

Affordable housing issue: users' perception on the adoption of cargotecture housing in developing economies

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Abstract:

The housing deficit in developing countries has been an issue of concern due to the influx of people into the urban centers for employment and a better life. Various housing policies implemented by the government are yet to achieve the affordable housing goals. Based on this background, this study aimed to assess users' perception of the adoption of cargotecture for affordable housing provision in developing economies using Nigeria as a case study. This study conducted a survey using purposive quota sampling techniques among one hundred and thirteen low-income earners in Lagos City, Nigeria. The study findings showed that the factors influencing adoption of cargotecture housing in the study area include reusability value, design flexibility, construction flexibility, and cost-effectiveness compared with conventional materials. The findings also indicated the limiting factors that mitigate the adoption of cargotecture housing as concerns on thermal insulation, limited examples of cargotecture housing, low awareness of cargotecture housing, and concerns about insulation. The study concludes that adopting cargotecture housing could help solve the housing issues, such as deficit, affordability, collapse, pollution, sustainability, flexibility, durability, and delay in completion time. The study recommends that cargotecture houses should be built with the low-income earners in mind with the option of instalmental payment to reduce homelessness.

Keywords:

Affordable Housing; cargotecture; housing deficit; low-income earners, shipping container

1 Introduction

Housing is recognised globally as one of the basic needs for humanity's growth and existence (Ajayi, 2019, Adeshina & Idaeho, 2019). Urbanisation and population growth have made it difficult for most developing countries to achieve housing goals. In Nigeria, population growth, commercialisation, politics, urban migration, and the high

cost of building materials have made housing unaffordable (Omiunu, 2014, Adeshina & Idaeho, 2019). Ezeigwe (2015) noticed that the main challenge of housing in Nigeria is affordability. According to the United Nations Population Fund annual report (2007), a larger percentage of the urban migrant in Nigeria are low-income earners who always live in shanty houses. Ugochukwu and Chioma (2015) opined that the Nigerian government has shown commitment to addressing the housing problem in several ways since its independence but has only resulted in low-quality, insufficient, and unaffordable housing units across the country. Ajayi (2019) asserted that the housing policy in Nigeria has failed to address the issue of housing affordability because the policy placed total responsibility on the government to provide housing for all the citizens.

The United Nations-Habitat stated that thirty percent of the world's urban population resides in slums, a distressing condition where people lack access to essential facilities in their houses. Ezeigwe (2015) noted that the lack of affordable housing is not just a Nigerian problem. It is a common experience in developed and developing countries (Ibimilua & Ibitoye, 2015). Ajayi (2019) opined that access to affordable housing among the middle and the lower-income earners in Nigeria remained an unfulfilled dream. As stated by the federal department of housing and urban development, affordable housing is an individual's ability to spend 30% or less of their monthly income on housing. Odia (2017) and Ogunbayo *et al.*, (2018) pointed out that housing affordability is measured by the factors such as the income level of the owners, the cost of the land, building materials, and labour that will be engaged in the construction of the house, and the cost of the funds.

According to National Housing Policy (1991), Patil and Pataskar (2013); Gulghane and Khandve (2015) opined that building materials account for more than half of the total cost of housing production. Similarly, Ugochukwu and Chioma (2015) argued that most housing developers insist on using conventional building materials and technologies. Ogundipe, *et al.*, (2021) noted that most end users lack adequate information about alternative building materials performance and management. Therefore, the research on affordable housing needs to focus more on adopting alternative non-conventional building materials. Ugochukwu and Chioma (2015) opined that adopting non-conventional building materials and technology will go a long way in solving housing deficit issues in developing countries. Based on this background, this study assessed users' perception of factors influencing adoption of cargotecture housing in developing economies using Lagos, Nigeria, as a case study.

2 Literature Review

The steel container is known by various alias based on its uses. When used for shipping purposes, it is referred to as a shipping container, cargo container, Conex box, or ISO container (Intermodal Steel Building Units and Containers Homes 2009). A shipping container is a modular building component derived from reusing steel shipping containers as a structural element or architectural envelope in a building (Radwan, 2015). This type of architecture is often called cargotecture, a combination of conventional architecture with shipping containers. Shipping container housing is a form of lean construction that provides alternative construction materials to blocks,

bricks, and mortar or concrete by incorporating prefabrication and modularisation principles. Ogundipe *et al.*, (2021) argued that continuous use of concrete for housing production negatively affects the environment due to the depletion of raw resources. In Nigeria, shipping containers are found at the Tin-can Island port Lagos to import and export goods via accessible transport networks. Most construction firms use shipping containers for temporary site offices and storage, while others use them for shops, markets, and sheds (Oloto & Adebayo 2015). Maphumulo (2016), Tanyer, Tavukcuoglu and Bekboliev (2018) noted that the reuse of shipping containers for construction materials is known as an intermodal steel building unit, while the practice of reusing shipping containers to create temporary shelter and dwelling units is known as cargotecture. Each shipping container has six components, the base, four sides, and the top. The sides are corrugated to withstand pressures that may arise during loading and transport (Intermodal Steel Building Units and Containers Homes 2009). Shipping container bottom floors are built of hardwood, such as birch or teak, and can bear a considerable weight. It can survive extreme weather and saltwater temperatures and have a long-life cycle (Nunes 2009).

Table 1: Standard shipping container dimension chart

Container type	10ft. shipping container	20ft shipping container	40ft shipping container	20ft high-cube shipping container	40ft high-cube shipping container
External length	10ft. (3.05m)	20ft. (6.09m)	40ft. (12.18m)	20ft. (6.09m)	40ft. (12.18m)
Internal length	9ft. 2in. (2.79m)	19ft. 4in. (5.89m)	39ft. 5in. (11.99m)	19ft. 4in. (5.89m)	39ft. 5in. (11.99m)
External height	8ft. 6in. (2.59m)	8ft. 6in. (2.59m)	8ft. 6in. (2.59m)	9ft. 6in. (2.90m)	9ft. 6in. (2.90m)
Internal height	7ft. 8in. (2.34m)	7ft. 10in. (2.39m)	7ft. 10in. (2.39m)	8ft. 8in. (2.64m)	8ft. 10in. (2.69m)
External width	8ft. (2.44m)	8ft. (2.44m)	8ft. (2.44m)	8ft. (2.44m)	8ft. (2.44m)
Internal width	7ft. 7in. (2.31m)	7ft. 8in. (2.34m)	7ft. 8in. (2.34m)	7ft. 7in. (2.31m)	7ft. 8in. (2.34m)

Source: Interport Global Logistic, assessed July 23, 2020

Most times, shipping containers became an environmental concern and were abandoned at the seaports or warehouses after delivering goods and occupying useful spaces (Galal El-Deen Mohamed, 2017). Thus, challenged building stakeholders' in converting shipping containers to innovative housing. Shipping containers are produced with 'weathering steel,' usually called 'corten steel.' Corten steel containers are much stronger than traditional steel and are less prone to corrosion. Moore, Yildirim and Baur (2015) opined that shipping containers are desirable construction materials for different purposes. In addition, Nduka *et al.*, (2018) opined that shipping containers could be a viable means of solving housing gaps in developing and post-disaster countries.

Moreover, in the last decades, different studies have been carried out on adopting and applying cargotecture as alternative building materials. In India, Vijayalaxmi (2010) argued that cargotecture or 'greentainer' buildings have similar embodied energy and indoor thermal performance compared with the buildings constructed with conventional materials. Similarly, in Turkey Atmaca and Atmaca (2016) noted that the net present value approach was adopted to investigate life cycle investment, operation,

maintenance, service, and end-of-life costs of using cargotecture or prefabricated housing for post-disaster construction. In Egypt, Galal El-Deen Mohamed (2017) opined that shipping containers help students learn and practice modular architecture. In addition, some studies on the structural capacity of cargotecture include (Giriunas *et al.*, 2012; Islam *et al.*, 2016; Tanyer, Tavukcuoglu & Bekboliev 2018). Consequently, Grant (2013), Ismail *et al.*, (2015) opined that thermal and energy performances differ in different climatic conditions. Botes (2013), Oloto & Adebayo (2015), and Balogun (2018) addressed the possibility of using cargotecture in solving the housing shortfall in developing countries. Zhang *et al.* (2014), Hong (2017) examined the suitable dimension of providing temporary housing for post-disaster/conflict victims. Nduka *et al.*, (2018) assessed drivers and barriers to using cargotecture for habitable housing.

Knowledge of the applicability of cargotecture has dramatically expanded in recent times. Recently, many people were building their houses using shipping containers. Smith (2006), Brandt (2011), Alemdağ and Aydin (2015) argued that cargotecture offered to design and construction flexibility in solving the housing deficit in an economically depressed country. Elrayies (2017); Botes (2017) opined that cargotecture is relatively cheap, the construction process is environmentally friendly, and three times faster in construction of multi-storey buildings than conventional. Radwan (2015) asserted that cargotecture is suitable for low-cost mass housing and requires little time to maintain. According to Nduka *et al.*, (2018) cargotecture prevent wastage and serves as a mean of providing temporary housing. Grebowski and Kaldunek (2017) opined that cargotecture housing is mobile, as the components could be transported away from the original location.

Noticeable limitations of adopting cargotectures include: Nduka *et al.*, (2018) argued that low awareness, the problem of acceptability, and restrictions in height and space were the major factors limiting the use of shipping containers in Nigeria. In Australia, Islam *et al.*, (2016) argued that the limitation of using cargotecture housing include: concern of thermal insulation because of highly moisturised zone, region Byelaws, negative environmental impacts, and shortage of skilled labour required for the construction and maintenance. Brandt (2011) and Alemdağ and Aydin (2015); Islam *et al.*, (2016) opined that concern of thermal insulation of using cargotecture in a highly moisturised zone. Islam *et al.*, (2016) argued that some regions might have Byelaws that prevent the use of cargotecture housing. Giriunas, Sezen, and Dupaix (2012) opined that public acceptability of cargotecture may be a limiting factor to its adoption. Brandt (2011); Islam *et al.*, (2016) opined that the shortage of skilled labour required for the construction and maintenance of cargotecture limits the adoption. Hence, this study seeks to fill the knowledge gaps by investigating user perception of factors influencing the adoption of cargotecture housing; and limiting factors of cargotectures housing adoption in developing countries like Nigeria.

3 Research Method

The research investigates users' perception of factors influencing the adoption of cargotecture as an affordable housing provision for low-income earners in Lagos city, Nigeria. Lagos was considered for the survey because it is a commercial hub for industrialisation that has led to the rise in rural-urban migration (Ogunde *et al.*, 2017).

The study adopted purposive sampling techniques in identifying 50 Government workers (levels 1-6), 20 entrepreneurs, 35 private workers, and 45 other individuals (10 domestic workers, 10 drivers, 15 artisans, 10 labourers) in the study area with an annual income of $\text{₦}250,000 \leq X \leq \text{₦}1,000,000$. However, due to the Covid-19 pandemic lockdown and restriction in the year 2020, 113 respondents participated in the survey. Hence, the survey was conducted on a five-point Likert scale 5= highly significant, 4= significant, 3= moderately significant, 2= of less significant, 1= insignificant on the 17 identified factors influencing adoption of cargotecture housing, and 15 limiting factors of cargotectures housing adoption in the study area. The survey questionnaire was administered physically and via email. The data obtained from the survey were analysed using Statistical Package for Social Sciences (SPSS) version 21. Descriptive statistics such as percentages, mean, and relative importance index ranked user perception on the identified factors in line with the study's objectives. The results of the analysis were presented in pie charts and tables.

4 Findings and Discussion

Figure 1 presents the occupation description of the respondent. The largest 31.9 % (36) of the respondents have their occupation under other categories involving (domestic workers, drivers, artisans, and labourers), 26.5 % (30) were private workers, 23.9 % (27) were entrepreneurs, and 17.7 % (20) were government workers.

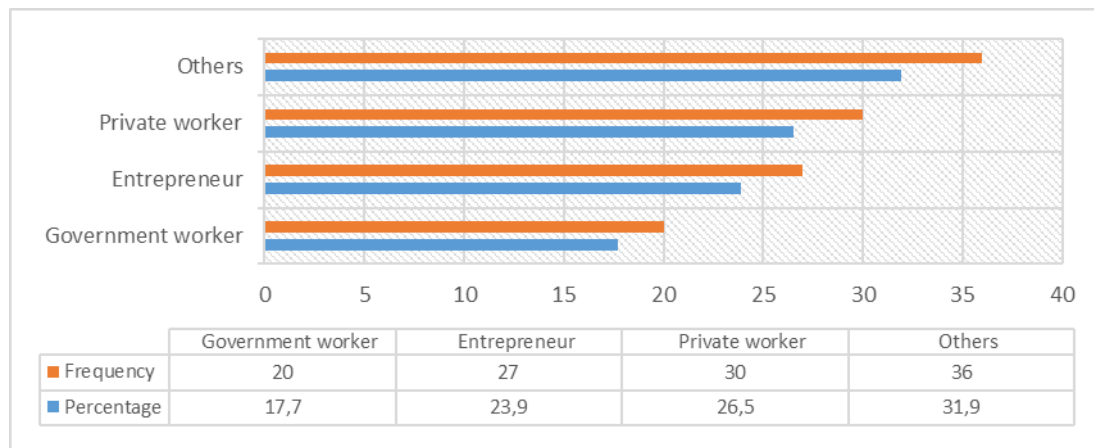


Figure 1: Occupation description of the respondents

Figure 2 presents the average annual income of the respondent. 76.1 % (86) of the respondents earn between $\text{₦}250,000 - \text{₦}500,000$ annually. This is followed by 13.3 % (15) who earn an annual income of less than $\text{₦}250,000$. Also, 9.7% (11) earns between $\text{₦}750,000 - \text{₦}1,000,000$ annually, while 0.9% (1) earns between $\text{₦}500,000 - \text{₦}750,000$ annually income. None of the respondents earns above $\text{₦}1,000,000$ annually.

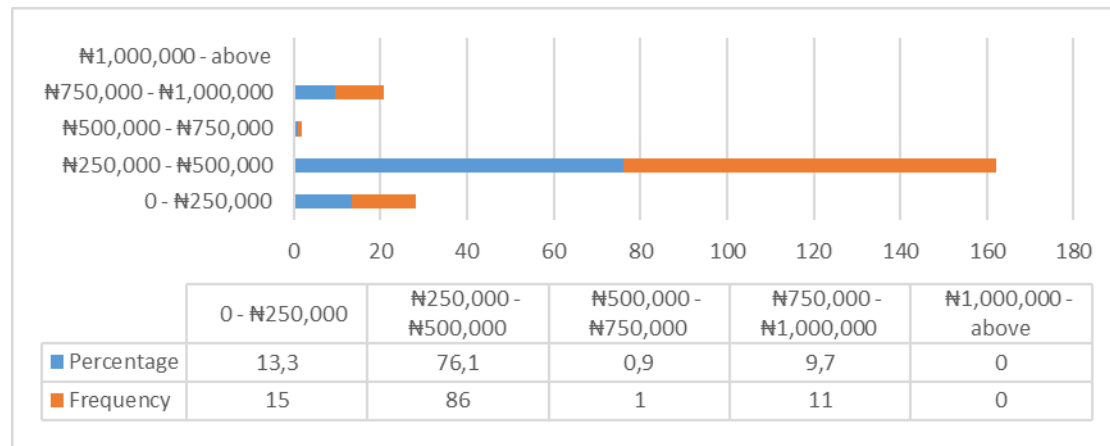


Figure 2: Average annual income of the respondents

From figure 3, 45.1% of the respondents live in rented houses, 27.4 % (28) live in their self-owned homes, and 27.4% (27) squat or live with family.

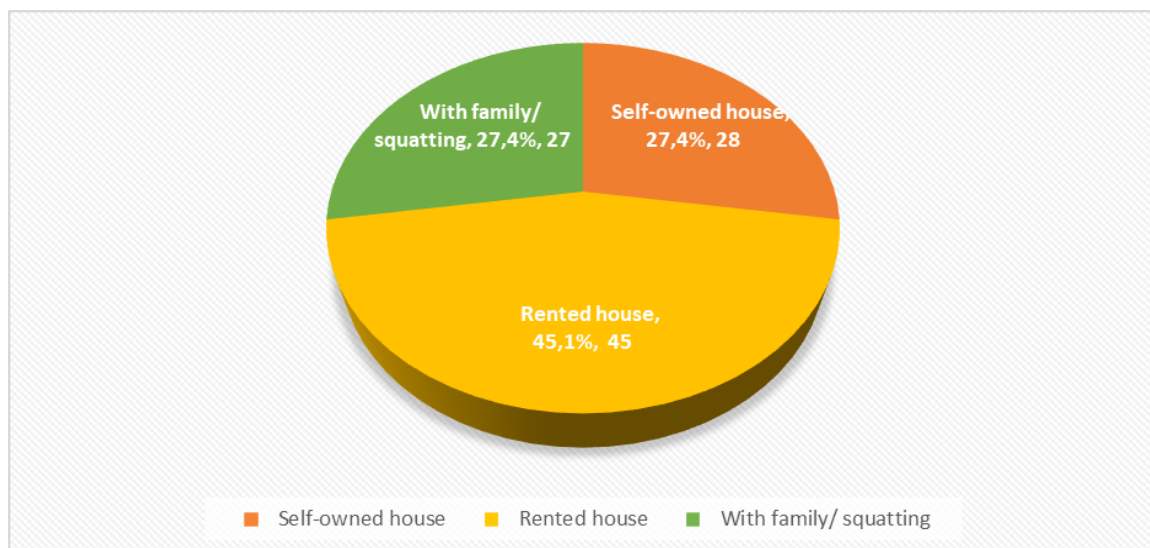


Figure 3: The family size of the respondents

Table 2 presents the respondents' perception of the factors that aid the adoption of cargotecture housing using a 1-5 Likert scale rating (5= highly significant, 4= significant, 3= moderately significant, 2= less significant, 1= insignificant). The respondent perception was ranked using the mean and relative importance index. The top-ranked factors influencing the adoption cargotecture are its reusability nature with little modification with (MS= 3.71, RII= 0.742), this is followed by design flexibility (MS= 3.67, RII= 0.735), and construction flexibility (MS= 3.61, RII= 0.722). The finding is in line with Smith (2006), Brandt (2011), and Alemdağ and Aydin (2015) as cargotecture offered design and construction flexibility in solving housing deficit in an economically depressed country. Other factors that were highly ranked include cargotecture is cost-effective than conventional building materials (MS= 3.57, RII= 0.713), cargotecture is sustainable (MS= 3.57, RII= 0.713), speedy means of owning a

house (MS= 3.55, RII= 0.710) respectively. However, the last three ranked factors were cargotecture is best used for the construction of schools (MS=3.39, RII=0.678), cargotecture provides quality and affordable housing (MS=3.35, RII=0.671), off-site construction (MS=3.30, RII=0.660).

Table 2: Factors influencing the adoption of cargotecture housing

Factors	Mean	R.I. I.	Ranking
Cargotecture reusability with little modification	3.71	0.742	1
Design flexibility	3.67	0.735	2
Constrcution felxibility	3.61	0.722	3
Cost-effective than conventional building materials	3.57	0.713	4
Cargotecture is sustainable	3.57	0.713	4
Speedy means of owning a house	3.55	0.710	6
Cargotecture offers movable housing	3.53	0.706	7
Suitable for low-cost mass housing	3.52	0.704	8
Waste reduction	3.51	0.703	9
The construction process is environmentally friendly	3.50	0.701	10
Affordable maintenance cost and process	3.49	0.697	11
Increase profitability	3.49	0.697	11
Cargotecture will be best used in the construction of houses	3.48	0.696	13
Cargotecture tends to offer affordable housing delivery for low-income earners	3.46	0.692	14
Cargotecture is best used for the construction of schools	3.39	0.678	15
It provides quality and affordable housing	3.35	0.671	16
Off-site construction	3.30	0.66	17

Source: Researcher's field survey (2020)

Table 3 presents the respondents' perception examined limiting factors of cargotectures housing adoption using a 1-5 Likert scale rating (5= highly significant, 4= significant, 3= moderately significant, 2= less significant, 1= insignificant). The respondent perception was ranked using the mean and relative importance index. The most perceived factor limiting adoption cargotecture housing is the concerns on thermal insulation (MS= 3.6, RII= 0.733), followed by Limited examples of cargotecture housing (MS= 3.65, RII= 0.729), low awareness on cargotecture housing (MS= 3.64, RII= 0.737), and concerns on insulation (MS= 3.61, RII= 0.712). The findings support Nduka *et al.* (2018) on low public awareness of adopting cargotecture housing. The finding is also in agreement with Brandt (2011), Alemdağ, & Aydin (2015), Islam *et al.*, (2016) findings that there is a concern about using thermal insulation for cargotecture housing in a highly moisturised zone. Other factors that are least ranked were supporting Byelaws (MS= 3.38, RII= 0.676), concerns on repainting (MS= 3.35, RII= 0.669), and concerns about rusting (MS= 3.34, RII= 0.667) were against the findings of (Islam *et al.*, 2016, Nduka *et al.*, (2018).

Table 3: Factors limiting the adoption of cargotecture housing

Limiting factors on cargotecture	Mean	R.I.I.	Rank
Thermal insulation	3.66	0.733	1 st
Limited examples of cargotecture housing	3.65	0.729	2 nd
Low awareness on cargotecture housing	3.64	0.727	3 rd
Concerns on insulation	3.61	0.722	4 th
Shortage of skilled workers	3.56	0.712	5 th
Concern on installation of service facilities	3.54	0.708	6 th
Public acceptability	3.5	0.701	7 th
Restriction in height	3.44	0.688	8 th
Concern on removing blocked drainage pipes	3.42	0.683	9 th
Concerns on seepages/ leakages	3.41	0.681	10 th
Toxic emission from container	3.4	0.68	11 th
Inadequate space circulation	3.39	0.678	12 th
Supporting byelaw	3.38	0.676	13 th
Concerns on repainting	3.35	0.669	14 th
Concerns on rusting	3.34	0.667	15 th

Source: Researcher's field survey (2020)

5 Conclusion and Further Research

This study has examined users' perception of factors influencing the adoption and limiting factors of cargotecture housing among low-income earners in developing countries, using Lagos, Nigeria, as a case study. This is to establish facts from the general opinion about adopting shipping containers for housing. The study survey perception of the respondents that cut across different parastatal (government workers on (level 1-6), entrepreneurs, private organisation workers, and other individuals that consist of (domestic workers, drivers, artisans, labourers) in Lagos city, Nigeria. The major factors influencing the adoption of cargotecture housing include the reusability nature of cargotecture with little modification, design flexibility, construction flexibility, and cost-effectiveness compared with conventional materials. Similarly, the limiting factors of cargotecture housing adoption include concerns about thermal insulation, limited examples of cargotecture housing, low awareness of cargotecture housing, and concerns about insulation. The study concludes that adopting cargotecture housing could help solve the housing issues, such as deficit, affordability, collapse, pollution, sustainability, flexibility, durability, and delay in completion time.

The study highlighted factors influencing the adoption of cargotecture housing among low-income earners in developing countries like Nigeria in addressing the needs for affordable housing due to the high population growth rate and urban expansion. In addition, the study also examined factors militating against the adoption of cargotecture housing in the study area. These contributions will help government agencies, stakeholders, and individuals intending house owners to see the possibility of adopting cargotecture housing in the future. However, stakeholders need to educate the public, government, and policymakers on the architectural benefits of shipping containers for cargotecture housing. This study's practical implication provides insight into how low-income earners in the urban cities living in shanty houses can access affordable housing using cargotecture. Therefore, the study recommends that cargotecture housing should

be built with the low-income earners in mind, including the option of installment payment to reduce homelessness. Additionally, this study's finding also gives room to further research by exploring more case studies involving a large sample size of respondents from the privates and public sectors.

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