UNDERSTANDING THE PERFORMANCE OF EXPANDED POLYSTYRENE (EPS) TOWARDS SUSTAINABLE HOUSING CONSTRUCTION

Understanding The Performance of Expanded Polystyrene (Eps) Towards Sustainable Housing Construction

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ABSTRACT

Goal **11** of the Sustainable Development Goal (SDG) mandates delivering buildings utilising sustainable materials. An emerging material used to fulfil this goal is Expanded Polystyrene (EPS), a thermo- plastic material whose end-product is a meshed panel that can be moulded into different shapes and sizes used in constructing buildings. Although the use of EPS is relatively new in construction (as against its use in industrial packaging), it is attributed to having commendable sustainable properties. Despite its commendable characteristics, studies on EPS predominantly cover its technical and mechanical aspects (from the views of professional/experts). In a bid to enhance the appreciation of the material, this study seeks to investigate the performance of EPS in Citec Mbdra Mount Pleasant Estate Abuja relative to occupant's satisfaction. A total of 57 occupants were identified from Citec Construction Ltd to being involved in constructing the howses they occupy and thus have some experience on the use of EPS. While data is collected using a survey with the aid of a questionnaire, data is analysed both descriptively and inferentially using IBM SPSS Statistics 23 and M.S. Excel using frequencies, Mean Score and Relative Satisfaction Index (RSI). Results reveal that majority of the respondents are adults over 26 years of age and have lived in the houses for ovpr 3 years. Furthermore, out of the 6 factors studied, while maintainability is the only factor thaf leans towairabccupants being satisfied with the performance of EPS (with a Mean Score of 3.56), hot weather insulationjs also the only factor that leans towards occupants being dissatisfied with the performance of EPS (with a Mean Score of 2.47). The other factors leaned towards occupants being 'unsure'. It was found that the satisfaction of occupants residing in Citec Mbora Estate in terms of the physical performance of EPS (maintainability and aesthetics) is more than the satisfaction in terms of general insulation performance (heat, cold and sound). Future research can look deeper into other factors that cause satisfaction (such as cost, frequency, and culture of maintenance of EPS) of the houses built with EPS in Citec Mbora Mount Pleasant Estate. Also, environmental factors that affect insulation can be covered in future studies However, those who know about EPS confirms its flexibility, quick construction time, and its environmental friendliness all herald a great future for the applications of these advanced building products in the Nigerian construction industry, but EPS is not readily available like other conventional materials which makes its application challenging to professionals of the built environment.

Keywords: Citec Mbora Estate, Expanded Polystyrene (EPS), Housing construction, Occupant's satisfaction

INTRODUCTION

Among other mandates of Goal 11 of the Sustainable Development Goal (SDG), it is determined to support sustainable and resilient buildings utilising sustainable materials (SDG, 2015). This mandate arose from the several challenges prevailing in housing provision (availability, affordability and accessibility), which persists in developing countries. In a bid to improve these challenges, researchers have made efforts to identify the factors retarding effective housing delivery particularly in developing countries. For instance, Ede, Alegiuno, & Aawoyera (2014) link the challenge facing effective housing delivery to rural-urban drift, a general increase in living cost, high cost of urban land with the consequent high cost of housing schemes, the presence of excessive demands and shortage of housing facilities. Also, Ngugi, Kaluli, & Gairy (2017) and Kageni (2014) attribute cost of construction materials, rising population, and low income, among other factors causing challenges of effective housing delivery. While it is evident that these underlying factors driving challenges faced by ineffective housing delivery differ, there is unanimous agreement that optimising these challenges largely depends on sustainable construction practices which includes the use of sustainable construction materials.

Although there exists an array of sustainable building materials adaptable to countries, regions and locations, Ibrahim, Bankole, Maaji, Ohize, & Abdul (2013), Ede et al. (2014) and also Ngugi et al. (2017) all approve Expanded Polystyrene (EPS) to being a building material suitable for the construction of affordable and sustainable housing in developing countries. Expanded Polystyrene (EPS) used in construction is a thermo- plastic material whose end-product is a meshed panel that can be moulded into different shapes and sizes. The works of Paolella & Grifoni (2013), Ede et al. (2014), Ngugi et al. (2017) and also Mansir et al. (2019) all showcase building elements produced with EPS and used in housing construction (which include walls, roofs, staircase, ceiling and floor slabs). Although EPS is relatively new in construction (as against its use in industrial packaging), EPS has exhibited commendable characteristics, which makes it suitable for use as a sustainable building material. The commendation of its use across authors can be contextualised into its physical properties, which include availability, lightness, simplicity in use (Paolella & Grifoni, 2013); it's sustainably economical in terms of both initial and operating costs (Doroudiani & Omidian, 2010; Kageni, 2014; Ngugi et al., 2017); it's environmentally friendly in terms of energy efficiency and insulation property (Doroudiani & Omidian, 2010; Kageni, 2014; Ngugi et al., 2017); and also it is flexible in production into different shapes and sizes (Doroudiani & Omidian, 2010; Ngugi et al., 2017).

Even though the commendable characteristics of EPS is alluded to making it a sustainable construction material, its (EPS) application in building construction in Nigeria is posed with challenges. For instance, Ibrahim et al. (2013), Ede et al. (2014) and also Mansir et al. (2019) all claim that there are not so many construction firms using EPS in Nigeria. Likewise, Ede et al. (2014) attribute low patronage in using EPS in construction to relatively scarce knowledge in the innovative methods of construction using EPS and poor access to the material. Furthermore, Mansir et al. (2019) assert that a low level of awareness of the building professionals and the general public and its non-availability has hampered the diffusion of EPS in Nigeria. Irrespective of these challenges, however, researchers are continuously improving the patronage in using EPS, which implies proffering solutions to sustainable building delivery. For instance, Ibrahim et al. (2013) assessed the properties of EPS used in building construction in Citec Mbora Mount Pleasant Estate in Mbora District Abuja relative to mechanical performance (compressive strength specifically). Similarly, Mansir et al. (2019) investigated the factors affecting the use of EPS among professionals of Citec Construction Limited. While these studies somewhat covered the technical performance of EPS used in housing construction based on professionals' opinions, (Ishiyaku 2016) believes that the full evaluation of a sustainable material used in construction should also entail liaising with users to get their opinions. As such, this study seeks to advance the understanding of EPS in Citec Mbora Mount Pleasant Estate relative to occupant's satisfaction with its performance.

The use of EPS material technology seems to be highly appealing to the major players in the construction industry. Clients, designers, contractors, and end-users are frequently at odds over the key construction industry issues of cost, quality, and time. Construction of a facility of the greatest quality while keeping costs and construction time to a bare minimum is the goal of every customer (Aina and Wahab, 2011). Customers are drawn to high-quality homes that are within their budgetary constraints. Building materials that are appropriate and carefully chosen are the most appropriate means of accomplishing this. Expanded Polystyrene is one product that may help achieve high quality, low cost, and quick construction product completion (Omolola, 2014). Houses built in Citec Mbora Mount Pleasant Estate by Citec Construction Limited are classical cases of buildings built with EPS in Nigeria. As such, EPS has performed well in its application in Nigeria.

LITERATURE REVIEW

The subsequent sub sections review the literature on EPS, its use in housing construction and its performance requirements in general. Also, the use of EPS in Citec Estate is discussed.

Sustainable Building Construction Using Expanded Polystyrene

Sustainable Development Goal 11 (SDG 11 or Global Goal 11) is one of 17 Sustainable Development Goals adopted by the United Nations General Assembly in 2015. It is about "sustainable cities and communities." Goal 11 of the Sustainable Development Goals aims to "Make cities more inclusive, safe, resilient, and sustainable" (U.N., 2017). As a result, the 17 SDGs recognise the importance of balancing social, economic, and environmental sustainability (UNDP, 2021). Investment in public transportation, the creation of green public spaces, and participatory and inclusive urban planning and administration are among the SDG 11 priorities (SDG, 2015). The achievement of Goal 11 of the SDG is being tracked through the use of fifteen indicator metrics. Safe and affordable housing, affordable and sustainable transportation systems; inclusive and sustainable urbanisation; protection of the world's cultural and natural heritage; reduction of the negative effects of natural disasters; reduction of city environmental impacts; and provide access to safe and inclusive green, and public spaces are among the seven "outcome targets" (SDG, 2015). Strong national and regional development planning; adopt policies for inclusiveness, resource efficiency, and disaster risk reduction; and help least developed nations develop sustainable and resilient infrastructure are among the three "ways of accomplishing" goals (U.N., 2017; Africa UNDP, 2021).

For the construction industry, the sustainability of buildings is a critical issue. Sustainable buildings are characterised by lower construction costs for energy consumption and operations, are environmentally friendly, are capable of conserving natural resources while also being comfortable and healthy for their occupants (Mesaros et al. 2016). The availability of secure and inexpensive housing gives personal, social, and economic advantages to individuals while also contributing to the health and safety of those who live there (Shi et al., 2015). According to Yüksek (2014), energy is one of the most important factors in economic growth and social development in all countries, and as urbanisation continues to grow at a rapid pace, the construction of residential areas is being carried out intensively at the same time that the world is experiencing a scarcity of energy resources. As a result, modifications to housing design and construction technologies are required to reduce the cost, gas emissions, and other environmental impacts Raj et al. (2014) and mitigates the impact of depleting energy supplies, which is a danger to humanity's present and future (Ogundiran, 2014).

Because of this, other insulating materials such as EPS or other kinds of combustible materials should be taken into account. According to Ogundiran (2014), both the customer and the residents of the EPS were pleased with the building's excellent recyclability, dependability, flexibility, and moisture resistance. They made a further assertion: EPS applications in the Nigerian construction sector has an excellent future. According to Raj et al. (2014), the usage of pre-reinforced EPS sheets will minimise total building costs by reducing construction time and, therefore, labour expenses. Because the dead weight of the superstructure is relatively low compared to that of traditional reinforced concrete, it may also be built where the soil carrying capacity is limited. As a result of its lightweight, energy-absorbing, and heat-preserving properties, EPS is used in many specific construction industries, including high-rise buildings, floating marine platforms, and large-sized and long-span concrete (Shi et al. 2015; Kumm, 2013). As a result, it should be considered for use as an alternative building material.

Expanded Polystyrene Used in Housing Construction and its Performance Requirement

The drive towards sustainable housing delivery (as championed by Goal 11 of SDG, 2015)) has yielded the use of diverse materials believed to fulfil the economic, social and environmental paradigms attributed to sustainable development. Among other materials believed to be sustainable for housing construction, EPS is gradually gaining the limelight. EPS is a thermo- plastic material formed by the union of so many polystyrene beads produced during a modelling process with the supply of heat and water steam until the full formation of the desired properties is attained(Ede et al., 2014;Ngugi et al., 2017). Although the use of EPS is relatively new in construction (as Kageni, 2014 and Ngugi et al., 2017) claimed, its use in industrial packaging has been much longer. While EPS used in packaging is usually monolithic, EPS used in the design and construction of buildings usually has steel mesh reinforcement embedded in it (Ibrahim et al., 2013; Ngugi et al., 2017). Detailed procedure for the assemblage of EPS elements used in housing construction can be found(Ministry of Housing and Urban Poverty Alleviation Government of India 2017). The polystyrene material is depicted in Figure 1.

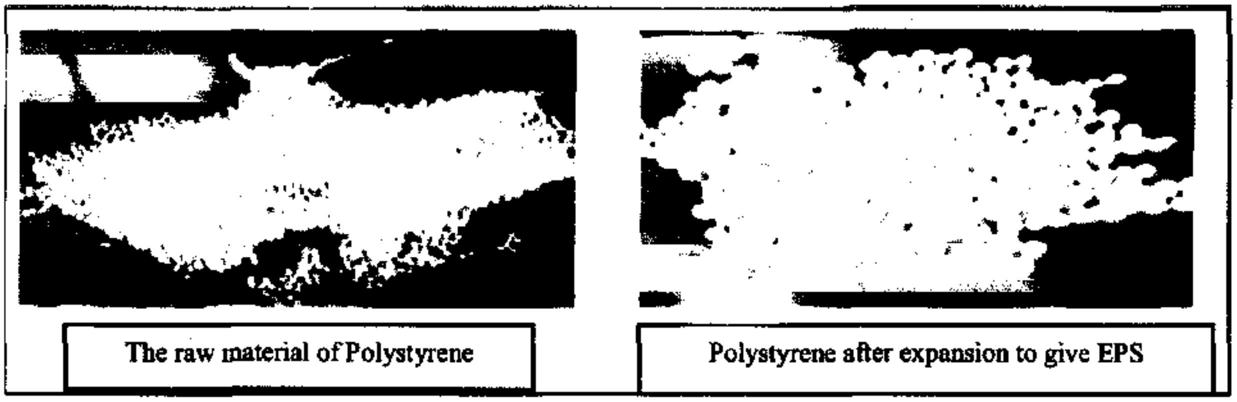

Figure 1: Polystyrene Material
Source: (Mansir et al. 2019)

Pre-expansion, intermediate conditioning and stabilisation, moulding, shape, and post-production operations are among the five platforms of polystyrene manufacturing (Saint-Goban, 2009). The EPS beads (figure. 1) are heated to around 800 and 1000 degrees using a steam boiler during the pre-expansion step. To expand the beads holding a sequence of non-interconnected closed cells pentane re-agent is added. As the beads cool, the air is induced into them, lowering the bulk density from 630kg/m3 to 10 and 35kg/m3. The EPS is cooled in the intermediate conditioning and stabilisation step before being transported to an aerated storage silo for development. The EPS cools in the silo, and air diffuses into the gap/pores, progressively replacing the other components until the beads encapsulate over 90% of the air. At this point, the beads have regained their mechanical elasticity and their expansion capability. Moulding is the third stage in EPS manufacture. The pre-expanded beads are moulded into boards, blocks, or unique product designs. During the moulding process, the steam forced each bead to fuse to its neighbour, resulting in a consistent product. The shaping step is the fourth in the process. The moulding block is allowed to cool once it has been withdrawn from the moulding machine. The block is subsequently chopped or shaped using a hot wire or other suitable processes. The completed material (EPS) is laminated with foils, plastics, roofing felt, and wall cladding materials in the final post-production phase.

The growth in EPS use can be attributed to some of its commendable properties when used as a sustainable building material. For instance, Paolella & Grifoni (2013) characterise EPS as being readily available, light in weight, resistance, insulating properties, cheapness and simplicity in use. Also, Ngugi et al. (2017) indicated EPS used in construction to exhibiting lower construction costs for energy consumption and operations; environmentally friendly; able to save natural resources; comfortable and healthy for users; and flexibility of being manufactured in multitude shapes and for multiple applications. Furthermore, Doroudiani & Omidian (2010) reported that EPS in construction proffers low material usage and installation costs, good performance, resistance to biodegradation, resistance to moisture penetration and availability in a wide range of sizes and densities. Also, EPS is cost effective for thermal and sound insulation (Kageni, 2014). All these commendable characteristics of EPS buttress the claim of its passing for sustainable construction material.

Several pieces of research have been conducted to ascertain the potentials of EPS in fulfilling its functional requirement as a sustainable material in housing construction. Findings from conducted researches have informed on its potentials to be used for sustainable housing construction. Table 1 depicts authors' works that covered specific functional requirements of EPS relative to varying scopes in studying EPS used in construction.

Table 1: Performance Requirement Factors of EPS Used in Construction

S/No	Factor	Authors
1	Aesthetics	Ibrahim et al. (2013) ; Ministry of Housing and Urban Poverty Alleviation Government of India (2017)
2	Hot weather resistance	EUMEPS (2013); Lakatos & Kalmár (2013) ; Alam et al. (2013); Briga-Sá et al. (2013)
3	Fire resistance	EUMEPS (2013) ; Alam et al. (2013) ; Briga-Sá et al. (2013); Ministry of Housing and Urban Poverty Alleviation Government of India (2017) ; Ngugi et al. (2017)
4	Cold weather resistance	Daouas et al. (2009) ; Kageni (2014) ; Raj et al. (2014) ; Ngugi et al. (2017)
5	Maintainability	EUMEPS (2013); Lakatos & Kalmár (2013) ; Alam et al. (2013); Paolella & Grifoni (2013) ; Ministry of Housing and Urban Poverty Alleviation Government of Ind ia (2017)
6	Resistance to the impact of sound	Raj et al. (2014) ; Ngugi et al. (2017) ; Briga-Sá et al. (2013); Ministry of Housing and Urban Poverty Alleviation Government of India, (2017)

Source: (Mansir et al. 2019)

Specific to housing construction, EPS has been reported by several authors to be used for wall panels, floor slabs and roof, among other building elements. Table 2 captures some works researched on EPS relative to building elements used in housing construction.

Table 2: Building Elements Made with EPS

S/No	Element	Authors
1	Wall	Daouas et al. (2009) ; Paolella & Grifoni (2013) ; Ede et al. (2014); Ngugi et al. (2017)
2	Floor (lightweight)	Paolella & Grifoni (2013); Ede et al. (2014); Ngugi et al. (2017)
3	Roof (insulation)	Paolella & Grifoni (2013); Ngugi et al. (2017)
4	Staircase	Ibrahim et al. (2013) ; Ministry of Housing and Urban Poverty Alleviation Government of India (2017)
5	Ceiling	Paolella & Grifoni (2013); Ngugi et al. (2017)

Source: (Mansir et al. 2019)

These studies were conducted in several countries. While the works of Kageni (2014) and also Ngugi et al. (2017) illustrates the use of EPS in housing construction in Kenya, the work of Daouas et al. (2009) discussed the use of EPS in Tunisia. Similarly, Doroudiani & Omidian (2010) demonstrates the use of EPS in Canada.

In Nigeria, the works of Ibrahim et al. (2013), Ede et al. (2014) and also Mansir et al. (2019) equally covered the use of EPS as a material used in housing construction. Although these studies differ in scope, they all concluded that EPS is indeed sustainable for housing construction.

The Use of Expanded Polystyrene in Citec Estate

According to Ibrahim et al. (2013), Ede et al. (2014) and also Mansir et al. (2019), there are not so many construction firms using EPS in Nigeria. Citec Construction Limited is one among such limited firms that use EPS in construction. This is evident in its housing construction project at Citec Estate Mount Pleasant at Mbora District Abuja. The project is a proposed 3,000 unit mass housing estate whereby thousands of housing units using EPS have been completed and occupied since the project commenced in 2003. As at the time of collecting data for this study, others units in the Estate are under construction. Within the estate, there is a workshop for the production of building elements using EPS. Some elements produced using EPS in the workshop are depicted in Figure 2.

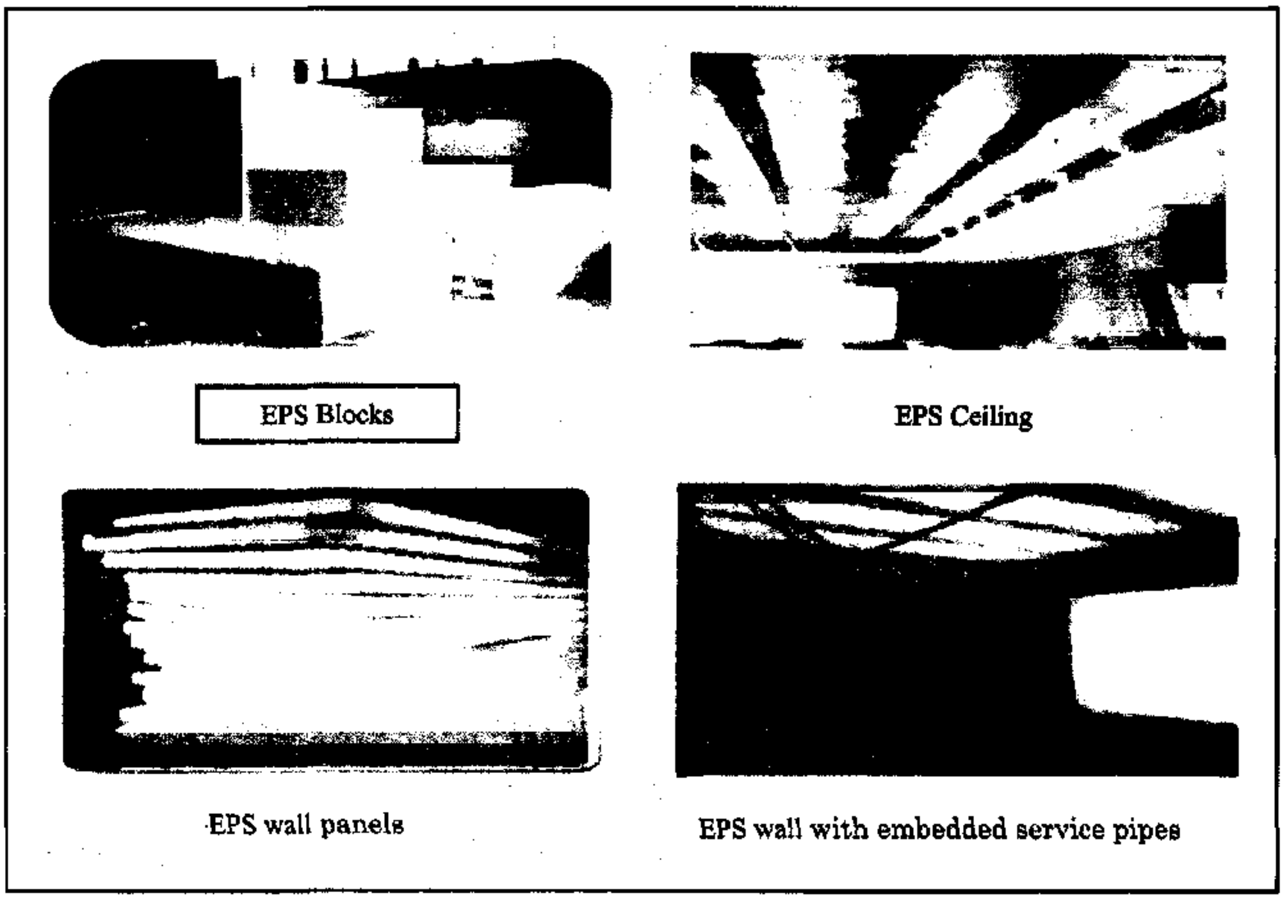

Figure 2: EPS Elements Produced in the Workshop at Citec Mbora Mount Pleasant Estate Abuja
Source: (Field Survey, 2019; Mansir et al. 2019)

In construction, polystyrene blocks are used as permanent insulation in structures and serve as thermal insulation, as seen in Figure 2. They are energy efficient and provide optimum insulation for building walls and roofs, and floors. Electrical wiring and plumbing pipes can be put into the polystyrene material, which makes it suitable for use in various applications. Constructing with EPS blocks is similar to building with toy blocks in that it is straightforward. Stability is achieved as soon as the concrete is cast into the blocks (EPS), and after the blocks are in position and situ, they create a structural framework. Although the fabrication of EPS elements of variable size, shape or colour can be done off-site, their assembling and subsequent finishing are done on-site. As is shown in Figure 2, service pipes are also embedded in the EPS element.

METHODOLOGY

This study seeks to investigate the performance of EPS through occupant's satisfaction. Several studies have assessed the performance of buildings through occupants/users satisfaction (such as Salleh & Ahmad (2008), Bilau & Witt (2015), Ishiyaku (2016) and also Nkpite & Wokekoro (2017). Adopting the data collection technique of these studies, data for this study is collected using a survey technique with the aid of a structured questionnaire. Each question consists of a 5-point Likert-type response item with categories as: Very Satisfied (5); Satisfied (4); Unsure (3); Dissatisfied (2); and Very Dissatisfied (1). Specific to assessing EPS used in buildings in Nigeria, this scale is recommended for use by (Ede et al. 2014).

Judgmental sampling is used in selecting the respondents. The claim informs the choice of such non-probability sampling of Fellows & Liu (2008), where they recommend its use when a researcher intends to use some informed judgement to determine the population and or sample of a study. Similarly, Saunders, Lewis, & Thornhill (2009) recommend judgemental sampling when a researcher wishes to select respondents that are particularly informative in fulfilling the research objectives. Since the respondents of this study cover occupants of the houses built with EPS in Citec Estate Mount Pleasant, Mbora District Abuja, information was obtained on respondents knowing that the houses they occupy were built with EPS. Based on such informed judgement, the researcher found that 57 occupants (which forms the sample of the study) residing in the estate acquired their houses when construction work was ongoing and are somewhat informed that EPS was used in the construction of the houses based on their involvement in some activities during the construction process. On the other hand, many occupants occupied the houses after construction in various capacities (owner-occupier or tenant). This information was obtained from Citec Construction Limited, the construction company that used EPS in building houses in Citec Estate Mount Pleasant, Mbora District Abuja since 2003.

Data will be analysed both descriptively and inferentially using IBM SPSS Statistics 23 to compute the frequencies. Furthermore, MS Excel will be used to compute the Mean Score. This measure has been used in construction management researches whereby John & Itodo (2013), Samuel & Eziyi (2014), Chan & Hou (2015) and also Ejohwomu et al. (2017) express it as:

$$\overline{X} = \frac{\sum X_i}{n}$$

where: $\overline{X}$ denotes the Mean Score

$\sum X_i$ is the sum of the number of responses and score awarded a variable (V_i; for $5 \geq V_i \geq 1$)

n denotes the total number of responses

The Mean Score obtained will be used as a basis to ascertain where each factor studied leans towards in the 5 point scale used (supported by Holt, 2014; Samuel & Eziyi, 2014; and also John & Itodo, 2013). Additionally, MS Excel will be used to compute the Relative Satisfaction Index (RSI), which will serve as a basis to rank the satisfaction level (by the occupants) of the performance requirements of EPS studied. The suitability in using RSI is obtained from the works of Aigbavboa & Thwala (2010) and also Olusola (2012), where they express RSI as:

$$RSI = \frac{1n_1 + 2n_2 + \ldots An_A}{AN} \quad (0 \leq RSI \leq 1)$$

Where:

$n_1, n_2, \ldots, n_A$ = number of respondents scoring response stem integers 1 to Amax (5), respectively.

A = largest integer on the response item (5 for this research)

N= total number of respondents

Furthermore, the respondent proportion scoring above or below the median value will be calculated. Such analysis helps draw inferences from the scoring profiles for each factor studied (refer to Holt, 2014; Joshi, Kale, Chandel, & Pal, 2015; Bishop & Herron, 2015; Carifio & Perla, 2007; and Harpe, 2015).

DISCUSSION OF RESULTS

All 57 questionnaires distributed were not only successfully retrieved, but all questions were answered. The demographics of the respondents are presented in Table 3.

Table 3: Demographics of respondents

Demography	Number of respondents	Percentage
Age (years)		
18-25	5	8.77
26-50	31	54.39
Above 50	21	36.84
Total	**57**	**100**
Period of occupancy (years)		
1-3	12	21.05
4-6	35	61.40
7-9	10	17.54
10 and above	0	0
Total	**57**	**100**

The age range of the respondents in ascending order are: 5 respondents are aged between 18-25 years; 21 respondents are aged over 50 years, and 31 respondents are aged between 18-25 years. From these results, most of the respondents (91.23 percent) are adults, which adds reliability to the opinions obtained on the performance requirement of EPS in the houses at Citec Mbora Estate Abuja. Also, while 21.05 percent of the respondents have lived in the houses between 1-3 years, 61.40 percent of the respondents have lived in the houses between 4-6 years. Similarly, while 17.54 percent of the respondents have lived in the houses between 7-9 years, none of the respondents have lived in the estate 10 years and above. From these results, over three-quarters of the respondents (78.94 percent) have lived in the houses for over 3 years. This duration of stay by the respondents in the estate is deemed to add reliability in the opinions obtained on the performance requirement of EPS based on their experience living in the houses at the estate.

Table 4 depicts the results of the 6 performance requirement factors of EPS studied. While maintainability of EPS ranked 1st (with a mean value of 3.56; RSI of 0.71), aesthetics ranked 2nd (with a mean value of 3.23; RSI of 0.65). Also, while fire resistance of EPS ranked 3rd (with a mean value of 3.14; RSI of 0.63), cold weather insulation ranked 4th (with a mean value of 2.81; RSI of 0.56). Furthermore, while Sound insulation of EPS ranked 5th (with a mean value of 2.54; RSI of 0.51), hot weather insulation ranked 6th (with a mean value of 2.47; RSI of 0.49).

Table 4: Satisfaction of the performance requirement of EPS in housing construction

Factor	Frequency of responses					Total	Scores below median	Scores above median	Mean Score	RSI	Rank
	5 VS	4 S	3 U	2 D	1 V.D.						
Maintainability	9	14	34	0	0	57	0	23	3.56	0.71	1st
Aesthetics	0	19	32	6	0	57	6	19	3.23	0.65	2nd
Fire resistance	5	5	40	7	0	57	7	10	3.14	0.63	3rd

Cold weather insulation	3	5	28	20	1	57	21	8	2.81	0.56	4th
Sound insulation	2	4	19	30	2	57	32	6	2.54	0.51	5th
Hot weather insulation	2	3	18	31	3	57	34	5	2.47	0.49	6th

Legend: 5- Very Satisfied, 4- Satisfied, 3- Unsure, 2- Dissatisfied, 1- Very Dissatisfied

From these results, although more respondents are satisfied with the 'maintainability' of EPS (23) followed by its 'aesthetics' (19), these numbers do not add up to half of the respondents studied. Also, while more respondents are dissatisfied with the 'hot weather insulation' of EPS (34) followed by its 'sound insulation (32), these numbers exceed half of the respondents studied.

While the Mean Score of maintainability (3.56) is the only result that leans towards occupants being satisfied with the performance of EPS, the Mean Score of hot weather insulation (2.47) is also the only result that leans towards occupants being dissatisfied with the performance of EPS. The Mean Score of aesthetics (3.23), fire resistance (3.14), cold weather insulation (2.81) and also sound insulation (2.54) all lean towards occupants being unsure with the performance of EPS.

Although the maintainability of EPS ranked 1st, it recorded the second largest number of respondents (34) that are unsure of its performance. Also, although fire resistance of EPS ranked 3rd, it recorded the largest number (40) of respondents that are unsure of its performance. These large numbers (constituting over half of the respondents studied in each factor) could result from a large number of respondents never experiencing any damage to the EPS from fire or any agent during their stay in the estate.

FINDINGS

Overall, occupants of Citec Mbora Estate are more satisfied with the maintainability of EPS and least satisfied with the hot weather insulation of EPS. Similarly, occupants of Citec Mbora Estate are more dissatisfied with its performance in hot weather insulation and sound insulation (more than half of the respondents are dissatisfied with each) than they are satisfied with its maintainability and aesthetics (less than half of the respondents are satisfied with each).

Furthermore, occupants of Citec Mbora Estate are more satisfied with the performance of EPS in cold weather insulation than they are with its performance in hot weather insulation. This is, however, contrary to the findings ofMansir et al. (2019), whereby professionals rated the performance of EPS used in constructing houses in Citec Mbora Estate to be better in heat insulation than in cold insulation. This is also contrary to the findings ofIbrahim et al. (2013) and also Ede et al. (2014) that rated the performance of EPS to be better in heat insulation than in cold insulation. A probable reason for this could be attributed to the active ventilation (fan, air conditioning) often used in the houses due to the annual climatic variation in Abuja, whereby hot weather lasts longer than cold weather.

Also, occupants of Citec Mbora Estate are more satisfied with the performance of EPS in terms of its aesthetic appeal than in its sound insulation. This supports the findings in Mansir et al. (2019), whereby professionals rated the performance of EPS used in constructing houses in Citec Mbora Estate to be better in aesthetics appeal than in sound insulation.

CONCLUSION AND RECOMMENDATIONS FOR FUTURE STUDY

The satisfaction of occupants residing in Citec Mbora Estate in terms of the physical performance of EPS (maintainability and aesthetics) is more than the satisfaction in terms of general insulation performance (heat, cold and sound). While this may be commendable, particularly regarding obsolescence costs, more efforts should be made regarding improving the insulation property of EPS used in constructing houses during manufacturing. Future research can look deeper into other factors that cause satisfaction with the factors studied in this research (factors such as cost, frequency, and culture of maintenance of EPS). Also, environmental factors that affect insulation can be covered in future studies of the houses built with EPS in Citec Mbora Mount Pleasant Estate.

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