Empirical Investigation of Discipline-specific Skills Required for the Employability of Built environment Graduates

John Aliu[1], Douglas Aghimien[2], Clinton Aigbavboa[3], Ayodeji Oke[4] Andrew Ebekozien[5], Osunsanmi Temidayo[6]

[1]Institute for Resilient Infrastructure Systems, College of Engineering, University of Georgia, Athens, Georgia, USA

[2]School of Art, Design and Architecture, Faculty of Arts, Design and Humanities, De Montfort University, Leicester, United Kingdom.

[3]CIDB Centre of Excellence, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa

[4]Department of Quantity Surveying, Federal University of Technology Akure, Nigeria and CIDB centre of Excellence, University of Johannesburg, South Africa

[5]Department of Construction Management and Quantity Surveying, University of Johannesburg, Johannesburg, South Africa; School of Social Sciences, Universiti Sains Malaysia, Gelugor, Malaysia;
Department of Quantity Surveying, Auchi Polytechnic, Auchi, Nigeria.

[6]Faculty of Computing, Engineering and Built Environment, Edinburg Napier University, United Kingdom

*Corresponding author: Ajseries77@gmail.com

ABSTRACT

As the world continues to experience significant and dynamic changes, the concept of graduate employability remains a well-discussed subject in the body of knowledge. Consequently, the concept has attracted the interest of educators, policymakers, researchers, and graduates themselves. As a vital cog in the employability conversation, the quality of present-day graduates is highly dependent on the effectiveness of training received from higher education institutions. This formal training provides learners with discipline-specific skills (academic skills) and knowledge which helps them obtain a firm foundation in their chosen discipline or profession. This study seeks to unearth the various discipline-specific skills (DSS) that built-environment graduates need to possess to thrive in the labour market after graduation. A quantitative research approach was adopted to achieve this study's objective with close-ended questionnaires developed and administered to built environment professionals based in the Gauteng province of South Africa. Retrieved data were analysed using several statistical tools such as percentage, frequency, Mean Item Score, One-Sample *T*-test, and Exploratory Factor Analysis. Findings revealed four clusters highlighting the key DSS required by built environment graduates. These include lifelong learning, hands-on experience, digital literacy and knowledge of the subject area. The outcomes of this study will be beneficial to several stakeholders involved in construction education and employability skills discussion.

Keywords: Built environment, Construction education, Discipline-specific skills, Employability, Employability skills, Engineering education, Graduateness, Pedagogy.

INTRODUCTION

The concept of graduate employability remains one of the most relevant themes across the world today (Ebekozien *et al.,* 2022). The terms 'industry-ready graduates' and 'graduate skills' have become a recurring theme whenever professionals from the construction industry and academia converge for seminars, conferences, and symposiums. These constant debates have become increasingly prominent in recent times due to the struggles faced by higher education in producing graduates with the required skills, knowledge and competencies to meet the needs of the construction industry (Rawlins and Marasini, 2011; Aliu and Aigbavboa, 2019). This situation has considerably increased the pressure on higher education to improve graduate employability by ensuring a well-rounded educational experience for learners in the built environment (Pitan, 2016). Through quality education, learners are adequately prepared to handle industry activities, which in turn leads to socio-economic prosperity and ultimately a knowledge-based society. Furthermore, due to the dynamism and unpredicting nature of the construction industry, employers are constantly searching for graduates (students who graduated from built environment and STEM-related courses) who are academically sound and possess relevant non-academic skills (Ebekozien *et al.,* 2022). According Oke *et al.,* (2018), Aliu *et al.,* (2021) and White and Smith (2022), employers continuously seek STEM graduates who can think critically, communicate effectively, work effectively among teams to achieve a common goal, display inventiveness in solving problems, accept and adjust to new surroundings and lead teams seamlessly on new ventures whenever called upon. Other non-academic skills that employers highly seek after include adaptability skills, problem-solving skills, teamwork skills, and management skills (Ariana, 2010; Conrad and Newberry 2012; Jackson and Chapman, 2012; Oke *et al.,* 2018; Nowiński *et al.,* 2019).

At the core of the employability conversation lies the students, who are often regarded as the construction industry's future. To possess the above-named skills, there is a salient need for adequate training from Higher Education Institutions (HEIs). This formal training provides learners with discipline-specific skills that can help them obtain a firm foundation in their chosen profession. More so, these sets of skills are regarded as fundamental knowledge that learners have to possess during their academic cycle. These skills usually originate in subject matter areas, specific domains, and respective disciplines. Learners can obtain Discipline-Specific Skills (DSS) or knowledge during lectures, group assignments, simulations, tutorials, work-integrated learning via face-to-face approaches or online means, among several others. Unfortunately, there is still the clamour for improvement in the training in HEIs as graduates within the construction industry have been noted to be lacking in some DSS needed for effective and efficient performance (Aliu and Aigbavboa, 2020). The case is worse in the construction industry of developing countries like South Africa, where lack of adequate training and required skills have been noted as factors affecting the industry's poor performance (Windapo and Cattell, 2013). Albeit this problem, there is a paucity of research focus designed to unearth the DSS needed by graduates within the construction industry of developing countries. Understanding these required skills is a crucial step towards solving the age-long problem of lack of adequate technical capabilities that have bedevilled the construction industry in South Africa and other developing countries worldwide (Aghimien *et al*., 2021b).

Based on the aforementioned, this study was designed to unearth the DSS required by built environment graduates using South Africa as a case study. The objective was to identify and empirically assess the key DSS that graduates need to succeed and be productive within the construction industry, and by extension promoting better service delivery of the industry. The findings offer practical guidelines for lecturers and relevant stakeholders in HEIs in shaping the teaching and learning of construction students in a bid to turning-out students that are ready for the industry. More so, the study's findings set the base for a wider debate on the required DSS for graduates in the construction industry and its finding can serve as a good theoretical platform for future studies, particularly in countries where such studies have not been conducted.

THEORETICAL BACKGROUND

An overview of the concept of learning

Human learning is a constant activity that has gained prominence throughout the years. As the quest to improve learning and teaching continues over the years, researchers from various backgrounds have continued to test their theories in various settings to ascertain what learning actually entails. According to Shuell (1986), due to the dissimilar views regarding the methods and consequences of learning, a general definition of 'learning' has been difficult to arrive at. However, one thing is certain; human learning reflects the process of effective interaction with the immediate surrounding, which entails both the physical and the social dimension (Wetzel and Farrow, 2021). Schunk (2012, page 3) describes learning as "an enduring change in behaviour, or in the capacity to behave in a given fashion, which results from practice or other forms of experience". This definition reflects three key indicators of the learning process: These include 'change', 'evolution' and 'experience'. The first indicator, which is 'change', suggests that individuals can attain holistic learning when they achieve the ability to do things effectively, efficiently and distinctively. The second indicator, 'evolution' suggests that individuals can be familiar with ideas that they have been taught over time, but may lose their memory of them as time goes on. The third indicator, experience' suggests that individuals can obtain understanding via the constant practicing of what they have been taught and by observation from other learners and their educators (Schunk, 2012).

In another definition of learning, Kimble (1964, page 32) described it as "a relatively permanent change in behavioural potentiality that occurs as a result of reinforced practice". This definition reflects several key terminologies that are worth taking cognisance of. Firstly, the term 'relatively permanent' suggests that the behavioural changes which occurs as a result of learning are permanent and long-term and not temporary and short-term. Secondly, the 'behavioural change' suggests that effective learning must play a part in a significant and visible change in behaviour that was non-existent before the learning process occurred. Thirdly, the aspect of 'potential' suggests that the process of learning may not necessarily result in a behavioural change straightaway or immediately but will occur over a period of time. The fourth aspect deals with the issue of 'reinforced' which suggests the thoroughness and purposefulness of the learning activities and processes. Finally, the aspect of 'practice' suggests that behavioural change is directly proportional to thorough training and practice as noted (Kimble, 1964). Kimble's definition served as a bedrock for a revamped definition of learning as posited by Hergenhahn (1988) who describes learning as "a relatively permanent change in behaviour or in behavioural potentiality that results from experience and cannot be attributed to temporary body states such as those induced by illness, fatigue, or drugs (Hergenhahn, 1988). According to Behlol and Dad (2010), learning can be described as the gradual and permanent change in the knowledge and behaviour of an individual due to the experience he or she undergoes. Learning is also the process of gaining knowledge and expertise over a period of time (Kapici *et al.,* 2019). Most recently, Aliu *et al.,* (2021) defined learning as the the acquisition of knowledge or skills through experience, study, or by formal and informal modes of learning. The inclusion of 'experience', 'knowledge' and 'skills' makes the definition of Aliu *et al.,* (2021) peculiar to this study and thus, their definition was adopted for this research.

The Kolb's Experiential Learning Theory

This study was framed by Kolb's Experiential Learning Theory (ELT) as it provides a solid background to understand the learning and education endeavour as a lifelong process (Kolb, 1984). The main components (learning modes) of Kolb's four-stage model are Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC) and Active Experimentation (AE), as shown in Figure 1. CE refers to the tangible learning process or experience that learners have undertaken or currently undertaking. Learners, in this case, are highly interactive, sensitive and adaptable to various types of environments. In the case of RO, the learners are consciously reflecting on the learning experience and making observations from such experiences. Learners, in this case, are versatile and often display judgement when the opportunity arises. AC refers to the process by which logic is applied in conceiving an idea or theory. Learners, in this case, are meticulous thinkers and are often systematic evaluators of concepts. Lastly, the AE underlines the essence of experimentation (establishing practical approaches) to influence an experience (solve problems or arising issues). Learners, in this case, are risk-takers, creators and critical thinkers as they are constantly seeking answers to problems (Kolb, 1984; Stirling *et al.,* 2016). Therefore, these learning modes illustrate an effective learning process that can be interpreted linearly. These learning modes are also correlated and influence each other and, ultimately, the learning process. The learners begin with having a concrete experience that enables them to reflect and make sense of their learning experience. After reflections, learners piece together their thoughts and establish abstract concepts which can serve as a foundation for future actions (Chan, 2012; Aliu *et al.,* 2021).

(Figure 1)

Aside from these four learning modes, four basic learning styles were also considered in the process of acquiring new or building on existing knowledge. These include accommodating, assimilating, converging, and diverging. It is worthy to note that these learning styles are inclined towards at least two learning modes. The accommodating learning style is associated with the AE and DE. Some of the major forms of skills and competencies that accompanies this learning style are risk-taking skills, adaptability and actively embarking in productive endeavours (Kolb, 1984). The assimilating learning style is associated with the RO and Abstract AC. Some of the major forms of skills and competencies that accompanies this learning style are the abilities to abstract and create ideas. The converging style of learning is associated with AC and AE. Some of the major forms of skills and competencies that accompanies this learning style are problem solving abilities and critical reasoning. Finally, the diverging style of learning is associated with the RO and CE. Some of the major forms of skills and competencies that accompanies this learning style are creativity and inventiveness (Kolb, 1984).

One of the key reasons why this theory was adopted for this study is because it is relevant to learning interventions across several disciplines such as science education, social science education, experiential education, etc. Also, due to the extensive researches, the theory has generated over the years, this model can be considered reliable (Kayes, 2005; Baker *et al.,* 2012). In addition, the Kolb's model can be regarded as the combination between experience and reflection which can innovatively be used to design several types of learning interventions. The theory also requires learners to obtain experience, to think logically and to act based on what they have critically thought through, which implies that the knowledge process involves grasping experience and then transforming the experience obtained. Therefore, CE and AC involve grasping the experience, whereas, RO and AE involves the transformation of such experiences (Hedin, 2010). This means that the completion of the various stages of the cycle paves the way for the transformation of experience to knowledge and ultimately academic skills (Aliu *et al.,* 2021).

From a general view, studies have emanated with diverse skills that are related to the aforementioned four components. These skills are acquired by studying an academic discipline. They include knowledge of subject area and curricula, critical thinking, pedagogical skills, coordination skills, communication skills, administrative skills, management skills, lifelong learning, decision-making skills, digital literacy, self-confidence, exposure to other disciplines, problem-solving skills, collaborative skills, hands-on experience, and technical skills as confirmed by (Pool and Sewell, 2007; Bridgstock, 2009; Hutchinson, 2013; Ahmed *et al.,* 2014; Nagarajan and Edwards, 2015; Lamanauskas, 2017; Aliu and Aigbavboa, 2019). It is based on this understanding of learning activities that the different roles of discipline-specific skills (DSS) in developing the employability of built environment graduates as seen in Table 1 were assessed in this study.

(Table 1)

RESEARCH METHODOLOGY

A quantitative approach was adopted in the actualisation of the research aims and objectives of this study. One of the merits of the quantitative research design is the unbiased analysis of mathematical, numerical and statistical data (Sukamolson, 2007). Such data may be obtained via several means such as well-structured questionnaires, survey studies, group discussions, oral histories and voting polls (Akinradewo *et al.,* 2020). This study first identified the required DSS needed by built environment graduates from the review of extant employability studies and a summary is given in Table 1. The various DSS in Table 1 was obtained using thematic analysis which identified key patterns in the existing studies that addressed the subject matter. The initial search result produced 24 variables which was later trimmed down to 16 after several checks and rechecks. Variables which had similar wordings were eliminated to avoid repetitions. Primary data were collected through a well-structured questionnaire that was designed based on the identified DSS. Due to the ease of data collection and time-saving propensities, a close-ended set of questions were adopted using a five-point Likert scale where five is 'very important' and one is 'not important'.

The target population for this study were relevant professionals drawn from the Councils for the Built Environment Professions (CBEP) in South Africa. These professionals (architects, construction managers, construction project managers, engineers and quantity surveyors) are from academia, the construction industry and government. In achieving this study's aims, the total number of registered and candidate members of the various relevant built environment professions was obtained from the annual reports as provided by the CBEP website (40,015, according to the latest statistics). For this study, two categories of non-probability sampling techniques were considered, namely purposive (judgment) and snowball techniques (Aliu *et al.,* 2021). The purposive sampling technique was considered because it relies on the judgement of the researcher when it comes to selecting the population that is of interest to the study. Apart from being a time-effective sampling method, purposive sampling is also cost-effective. In addition to the purposive technique, snowball sampling (chain sampling) was also adopted. Participants were requested to identify other professionals (referrals) who could contribute to the realisation of the study. Like the purposive technique, the snowball sampling technique was also time and cost-efficient. The study was conducted in Gauteng province because the province contributes enormously to construction activities in South Africa (Akinradewo *et al.,* 2021). More so, the province is responsible for the highest number of employment within the country's construction industry (Aghimien *et al*., 2021a; cidb, 2020). Several mathematical formulae were considered to achieve the required sample size. The equation 1 proposed by Yamane (1967) was adopted for this study which yielded a sample size of 204 responses for this study. The level of precision is also called sampling error – it is the range in which the true value of the population is estimated to be. Usually, according to the Yamane formula, where confidence level is 95%, sample size precision levels can be ±3%, ±5%, ±7% and ± 10% depending on the size of the population. The population for this study was 40,015. By using Yamane's formula as calculated in the main document, 204 was realised.

$$S=\frac{N}{1+N(e)^2} \qquad \text{Equation 1}$$

Where, N= Number of respondents, e=7% level of precision which is ± 7%

Data cleaning and screening were carried out by the Statistical Consultation Service experts (STATKON) of the University of Johannesburg before the commencement of data analysis. Subsequently, the cleaned data were analysed using several statistical tools such as percentage, frequency, Mean Item Score (MIS), One-Sample *T*-test (OST), and Exploratory Factor Analysis (EFA). Also, the reliability and validity of the research instrument were determined. The Cronbach's alpha value of 0.785 was recorded, indicating the high reliability of the questionnaire survey. This was supported by Hair *et al.* (2010) who suggested that the higher the values, the higher the reliability. On the other hand, the validity was achieved by pilot testing the questionnaires on a small sample as recommended by Ticehurst and Veal (2000). A pilot study helps to eliminate any flaws and weaknesses of the survey instrument before the main study. However, results from the pilot study were not analysed and integrated into this current research. Instead, the pilot study helped to fine-tune the instructions given to respondents and ultimately improve the overall structure and grammatical patterns of the questionnaire. One-Sample *T*-test which is a parametric test was used to ascertain the importance attributed to variables by the respondents. In addition, due to the number of DSS variables assessed, exploratory factor analysis (EFA) was employed to further regroup the DSS into more manageable and concise subscales.

FINDINGS AND DISCUSSIONS

Respondents' background information

To obtain the profile of the respondents, this study conducted frequency distributions of the data of the participants (professionals from the built environment from academia, government establishments and the construction industry). Background data obtained were respondents' level of education, original professional qualifications, years of experience and type of institution to which their organisations belong. These data were required to ascertain the experience and knowledgeability of the respondents to enhance the credibility of the data provided. As seen from Table 2, 29.4% (N-60) of the total population possess a master's degree, followed by 28.4% (N-58) with a bachelor's degree. In terms of their professional qualifications, the largest category of respondents were engineers, representing 36.3% (N-74). A further look at Table 2 shows that 48% (N-98) of the respondents had between 1 - 5 years of experience, while 34.8% (N-71) had more than 6 – 10 years of experience. Meanwhile, 4.4% (N-9) had more than 20 years of work experience.

(Table 2)

Discipline-specific Skills required by Graduates in the Construction Industry

Table 3 shows the different DSS that are important for graduate employability as ranked by the respondents in HEIs, the construction and government organisations. From the table, all DSS were ranked above the 3.00 mean score average of a 5-point Likert scale which was deemed adequate. In addition, technical skills, hands-on experience, knowledge of the subject area, self-confidence and exposure to other disciplines were the highest-ranked discipline-specific factors with MIS of 4.52, 4.50, 4.33, 4.26, and 4.25 respectively. Across the three categories of respondents, these five skills were ranked highly. Since discipline-specific factors deal with the knowledge and skills gained by studying an academic discipline, it is no surprise that the three categories of respondents all have a convergent view towards the importance of this employability construct. Also, according to the table, the least ranked factor was administrative skills with a mean value of 3.92. This is possible because by studying towards an academic degree, learners are presented with the opportunity to obtain a holistic understanding of their chosen courses and modules and not to overly focus on the administrative aspects of their universities as there are professionals who are trained for such purposes. Although, realising their strength and weakness as well as administrative skills were ranked as the least important DSS with MIS of 3.96 and 3.92 respectively, their importance cannot be overlooked as they are well above the average of 3.0. Thus, graduates that will succeed and be productive in the industry will do well to possess these skills along with others that are considered important.

(Table 3)

One-sample *T*-test was conducted to further ascertain the level of importance of these DSS. Table 4 presents the MIS for each discipline-specific skill with their respective standard deviation and standard error. According to the study of Elliott and Woodward (2007), the null hypothesis (H_0) for each discipline-specific skill was set at unimportant when: $U = U_0$. On the other hand, the alternate hypotheses (H_a) state that the discipline-specific skill was deemed important when $U > U_0$. For both assumptions, U_0 represents the population mean and in this study, pegged at 3.0, while the significance level was pegged at 95% confidence interval. Based on this, a discipline-specific skill was considered important when it possesses a mean of 3.0 and above. As noted by Hassani *et al.,* (2010), the standard error (SE) is a measure of how a sample represents the population under question. This means, if the study was repeated several times, the SE represents the variability of the mean values. Therefore, a large SE indicates several differences among various sample means, while a small SE indicates similarities between most sample means and population mean (Oke and Aghimien, 2018). From Table 4, the SE associated with respective means is close to zero, indicating that the sample truly reflects the population. A more critical look at Table 4 shows that the SD of all discipline-specific skills are less than 1.0, indicating little data variability. Hence, there is consistency in the agreement among respondents regarding these 12 skills. The result also shows the *p*-value that highlights the significance of each discipline-specific skill. More so, the one-sample *T*-test significance values at two-tailed all fall below the 0.05 threshold, indicating no statistically significant differences in respondents' opinions. This further indicates consistency in the ranking of the skills based on the opinions of the respondents.

(Table 4)

Exploratory Factor Analysis (EFA)

The 12 DSS that were identified from the literature were further subjected to EFA using Statistical Package for the Social Sciences (SPSS) version 26. Fabrigar and Wegener (2011) opined that EFA is often conducted to determine the possible correlation patterns that exist in a given data set, which is then used to extract variables into various factor clusters. SPSS checked the data suitability for EFA through the correlation matrix. During the check, satisfactory coefficients were observed from the communalities extraction table which indicates suitability for factor analysis. From the communalities table shown in Table 5, values between 0.40 and 0.70 were recorded which is in accordance with the studies of Costello and Osborne (2005). These values indicate the appropriateness of the variables measuring DSS.

The Kaiser-Mayor Olkine (KMO), which is the measure of sampling adequacy yielded 0.775, which was above the 0.6 thresholds (Hair *et al.,* 2010). The result of Bartlett's test of sphericity yielded a high chi-squared value of 536.794, with an associated significance level (Sig.) of 0.000, which is less than 0.050. Thus, the variables are factorable and are suitable for EFA (George and Mallery, 2003). As a result, all 12 DSS were subjected to principal component analysis (PCA).

(Table 5)

Table 6 shows the total variance of the variables indicated by the eigenvalues using Kaiser's criterion. In this case, four principal components with eigenvalues > 1 (3.701, 1.306, 1.118 and 1.013) were retained. These principal component explains 30.8%, 10.9%, 9.3% and 8.4% of the variance respectively. These four clusters of DSS accounts for a cumulative 59.5% of the total variance explained by all 12 DSS. The scree plot was further inspected and the components with eigenvalues above 1 were retained as cluster as shown in Figure 2. The break after the fourth factor showed components which tailed off. Subsequently, a Varimax rotation was conducted to produce the rotated component matrix, which further shows the loadings of the DSS in Table 6.

(Table 6)

(Figure 2)

Discussion of extracted components

The DSS required by graduates in the construction industry as seen in Table 3 are discussed based on their rotated clusters from EFA conducted.

Cluster 1 – Lifelong learning: A total of five factors loaded onto this cluster and they are 'Lifelong learning' (78.4%), 'Coordinating skills' (67.2%), 'Relationships with peers' (61%), 'Administrative skills' (60.3%) and 'Self-confidence' (56%). These factors all relate to the skills that describe the ability of individuals to keep learning either for personal development or professional advancement and they explain a cumulative percentage variance of 30.8% of the total variance. These sets of skills allow learners to understand the dynamism of the world they find themselves in, as they not only learn within the confines of a classroom but also outside of it (Boyadjieva and Ilieva-Trichkova, 2018; Aliu *et al.,* 2021a). Lifelong learning also refers to the learning that leads to the personal development of students which can lead to personal fulfillment and satisfaction. Fischer (2000) also noted that graduates are constantly flooded with more information they can handle and assimilate due to the increasingly dynamic nature of the world of work. Lifelong learning also refers to a wide range of learning that are formal, non-formal and informal in nature. Formal learning constitutes the learning that happens within a structured and organised context and offers formal certificates after successful completion such as an educational institution (Davies *et al.,* 2019). Non-formal learning is the learning that occur outside formal learning environment but within some level of organisational framework such as vocational centres. Informal learning is defined as the learning that occurs outside a structured and formal classroom environment. They are often called experiential learning and can sometimes be referred to as accidental learning. Such learning can occur by virtue of participating in daily activities which are work-related, family-related and leisure-related. Lifelong learning also involves the various attitudes, values, behaviours, knowledge and skills that individuals acquire on a daily basis by virtue of interacting with other people and the society at large. Some examples of lifelong learning that students can involve themselves in include – developing new skills, learning how to adopt and manipulate technological tools and softwares, acquiring new knowledge to improve their overall outlook, learning a new sport amongst several others (Aliu *et al.,* 2021c). Some attributes that are obtained during the lifelong learning process include coordinating skills, interpersonal relationships with peers and superiors, administrative skills and self-confidence (Prokou, 2008; Aliu and Aigbavboa, 2021b). Generally, job seekers who constantly engage in personal learning are often highly rated by employers as they are seen as adaptable, flexible and relevant to the workplace (Midtsundstad and Nielsen, 2019). Simply put, lifelong learning can improve the confidence and self-esteem of individuals as well as their health and quality of life. Lifelong learning is stimulated by conventional formal education which postulates that learning can occur anytime and anywhere. Through modules and courses in a particular discipline, students are motivated to learn and voluntarily seek knowledge.

Cluster 2 – Hands-on experience: A total of three factors loaded onto this cluster and they are 'Hands-on experience' (81.3%), 'Exposure to other disciplines' (77.6%) and 'Technical skills' (64.8%). These factors all relate to the skills that describe the ability of individuals to obtain knowledge by virtue of actively engaging in the process rather than just doing and they explain a cumulative percentage variance of 10.9% of the total variance. Learners can obtain hands-on experience during supervised industrial attachments, internships, lab activities and workshop classes. As individuals actively participate in the learning process, they obtain a deeper understanding of the subject matter which improves their retention skills as they learn by doing. For example, a civil engineering student gains valuable knowledge during construction site visits which improves his/her overall learning process. During site visits, they are exposed to other professionals from other disciplines of the built environment such as mechanical engineers, architects, electrical engineers, land surveyors among several others.

Therefore, construction site visits are pivotal to the development of technical skills among learners (Ashford and Mills, 2006; Murray and Tennant, 2016; Eiris Pereira and Gheisari, 2019). According to Aliu and Aigbavboa (2020), hands-on experiences provides valuable learning opportunities which reinforces what has been taught during conventional lectures which goes a long way in boosting curriculum retention (Satterthwait, 2010). By obtaining hands-on experience, information obtained from traditional lectures further encourages increased student engagement in the learning process. It is also vital to note that hands-on experience fosters creativity and critical thinking skills among students which can help to boost the problem-solving skills on the long run. During the process of participating in hands-on activities, students are afforded the opportunity to work independently or in teams which improves their employability skills as studied by Aliu and Aigbavboa (2021) and Aliu *et al.,* (2021). Furthermore, hands-on experiences offers students a different perspective and a context for academic learning as it allows theory to be put into practice. This ultimately improves the learning process, stimulates curiosity, expands creativity, fosters professional development and boosts confidence among students. While hands-on activities plays a crucial role in exposing students to the world of work, it can also help the students to understand their strengths and skills which are all key elements in the employability discussion. Finally, hands-on activities are often known to promote long term memory retention as it provides individualised learning opportunities for students. According to Khoiri *et al.,* (2021), when students learn by doing, it becomes easier for them to possess the 4 C's of 21st century education – collaboration skills, communication skills, creativity skills and critical thinking skills.

Cluster 3 – Digital literacy: Just two factors were loaded onto this cluster and they are 'Digital literacy' (76.4%) and 'Realising strengths and weaknesses' (68.2%). These factors all relate to the skills that describe the ability of individuals to effectively use information and communication technologies to solve problems (Iordache *et al.,* 2017). In other words, this set of skills allow learners to manipulate digital tools and services for their personal and professional development. Through ICT skills, learners can use a wide range of digital devices, communication applications, computer networks to access and manage information. For example, as learners engage in their everyday learning, they develop their digital skills by virtue of accessing the internet, utilising PowerPoint for presentation, taking online classes, using interactive whiteboards during lessons among others. With the advent of The Fourth Industrial Revolution (4IR), learners will be increasingly required to possess knowledge of technologies such as artificial intelligence, data science, robotics, advanced simulation, data communication, system automation, real-time inventory operations, cloud computing, and information technologies (Penprase, 2018; Aliu *et al.,* 2021b; Aghimien *et al.,* 2021a; Kim and Irizarry, 2021). With this new wave of digitalisation, learners are expected to not only possess a deep knowledge of their discipline, but also an in-depth understanding of several of these technologies. Therefore, one of the most important skill for future graduates is the ability to work with innovative technologies, big data analytics and predictive algorithms (Zhao *et al.,* 2015; Motyl *et al.,* 2017; Karre *et al.,* 2017; Aliu *et al.,* 2021a). The 4IR era will require future graduates to interact with relevant stakeholders in more value-added ways than previously done. One of the most important soft skills needed in this era is the ability to communicate clearly and timely (Jeganathan *et al.,* 2018). With large data available in this era of innovation, knowledge management will also require the contributions of suppliers and customers, hence future graduates must become excellent communicators to build a climate of collaboration between relevant stakeholders (Venkatraman *et al.,* 2018). To be at the forefront of this innovative era, future graduates will be expected to possess emotional intelligence and cultural awareness while exhibiting critical thinking abilities (Kazancoglu and Ozkan-Ozen, 2018). It is also expected that this innovative era will trigger the delocalisation of the project teams; therefore, future graduates will be expected to assemble the right team from a technical, cognitive and relational perspective. More so, 'fast-pace' and 'speed' will become key terminologies in the 4IR era; hence, future graduates will be required to exhibit consistent problem-solving capacity to proffer solutions to problems in real-time and on time.

Cluster 4 – Knowledge of the subject area: Just two factors were loaded onto this cluster and they are 'Knowledge of the subject area' (72.6%) and 'Knowledge of overall curricula' (67.6%). These factors all relate to the skills that describe the ability of learners to fully grasp the overall idea of the chosen discipline as well as the overall curricula. According to Bridgstock (2009), they are those sets of skills, knowledge, and competencies that are embedded in a specific discipline to address specific job-related requirements. These skills usually originate in subject matter areas, specific domains, and disciplines. For instance, a civil engineering graduate should have the ability to apply principles to the engineering practice to design and supervise construction projects after graduation. Also, a graduate in quantity surveying (QS) should possess the ability to conduct feasibility studies to estimate materials, time and labour costs. A graduate surveyor should also be able to prepare, negotiate and analyse costs for tenders and contracts. Therefore, for built environment students to obtain employment from the industry successfully after graduation, they are required to possess foundational knowledge within that field. Learners can obtain discipline-specific skills or knowledge during lectures, simulations, tutorials, work-integrated learning via face-to-face approaches or online means.

(Figure 3)

PRACTICAL IMPLICATIONS OF THE RESEARCH

This study examined the various discipline-specific skills (DSS) that built-environment graduates need to possess to thrive in the labour market after graduation. The clusters obtained from the study increases the need for HEIs to understand the importance of their curricula (course content and delivery) in developing students for the future of the construction industry. By revisiting the discussions surrounding academic skills, this research highlights why and how the distillation of discipline-specific skills remains a crucial step towards solving the age-long problem of lack of adequate technical capabilities that have plagued the construction industry in South Africa and other developing countries globally. The various clusters shown in Figure 3 highlighted the key areas in which discipline-specific skills can provide students with an edge in their academic journey. These set of skills were found to improve the lifelong learning process of students, which motivates them to keep learning voluntarily. Thus, academic skills encourages students to become more effective learners. Consequently, the findings of this study reiterates the need for HEIs to establish effective collaborations with the construction industry. Through collaborations, HEIs will become increasingly aware of the constantly changing dynamics of the industry, thus, aligning their curriculum to the industry needs. In summary, the findings of this study makes a case for HEIs to revisit their course content (materials and delivery) to ensure that their activities are fit-for-industry-purpose.

CONCLUSION AND RECOMMENDATIONS

This study set out to unearth the DSS required by built environment graduates with a view to improving the quality of graduates produced by HEIs and ensuring improve graduate performance in the construction industry. Based on the submissions from past studies and construction professionals in South Africa, the study concludes that built environment graduates that will succeed in the industry must possess skills relating to lifelong learning, hands-on experience, digital literacy and knowledge of subject area. While the possession of an academic degree does improve a student's chances of obtaining employment opportunities, it does not automatically guarantee personal or industry success. Ultimately, the stakes are now higher, and the employability markers have changed. This is because, owing to the factors and dynamics that have continuously impacted the present-day construction industry, an academic degree is not nearly enough to prepare graduates for the future. Moreover, the present-day industry can be described as fast-paced, dynamic, flexible and ever-changing which places optimum pressure on learners to be multi-skilled (academically and non-academically) in order to thrive in industry positions after graduation.

Therefore, the findings of this study offer significant practical benefits to both learners in HEIs as well as lecturers and other stakeholders responsible for training these learners. The identified DSS can be taken into consideration is designing the curricula and performance evaluation of learners. Much more, the findings provide learners critical features to look out for in themselves and possibly improve upon before entering the construction industry as professionals. More so, this research makes a case for understanding the relevance of the course content and delivery in ensuring that education activities adequately meet the learning outcomes designed by HEIs. The findings of this research are also relevant to education policy makers and accreditation bodies whose jobs are to ensure that education provided by HEIs meets appropriate standards of quality and integrity. Furthermore, the findings of the study give a good theoretical background for future works to be conducted on the DSS required for each specific profession within the built environment and for a similar study to be conducted in countries where such study is non-existent. Albeit the significant contribution of this study to the current employability discourse, care must be taken in generalising its findings for the entire South Africa.

As a limitation, this study was restricted to the Gauteng province of South Africa. Future studies can be conducted across other provinces to obtain a broader view of the subject matter. Also, the purposive sampling technique adopted in this study has its own bias. Therefore, it may be difficult to generalise the findings of this research to a wider population and the findings may vary if another sampling technique is adopted. Much more, future works can target specific profession within the built environment to determine if the required DSS varies across diverse profession. Future studies could also be conducted in developed countries to test the findings of this study and to fill any missing gaps in the employability discussion this study struggled to address.

Disclosure statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

REFERENCES

Aghimien, D. O, Aigbavboa, C. O, and Oke, A. E., Thwala, W.D. (2021b). Construction Digitalisation – A Capability Maturity Model for Construction Organisations. 1st ed., Routledge, New York, USA

Aghimien, D., Aigbavboa, C. and Matabane, K., (2021a). Dynamic capabilities for construction organisations in the fourth industrial revolution era. *International Journal of Construction Management*, pp.1-10.

Ahmed, S. M., Yaris, C., Farooqui, R. U., & Saqib, M. (2014). Key attributes and skills for curriculum improvement for undergraduate construction management programs. *International Journal of Construction Education and Research*, *10*(4), 240-254.

Ahn, Y. H., Annie, R. P., & Kwon, H. (2012). Key competencies for US construction graduates: Industry perspective. *Journal of Professional Issues in Engineering Education and Practice*, *138*(2), 123-130. DOI: 10.1061/ (ASCE)EI.1943-55410000089.

Akinradewo, O., Aghimien, D., Aigbavboa, C., & Onyia, M. (2020). Factors influencing the adoption of insurance as a risk treatment tool by contractors in the construction industry. *International Journal of Construction Management*, 1-9.

Akinradewo, O., Aigbavboa, C., Aghimien, D., Oke, A. and Ogunbayo, B., (2021). Modular method of construction in developing countries: the underlying challenges. *International Journal of Construction Management*, pp.1-11.

Aliu, J., & Aigbavboa, C. (2021). Key generic skills for employability of built environment graduates. *International Journal of Construction Management*, 1-19.

Aliu, J., & Aigbavboa, C. (2021). Reviewing problem-solving as a key employability skill for built environment graduates. In *Collaboration and Integration in Construction, Engineering, Management and Technology* (pp. 399-403). Springer, Cham.

Aliu, J., & Aigbavboa, C. O. (2019). Employers' perception of employability skills among built-environment graduates. *Journal of Engineering, Design and Technology*.

Aliu, J., & Aigbavboa, C. O. (2020). Structural determinants of graduate employability: impact of university and industry collaborations. *Journal of Engineering, Design and Technology*.

Aliu, J., Aigbavboa, C. and Thwala, W. (2021). *A 21st Century Employability Skills Improvement Framework for the Construction Industry*. Routledge.

Arain, F. M. (2010). Identifying competencies for baccalaureate level construction education: Enhancing employability of young professionals in the construction industry. In *Construction Research Congress 2010: Innovation for Reshaping Construction Practice* (pp. 194-204).

Archer, W., & Davison, J. (2008). Graduate employability. *The council for industry and Higher Education*, 1-20.

Ariana, S.M. (2010). Some thoughts on writing skills. *Annals of the University of Oradea, Economic Science Series, 19*(1), pp. 134-140.

Ashford, P., & Mills, A. (2006, January). Evaluating the effectiveness of construction site visits as a learning experience for undergraduate students enrolled in a built environment course. In *TL Forum 2006: Experience of Learning: Proceedings of the 15th Annual Teaching Learning Forum*. The University of Western Australia.

Baker, M.A., Robinson, J.S. and Kolb, D.A., (2012). Aligning Kolb's Experiential Learning Theory with a Comprehensive Agricultural Education Model. *Journal of Agricultural Education*, *53*(4).

Behlol, M.G. and Dad, H., (2010). Concept of learning. *International Journal of Psychological Studies*, *2*(2), p.231.

Bhattacharjee, S., Ghosh, S., Young-Corbett, D. E., & Fiori, C. M. (2013). Comparison of industry expectations and student perceptions of knowledge and skills required for construction career success. *International Journal of Construction Education and Research*, *9*(1), 19-38.

Boyadjieva, P., & Ilieva-Trichkova, P. (2018). Lifelong learning as an emancipation process: A capability approach. In *The Palgrave international handbook on adult and lifelong education and learning* (pp. 267-288). Palgrave Macmillan, London.

Bridgstock, R. (2009). The graduate attributes we have overlooked: enhancing graduate employability through career management skills. Higher Education Research & Development, 28(1), 31–44.

Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work? "Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century US workforce*. Partnership for 21st Century Skills. 1 Massachusetts Avenue NW Suite 700, Washington, DC 20001.

Chan, C. (2012). Exploring an experiential learning project through Kolb's Learning Theory using a qualitative research method. *European Journal of Engineering Education,* 37(4): 405-415.

Conrad, D., & Newberry, R. (2012). Identification and instruction of important business communication skills for graduate business education. *Journal of Education for Business*, *87*(2), 112-120.

Construction Industry Development Board (CIDB, 2020). *Report on the impact of Covid-19 on the South African Construction Industry*. [online] Available at: https://www.cidb.org.za/news-and-events/cidb-media-statements/ [Accessed 06 July 2021].

Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical assessment, research, and evaluation*, *10*(1), 7.

Davies, B., Diemand-Yauman, C., & van Dam, N. (2019). Competitive advantage with a human dimension: From lifelong learning to lifelong employability. *McKinsey Quarterly*.

Ebekozien, A., Aigbavboa, C.O., Aliu, J. and Thwala, W.D., (2022). Generic skills of future built environment practitioners in South Africa: unexplored mechanism via students' perception. *Journal of Engineering, Design and Technology*.

Ebekozien, A., Aigbavboa, C.O., Thwala, W.D.D., Aigbedion, M.I. and Ogbaini, I.F., (2021). An appraisal of generic skills for Nigerian built environment professionals in workplace: the unexplored approach. *Journal of Engineering, Design and Technology*.

Eiris Pereira, R., & Gheisari, M. (2019). Site visit application in construction education: a descriptive study of faculty members. *International Journal of Construction Education and Research*, *15*(2), 83-99.

Elliott, A.C. and Woodward, W.A., (2007). Comparing one or two means using the t-test. *Statistical analysis quick reference guidebook: With SPSS examples*, pp.47-76.

Fabrigar, L. R., & Wegener, D. T. (2011). *Exploratory factor analysis*. Oxford University Press.

Farooqui, R. U., & Ahmed, S. M. (2009). Key skills for graduating construction management students—A comparative study of industry and academic perspectives. In *Construction Research Congress 2009: Building a Sustainable Future* (pp. 1439-1448).

Fischer, G. (2000). Lifelong learning—more than training. *Journal of Interactive Learning Research*, *11*(3), 265-294.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Confirmatory factor analysis. *Multivariate Data Analysis, 7th ed.; Pearson Education, Inc.: Upper Saddle River, NJ, USA*, 600-638.

Hassani, H., Ghodsi, M., & Howell, G. (2010). A note on standard deviation and standard error. *Teaching Mathematics and its Applications: An International Journal of the IMA*, *29*(2), 108-112.

Hedin, N., (2010). Experiential learning: Theory and challenges. *Christian education journal*, *7*(1), pp.107-117.

Hergenhahn, B.R. (1988). *An introduction to theories of learning* (3rd ed.). Upper Saddle River, NJ: Prentice-Hall International.

Hutchinson, J. (2013). *School organisation and STEM career-related learning.* Derby: International Centre for Guidance Studies.

Iordache, C., Mariën, I., & Baelden, D. (2017). Developing digital skills and competences: A quick-scan analysis of 13 digital literacy models. *Italian Journal of Sociology of Education*, *9*(1).

Jackson, D., & Chapman, E. (2012). Non-technical competencies in undergraduate business degree programs: Australian and UK perspectives. *Studies in Higher Education*, *37*(5), 541-567. DOI - 10.1080/03075079.2010.527935.

Jeganathan, L., Khan, A. N., Raju, J. K., & Narayanasamy, S. (2018, November). On a frame work of curriculum for engineering education 4.0. In *2018 World Engineering Education Forum-Global Engineering Deans Council (WEEF-GEDC)* (pp. 1-6). IEEE.

Kapici, H.O., Akcay, H. and de Jong, T., (2019). Using hands-on and virtual laboratories alone or together—which works better for acquiring knowledge and skills?. *Journal of science education and technology*, *28*(3), pp.231-250.

Karre, H., Hammer, M., Kleindienst, M., & Ramsauer, C. (2017). Transition towards an Industry 4.0 state of the Lean Lab at Graz University of Technology. *Procedia manufacturing*, *9*, 206-213.

Kayes, D.C., (2005). Internal validity and reliability of Kolb's learning style inventory version 3 (1999). *Journal of business and psychology*, *20*(2), pp.249-257.

Kazancoglu, Y., & Ozkan-Ozen, Y. D. (2018). Analysing Workforce 4.0 in the Fourth Industrial Revolution and proposing a road map from operations management perspective with fuzzy DEMATEL. *Journal of Enterprise Information Management*.

Khoiri, A., Komariah, N., Utami, R. T., Paramarta, V., & Sunarsi, D. (2021, February). 4Cs Analysis of 21st Century Skills-Based School Areas. In *Journal of Physics: Conference Series* (Vol. 1764, No. 1, p. 012142). IOP Publishing.

Kim, J. and Irizarry, J., (2021). Evaluating the use of augmented reality technology to improve construction management student's spatial skills. *International Journal of Construction Education and Research*, *17*(2), pp.99-116.

Kimble, G.A. (1964). Categories of learning and the problem of definition: Comments on Professor Grant's paper. In *Categories of human learning* (pp. 32–45). Cambridge, MA: Academic Press.

Kolb, D.A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Lamanauskas, V. & Augienė, D. (2017). Career education in comprehensive schools of Lithuania: Career professionals` position. In A. Klim-Klimaszewska, M. Podhajecka and A. Fijalkowska-Mroczek (Eds.).

Midtsundstad, T., & Nielsen, R. A. (2019). Lifelong learning and the continued participation of older Norwegian adults in employment. *European Journal of Education*, *54*(1), 48-59.

Motyl, B., Baronio, G., Uberti, S., Speranza, D., & Filippi, S. (2017). How will change the future engineers' skills in the Industry 4.0 framework? A questionnaire survey. *Procedia manufacturing*, *11*, 1501-1509.

Murray, M. and Tennant, S., (2016), July. "Off-piste pedagogy": construction site visits for undergraduate civil engineers. In *Sixth International Symposium of Engineering Education* (pp. 165-172).

Nagarajan, S., & Edwards, J. (2015). The Role of Universities, Employers, Graduates and Professional Associations in the Development of Professional Skills of New Graduates. *Journal of Perspectives in Applied Academic Practice*, *3*(2).

Nowiński, W., Haddoud, M. Y., Lančarič, D., Egerová, D., & Czeglédi, C. (2019). The impact of entrepreneurship education, entrepreneurial self-efficacy and gender on entrepreneurial intentions of university students in the Visegrad countries. *Studies in Higher Education*, *44*(2), 361-379.

Oke, A. E., & Aghimien, D. O. (2018). Drivers of value management in the Nigerian construction industry. *Journal of Engineering, Design and Technology*.

Oke, A.E., Ogunsemi, D.R. and Adeyelu, M.F., (2018). Quantity surveyors and skills required for procurement management. *International Journal of Construction Management*, *18*(6), pp.507-516.

Penprase, B. E. (2018). The fourth industrial revolution and higher education. *Higher education in the era of the fourth industrial revolution*, 207.

Pitan, O. S. (2016). Towards enhancing university graduate employability in Nigeria. *Journal of Sociology and Social Anthropology*, *7*(1), 1-11.

Pool, L. D., & Sewell, P. (2007). The key to employability: developing a practical model of graduate employability. *Education+ Training*.'

Prokou, E. (2008). The emphasis on employability and the changing role of the university in Europe. *Higher Education in Europe*, *33*(4), 387-394.

Rawlins, J., & Marasini, R. (2011). Are the construction graduates on CIOB accredited degree courses meeting the skills required by the industry. *Management*, *167*, 174.

Russell, J. S., Hanna, A., Bank, L. C., & Shapira, A. (2007). Education in construction engineering and management built on tradition: Blueprint for tomorrow. *Journal of Construction Engineering and Management*, *133*(9), 661-668. DOI: 10.1061/(ASCE)0733-9364(2007)133:9(661).

Satterthwait, D., (2010). Why are hands-on science activities so effective for student learning? *Teaching Science*, *56*(2), pp.7-10.

Schunk, D.H., (2012). *Learning theories an educational perspective sixth edition*. Pearson.

Shuell, T.J. (1986). Cognitive conceptions of learning. *Review of Educational Research*, *56*, pp. 411–436.

Stirling, A., Kerr, G., Banwell, J., MacPherson, E. and Heron, A. (2016). *A practical guide for work-integrated learning: Effective practices to enhance the educational quality of structured work experiences offered through colleges and universities*. Toronto, ON: Higher Education Quality Council of Ontario.

Sukamolson, S. (2007). Fundamentals of quantitative research. *Language Institute Chulalongkorn University*, *1*, 2-3.

Ticehurst, G. W., & Veal, A. J. (2000). Questionnaire surveys. *Business research methods: A managerial approach*, 135-158.

Venkatraman, S., de Souza-Daw, T., & Kaspi, S. (2018). Improving employment outcomes of career and technical education students. *Higher Education, Skills and Work-based Learning*.

Wetzel, E.M. and Farrow, C.B., (2021). Active learning in construction management education: faculty perceptions of engagement and learning. *International Journal of Construction Management*, pp.1-9.

White, P. and Smith, E., (2022). From subject choice to career path: Female STEM graduates in the UK labour market. *Oxford Review of Education*, pp.1-17.

Windapo, A.O. and Cattell, K. (2013). The South African construction industry: Perceptions of key challenges facing its performance, development and growth. *Journal of Construction in Developing Countries*, 18(2), 65–79

Yamane, T. (1967). *Statistics: An introductory analysis* (No. HA29 Y2 1967).

Zhao, D., McCoy, A.P., Bulbul, T., Fiori, C. and Nikkhoo, P., (2015). Building collaborative construction skills through BIM-integrated learning environment. *International Journal of Construction Education and Research*, *11*(2), pp.97-120.