivery (Ma and Luu; 2013; Wong, 2015). The primary responsibilities of the respective professionals however is to contribute and coordinate resources towards achieving reduced energy consumption, environmental protection, improved health and safety of users and increased productivity (Kubba, 2010). The generic duties associated with energy modelling and simulation, assessment and certification, commissioning, and material selection are however unparalleled. Ma and Luu (2013) also identified that, skills in knowledge of green design processes, requirement and their cost implication are also fundamental. These knowledge domains present the highlight of critical areas where appropriate training is imperative in the construction industry, and notably in developing countries. It is evidenced therefore that abundant skills in SC must be developed using appropriate training methods.

2.2. Models for sustainable construction training

Training methods apply within the construction industry can be categorised as organisation-based and individual learning approaches. Organisation-based methods include seminars, workshop, demonstration projects, educational think-tank (Glass et al., 2008; Dada, 2012). Individual-based methods include andragogy, experiential, action and symbolic interactionism (Cheetam and Chivers, 2011; Loosemore, et al.,

2003). However, the individual training methods are collectively or individually employed as either project site-based environment (Robichaud and Anantatmula, 2011; Lee et al., 2014) or web-based methods (de-Freitas, 2008; Gorse et al., 2009). Munaaim et al. (2007) observed that elements of project learning: technology; human network; and self-access are also increasingly adopted to advance training models. Higham and Thomson (2015) identified two training model namely: structured formal learning (curriculum-based training) and informal training. Higham and Thomson (2015) further enthused that formal and informal training models are adequate to eliminate 'sustainability literacy' in the construction industry. Dawe et al. (2005) projected integrated view with multi-actors involvement.

Experienced-based training emphasised the important of learner's practical knowledge (experience) in training. Mathur et al. (2008) observed that structured training model supports empirical 'informal pathways to education such as apprenticeships, work shadowing, peer support and communities of practice which also promote mutual and social learning'. Schweber (2013) discussed a model based on literature guidance used by professionals who are unable to adapt formal training. Chindo et al. (2015) verified global training frameworks and identified dual-based and college-based training systems in Nigeria. Dual-based methods lean towards project-based training while college-based training is similar to structured training. The difference between both models is the inclusion of industry-based training in the dual-based approach. Regional exemplar demonstration projects, establishment of educational think-tank are advocated by du Plessis (2007) and Glass et al. (2008). Callcutt (2007) recommended co-ordinated training programme for multi-disciplinary strategic teams.

At the industry level, these models are vastly applied across board. However, seminars, workshop and Continuous Professional Development (CPD) are vastly discussed in construction related literature (Dada 2012, Glass et al., 2008; Ariffin and Torrance, 2008). Whilst the use of these models remains widespread, studies that evaluate their effectiveness in terms of how well learned skills are translated to practice are few. In sum therefore, training theory is either formal or informal, utilising individual or organisation-based approaches. Higham and Thomson (2015) observed that successive studies failed to demonstrate comprehensively the effectiveness of these approaches. Abdel-Wahab's et al. (2009) effort to appraise the value of training in North-East England using return on investment is recognised. Besides focusing on benefit to business performance, the study was only theoretical using secondary data. This expands the scope study by Ab-Wahab's study using empirical evidence to establish the value (performance) of training methods. The study analysed the impact of training method on knowledge development and transfer performance.

2.3. Knowledge development and transfer

Transfer, dissemination and diffusion of innovation across the construction industry domain need a change driven paradigm that is mutually contextualised, vibrant and 'self-reflexive' (Treleaven et al., 2012). Treleaven et al. (2012) suggested that a training model which adapts experiential learning and participation in research could suffice these requirements. Their work therefore defined the envisaged model using three focal knowledge transfer parameters that is: organisation commitment; motivation to initiate change; and accessibility to resources. The model embed action research paradigm, but is criticised because task of

knowledge creation is not limited to research but a collaborative creation of actors sharing actions (Schweber, 2013). Loosemore et al. (2003) also found the experiential learning model useful to promote collaborative or interdisciplinary learning and practice. This school of thought is consistent with an earlier proposition made by Holton (1996).

According to Holton (1996) (Figure 1), knowledge transfer to organisational practice requires strategic plans. When the plans are reinforced by commitment, accessible resources and motivation (Treleaven et al., 2012); top-down change infiltration of learning could be generated. The scope of these parameters is however not considered in this paper. This is further explained by the organisational climate in the Training Transfer Model [TTM] (Holton, 1996). In addition to the favourable organisational climate debate, Harvey and Kamvounias (2008) maintained that motivation must be supported by individual behaviour and staff buy-in to prevent non-compliance. Treleaven et al. (2012) did not however buttress the role of the learner and training content/delivery in knowledge transfer. TTM however, conceived that training transfer is a function of the learner, organisation climate (motivation) and the training content (Holton, 1996; Loosemore et al., 2003). Loosemore et al. (2003) therefore affirmed that limited need exist to initiate training without evaluating its delivery/content pedagogies for effectiveness. The propriety of training therefore is based on two aspects: the effectiveness of the training contents (skills, knowledge, attitude); and delivery (methods) (Loosemore et al., 2003). The implication is that learning is effectively measured against the degree in which learning interventions are transferred into organisational change and practice (Loosemore et al., 2003). The magnitude of organisational change is modelled on the impacts on practice performance (Holton, 1996).

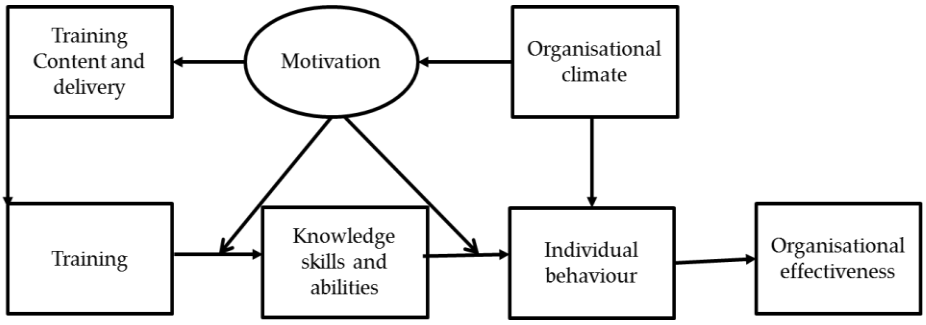

Figure 1. Training Transfer Model (Holton, 1996)

According to Figure 1, the learner's motivation helps to mediate in ensuring that knowledge is gained on targeted learning areas such as sustainable construction. The actual transfer into organisational change is dependent on employees' motivation (Donovan et al., 2001). The motivation to learn is on the other hand influenced by learning content and delivery approach (Loosemore et al., 2003). Holton (1996) therefore argued that, the learner must be given the opportunity to transfer knowledge into practice and must also be taught how to transfer knowledge (positive organisational climate). Yamnil and McLean (2001) also established the need for training content to reflect the work environment to facilitate knowledge transfer. This study posits that to transfer means to transform; and this cognisance is critical to knowledge adaptation

in practice development. The rational is that actors do not only transform knowledge within an organisational domain only, but also mediate with external linkages in spreading extended networks. Therefore, training methods are best developed using individual training approaches.

3. Conceptual framework and hypotheses of the study

The concept of sustainability training is contextualised on two important dimensions namely: method adequacy; and motivation. The study tackles the dimension of method adequacy because the effectiveness of learning outcome is situated to influence training performance (Higham and Thomson, 2015). Two training methods (project site-based training [PSTM] and web-based training method [WBTM]) are postulated to have strong linkages with individual learning (Mathur et al., 2008; Gleeson and Thomson, 2012; Higham and Thomson, 2015). The postulation is examined further in this study by introducing knowledge transfer performance (KTP). The emerging proposition is stated that effective training method supports individual learning (IL); and this premise is valid by the extent in which it correlates knowledge transfer performance (KTP) (Figure 2). The parameters in the framework are defined in Table 1. Three hypotheses were set-up for investigation as seen below:

Ho1*: there is no significant variation in respondents' perception of individual learning training methods' ideologies.*

Ho2: *there is no significant correlation between individual learning training methods (IL-TM) and sustainability knowledge transfer performance (SKTP).*

Ho3: *there is no significant relationship between IL-TM and canonical roots of KTP.*

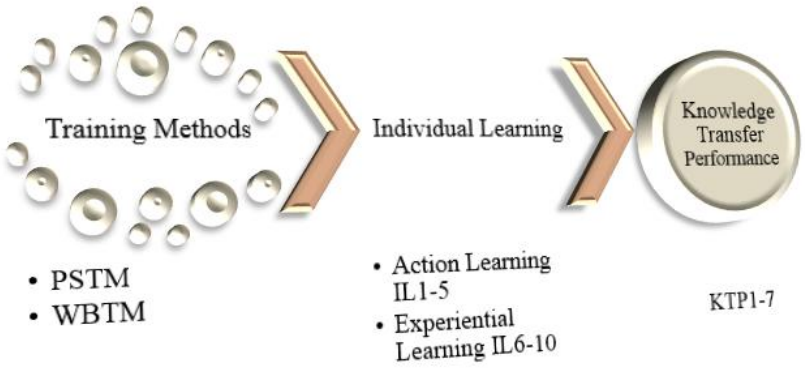

Figure 2. Conceptual Framework of the Study

4. Research methodology

Exploring the correlational effects of training methods on sustainable construction knowledge transfer performance requires an explanatory research. Yin (2003) summarised the motive of explanatory research as a strategy which seeks to explain causal relationship that is, which factors create what effects. Questionnaire survey using self and web-based administration to 200 targeted built environment professionals in South-South and South-East, Nigeria was carried-out. The population comprised Architects, Builders, Engineers, and Quantity Surveyors. The population was drawn from consultancy, contractors' organisations, public sector and academic institutions in three states of the regions (Akwa Ibom, Rivers and Imo State). The sample size was determined using Taro Yamane. The records of the respective professions were obtained from their respective professional bodies. The population of the listed professionals in Akwa Ibom and Rivers state is 203 (Adewuyi and Odesola, 2015). The finite population was subjected to sample size determination formula to obtain 128 respondents. However, additional 56 per cent (72) professionals were included to cover Imo state at 95% level of significance.

The questionnaire consists of three questions. Question one elicited respondents' demographic information; question two appraised the extent in which training methods fulfils individual learning objectives. Question three determined the correlation effects of training methods on sustainability knowledge transfer performance. Question one was closed ended, while two and three were constructed using 5-point Likert scales, 1 being very low and 5 very high impacts. The study's constructs were examined for external validity and reliability. Construct reliability involved Lee Cronbach Alpha (see result section), while external validity was determined using adequacy of sample/sampling determination. Systematic sampling procedures and the valid statistical conclusion reached were applied parameters for evaluating validity and reliability of the research instrument (Bhattacherjee, 2012).

Survey data were evaluated for proportion and correlational effects using descriptive statistics and canonical correlation analysis. Canonical correlation analysis explored the relationship between two sets of variables with multiple constructs. It creates separate multivariate for comparison using multiple dependent variables thereby accounting for extraneous factors not measured directly by a study. The use of this statistical tool has gained diffused application in construction research including Antonio et al. (2013) and Wong et al. (2015). In the respective studies, multiple tests are employed for interpretation of causal relationship but three of the related tests are popular across industry domain. The tests include: multivariate test of significance; Eigen values and correlations; and dimension reduction analysis; and the study adopted these tests. The descriptive analysis involved percentages and Relative Important Index (RII). To test the hypotheses, two principal criteria, the critical p-value and the proportion of squared canonical coefficient (R^2c) (Sherry and Hanson, 2005) were adopted. According to Sherry and Hanson (2005) R^2c between 45-100% exhibits higher utility value and are accepted while 0 – 45% are rejected for having low utility value. Using the p-value, H_0 is rejected with $p < 0.05$; and accepted H_o if $p > 0.05$.

To measure the variables, 17 constructs are generated to determine the effectiveness of project site-based training method (PSTM) and web-based training method (WBTM) and SKTP (Table 1). Structured and formal training methods were excluded from the study based on their non-relatedness to the ideologies of individual

learning (Higham and Thomson, 2015; Oni and Crafford, 2017). Five (5) individual learning methods' constructs each, drawn from the literatures were used to evaluate the dimensions of PSTM and WBTM. These constructs are unitised based on the need to cross-fertilise their philosophies to form a hybrid model (Figure II). Seven (7) constructs drawn from Holton (1996) Training Transfer Model and Treleaven et al. (2012) 'self-reflexive' model are used to examine the dimension of SKTP.

Table 1. Variables of the Study

Authors	**Sustainable Knowledge Transfer Performance (SKTP)**
Holton (1996); Loosemore et al. (2001); Donovan et al. (2001).	(KTP 1-7) opportunity to transfer knowledge on work type; feedback on satisfaction with training outcome; content of training address sustainability; motivation to use knowledge gain; practical lesson/demonstration of gained knowledge translation to practice; cues provided to stimulate remembrance of knowledge gained, positive feedback on task performed innovatively.
Authors	**Individual Learning Criteria**
Gleeson and Thomson (2012); Higham and Thomson (2015); Cheetam and Chivers (2001); and Loosemore et al. (2003)	(IL 1-10) Learning as a process than outcome; learning is continuous and anchored on experience; ability to balance learner's view with others; ability to acclimatize real-life cases; interaction between people and environment; preference to solving real-life problem; people of common knowledge analysing learnt lessons; minimal external intervention; cross-fertilization of new knowledge; and learning using multidisciplinary groups.

5. Results

5.1. Respondents' characteristics

Seventy four (74) valid questionnaires were retrieved and analysed. Valid response proportion equals to 37% response rate; and this is adequate compared to 30% benchmark reported as the most successful in construction management research (Hoxley, 2008). Result in Figure III indicates that four professions are heterogeneously represented in the sample. Quantity surveyors and builders constitute 56%; and another 22% each are architects and engineers. The sample also comprised 54 (73%) registered professionals and 20(27%) probationers. High proportion of registered professional is however adequate to accept the outcome of the study. The distribution of respondents in the sample shows that consultancy and contracting sectors constitute 20% each, academic (10%) and public sector (50%). The average year of experience is eight (8); although another 5% each are below 5 years and above 20 years. The overall inference on the composition of the sample portrays adequacy to validate the data collected. The sectors are therefore heterogeneously represented, years of experience are high, and respondents are also professionally certified.

The opinion of the sample respondents about the influence of training on the effectiveness of sustainability development and transfer are therefore heterogeneous (evenly distributed).

5.2. Relative importance of the study variables and reliability test

The Relative Important Index (RII) of the construct dilates towards 1.00 (Figure IV). Two bands of RII exist in each category; RII relating to SKTP lies between 0.573 – 0.941 whilst IL is in the region of 0.746 – 0.865. The averaged RII for SKTP criteria is 0.792 and 0.815 for IL. Criteria in both categories however achieved RII above average thereby indicating that TM will support knowledge transfer performance when these conditions are incorporated in the training process.

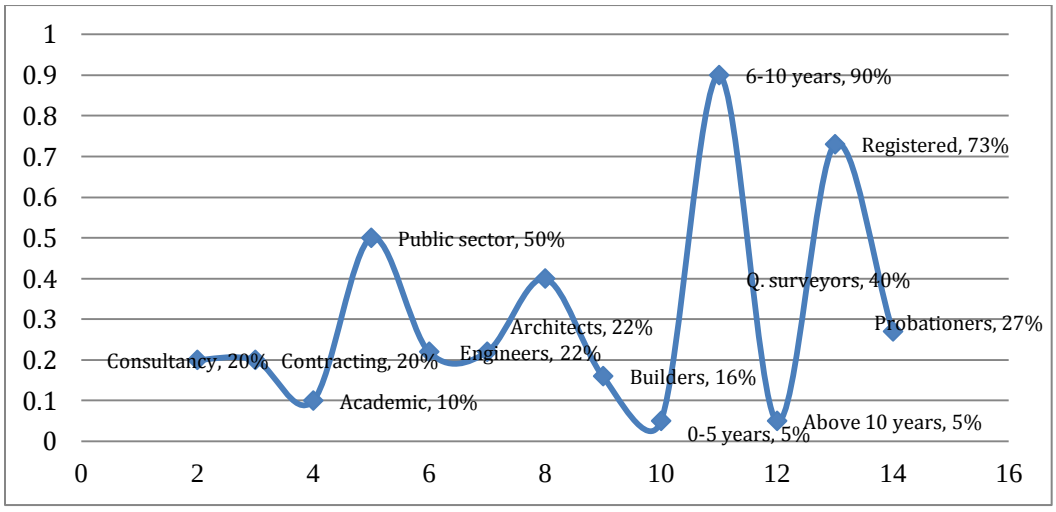

Figure 3. Respondents Demography

Lee Cronbach test of consistency and fitness of scale depict similar result and indicate that the measurement variables SKTP and TM are consistent. Average Cronbach Alpha values of 0.850 and 0.870 respectively were obtained for SKTP and IL. These values indicate very good reliability indices to conclude that individual learning variables (IL1-IL10) are indicators of project site-based and web-based training methods. It further indicates that knowledge transfer performance (KTP1 and KTP3-KTP7) are ideal indicators for assessing sustainability knowledge development and transfer performance. However, KTP 2 indicates both methods do not encourage feedback on the effectiveness of training outcome in practice. When these findings are validated with the benchmark in the literature, the reliability index for over 84% of KTP constructs and 100% of IL constructs are greater than 0.70 adopted for statistical inference (Pallant, 2010).

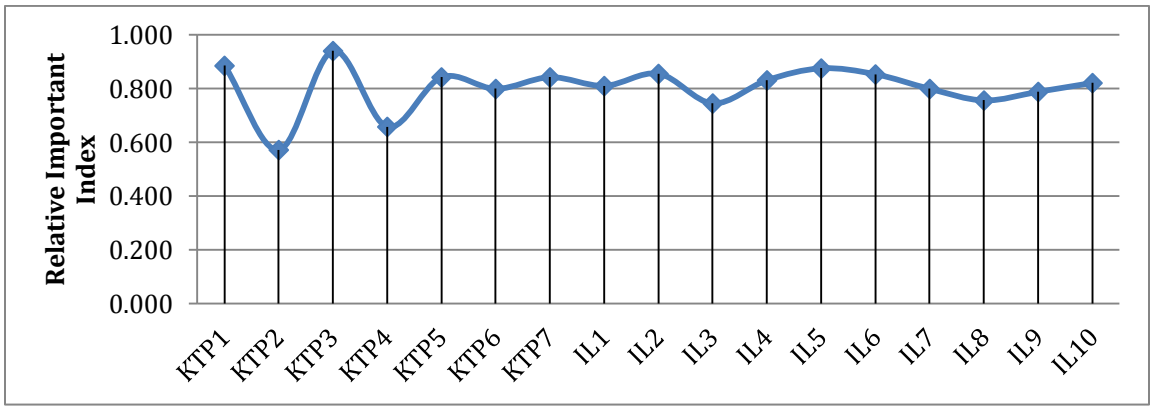

Figure 4. Relative Important Index (See Table 1 for KTP 1-7; IL1-10)

5.3. Stakeholders' preferred method for sustainability training

The level of use of four training methods (TM) was examined to investigate the extent in which these methods are contextualised in the study environment. To complement the level of use, the prevalence of these methods in the study area were also investigated to establish level of awareness. The results of both tests is presented in Figure V. Stakeholders' preferred approach is project site-based training method (PSTM); and over half (56%) of the study population chooses this method. Fifteen percent others prefer seminar, workshop and conferences (SWCTM), 17% favour WBTM, while 12% others select training using structured curriculum method (SCTM). The population with preference to SWCTM are either young graduates or those pursuing further learning in higher institutions. The penchant to PSTM was not expected because of (1) low up-scaling of sustainable construction practices in the study area (Ujene and Oladokun, 2017); (2) scanty real-life project utilising sustainable construction approaches exists, and (3) low client demand for sustainable buildings (Nduka and Ogunsami, 2015). The prevalence of SWCTM on the other hand, is largely due to its wide adoption for Continuous Professional Development (CPD) training by professional bodies. The prevalent and preferred methods were further evaluated to determine most appropriate model for learning sustainable construction. The result shows that, preference determines the training method adopted, the stakeholder selection follows the trend reported in Figure IV. In descending order therefore, the prevalent training methods are workshops, Seminar and conferences; web-based, structured curriculum and project-based training. Project site-based and web-based training methods are the most effective. The study also examined whether preference could be influenced by endogenous chances. The test of hypothesis one (Ho1) provide further insight.

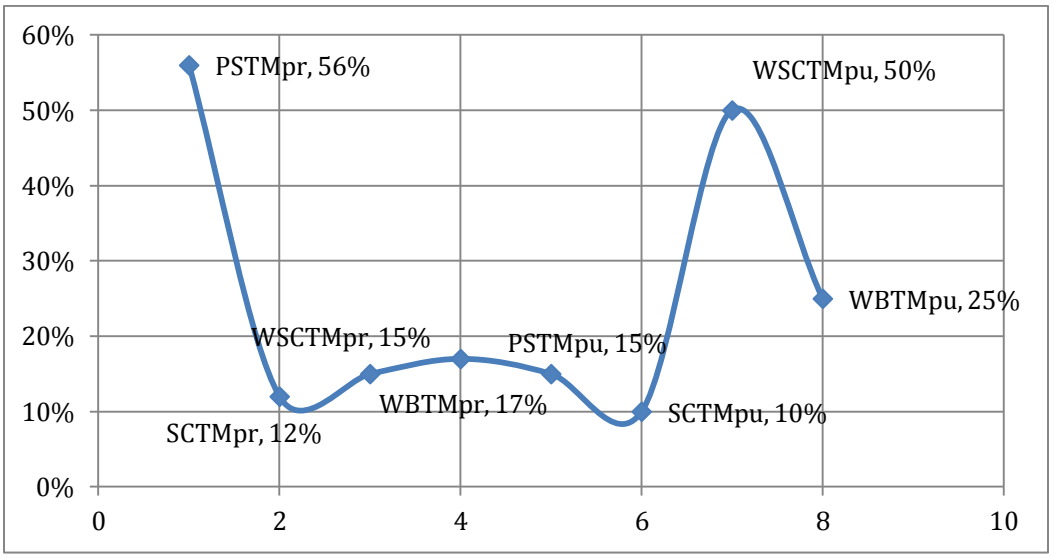

Figure V: Preferred and Prevalent Training Method for Sustainable Construction Learning (PSTMpr = prefer project site-based; PSTMpu = prevalent use project site-based; SCTMpr = prefer structured curriculum; SCTMpu = prevalent use project-based; WSCTMpr = prefer workshop, seminar and conference; WSCTMpu = prevalent use workshop, seminar, conference; WBTMpr = prefer web-based; WBTMpu = prevalent use web-based)

5.4. Test of variation in respondents' perception of preferred method ideologies

The first hypothesis test explored variations in the perception of respondents on whether tested constructs of individual learning philosophies agrees to training methods. Hypothesis one (Ho_1) was tested using Kruskal Wallis test. The objective was to determine whether there is a significant variation in respondents' perceptions about individual learning (action and experiential) philosophies agreeing to PSTM and WBTM as the preferred individual learning training methods for sustainability. The practice areas adopted were public, academic, consultancy and contracting. The result generated Chi-square values (4.737 > 0.05) and Asymptotic Sig. or P-value (0.905 > 0.05) (Table 2); and the first hypothesis was accepted. The implication is that respondents' perception about the variables construct do not differ significantly. The population perception about IL philosophies promoting PSTM and WBTM is uniform and is centred on the mean. Individual learning philosophies underpin PSTM and WBTM's training methods.

In the following section, the study further determined (a) whether IL-TM represents expressed individual TM for the theoretical SKTP; (b) the extent in which the ideologies of training methods agrees to individual learning, and (c) whether IL-TM can enhance or otherwise correlate SKTP. This dimension is evaluated by the second hypothesis tests.

Table 2. Respondents' Agreement Validity of Variables Constructs

Sector	Mean Rank	Chi-Square (χ^2)	Df	Asymptotic Sig./P-value	Decision
Consultancy	9.23				
Contracting	10.95	4.737	3	0.905	Accept
Academic	7.63				
Public Sector	8.44				

5.5. Effect of training methods on sustainability knowledge transfer performance

The canonical correlation analysis utilised independent variables (IL) and dependent variables (KTP). The analysis generated seven (7) canonical roots for seven indicators of KTP from Multivariate Tests of Significance (Table 3). The Multivariate Tests of Significance is used to evaluate the overall correlation between training methods (PSTM; WBTM) and SKTP. Multivariate significance utilises many test parameters but the Wilk's Lamda has seen a wider application (Garson, 2015). At 95% level of significance, the test showed Wilk's value (F = 0.000 < p = 0.05) and the significance of Wilk's value (0.290 > p = 0.05). This indicates presence of correlation relationship between training method and sustainability knowledge transfer performance (TM and SKTP). The indicative hypothesis (Ho_2) is therefore rejected. The implication is that, a significant relationship exist between IL-TM and SKTP (F = 0.000 < p = 0.05). This inference is significant and accepted at (0.290 > p = 0.05). The general fitness of the canonical model for Ho_2 is adequate and appropriate.

The Eigen Value and Canonical Correlation value indicates the extent of the variates of the canonical roots (Sherry and Hanson, 2005). It is used to determine the strength of present or absent of correlational relationships. The result shows a high positive correlation value of 0.995 with explained variance of 73.938% and a high significant Eigen value of 93.767. This result reinforces two things: first, that canonical model generated by multivariate test is adequate. The second is that the rejection of the indicative hypothesis (Ho2) is appropriate; and the tie is explained by 73.93% of IL-TM pedagogies (constructs or canonical roots).

Dimension Reduction Analysis test is used to evaluates the magnitude and significance of the relationship between IL-TM and canonical roots (KTP). The result shows all canonical roots are significant (F = 0.290; 0.522; 0.754, 0.792; 0.853; 0.825; and 0.918 > p = 0.05). The accepted hypothesis (Ho2) is therefore a valid inference for the relationship between IL-TM and SKTP. However, Wilk's values for Root 1 to 4 support current hypothesis (F = 0.000; 0.000; 0.009 and 0.053 ≤ p = 0.05); while Roots 5-7 indicated an insignificant Wilk's values (F = 0.211; 0.471; and 0.888) > p = 0.05). The ratio of about 60/40 is therefore established for valid and non-valid roots. Since the significant root ratio is greater than insignificant ratio, the model fitness is sustained and the rejected hypothesis validated.

The study further evaluated whether it is appropriate to draw-up this statistical inference or not? The squared correlation coefficient is used to examine the adequacy of the valid canonical roots and to test hypothesis (Ho3).

Table 3. Canonical Correlation Analysis between Training Methods and SKTP

Dependent,=Individual learning training method (IL-TM); Independent = Sustainability Transfer Performance (SKTP)			
Multivariate Tests of Significance			
Test Name	Value	Appox. F	Sig. of F
Wilks	0.000	1.442	0.290
Eigen Values and Canonical Correlations			
Root No/Name	**Eigen Value**	**Pct.**	**Canon. Cor**
IL1-IL10	93.767	73.938	0.995
Dimension Reduction Analysis			
Roots	**Wilks L.**	**F-value**	**Sig. of F**
Opportunity to transfer knowledge on work type	0.000	1.342	0.290
Feedback on satisfaction with training outcome	0.000	1.011	0.522
Content of training address sustainability	0.009	0.770	0.754
Motivation to use knowledge gain	0.053	0.710	0.792
Demonstration of gained knowledge translation to practice	0.211	0.595	0.853
Cues provided to stimulate recall of knowledge gained	0.471	0.548	0.825
Positive feedback on task performed innovatively	0.888	0.221	0.918

Wilk's L. = Wilk's Lambda; F = F-value; Hypoth DF. = hypothesis Degree of Freedom; Error DF = Error Degree of Freedom; Sig. of F = Significance of F value; Cum. Pct. = Cumulative Percentage; Pct. = Percentage; Canon. Cor. = Canonical Correlation; Sq. Cor. = Square correlation

5.6. Validity of the canonical roots inference

Based on Sherry and Hanson (2005) criteria, the squared correlation coefficient (R^2c) (Table 4) are significant. The result in Table 4 indicates that 86% of the canonical roots are significant with R^2c values (47 – 98.9% > 45%). However, the deviation of Root (7) from the established inference is acknowledged. This concern is insignificant since it represents only 14% of the total Roots. Hypothesis 3 is therefore accepted. There is a significant relationship between IL-TM and KTP. Individual training method (PSTM; WBTM) ability to enhance KTP is therefore explained by 86% of the generated variates.

Table 4. Squared Correlation Coefficient (R^2c)

Root No/Name	Sq.Cor (R^2c)	%	Decision
1 Opportunity to transfer knowledge on work type	0.989	98.90	Significant
2 Feedback on satisfaction with training outcome	0.958	95.80	Significant
3 Content of training address sustainability	0.830	83.00	Significant
4 Motivation to use knowledge gain	0.748	74.80	Significant
5 Demonstration of gained knowledge translation to practice	0.551	55.10	Significant
6 Cues provided to stimulate recall of knowledge gained	0.470	47.00	Significant
7 Positive feedback on task performed innovatively	0.112	11.20	Not significant

Cut-off: R^2c = 45-100% (Sherry and Hanson, 2005)

6. Discussions

The study established that sustainable construction knowledge transfer is dependent on the training method used. This decision is derived from the statistical analyses which proof that stakeholders' preference of training methods are based on their effectiveness in promoting knowledge transfer. The tests of model fitness, Multivariate Tests of Significance and Eigen Co-efficient also support the significant correlation between training methods and sustainability knowledge transfer performance. The conclusion is that, the prevalence of certain training methods is based on their pedagogic philosophies developed on individual learning ethos. The result is a novel finding and a significant contribution to human resource management literatures. The results on the relatedness of individual learning to training methods (PSTM and WBTM) are also consistent with literature. Hansmmann (2010) stated that individual learning is needed for effective learning and diffused application of sustainable construction. Further implication buttresses the adequacy of essential criteria in Holton (1996) TTM philosophies. TTM emphasised that knowledge transfer depend on the linkage between the training content/delivery, motivation and organisational climate. These dimensions are collectively captured by the individual learning training method (IL-TM) except content. Perspective on content is a subject for sustainable construction curriculum appraisal.

Wilk's test is based on the degree of relationship relies on sample size effect. The Wilk's value of 0.000 (Table 2) infers the reverse effect of size and the broad implication is that that the sample size contributing to the model fitness is 100% that is, (R^2c = 1-0.000). It also means that, the result of the hypothesis is heterogeneous across the sample. Individual respondents' perception and conviction is that training method TM influences knowledge transfer performance (SKTP). Although, the validity of the canonical roots is not in agreement with sample effect, the study adopted a high target in considering R^2c between 0% and 45% as low utility points. High benchmark is deemed to be a significant criterion for examining canonical roots validity across related researches. Abeysekera (2014) applied 45-100% benchmark as a cut-off point to determine the level of usefulness observed in criterion variables examined in his study. The usefulness of observed variables is represented by the percentage of shared variance between the observed criterion variable and the latent criterion variable in each canonical function. A high degree of usefulness (i.e., high R^2c = 45 -100%) therefore indicates that training methods' philosophies are useful constructs of PSTM and WBTM. This means that Root 1-6 are expressed theoretical constructs of SKTP. The following sections provide further details about the elements of the validated training methods.

6.1. Project Site-Based Training Method (PSTM)

Robichaud and Anantatmula (2011) cited earlier considered this training method most appropriate in educating construction personnel and the reasons for this assertion are enormous in the relevant literatures. PSTM empowers the project manager to kick-starts a project with a meeting for education and training of personnel. During the training interface, the different aspects of sustainable construction practices can be examined by the relevant personnel including sub-contractors. Tramontin and Moodley (2016) buttressed the important of site-based training but found actual integration very negligible in the construction industry. Ene et al. (2014) however differed significantly with the outcome of the survey about the appropriateness of

this method. Their argument is that, construction site is not an appropriate learning environment and attempt to integrate training during site construction could disrupt schedule. To overcome this concern however, Ene et al. (2014) recommends the deployment of virtual work/learning environment. This later approach undelays the web-based training method discussed later. Nevertheless, the highlighted lapses, PSTM promotes understanding of sustainability, drive implementation of green building practices at project level, and improve efficiency of green construction implementation (Lee et al. 2014). These drivers must underpin the improvement to integrate the model at the construction phase of project delivery.

6.2. Web-Based Training Method (WBTM)

The virtual site offer one of the easiest ways to disseminate new skills by ensuring that future generations benefit; hence, penchant to this model is never a surprise. Construction stakeholders' penchants to this model have been conceived differently. De Freitas (2008) maintained that virtual site enhance resourceful interactions. This is based on the overlay of data, images of real-life learning experience making possible interplay between the learner and the student and virtual environment. Gorse et al. (2009) assert that this method is succeeding well beyond conventional training model based on its linkage to real–time information and increased access to materials. However, the setback to the use of this method is the reliance on information technology (IT). The efficiency of IT uses in the construction sector is low (Ibironke et al., 2011; Srinath et al., 2012). Nevertheless, the use of this model is prevalent among sustainable construction promoters such as Green Building Councils, Professional Bodies, Advocacy Councils and Regulatory Bodies. The low IT integration therefore situates project site-based method as the most appropriate training model within the context of development countries and the study environment.

7. Conclusion

Today's construction industry is faced with skills and knowledge dearth in sustainable construction practices. Existing understanding suggests that training in sustainability knowledge within the construction industry must be improved to facilitate diffused adoption. Although the dimensions of training in human resource management literature have reached deep, the effect of training delivery method inputs on knowledge development and transfer is limitedly linked empirically. To advance sustainability learning, developing pedagogies support the use of individual training methods. This study evaluated the impact of two training methods postulated on individual learning philosophies on sustainability knowledge development and transfer. The result revealed that project site-based and web-based training methods and sustainability knowledge development and transfer are correlated. The implication infers that project site and web-based training methods are effective to motivate and stimulate organisational climate needed to facilitate sustainability knowledge development and transfer. Further implication is that motivation and favourable organisation climate must be continuously reinforced in the design of training programmes for effective knowledge development and transfer performance.

The result of the study provides the beginning of a descriptive model of learning improvement tool for decoupling the impact of knowledge gap on the cost of sustainable construction in developing countries. Unlike previous studies on training effectiveness, the study used multiple dimensions to evaluate effectiveness dissimilar to the prevalent reliance on project performance. The conclusion opens the window of undeveloped research space. Further studies may wish to explore the characteristics and attributes of effective organisational climate needed to support sustainability learning. It is further noted that, the relationships discussed represent correlations and not causation. That is to say that, the relationships between training method and performance discussed in this paper do not imply that, the use of any single training method necessarily create a change in the sustainability knowledge transfer and development in a statistical sense. The observed changes in performance and practice use may have a common cause not explained in this analysis, or there may be underlying measures of another factor not addressed in this study. This is not to also deny that there is abundant subjective evidence showing that training method use does indeed improve sustainability knowledge transfer and development. The result that pedagogic dimensions of project site and web-based training are individual learning philosophies is novel and represents significant contribution to human resource management literatures.

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