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Reducing Construction Carbon Footprint Through Increasing Local Reuse of Building Material in Calabar, Cross River State

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Abstract

This paper explores the potential for reducing the construction carbon footprint by increasing the local reuse of building materials from construction sites in Cross River State. The construction sector consumes vast resources and generates substantial waste throughout the design, processing, transportation, construction, and demolition phases. These activities are energy-intensive and pose health and safety risks. Building construction significantly contributes to energy use and carbon dioxide emissions, accounting for about 40% of greenhouse gas emissions. In West African states, including Nigeria, where construction material costs have soared, the high expense of building materials has become unaffordable for many low-income earners in urban areas. This scenario necessitates a shift towards green building practices, including the reuse of surplus construction products. Such a shift could involve training for energy-efficient practices and creating employment opportunities for workers displaced by these changes, as well as establishing a market for used construction materials. The paper proposes the establishment of a network of construction reuse centers in Cross River State. It discusses current drivers and barriers to adopting this model and its potential benefits, including a reduction in carbon footprints and a move towards a more sustainable construction industry. In the United States, the Natural Building Materials Reuse Association connects over 500 enterprises, showcasing the potential for similar initiatives in Nigeria. Recent statistics indicate that approximately 200,000 tons of metal and 320,000 tons of conjugated sheets have been recycled and reused in Nigeria. Reusing construction materials can reduce the need for raw materials, processing, and manufacturing, significantly cutting transportation impacts and overall environmental effects. For instance, reclaimed steel and timber have demonstrated environmental impact reductions of 96% and 99%, respectively.

Key words: building materials, carbon footprint, construction, reuse,

Background to the study

Building energy use remains a very significant proportion of overall energy demand around the world according to United Nations Environmental Programme (2020) buildings are the longest driver of both energy were and carbon (iv) oxide emission, it also account for about 40Z of greenhouse gas emission (Osuizugbo and Ojelabi (2020), Bevan and Yong (2015), Nduka and Sotumbe (2014), Amuda Yusuf, etal (2020) upheld that building accounted for 57% of total final energy consumption in African and 32% of total process related carbon (iv) oxide emission in 2019. Among the Asian tigers (Chin, India, Malaysia, Indonesia, Asia) building accounted for 26% of total final energy consumption and 24% total process and carbon (iv) oxide emission 29% of greenhouse emission whereas in South America and the Caribbean's, building accounted for 21% total process carbon (iv) oxide emission and 24% of total final energy consumption.

Osuizugbo etal (2021) contended that, it the presence patterns in the construction industry is not reverse there is a high propensity of increasing ecological footprints that may be detrimental to the sustainable development of the overall built environment as the expansion of the built environment will destroy the natural habitat and invoke some more ecologically related misnomers on the land surface driven mainly by increases in population declining incomes and economic prosperity, and rapid urbanization. Although the construction industry is the means through which nations actualized their potentials for urban development livelihood enhancement and increase in the gross domestic product (GDP) worldwide, but the same industry uses huge amount of limited resources and produces huge waste during construction and deconstruction processes which have the negative impact on most prospective builder balance sheet and possess a negative environmental impacts as it decrease impact use efficiency and increases carbon foot print. All these has resulted in a paradigm shift in favour of embedding ecological principles into constructing projects lifecycle and looking forward to others associated technologies of creating structures and using processes that are environmentally friendly and resource efficiency throughout the life cycle of the building (Buys and Hurbissoon, 2011). This new paradigm on shift has the capacity of reducing carbon emissions by 39%, water usage by 40% energy usage by 50% and solid waste by 70%.

Most construction sectors are supported by centers of reuse surplus building are materials in most large towns and supplying a significant flow of materials to the skilled and unskilled smelters and the market. One example of this is bricks which can be reused (surplus bricks collected from a construction site and reused elsewhere), reclaimed and remarketed. In this case excess mortar is removed and the bricks is downcycled (bricks crushed and reused). Downcycling in this context is used to distinguished the form of recycling where a higher-value product is remanufactured into something of lower value, thereby downgrading its value.

One promising approach to reducing the carbon footprint of construction is the increased reuse of building materials. Reuse, as opposed to recycling or downcycling, involves utilizing materials in their original form, thereby preserving the embodied energy and reducing the demand for new raw materials. This strategy not only reduces carbon emissions but also minimizes waste, conserves natural resources, and contributes to the circular economy. The reuse of building materials is particularly relevant in regions where construction activities are booming, and the demand for materials is high. By fostering a culture of reuse and promoting the use of locally sourced materials, the construction industry can play a significant role in mitigating climate change and advancing sustainable development.

Statement of the Research Problem Despite the evident benefits of material reuse in reducing carbon emissions and promoting sustainability, the construction industry has been slow to adopt this practice on a large scale. Several barriers, including regulatory challenges, lack of awareness, and logistical difficulties, have impeded the widespread implementation of material reuse strategies. Moreover, there is a scarcity of research that quantifies the potential carbon savings from increased local reuse of building materials, particularly in developing regions where construction activities are rapidly expanding.

The reluctance to embrace material reuse is further exacerbated by the absence of robust frameworks that guide the selection, testing, and integration of reused materials into new construction projects. As a result, valuable opportunities to reduce the carbon footprint of construction are being missed. This research seeks to address these gaps by investigating the potential of increasing local reuse of building materials as a viable strategy for reducing construction-related carbon emissions.

Literature Review

Reuse Enterprise Linking to Site Waste Management Centres Building the initiative of reuse enterprise on the introduction of solid waste management plan in 2008 in Nigeria is a very welcome generic project on its currently obtained in major Nigerian cities. This combines current expertise in reuse and a growing network reusable building products from construction and demolition waste stream by providing waste collection service on construction sites, and the development of centres that sorts, store and display materials for resale in small building trade markets. Although currently in Nigeria business horizon is limited and handled by unskilled middlemen as opposed to recycling initiatives model. The initial startup investment capital, popularity of the reuse materials in the market and high premises cost remains a significant barrier to building new initiative by going beyond source segregation of materials to enable local ruse of surplus materials from construction sites.

Research by Essex and Whelan (2010) has shown that new construction sites generate the greatest volume of construction products that can be easily reused locally. The range of products includes bricks, blocks, timber, tiles, plumbing and sanitary wares tools, finishes, metal rods and more. Analysis of average waste volume and material breakdowns produced by the building Researcher Establishment in United Kingdom shows that their project could support a network of reuse centres in the major cities in UK and Nigeria especially when combined with refurbishment, commercial fit-out and the growing opportunity of eco-retrofit, the opportunity for reuse is even greater.

Reducing Construction's Carbon Footprint. The construction industry is the largest source of waste in Nigeria. According to Osuizugbo and Ojelabi (2020) and Wrajo (2010) the construction industry is responsible for over 100 million tons of construction excavating and demolition waste over the last decade. Not all of this waste is reusable, excavation waste is used for filling swamp or reclaiming spoiled area and can be fed through a soil washing process while the rest can be crushed to create recycle aggregate or Incineration of biomass to recover energy. Raising a brick or precast concrete or a lane of timber, or a length of iron rod or electrical materials as a construction product recover for great energy, while recycling and downcycling are increasing, reuse in declining in a study survey reported by key, (2008) showed that in the last decade, the amount of construction materials reused in the UK has plummeted by 25% while total construction reused and demolition waste was estimated at 89.6 million tones. A total of 46 million tones was recycled while the remaining 43 million tones was spread on exempt site (or thrown away to landfill as waste. In similar study carried by Alade (2024) he observed that the amount of construction materials reused in Lagos State has increased to about 43% while total construction and demolition wastes was estimated at 32.4 million tones. A total of 19 million tones was recycle while the remaining 21.4 million tones was thrown to the landfill as waste, while some was used to fill eroded lands. Diversion of waste from landfills in Lagos is overwhelming achieved through downlinking. The breakdown of composition of construction waste (%) is shown in the figure below.

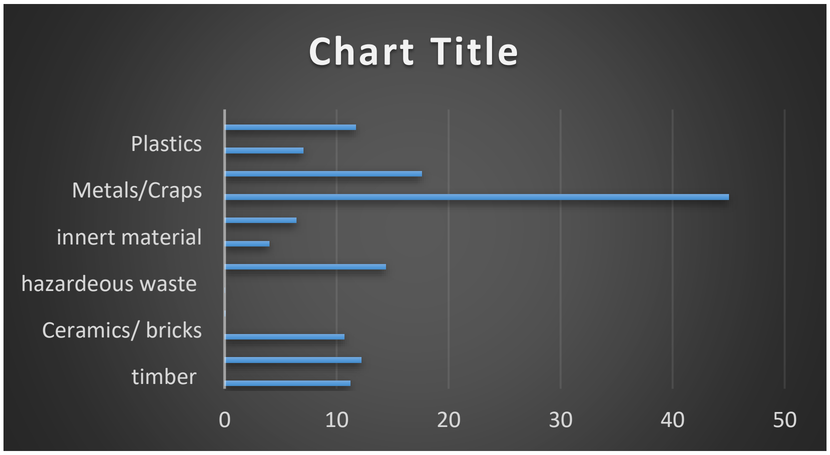

Fig 1: Breakdown of composition of construction waste (%) adapted from Alade (2014) BRE (2009).

The breakdown of composition of construction waste computed was based on estimate from residential, institutional and public sector building and ongoing civil engineering projects. The analysis excludes contents of buildings (blinds, furniture's electrical equipment's). the analysis demonstrates a considerable potential to develop a nationwide network of building material reuse centres based on an overall reusable portion of at less 10%. Also considering construction works in rapidly developing urban centres in Nigeria reuses centres require adequate feedstocks from commercial and civil projects in the central business district and area of city expansion and renewal, thus comparing the estimate of the amount of reusable products li9kely to come from Lagos, Kano, Aba and Onitsha across Nigeria, it clearly suggest that more than 350-80 construction reuse centres would be needed in these cities with a population of above 100,000 person. As the reuse centres increase a concomitant higher level of recycling takes place this is in tandem with areas such as London boroughs Belgium, Glasgow where recycling rate is 72% and with a population of over 150,000 persons.

The construction sector role of reducing carbon footprint in Nigeria is still at the lowest ebb, focus is yet to be achieved, but what is currently practiced is the designing of structures that will lower the carbon emission rates, enhancing retrofit agenda and developing down cycling centres in every major Nigerian city. Until the focus in fully achieved construction sectors in Nigeria must accept to take responsibility for reducing our daily carbon emission by at least 15% from on-site energy use and transport. One way of achieving this milestone is for carbon emissions of construction projects to be minimized at the project's outset and then measured and reduced as a contractual requirement, it is then most likely, the potential of reducing carbon footprint is likely to shift towards greater reuse.

Beyond the level of inter-regional growth are volume of developments currently taking place in these cities that are specific opportunities currently springing up for reuse, the main barriers to extensive adoption as a green technology in the construction industries which include higher initial cost of the reuse technology market demand, limited knowledge and skills on the part of the users' sub-contractors and the relative resistance to change and lack of government incentives and commitment (Amauda-Yusuf et al, 2020). However, Leyden and Essex, (2008) opined that supply and demand for reusable building material's rarely happens at the same time or at the right time quantities exchange of large volume of recycle and excavated materials need to be advertised for reuse, with direct notification to all who deal in a certain product range and within a given geographical area as a viable opportunity to link brokers and end-users with new reuse centres through a collaborative approach which would support both delivery and replication of locally sustainable reusable technologies.

Materials and Methods

The study adopted a field survey method to reveal the drivers for reducing carbon footprints and the Nigerian construction industry. A list of drivers and barriers was used to design the survey questionnaire to achieve the study objectives. A pilot study was conducted before administering the questionnaire to the respondent. The reliability test shows a cronbach Alhpa score of 0.75% against the measured item, the purpose sampling method was used in the questionnaire administering in Calabar. Questionnaire was administered to builders, contractors, building equipment suppliers, used iron, bricks, woods and others accessories vendors and scavengers. The questions constructed using the liked scale's a total of 200 questionnaires were administered, dated obtained was analyzed. The relative importance index (RII) was used to determine a relative importance of variables considered in research.

Research and Discussion

To determine the drivers for reducing carbon footprints in the Nigeria in construction industry the field data is presented as a weighted men average in table.

Table 1: DRIVERS FOR REDUCING CARBON FOOTPRINTS BY INCREASING LOCAL REUSE OF BUILDING MATERIALS.

S/N	Drivers	Weighted Mean	RII	Spear Mean Rank
1	State of the local economy	3.67	0.73	3
2	Creation of new jobs	4.27	0.85	1
3	Minimization of environmental burden	3.64	072	5
4	Provision of essential household appliance for low income	3.180	0.64	7
5	supply chain partners and regulators	4.18	0.83	2
6	Product quality and eco-footprints of the product	3.45	0.69	6
7	Attitude of consumers of reuse products	3.65	073	4

Table 1 revealed that there are more male in the reuse enterprise (128 males) constituting 0.4% while the female (62) constituting 36.0 percent, more participants in the survey hach HND constituting 37.5, this was closely followed by OND holder (32.0 percent). Professional background of respondents showed that more unskilled workers Artisan constituted the bulk 4/0 percent civil engineers 13.0 percent and Architects, 8.5 percent. On experience in the construction industry, participants with 16-20 years constituted the majority, this is closely followed by 11-15 years (33.0 percent) this group of participants had demonstrated to had adequate experience in the construction reuse enterprise and this possess the competence that in required for such and enterprise.

Table 2 CHARACTERISTIC OF SURVEY PARTICIPANTS

		Frequency	Percentage (%)
Sex:	Male	128	64.00
	Female	63	36.00
Total:		200	100
Qualification Attained			
OND		75.64	32.0
HND		75	37.5
B.Sc/B.Tech.		51	25.5
MSc		10	5.10
Total:		200	
Professional Background of Respondent			
Artisan		82	41.0
Builders Civil Engineers		75	37.5
Architects		17	8.5
Total:		200	
Experience in the Construction Industry			
5 – 10 years		22	11.0
11-15 years		66	33.0
16-20 years		80	40.0
21 and above		32	16.0
Total:		200	

Drivers for reducing carbon footprints by increasing local reuse of building materials.

The result is represented on table 2. Table 2 shows that the degree of importance of the drivers for reducing carbon footprint is high for two out of the seven factors (RII – 0.80). The values of the other factors are relatively moderately high with the least scoring RII value of 0.64, with the state of the economy coming third, and attitude of consumers of reused products being fourth by the spearman rank coefficient.

Barriers to local reuse of construction materials as a means of reducing carbon footprints. The relative importance index (RII) and standard error was used to analyzed the data and ranked using the spearman rank coefficient and presented in table 3; Table 3 shows that lack of incentives for promoting reuse of construction materials was ranked first on the level of relevance, with RII=0.89 and standard duration of .403, low level of awareness was ranked the second with RII=0.88 and standard Error value of .389, lack of institutions to formulate policies and set guideline came third and the least was market factors imitating against reuse items R=0.64 S.E=.233.

Table 3 BARRIERS TO LOCAL REUSE OF CONSTRUCTION MATERIALS AS A MEANS OF REDUCING CARBON FOOTPRINTS

S/N	Barriers	Weight mean	RII	S.E	Spearman rank
1	Low level awareness	4.40	0.88	.389	2
2	Lack of local expertise and higher cost	3.51	0.71	.340	5
3	Reluctance arising from the used to avoid future risk 3.30	3.30	0.67	26.5	8
4	Inadequate/lack of reuse handling tools	3.49	0.69	28.1	7
5	Market factors militating against reuse items	3.65	0.75	35.2	4
6	Poor level of technological transfer and knowledge in product reuse				
7	Lack of incentives for promoting reuse construction materials	4.45	.0.89	403.1	1
8	lack of institutional to formulate policies and set guidelines	3.85	0.56	.363	3

Estimated Quantities of Reuse Construction Materials between 2015-2022

Table 4 revealed that estimated quantities reuse material kept increasing from 2015 to 2022. This is probably due to many factors such as increased level awareness on the end-users, increased demand for reused materials due to the current state of the economy and the recovery technologies in use, the market factor for reused materials and the current upsurge for a green building geared at reducing the carbon footprint to the barest minimum.

Table 4: ESTIMATED QUANTITIES OF REUSE CONSTRUCTION MATERIALS BETWEEN 2015-2022

Period	Quantity of scrap metal tonnes/1kg	Quantity of wooden materials tonnes/1kg	Concrete	Ceramics and bricks	Electrical installation	Offices/Adhoc
2015	109046	127020	39420	3042	445	702
2016	114745	132362	40065	3164	478	844
2017	123094	144220	46343	3325	496	882
2018	140026	169120	47682	3788	508	894
2019	184168	194950	50026	3895	558	942
2020	203045	205366	52474	4006	565	1021
2021	235049	224412	56306	4140	592	1206
2022	392540	286184	64855	5268	634	1558

Conclusion

Strategies for on-shore infrastructural deconstruction to achieve zero carbon and zero waste including detailing how biomass heating and transformations as other practiced waste to energy solutions could be implemented. Facilitating a future of carbon footprint reduction through deconstruction and finding markets for reclaimed materials has been investigated, which highlighted the lost and carbon savings, thus increasing recycled building materials through small and medium-size recycling actions construction waste can be minimized and effectively handled. Although there are efforts by some state government and private enterprise currently on, household training for consolidation of materials to supply eco-construction projects, from approved suppliers, reuse of building products and architectural salvage need to harnessed for green building in the future.

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