

Resources Conservation and Waste Management Practices in Construction Industry

¹Kareem, W.A., ¹Asa, Olusola Adekunle. & ²Lawal, Musediq Olufemi
3. Department of Architectural Technology, The Federal Polytechnic, Ede
4. Department of Sociology, Osun State University, Osogbo, Nigeria

Abstract

Changing people's wasteful behaviour can make a significant contribution for sustainable growth. This is because wastes are often hazardous in nature thereby making them potentially hazardous to human health and/or the environment. Sustainable livelihood within the environment where the presence of wastes has become a phenomenon makes efforts at addressing this menace a central issue. In the light of this, a strategic solid waste resource management planning approach has been identified as capable of enhancing plausible solutions to take care of its menace. Such planning has to take into cognizance a comprehensive strategy that can remain flexible in light of changing economic, social, material (products and packaging) and environmental conditions. In relation to the present study, the need for resource conservation in order to minimise the rate of waste generation is being emphasized. The necessity of this revolves around the environmental benefits inherent in such efforts and economic gains it will bestow on the construction industry and other stakeholders within the society. This paper investigates the management of wastes generated from construction and demolition activities that has wide-ranging impacts on the environment. Waste management is perceived as a low project priority, and there is an absence of appropriate resources and incentives support it. A theory of waste behaviour is proposed for the construction industry, and recommendations are made to help managers improve workers' attitudes towards waste.

Keyword: Resource Conservation, Waste Management, Construction Industry

Introduction

Waste, which is also known as rubbish, trash, refuse, garbage, junk, litter is unwanted or useless materials. In biology, waste is any of the many unwanted substances or toxins that are expelled from living organisms; such as urea, sweat or faeces. Litter is waste which has been disposed of improperly. Waste is directly linked to human development, both technologically and socially. The compositions of different wastes have varied over time and location with industrial development and innovation being directly linked to waste materials such as plastics and nuclear technology. In recent time, large chunk of waste is generated as a result of development and urbanization processes. Typical in this case is construction waste. The Construction industry, while contributing to overall socio-economic development of any country, is a major exploiter of natural non-renewable resources and a polluter of the environment whereby it contributes to the environmental degradation through resource depletion, energy consumption air pollution and generation of waste in the acquisition of raw materials (Watuka and Aligula, 2003).

The construction industry produces around 120 million tonnes of construction, demolition and excavation waste per year with only half of this currently being recycled or reclaimed. Waste management involves taking action to reduce the volume of construction waste being sent to landfill. Through the identification of potential waste streams, setting targets for the recovery of materials and the process to ensure that these targets are met a range of benefits can be achieved. Construction clients and developers are increasingly looking to set targets and requirements for waste management and to move the industry from standard through to good and best practice in waste management.

To have a deep understanding of waste particularly within construction industry, it is important that we define what is meant by the concept of construction waste. The Building Research Establishment defined building waste as the difference between materials ordered and those placed for fixing on building projects. The Honk Kong Polytechnic (1993) defined construction waste as the by-products generated and removed from construction, renovation and demolition sites of building and civil engineering structures'. In environmental terms, the latter definition produces the better description as it identifies clearly materials that must be either recycled or re-used or disposed of.

The extensive building and infrastructure development projects as well as redevelopment of old areas in many developing countries particularly in Nigerian cities and towns have led to a significant increase in construction waste generation in the last few decades since our experience of oil boom. In advanced countries like USA approximately 29% of overall landfill volumes is from construction waste; in the United Kingdom it is about 50% and in Australia it is about 20% - 30% (Rogoth and Williams, 1994). Due to the enormous amount of waste generated in construction sites activities, it can be seen that any substantial reduction in construction waste will inevitably lead to a considerable reduction in the overall waste stream. In spite of significant impact of this source of waste generation, little consideration has been given to how to control the generation of construction

and demolition wastes in building projects in Nigeria. This may be attributed to the availability of relatively inexpensive means of waste disposal and the generally low environmental awareness of the construction industry in Nigeria. The present effort is an attempt at domesticating the findings of Teo and Loosemore (2001) on theory of waste behaviour in the construction industry in geopolitical entity called Nigeria.

Waste Management Practices in the Construction Industry

Past research into the causes of waste in construction project indicates that waste do arise at any stage of the construction process from inception, right through the design, construction and operation of the built facility (Spivey, 1974; Faniran and Caban, 1998), Waste management is made difficult in the construction due to the unique nature of each project, the hostility and unpredictability of the production environment, and the intense cost and time pressure that characterize many construction projects.

In reducing waste, two principles prevail: first reduce the qualities of waste generated and second adopt an effective system for managing the unavoidable waste produced. In managing the unavoidable waste, there are three options in order to reference, namely, 'refuse', 'recycle' or 'disposal'. The balance between the three will depend upon the nature of the materials wasted. The cost will in turn depend upon the availability of reusing and recycling options and the opportunities for reuse on a specific project (Chun *et al.*, 1994).

It should be noted that waste management activities were merely another workload burden perceived to be irrelevant to contractor job. This defeatist mindset represents a psychological barrier to the adoption of positive attitudes, and indicates that waste reduction depends upon the ability of managers to install the value that operatives attach to construction materials. If perception of economic viability change, then so could attitudes. This can be achieved through measures such as (a) education (training) programmes to increase knowledge levels, (b) incentives to operatives to engage in less wasteful practices, and (c) development of more efficient and convenient ways of dealing with waste to make its generation less of a certainty.

Theory of Waste Behaviour

There are three most prominent theories in the environmental research that emerged to explain waste behaviour. These are (1) Schwartz's norm-activation theory which states that environmentally conscious behaviour depends directly on the activation of altruistic moral norms rather than on general environmental concern (Schwartz, 1977).

(2) Ipsative Theory of Behaviour; this focus on how intervening factors such as resource constraints can prevent pro-environmental attitudes being expressed in people's behaviour (Frey, 1988); and (3) Theory of planned behaviour- this is the 'behavioural intention' of an individual which reflects how motivated he/she is to behave in a certain way. This is determined by three factors such as attitudinal, social and perceptual (Ajzen, 2001, 1993 & 1991).

In 1977 Schwartz developed a model of altruism which assumed that altruistic behavior will increase when a person becomes aware of another's suffering and, at the same time, feels responsibility for this suffering (Kollmuss & Agyeman, 2002). Schwartz explained behavior in terms of an interrelationship between four major constructs: awareness of consequences, ascription of responsibility, social norms and personal norms. This model predicted that the activation of moral norms results in altruistic behavior. This moral norm-activation occurs "when an individual becomes aware that his or her behavior has possible negative consequences for others and is willing to take personal responsibility for the others' well-being" (Allen & Ferrand, 1999, p. 340). Therefore, the central idea in this model is the indirect influence of social norms on an individual's behavior. Awareness of consequences and assumed responsibility are variables that influence the implementation of norms on actual behavior. If an individual experiences high levels of awareness of responsibility, and high levels of assumed responsibility, norms will guide behavior (Fransson & Garling, 1999). Schwartz's model insists that norms activation is more likely when the actor has two types of beliefs. First, the acting individual should be aware of the consequences of his act towards the subject of norm (Mustapha, 2010). Then, the individual has to feel responsible for causing or preventing these consequences (Bleamey, 1998, p48). However, if the individual perceives that his respect of norms might seriously harm his personal interest, he adopts defensive strategies. Then, he can either reject the consequences of the behaviour or his own responsibility in order to neutralize the norm (Schwartz, 1977). Besides, the model of the norm activation proved its efficacy for the study of several ecological behaviours: the important change in environmental attitudes (Heberlein, 1972), the emergence of an environmental ethic (Vandenbergh, 2005), the explanation of the individual consumption of energy (Black, *et al.*, 1985) and so on.

Methodology

This research is being anchored on Ajzen's theory of planned behaviour in order to provide insight into operative's attitudes towards waste as well as providing a conceptual vocabulary to help organize empirical observations. The research involved three phases of data collection and analysis. The first phase involved an

attitudinal survey, the second phase involved focus group interview, while the third phase made use of both participant and non-participant observation. The three-phase approach was necessary to enhance an avenue for reflection upon and response to the unexpected ‘leads’ which emerged in the phase one of the process. The first phase of data collection involved an attitudinal survey designed around the attitudinal factors identified in Ajzen’s theory of planned behaviour.

The objectives of the study include examination of (a) operatives’ belief and perceptions towards waste and to determine the influences that shape them; (b) the knowledge-based and awareness of their role in the waste generation process, and (c) the impediments to the effective adoption of waste management practices on construction sites. The survey consisted of open ended questions and takes the form of categorical or rating scale answers ascertain the intensity of a respondent’s attitudinal response on a native or positive evaluation. The survey instrument was administered to 50 operatives from two construction sites in Nigeria. Effort was made to ensure fairness in distribution of the respondents, so that the results are not skewed towards ideas from those within a particular company out of those selected. In this process, the selection of the respondents cut across five occupational groups such as supervisors, leading-hands, tradesmen, labourers and others working in a technical capacity.

The second phase based its analytical activities on the outcome of the findings from phase one. These were arranged under five main headings such as management support, common perceptions of waste, waste management training, incentives and employee involvement. This structured approach ensured uniformity in the order of discussions, which in turn facilitated easier analytical comparison. Observation of construction activities and subsequent generated waste management was also utilized to complement the other methods. The observation entailed both participant and non-participant techniques.

Table 1: Focus Group Propositions

Category	Participant Position	Recommendations
Management support	<ul style="list-style-type: none"> ▪ Waste management is a low project priority. ▪ Not enough is done to reduce waste. ▪ Insufficient recycling facilities are provided. 	Managers need to demonstrate greater commitment to waste management
Common perception of waste	<ul style="list-style-type: none"> ▪ There is little recycling or re-use value in construction materials. ▪ Waste is an inevitable by-product on construction projects. 	Restore value to materials by developing more efficient ways of dealing with waste.
Waste management training	<ul style="list-style-type: none"> ▪ Waste management training is insufficient. ▪ Knowledge about waste reduction techniques lacking ▪ Effective waste management has other benefits such as improving safety. 	More high quality training is needed across a wider range of occupational groups.
Incentives	<ul style="list-style-type: none"> ▪ Cost savings are the most attractive benefits to reducing waste. ▪ Site staff and management should both benefit from the potential cost savings of waste reduction. 	Create greater awareness of the economic benefits of waste reduction.
Employee	<ul style="list-style-type: none"> ▪ No encouragement to provide feedback on how waste can be reduced. ▪ Position that waste reduction is not part of assigned job. 	Install a sense of collective responsibility for waste management.

Overall, this research into the nature and determinants of operatives’ attitudes towards waste indicated that they are not negative but that any goodwill is impeded by a lack of managerial commitment to the issue of waste reduction. Current efforts to reduce waste are in their infancy, with many respondents reporting low adoption of waste reduction activities on their sites. In terms of the factors that shape attitude, the main areas of concern for managers are in the areas of knowledge, values and building project constraints. In particular, five key issues emerged as impeding the adoption of positive attitudes to waste on construction projects.

Sites observation

Causes of Construction waste

Based on site observations, it was noted that a significant amount of building materials ended up as waste on the sites studied, including: timber, metal, concrete, brick, sand, etc. there are many contributory factors to this, including human and mechanical, and these are identified in table 2 below. The observations showed that timber boards from timber formwork was the most significant waste type requiring disposal (about 50%), and steel from metal formwork had the highest recovery level of about 100%. Improper preparation and handling, misuse, and incorrect processing were the major cause of material wastage on construction sites. Generally speaking, more management attention was given to the materials that have a significant impact on the project cost, for example, steel reinforcement, and little attention was paid on controlling wastage of other materials.

Table 2: Causes of Building Waste Generated from Various site activities

Site Activities	Material	Causes of Wastage Generated
Timber formwork	Timber board	<ul style="list-style-type: none"> ▪ Cutting scrap striking of form work
Metal formwork	Iron bars	<ul style="list-style-type: none"> ▪ Striking of formwork
Reinforcement fixing	Iron bars	<ul style="list-style-type: none"> ▪ Cutting scrap ▪ Abortive work (e.g. drawings modified by structural engineer)
In-situ concreting	Concrete	<ul style="list-style-type: none"> ▪ Leftover on the mixing platform lump test ▪ Trial panel (if any)
Work	Bricks & blocks	<ul style="list-style-type: none"> ▪ Cutting waste ▪ Damage due to improper stacking ▪ Damage due to careless handling by workers during work ▪ Abortive work ▪ Excessive mixing
Dry wall	Light weight concrete	<ul style="list-style-type: none"> ▪ Cutting waste
Wall & floor screeding	On site mix cement	<ul style="list-style-type: none"> ▪ Broken bags due to careless handling unloading stage ▪ Broken bags due to careless left-over ▪ Abortive work
Wall & ceiling	Plaster	<ul style="list-style-type: none"> ▪ Broken bags due to careless Handling during unloading stage ▪ Broken bags due to careless handling during transportation ▪ Lost while applying ▪ Over-mixing
Floor & wall tiling	Tile	<ul style="list-style-type: none"> ▪ Cutting waste ▪ Damage due to improper stacking ▪ Damage by workers from other trades after installation
Installation of sanitary fittings		<ul style="list-style-type: none"> ▪ Damage due to careless handling by workers during work sanitary fittings ▪ Damage due to improper stacking ▪ Damage due to careless handling during installation ▪ Damage by workers from other trades after installation

Waste handling Methods

Generally, inert and non-inert waste on building sites was delivered to the ground floor refuse hips mixed up. Then transported by trucks and disposed of at land fills without sorting. It was found that metal was the only waste material worth recycling. This is because, little income is generated for recycled wood, concrete, and most other building materials. Therefore, most contractors (operatives) generally do not have the practice of

reuse/recycling of these materials nor on-site sorting. Figure 1 below, shows the flow chart recommended for waste handling on sites.

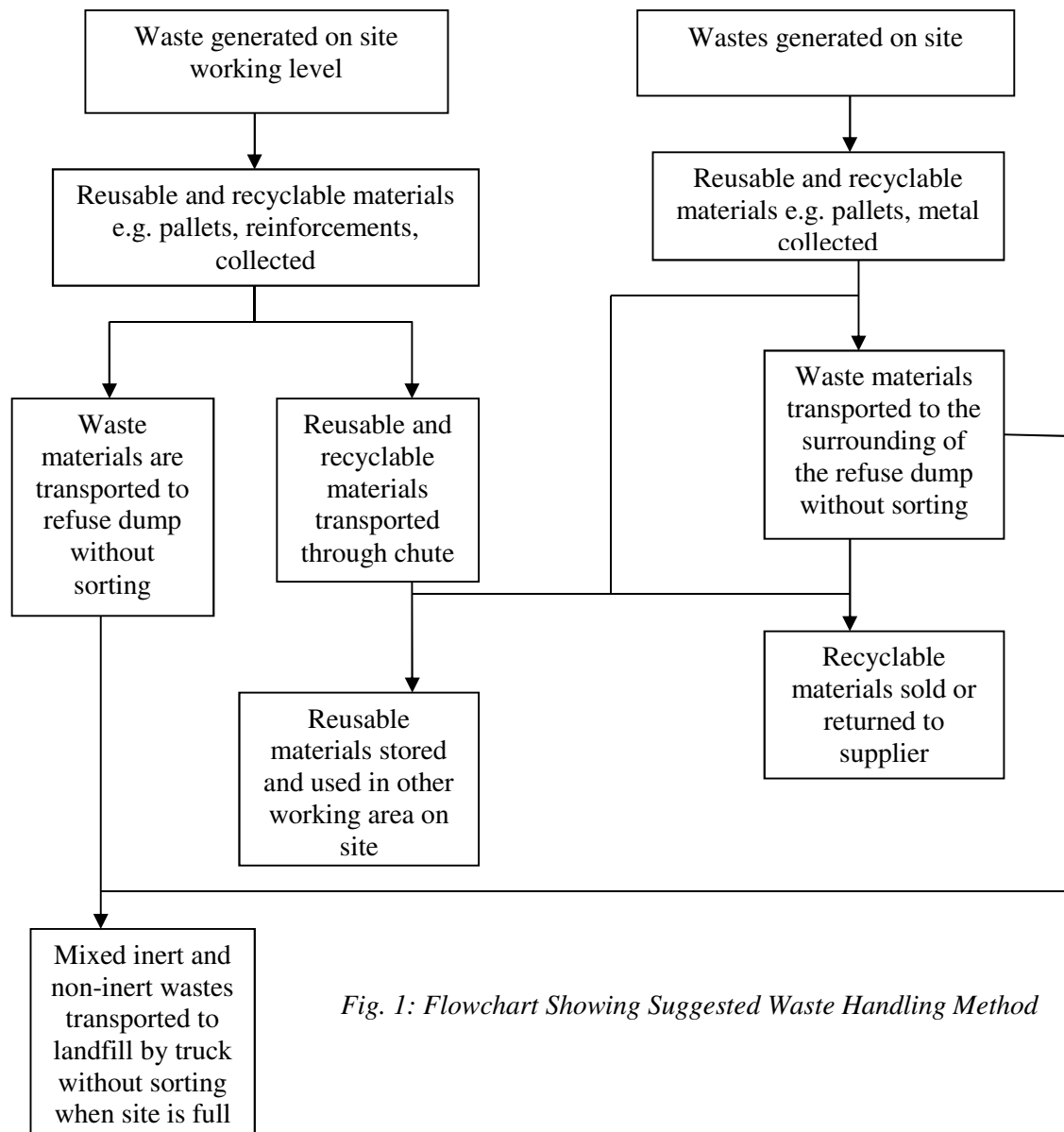


Fig. 1: Flowchart Showing Suggested Waste Handling Method

Obstacles to Waste Reduction in Construction Industry in Developing Nations

In spite of the beauty inherent in waste reduction in the construction industry particularly in the developing nations, certain obstacles were identified as militating against effective adherence. The findings here corroborated most of the discoveries in the earlier study by Teo and Loosemore (2001). These include (a) a lack of managerial commitment and support for the issue of waste, resulting in inadequate resources, man-power and time for waste management activities in comparison with other issues, such as safety, (b) lack of performance standard for managing waste, (c) difficulties in changing existing work practices and an informed and indifferent workforce, (d) a lack of integration of expertise and experience in the waste management of process, (e) action to reduce waste are predominantly profit motivated, and there is a perception that waste reduction activities are cost-effective, efficient, practical or compatible with core construction activities. Environmental issues currently have little effect on motivating operatives' adoption of waste reduction behavior, (f) a wide spread belief that waste reduction efforts will never be sufficient to completely eliminate waste, which has been accepted as an inevitable by-product of construction activity.

Social, Economic and Systemic Implication

The social, economic and systemic implications of resource conservation in construction industry manifest in terms of its revolving benefits covers issues that range from Economics and Business performance. Also not left behinds are the triple bottom line benefits of this activity as well as its percolating effects that trickles down to the owner of the properties, the developers and contractors, the designers, the occupiers and the managers. For instance, improvement in the efficiency and effectiveness of materials flow can generate economic benefits. A typical case as revealed by Miller *et al.* (2005) was waste minimisation strategies developed for the Australian where the budgeted amount for waste removal was reduced by approximately 50%. In addition to the potential economic benefits, the practices of resource conservation are noted as contributing to reducing risk and enhancing social and corporate responsibility. They also generate good public relations and may improve an organisation's business continuity by attracting like-minded clients, customers and employees. The cost reduction benefits are a small component of operational costs, but tracking and controlling waste is part of the overall strategy to improve organisational performance and outcomes.

Implementing waste reduction, avoidance and management strategies can generate cost savings, and can result in resource conservation, pollution and emissions prevention and landfill reduction benefits. Taking part in waste programs also raises awareness and generates behaviour change across industry groups. This may include improving an individual's understanding of the waste implications of purchasing decisions, not only related to their professional activities, but also to their personal purchasing habits. The after effects of this is entrenchment of behaviours that reduce waste streams and divert materials and products to appropriate recycling and re-use pathways, resulting in closure on materials loops.

Building owners equally have a lot to benefit in waste avoidance, reduction and management at the operational phase due to its long-term implications in the forms of building maintenance and service life. Also significant are decisions made at the design, major refurbishment and demolition phases. This will positively enhance a good corporate management message as well as asset procurement and facility management strategy that addresses waste for design and construction practices with the attendant significant financial advantages. The construction and demolition phases are important for developers and contractors because they generate a significant one-off volume of waste, either from new building or from refurbishment and fit-out. Both waste sources need to be effectively managed and controlled in order to optimize contract performance and time, cost and quality outcomes, and to derive optimal financial returns and risk management, particularly in light of the space and time constraints associated with refurbishment. The implications of waste management here include better execution of site management plans (including site control) and performance reporting, reduced costs for waste disposal, less space requirements and reduction in time spent on dealing with waste. If waste management strategies are undertaken well, cost avoidance is generated from appropriate purchasing decisions, and cost reductions are generated with reduced waste volume and mix.

It is important for the designer to align all parties to the design intent of waste minimisation, in order to optimise the benefits. The designers have the role of turning requirements that may be explicit or implicit in the brief into effective full life cycle strategies and, at least in capital construction stages, quantifiable outcomes and reporting requirements. The benefits of waste minimisation for designers therefore entail design finesse relating to a more informed relationship between good design and materials and products selection. It also improves the collaborative relationship between designers and suppliers, which, in turn, greens the supply chain and minimises local impacts and compliance costs. For building occupants, waste management is associated primarily with business activities and business costs. Important objectives are to optimize space utilisation, minimise furniture and equipment churn, and minimise activity-related waste generation. The importance of waste management for managers relates to operational effectiveness, satisfying tenants' requirements, and fulfilling the building owner's sustainability mandate. Cost-effectiveness is not seen as a primary motivator, as waste collection and removal represent a small proportion of the maintenance budget; nevertheless, cost savings can still be achieved.

Conclusion and Recommendations

In view of its size, the construction industry as a complex organization usually consists of large construction companies and numerous subcontracted small and medium enterprises, which are also known as Small and Medium Enterprises (SMEs). This therefore informed the regularity of waste generation within the industry. Going by the socio-economic, structural and environmental implication of waste generation in construction industry, concerns of avoidance of the waste has remained constant phenomenon. Waste avoidance, reduction and management are strategies that are increasingly becoming important across industry groups. The degree and relevance differs for each group, but the rationale of efficiency and effectiveness across economic, social and environmental arenas is a common driver. Measures towards the realization of this were highlighted as necessary most especially at the planning stage, construction stage and at the end of construction processes. Concise efforts at planning stage of construction will lead to avoidance and minimization of waste generation

through preparation of a detailed waste management plan. At construction stage good surround keeping and non-site sorting of wastes to enable reuse and recycling. Finally, at the end of construction the waste data should be calculated and used for future waste estimation.

The following waste management strategies were deduced from the study as ways forwards towards a cost-effective construction industry and for socio-economic sustainability. These strategies come in the form of recommendations that apply to every stakeholder within construction industry, while the other specifically focused on steps needed on how to minimize waste generated from each of the construction activities.

- ✚ Educational institutions should include the teachings of sustainable construction in the curriculum of professionals in the construction industry. Also, professional bodies should use conferences and workshops to educate practicing professionals.
- ✚ Government should introduce specific legislation governing the handling and disposal of construction wastes and follow up with strict monitoring to ensure compliance.
- ✚ Incentive schemes should be set up by Government to reward firms who embrace construction waste management wholly.
- ✚ Managers need to demonstrate commitment to the issue of waste and to provide the necessary waste infrastructure to help workers reduce it.
- ✚ The cost benefits of waste reduction must exist.
- ✚ More educational activities are needed to help raise workers' consciousness of the longer term social and ethical implication if their activities on site.
- ✚ Instruct workers about proper material handling and stacking method e.g. maximum height of stacked materials, tidy working and storage environment
- ✚ Store materials on firm, level base, especially when they are stacked.
- ✚ Better material supervision can reduce the amount of damage.
- ✚ Provide centralized area for storage.
- ✚ When mixing plaster, mix less needed towards the end of the day work.
- ✚ Provide storage for off cuts for reuse where needed.
- ✚ Better material protection and supervision can reduce wastage caused by workers and demand after installation on fittings.

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