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Exploration of Waste Categorization in Building Construction Activities in Southwestern States, Nigeria

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ABSTRACT: This paper examines the issue relevant to waste categorization across building construction activities in southwest states, Nigeria, this is achieved through the used of systematic random sampling to the administered questionnaire to two hundred six-one (261) questionnaires Architects, Builders, Engineers, Quantity Surveyor, Town Planners, and Project Manager etc. across the six (6) states that makeup of the southwest states of Nigeria namely Ekiti State, Lagos State, Ogun State, Ondo State, Oyo State and Osun State. The paper found that waste was generated from pre-design to post-construction stages, the wastes generated includes paper, other packaging materials, foam, cement, marbles, mortar, plastic/rubber, wood, glass, concrete, aluminium, wire, cable, and POP. Hence, the paper recommends for improvement on professional skills and materials handling, this will add to and boost the capacity of personnel and groups to achieve zero waste, waste minimization, best practices that will contribute to the general waste reduction of any form in building construction activities.

Keyword: Exploration, Building Construction, Construction Activities, Waste Categorization, Southwestern States, Nigeria

I. INTRODUCTION

Severally, building construction waste has been perceived, distinct, described and dubbed globally, for example., Gutberlet (2008) in their study described the definition of waste as highly subjective and that because of the multifarious usage of the concept; it is very difficult to define [11]. Further reported that while some see waste as a mere necessary-nuisance because it must be generated as long as man exists and carry out his day-to-day activities, some others see it as a risk to public health and the environment. However, Ferguson *et al.,* (1995) [8], Nagapan *et al.,* (2012a) [17] defined waste as unwanted or discard materials while Wang *et al.* (2014) [29] defined it as valuable natural resources. Further, the European Council Directive 91/156/EEC and Keal (2007) [7] described waste as any substance or object which the holder discards or intends to discard, or are required to be discarded, and such is subject to several regulatory requirements.

Serpell and Alarcon (1998) [21] and the Hong Kong Polytechnic described waste as any bye-product of human and industrial activities that are physical, which is of no importance/value. The Environmental Protection Act (EPA, 1990) [5] of the Parliament of the United Kingdom which implements the European Union Waste Framework Directive in England, Wales and Scotland respectively defined waste as scrap material or effluent or other surplus substance arising from the application of any process. Ismam and Ismail (2014) [12] and Zamah and Lehmann (2013) [31], both described waste as the symbol of inefficiencies occurring in the society and representation of all misallocated resources. According to Formoso *et al.* (1999) [9] citing the new production philosophy, waste is defined as any production inefficiency that results from the use of equipment, materials, labour, or capital in large quantities than those considered necessary. Besides, their study shows that inefficiency related wastes generate greater economic loss than material waste when it defined waste as any loss produced by production activities that generate direct and indirect costs but do not add value to the product.

Begun *et al.,* (2006) [3]; Lau *et al.,* (2008) [14] citing US EPA (1998) [27] reported that the definition of waste from building construction activities varied depending majorly on the type of construction and the practices where the sampling is performed. They in the same manner as Yuan and Shen (2011) further described building wastes are the solid wastes resulting solely from building and construction activities (which represent just one phase of the procurement process) and this includes wastes arising from demolition, renovation, earthworks and land clearing operations and should be studied separately [30]. The Building Research Establishment (BRE, 1978) described waste as the difference between the materials ordered and those placed for fixing on building projects.

The studies of Ekanayake and Ofori (2000) [10]; Wahab and Lawal (2011) [28] revealed that wastes occur during all the stages of building procurement process which results in material losses, the delayed time and the execution of unnecessary works. Together, they all have a direct impact on productivity, material loss and the completion time of a project which results in loss of a significant amount of revenue. The result of findings of Dania *et al.,* (2007) [4], see wastes from building and construction-related activities is a complex waste stream which is made up of a wide variety of materials that are in the form of debris, rubble, earth, concrete, steel, timber and mixed site clearance materials, arising from

various construction activities including land acquisition or formation, civil and building construction, demolition activities, road work and building renovation.

The Environmental Protection Department (EPD) (2009) [6], Shen *et al.,* (2002a) [22] described construction wastes as mixtures of inert and organic materials arising from all construction-related activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork and building renovation along all stages in implementing a construction project [23]. Formoso *et al*. (2002) [9], observed that the notion of waste is directly associated with the debris removed from the site and disposed-off in landfills, however, BRE, (1978); Ekayanake and Ofori (2000) [10] in another attempt at defining waste, stated that waste from building procurement activities is any material apart from earth material which needs to be transported elsewhere from the construction site or used within the construction site to landfill, incineration, recycling, reuse and composting, other than the intended specific purpose of the project due to material damage, excess, non-use among contractors towards the reduction of construction materials.

Similarly, Alwi, Hampson and Mohammed (2002a) [1]; Kofoworola and Gheewala (2009) [15]; Wahab and Lawal (2011) [28] reported that researches from Thailand, Nigeria, Malaysia and Indonesia described building wastes as not only associated with the material waste from construction processes alone but includes wastes from other activities on construction site that do not add value to the actual construction such as delays resulting from time spent on the repairs of broken-down equipment and machinery, materials stored far away from the point where they are needed, poor and inadequate handling of material and damages during on-site transportation, which is both physical and non-physical; are generated both directly and indirectly .

Koskela noted in his 1992 study that wastes which originate from building procurement activities include material losses and the execution of unnecessary work which attracts additional costs and do not add value to the product [13]. Shen *et al*. (2002a) [22], found that building material wastes which occur on a construction project are directly proportional to the difference between the value of the materials delivered and accepted on-site and those which have been properly used for the work and accurately measured in the work. Similarly, Dania *et al*. (2007) [4]; Formoso *et al*. (1999) [9] and Koskela (1992) [13] in their various studies published a more detail definition of waste in building and construction activities as "any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities which have been provided for in the design and documentation processes leading to the production of a building". This definition was also said to include incidences of wastages in labour and the energy used in construction works, material use, material damage, excess procurement and human errors in design and mistakes in measurement during construction.

From the foregoing, this study sees building waste as clearly something generated but unwanted during the building life cycle management stages (which includes pre-design and design activities; procurement of the work and pre-construction activities; construction and post-construction activities that includes occupancy, maintenance and demolition at end of life) and all of these can be prevented, reduced or eliminated. Most of the researchers' definitions of building waste did not deal with the causes of waste during the pre-design and design activities, procurement of the work and pre-construction activities, and the post-construction activities during which period the building is in use rather.

However, they defined building waste as only the physical materials generated during actual implementation/construction activities. The few researchers who described building waste contrarily by their causes include; Shen *et al*. (2004) [24]; Osmani, Glass and Price (2008) [20] and Nagapan *et al.,* (2016) [16] who held that the definition of building waste was as varied as the definition of waste. They described wastes from building construction activities as consisting of both the physical and non-physical bye-products which are generated during the activities of procuring construction projects, renovation and demolition workplaces and/or sites of building and civil engineering structures which are thereafter removed after its generation.

Tongo *et al.,* (2020a) [25], examined procurement waste management on building construction industry in southwestern, Nigeria, the study found that professional satisfactory index fell between ″disagree "and "not sure'' this translate that management support, staff knowledge, financial incentives/motivation, estimating/ordering practice, design issues, material Supply issues, material storage practice may not reduce the scourge of procurement waste in Building construction. In another study, Tongo, *et, al,* (2020 b) [26], examined the Professional's Perception of Materials Management Practices on Construction Sites in selected states in Nigeria through the use of structured questionnaires, administered to senior construction professional personnel of construction firms, the study established that delay in the completion time of project such as storage of materials on-site with mean value (4.9), incompetence of estimators (4.8), issuing of materials for use (4.7) and procurement for materials (4.6).

Therefore, the definition for this study is adopted from that by the Koskela (1992) [13] cited by Formoso *et al*. (1992) [9] which sees 'building waste' as any inefficiency resulting from insufficient knowledge/information of the project; human errors in design; wrong use of equipment, materials, labour and capital throughout the entire life cycle stages of a building project and the production processes leading to the delivery of a building. This also includes incidences of energy used in the construction works, material damage, excess procurement and measurement during construction. However, this study aim to explore different types of waste generated from building construction activities across the study area. To achieve this; the perception of the various respondents on the types of wastes emanating from the activities of building construction at the entire life cycle stages was assessed and rank.

II. METHODOLOGY

In this study, primary and secondary data were used. The primary data was attained through field survey, while secondary data were derived from published texts. To collect data and to meet the set objectives of this study two hundred and sixty-one (261) questionnaires were randomly administered among the built environment professionals (Architects, Builders, Engineers, Quantity Surveyor, Town Planners, and Project Manager etc.) across the six (6) states that made-up of southwest states of Nigeria namely Ekiti State, Lagos State, Ogun State, Ondo State, Oyo State

and Osun State. However, only the professional in the senior cadre level was picked as a sample and administered a questionnaire to. Data were analyzed using SPSS.

III. FINDINGS AND DISCUSSIONS

The result of the study found that both the waste types listed from literature and those established from the study are primarily physical. Paper waste was mostly generated at the pre-design and design stages respectively (31.7% and 39.5%). Wastes from cardboard and other packaging materials accounted for 35.1% of the waste associated with the pre-construction stage activities, 27.4% for construction stage activities and 23.5% for design stage activities of building construction process while, the rubber/plastic wastes are mostly (61.8%) associated with construction stage activities, the pre-construction stage (18.4%) and the post-construction (13.6%). Much (76.1%) of the POP waste is likened to be generated at the construction stage and some (17.3 %) at the post-construction.

Additionally, the findings from Table 1 show that most (81.9%) of the glass waste generated by the activities of building construction is associated with the construction stage and 13.6% with the post-construction stage. In the same light, the majority (85.8%) of ceramic/marble waste generated are associated with construction stage activities of a building project. A large proportion (84.3%) of the sampled respondents indicated that stone/hard-core/granite wastes are generated by the construction stage activities. Many also indicated that ferrous metals and aluminium wastes are mostly (76.2% and 88.2%) generated during the construction stage of a building project. Also, the respondents linked the generation of wood and paints/resin wastes mostly (80.5% and 75.2%) to the construction stage activities.

Table 1: Result of the ranking of Respondents on Building Construction Waste Types Generation by the Participating Firms.

Groups	Pre-design (%)	Design (%)	Pre-construction (%)	Construction (%)	Post-construction (%)	Mean Score	Rank	Total
Pipes	1.3	2.6	4.2	**74.5**	**17.3**	3.92	1	100
Paint/Resins	.8	1.3	5.0	**75.2**	**17.7**	3.89	2	100
Wood	1.1	1.1	7.4	**80.5**	**10.0**	3.87	3	100
POP	2.6	1.8	2.1	**76.1**	**17.3**	3.87	3	100
Glass	1.9	1.1	1.6	**81.9**	**13.6**	3.85	5	100
Ferrous Metal	1.3	2.9	8.7	**76.2**	**10.8**	3.81	6	100
Concrete	1.9	1.1	5.0	**78.5**	**13.5**	3.81	6	100
Stone/Hard-core/Granite	1.0	2.9	5.8	**84.3**	**6.0**	3.75	8	100
Aluminium	1.6	1.3	3.2	**88.5**	**5.3**	3.75	8	100
Sandcrete Blocks	1.6	2.1	4.7	**85.0**	**6.6**	3.74	10	100
Ceramic/Marble	2.1	3.4	1.3	**85.8**	**7.3**	3.71	11	100
Ceiling	1.6	1.3	4.8	**74.1**	**18.3**	3.69	12	100
Cement/Sand Mortar	1.9	1.4	4.1	**86.3**	**6.3**	3.68	13	100
Wires and Cables	.8	2.4	5.0	**72.6**	**19.3**	3.66	14	100
Soil	2.7	1.3	**15.4**	**74.8**	5.8	3.60	16	100
Plastic/Rubber/ Foam	2.9	3.2	**18.4**	**61.8**	13.6	3.56	16	100
Others	12.8	6.4	0.0	**61.7**	**19.1**	3.09	18	100
Cardboard and other packaging materials	10.8	23.5	**35.1**	**27.4**	3.2	2.85	17	100
Paper	**31.7**	**39.5**	13.5	9.8	5.5	1.97	19	100

Source: *Author field survey, 2020*

The survey also showed that soil, concrete block, cement/sand mortar and concrete wastes are mostly (74.8%, 85%, 86.3% and 78.5%) generated at the construction stage of a building project. Likewise, the generation of most (72.6%, 74.5% and 74.1%) of the wire and cable wastes, pipe wastes and ceiling wastes are linked to the life cycle activities of a building project at the construction stage, while some (61.7%) of the respondents indicated the other wastes (such as; site clearance, tree stumps, drywall, stucco, gypsum, Styrofoam and solid waste) which were not listed in the study but were mentioned by the respondents, to have their origin in the construction stage of building construction processes.

IV. CONCLUSION

Presently, there is increased concern about waste, and health implications of different form have reignited the debate in the international arena and politics calling for ways in decreasing wastage in building construction stages and the development of a sustainable construction system that is safe, cost-efficient, environmentally responsive. Hence, this study assessed waste categorization across building construction activities stages, from a professional perspective. The results revealed that certain proportions of respondents' agreed that waste is inevitable in buildings construction from pre-design to post-construction phase. There is need for improvement on professional skills and materials handling that will enhance and boost capacity personnel and groups to achieve zero waste, and use of, improved technology and adoption of best practices that would contribute to the reduction of any waste across construction phases.

REFERENCES

[1]. Alwi, S. Hampson, K. and Mohammed, S. (2002a). Waste in the Indonesian Construction Projects. *Proceedings of International conference of CIB W107 – Creating a Sustainable*

Construction Industry in Developing Countries, South Africa, pp. 305–315.
[2]. Alwi, S. Hampson, K. and Mohammed, S. (2002b). "Non-Value Adding Activities in Australian Construction Projects." *Proceedings International Conference on Advancement in Design, Construction, Contract Management and Maintenance of Building Structure,* pp. 270-278.
[3]. Begun, R. A., Siwar, S. K. Pereira, J. J. and Jaafar, A. H., (2006). "A Benefit Cost Analysis on the Economic Feasibility of Construction Waste Minimization - The Case of Malaysia". *Resources Conservation and Recycling*, *48*: 86-98.
[4]. Dania A. A., Kehinde, J. O. and Bala, K., (2007). "A Study of Construction Material Waste Management Practices by Construction Firms in Nigeria". *International Journal of Sustainable Construction Engineering & Technology*, 7(1); 121-129.
[5]. Environmental Protection Act 1990 c. 43 Part II Supplemental Section 75 [Online]. Available at: http://www.legislation.gov.uk/ukpga/1990/43/contents Accessed January 22, 2018.
[6]. Environmental Protection Department. (EPD, 2009). Monitoring of solid waste in Hong Kong: waste statistics for 2009. Hong Kong Special Administrative Region: Environmental Protection Department. 18 p
[7]. EU Council Directive 91/156/EEC, (1991). Article 1, Letter A, Council Directive 91/156/EEC of 18 March 1991 amending Directive 75/442/EEC on waste. Official Journal L *78*, 26 March 1991, pp. 32-37.
[8]. Ferguson J., Kermode, N., Nash, C. L., Sketch, W.A.J. and Huxford, R. P., (1995). "Managing and minimizing construction Waste: A practical Guide". *Institute of Civil Engineers London*, Thomas Telford, London.
[9]. Formoso, C. T., Isatto, E. L. and Hirota, E. H. (1999). "Method for Waste Control in the Building Industry", Proceedings of the Seventh Annual Conference of the International Group for Lean Construction (IGLC), Berkeley, CA. USA, pp. 325-334.
[10]. Ekanayake, L. L. and Ofori, G. (2000). Construction Material Waste Source Evaluation. *In: Proceedings of the Second Southern African Conference on Sustainable Development in the Built Environment*, Pretoria, *35*, 35–36.
[11]. Gutberlet, J., (2008). Recovering Resources – Recycling Citizenship: Urban Poverty Reduction in Latin America: Ashgate Publishing, Ltd.
[12]. Ismam, J. N. and Ismail, Z. (2014). Sustainable Construction Waste Management Strategic Implementation Model. *Journal of WSEAS Transactions on Environment and Development*, *10*: 48-59.
[13]. Koskela, L., (1992). Application of the New Production Philosophy to the Construction Industry - Technical Report No. 72. Centre for Integrated Facilities Engineering, Department of Civil Engineering, Stanford University, CA.
[14]. Lau, H. H., Whyte, A, and Law, P. L. (2008). Composition and Characterization of Construction Waste Generated by Residential Housing Project. *International Journal of Environmental Research, 2*(3): 261-268.
[15]. Kofoworola, O. F. and Gheewala, S. H., (2009). "Estimation of Construction Waste Generation and Management in Thailand", *Journal of Waste Management*, *29*(2): 731-738.
[16]. Nagapan, S., Rahman, I. A. and Asmi, A., & Adnan, N. F. (2013). Study of the Site's Construction Waste in Batu Pahat, Johor". *Procedia Engineering, 53*: 99-103.
[17]. Nagapan, S., Abdul-Rahman, I. A. and Asmi, A., (2012a). "Factors Contributing to Physical and Non-Physical Waste Generation in Construction Industry", *International Journal of Advances in Applied Sciences, 1*(1); 1-10.
[18]. Nagapan, S., Ismail, A. R. and Ade, A., (2012b). "Construction waste management: Malaysian Perspective," *International Conference on Civil and Environmental Engineering Sustainability* (IConCEES), Malaysia, pp. 299-309.
[19]. Osmani, M., (2011). "Construction Waste", In *Waste: A Handbook for Management* (Letcher TM & Vallero DA (eds)), Elsevier, Oxford, UK, pp. 207-208.
[20]. Osmani, M., Glass, J. and Price, A.D.F. (2008). "Architects' Perspectives on Construction Waste Reduction by Design", *Waste Management*, *28*(7): 1147-1158.
[21]. Serpell, A. and Alarcon, L. F. (1998). "Construction Process Improvement Methodology for Construction Projects". *International Journal of Project Management*, *16*(4): 215-221.
[22]. Shen, L. Y., Tam, V. Y. M. and Tam, C. M. (2002a). "Material Wastage in Construction Activities – A Hong Kong Survey". Proceedings of the CIB W107 1st International Conference I Developing Countries, 11–13 November, Stellenbosch, South Africa.
[23]. Shen, L.Y. & Tam, V. M. and Vivian, W. Y. (2002b). "Implementation of environmental management in the Hong Kong construction industry". *International Journal of Project Management*, *20*(7): 535-543.
[24]. Shen, L., Tam, V. M., Tam, C. and Drew, D. (2004). Mapping Approach for Examining Waste Management on Construction Sites. *Journal of Construction Engineering and Management*, *130*(4): 472-481.
[25]. Tongo, S., Oluwatayo, A., & Adeboye, B. (2020a). Professional perspicacity of building procurement on waste management in construction industry. *International Journal of Advance Research*, *8*(04), 1028-1032. doi:10.21474/IJAR01/10873
[26]. Tongo, S., Oluwatayo, A., & Adeboye, B. (2020b). Professionals' perception of main causes on materials wastes in Nigeria building construction industry. *International Journal of Advance Research, 8*(04), 856-861. doi:10.21474/IJAR01/10848
[27]. United States Environmental Protection Agency (US EPA) (1998). Characterisation of Building-Related Construction and Demolition Debris in United States. Report No. EPA530-R-98-010, U.S. Environmental Protection Agency Municipal and Industrial Solid Waste Division Office of Solid Waste.
[28]. Wahab, A. B. and Lawal, A. F. (2011). An Evaluation of Waste Control Measures in Construction in Nigeria. African *Journal of Environmental Science and Technology*, *5*(3): 246-254.
[29]. Wang, J., Li, Z. and Tam, V.W.Y. (2014). Critical factors in effective construction waste minimization at the design stage: A Shenzhen case study, China. *Resources, Conservation and Recycling*, *82*, 1–7.
[30]. Yuan, H. P. and Shen, L. Y., (2011). Trend of the Research on Construction and Demolition Waste Management. *Waste Management*, *31*(4): 670-679.
[31]. Zamah, A. U. and Lehmann, S. (2013). The Zero Waste Index: a Performance Measurement Tool for Waste Management Systems in 'Zero Waste City. *Journal of Cleaner Production*, *50*: 123-132.

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