CARD International Journal of Environmental Studies and Safety Research (IJESSR)
ISSN: 2536-7277 (Print) : 2536-7285 (Online)
Volume 2, Number 4, December 2017
http://www.casirmediapublishing.com

Waste Management on Construction Site

[1]Hime Elijah Akaakase; [2]Markus Kwaji; [3]Ityu Dorothy, [4]Dzer Jessica Terdoo & [5]Sylvester Igwe Sylvester

[1,2,3,4]Department of Vocational and Technical Education, Benue State University, Makurdi
[5]Department of Technology Education, Modibbo Adama University of Technology, Yola,
Email:akaakaseh@gmail.com,marcuskhore@gmail.com,dorothyityu@gmail.com,jessicadzer@yahooo.com,sylvester.sylvester01@yahoo.com
Corresponding Author: Markus Kwaji

ABSTRACT

Increasing waste generation on construction sites has become a topic of environment concern as it has contributed to causing an environmental hazard. Most construction wastes are not recycled but end up in landfills or dump which occupy the valuable land. Construction waste will increase from time to time during the development of very large projects especially located in town areas. Hence a study on waste management practices with a view to minimizing waste generation and encouraging recycling becomes important. The study indicates that design, operation, transportation, and construction are the major sources of waste generation and that landfills are the most current method being adopted in the disposal of construction waste and the industry best practice methods like reduce, reuse and recycling are less frequently used whereas recycling is recognized today as a solid waste management strategy that is preferable to landfilling or incineration and environmentally more desirable. Some safety precautions were highlighted. Prospect and challenges of waste management were also discussed. Conclusion was drawn with emphasis on more efforts been put in place to sustain management of construction site waste.

Keywords: Waste, Management, and Construction Site

INTRODUCTION

Responsible management of waste on a construction site is an essential aspect of sustainable building. In this context, managing waste means eliminating waste where possible; minimizing waste where feasible; and reusing materials which might otherwise become waste. Waste management is all activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulatory. It also encompasses the legal and regulatory framework that relates to waste

management encompassing guidance on recycling. Waste, on the other hand, is defined as waste that arises from construction, renovation and demolition activities (Kofoworolo and Gheewala, 2009). It may also include surplus and damaged products and materials arising in the course of construction work or used temporarily during the process of on-site activities. Although construction site waste is often included as one of the forms of municipal solid waste (MSW), it is considered being heterogeneous by comparing it with the general MSW (e.g. household waste) or other industrial solid waste (ISW) (e.g. hospital waste and computer waste). Normally, the majority of construction site waste can be reused or recycled **(**Tam 2008). Unlike household waste, construction site waste is generated by a limited few of contractors, the informal sector is involved in the general MSW and ISW while for construction waste, the main involves are contractors or specialist subcontractors (Khalil and Khan, 2009 Yuan 2008).This paper covers waste management on a construction site, scope in respect to disposal, methods of recycling, safety, prospect, and challenges.

Nowadays, construction wastes that are produced on site are increasing and becoming a larger portion of the waste disposal. This might cause serious impact to the environment. The construction waste has generated a significant amount of waste to the earth that causes a major impact on the global. Therefore, solutions have to be implemented to minimizing the construction waste to reduce the impact on the environment. Solid waste management practices have identified the reduction, recycling and reuse of wastes as essential for sustainable management of resources. Most construction site waste currently generated in the U.S is lawfully destined for disposal in landfills regulated under code of federal regulations (CFR) 40, subtitle D and C. Rising disposal costs and reduction in number of landfills create a need to search for alternatives to reduce, reuse, recycle and replace of construction waste being generated on construction sites. Hence the implementation of construction waste management which can be one of the apparent solutions for construction sites to minimize waste and waste disposal, ultimately reducing costs incurred during the process and contributing to the global 'environment-friendly' movement (Bon-Gang 2010).The construction waste will increase from time to time and during the development of very large projects especially located in the town area. Thus, the necessity of finding an appropriate solution to reduce the potential of construction waste been generated. In some areas, all or part of

construction waste stream is unlawfully deposited on land, or in natural drainages including water, contrary to regulations to protect human health, commerce, and the environment. Businesses and citizens legally dispose of millions of tons of construction waste in solid waste landfills each year. Increasingly, significant volumes of construction waste are removed from the waste stream through a process called diversion. Diverted materials are sorted for subsequent recycling and in some cases reused. Flaomo (1995) noted that there is a clear need for current approach of waste disposal that is focused on municipalities and uses of high energy/ technology to move towards waste processing and waste recycling (this involves public-private sections partnership, aiming for eventual waste minimization and prevention of the harmful effect of waste on man and the environment).

The construction waste may account for a staggering 40% of what ends up in landfillswith about 80%of that being bricks and concrete. Obviously, there is a lot of waste involved on construction sites, while serious waste management plans are normally expected for big commercial and industrial project tenders, the same care is not often put into waste disposal for residential building. For now, it's still relatively inexpensive and easy to dispose of general construction waste in landfills, although this is likely to change dramatically in the near future. Increasing production costs and regulations that require lifecycle assessments or other energy efficiency measures for building materials, methods and designs are likely to make residential construction waste a serious consideration eventually. The construction sites produce substantial amount of waste, which is about four times of that produced in households thereby accounting for more than 50 percent of the waste deposited in a typical landfill (Ferguson 1995, Coventry and Guthrie 1998). This means the rising of disposal costs and reductions in a number of landfills that create a need to seek for other solutions to either reduce, recycle and reuse or providing a good material from being damaged and lead to construction waste. Managing and monitoring the different waste streams on a construction site requires a detailed waste minimization strategy. This needs careful planning throughout the design, build and occupancy phases, to ensure its success, effectiveness, and compliance with building regulations. There are three basic strategies for dealing with waste: reduce, reuse and recycle. Waste prevention is the ideal and this can be addressed first by identifying possible waste streams early on in the

build process and then designing for their minimization. Using standard sizes for building components (windows, doors etc.) can prevent future waste, as can design for deconstruction, using recyclable components. It has been estimated that over-ordering accounts for 13 million tonnes of new building materials being thrown out every year. Better communication among building professionals to ensure exact calculations of required materials are made can mean that this waste is prevented. Just-in-time delivery strategies can further reduce waste created by improper storage and weather damage. Once the waste has been produced, the best method of managing it is through reuse either on the existing site, or a nearby site. Many materials can be usefully reclaimed, and even sold to offset the cost of a building project. Recycling materials are the final option for managing waste. Materials that can be reused or recycled need to be identified early in the building process, and segregated for easy storage, collection, and transfer. For the strategy to be effective, links also need to be established with local recycling and reuse facilities and contractors.

Waste management on construction sites constitutes awide range of material including lumber or wood, concrete, aggregate, drywall, masonry products, plastic and metal products. In addition, hazardous materials such as paints, solvents, and adhesive are used. Many of these materials eventually become waste. Typically, up to 10 percent of the materials delivered to a construction site become waste (Magdich, p. 1995).According to magdich 1995, it is understandable that most of the material used on construction sites are normally wood, concrete, aggregate, metal and so on. The construction waste defines as most of these materials only use 90 percent in the construction and the rest of the 10 percent will end up wastage on site. On construction sites, the waste can be produced anytime and anyplace on site, there is a great possibility of the material waste which may arise when deliveries to site as a result of inappropriate handling of materials, this means that the waste occurs at any moment and in all stages of constructing the projects. This paper addresses the sources of wastes on construction sites, waste management approaches and strategies, safety on construction site, prospects of waste management and challenges of waste management.

SOURCES OF WASTES ON CONSTRUCTION SITES

There are many factors that contribute to construction waste generated on site. The construction waste occurs due to single or a combination of many causes. The construction waste can be organized into four phases: design, procurement, handling of materials and operation (Ekanayake 2000). Design stage can lead to the excessive cutting of wastes due to carelessness or mistake was done by the designer on site. Osmani, Glass, and Price (2008) estimated that approximately 33% of on-site construction waste is related directly to design. The designer's inexperience in method and sequence of construction can affect the construction progress of a project. Other than that the changes made to the design while construction is in progress can also cause a lot of waste in constructability and assemblies of the building. Other design factors include lack of attention paid to dimensional coordination of products; lack of information in the drawings; errors in contract documents; incomplete contract documents at the commencement of project etc.

Transportation, in procurement, one of the main causes of is ordering errors (e.g. Ordering significantly more or less) of materials on a construction site, besides that the material purchased do not comply with the specification and lastly the lack of caring will result to damage of construction materials during transportation and that may lead to waste. Material handling, inappropriate storage of material will lead to damage or deterioration that will cause wastage of materials on site. Besides that, lack of confined space on site always causes a problem for material storage. On construction sites, there are many unfriendly attitudes of projects team and labourers that appear to be bad mannered such as stacking, which results in damage and aging of formwork. Lu, Pong, and Wong (2006) optimized the waste handling process by employing mathematical models and information technology

During Construction, errors by tradespersons or labourers will lead to damage of materials on site. These errors cause by the tradesperson in terms of damaging materials is often by accident due to negligence. Materials that are completely constructed to the building lead to damage caused by subsequent trades such as the use of incorrect material or not according to the specification, therefore demolition and replacement will be required, thus this will generate lots of waste during the stage of replacement of other materials.

WASTE MANAGEMENT APPROACHES ON CONSTRUCTION SITE

The increasing awareness of environmental impacts from construction wastes has led to the development of waste management as an important function of construction project management. Various approaches for managing construction wastes have been developed in the existing research works and practices, and these works can be grouped largely into three areas: waste classification, waste management strategies (avoiding waste, reducing waste, reusing waste, and recycling waste), and waste disposal technologies. In fact, construction wastes pass through a number of processes from generation to final disposal, and proper flow of these processes can improve waste management effectiveness. The waste classification includes:

Avoidable waste means material waste that can be avoided and controlled on the construction site by the contractors. Therefore, the contractor must try his best to minimize the waste that is produced from the site by on-site supervision. However, the contractor must search for an alternative solution to minimize the avoidable waste, he must hire a supervisor to check the material delivery and also during installation on site. A proper storage area of materials is needed on site to prevent and minimize the material from deterioration and damage. Unavoidable waste this means material waste on site that cannot be controlled by the contractors. The contractor must accept this type of waste that produced during the operation. On the construction site, the operators are working in a hectic and sophisticated environment which they are not able to handle the materials properly and will end up as the huge possibility of material waste generated on site. Unavoidable waste must be allowed such as the allowance of material waste including pricing during tendering stage. This should be allowance when the purchasing department is preparing the material schedules and ordering of materials. Most of the material that leads to unavoidable waste is 'cutting waste'. For example, the operator cuts the materials such as bricks, timbers, reinforcement bars and sheeted materials to suit the dimension according to the specification so the rest of the cutting waste end up to be waste unavoidable.

Potential waste, materials delivered on the site leads to waste as a result of damage when handling, moving, stacking and storing. Materials such as tiles are very fragile which may easily damage if it is not properly stored or handled. Other than that, the potential waste may arise when too many materials are delivered to the site without adequate storage for storing the materials idling or

unused for too long. Excess of materials delivered to the site has the high potential for creating storage problems, besides that, if the construction materials are delivered on site too early, this maybe a high percentage of risk of materials being damaged on site (Teoh 2009). Compensating waste, means when the materials or components are ordered to site and these materials will be used for its purpose other than those specified. For example, for compensating waste is known as 'substitution waste'. It is meant that the specification of the walls should be constructed of concrete blocks, but instead of concrete blocks, the operator replaced the concrete block with common bricks.

WASTE MANAGEMENT STRATEGIES

This practice has been guided by the principles of 3Rs of reducing, reuse and recycle, which classify waste management strategies according to their desirability (Peng, Scorpio And Kibert1997; Faniran and Caban, 1998). The 3Rs is meant to be a hierarchy, arranged in ascending order of their adverse impacts onthe environment from low to high. The reduction is considered as the most effective and efficient method for managing construction site waste. It can not only minimize the generation of construction site waste but also reduce the cost of transporting, disposal and recycling (Esin and Cosgun, 2007). It is defined as reducing the use of the construction materials and goods in order to minimize or reduce waste. Potentially, reducing waste on a construction site can be generally summarized into five categories: Minimizing waste on construction sites, builders can employ various measures to minimize the amount of waste that's produced in the first place. Their suppliers have a role to playing this too, either by supplying at the last minute (i.e. just in time deliveries) to help reduce the amount of packaging that's needed and the chance of breakage or spoiling or by agreeing to take back the materials that are left over.

Skips and waste removal, building sites will usually feature massive bins (called skips) that are dropped off at the site and used to collect and remove waste as its generated. Rubbish skips are normally stored either on the building site or just off the site in a position that won't cause a problem to traffic or pedestrians.

Reducing waste through government legislation, this means a waste reduction framework plan should be launched with the aims to improve public awareness

on waste reduction. This body should set out programmes to avoid and minimize waste; promote recovery, recycling and reuse of waste materials; prolong the life of existing landfills and reduce the increasing costs f waste transportation, treatment, and disposal. This body will also provide suggestions on how different economic sectors can incorporate various waste reduction measures into their business practices. The plan is expected to bring a change from the reuse of waste materials.

Reduction of waste by design, standardization of design to improve build-ability and reduce the off-cuts quantity. Standardization has the potential to dramatically reduce the current production of construction waste. By designing room, areas and ceiling heights in multiples of standard material size a substantial reduction in off-cut has been achieved. Recycling method is crucial in the efforts to prevent valuable materials from ending up in a landfill with the potential to turn 100 percent of non-hazardous waste back into new construction products. The key to successful recycling is to segregate waste as you go, using different skips or containers for different materials. If the space to do this is not available, use a reputable waste company who will remove and sort your waste. Unfortunately, not all construction waste can be used to recycle but many of the construction industry have started to practice in the United States. When waste materials are recycled, these provide the industry with an alternative source of raw materials. This results in less demand for virgin materials whose extraction, transport and processing are major sources of greenhouse gas emission. Recycling not only reduces greenhouse gas emission but also minimizing the construction waste as well (Alam 2012).

Reuse means using the same material in construction more than once, including using the material again for the same function (e.g. formwork in construction) (Ling and Leo 2000) and new life reuse for a new function (e.g. using the cut-corner steel bar for shelves; using the stony fraction for road base material) (Duran, Leniban and Regan 2006). It is the most desirable option after reduction because a minimum processing and energy use is achieved. When reduction and reuse become difficult, recycling is desired. Recycling can be summarized into 3 major benefits: reducing the demand for new resources; cutting down transport and production energy cost and utilizing waste which would otherwise be lost to landfill sites. Two major concerns on recycling are the

economic viability and acceptability of recycled materials. Typically, Tam and Tam 2006 found that from a purely economic point of view, recycled materials are only attractive when they are competitive with virgin materials in terms of cost and quality.

Recycling is the removal of material from waste for reprocessing. Recycling is recognized today as a solid waste management strategy that is preferable to landfilling or incineration and environmentally more desirable. Recently, increased awareness of the environment, concern over guaranteeing sustainable development, and aware of the need to organize waste management have all contributed to enhancing the image of recycling as an important instrument to attain these environment objectives. The recycling of waste materials has many benefits, which will indirectly protect the natural environment. In almost all communities in the country today, there is a growing concern for recycling and the environment. The true success of a construction waste recycling operation must be determined by establishing the scale of the operation to be implemented and its resulting economics (Peng *et al.,* 2010).

Recycling of construction site waste and other waste is currently the most pursued method of waste disposal. The materials are sorted out before recycling can be carried out effectively. Transportation is a major factor in the realization of recycling and can adversely affect the willingness of manufacturers to use the second-grade raw materials if the cost is high. Waste materials like glass, bricks, plastic types etc. can be recycled into such products. Whilst the developed countries experiment at the desirability of refuse recycling and reclamation, the practice is to a very high degree in poor parts of developing countries of the world, not done as part of any national disposal plan but scavengers and beggars. Some builders-particularly those with a focus on sustainability and efficiency- work to ensure that materials are recycled and reused. This may include training subcontractors to categorize and separate waste on-site before its disposal, to ensure that it goes to the right places. Waste is classified into eight categories including concrete, brick, tile and ceramics; wood, glass and plastic; bituminous mixtures, coal tar and tarred products etc., in Hong Kong, waste is normally in form of building debris, rubbles, earth, concrete, steel, timber and mixed site clearance materials (Shen, Tam, Tam and Drew 2004, Poon, Wong and Cheung 2004, Hoa, Hills and Huang….

2007).These are the most common recyclable construction materials and their uses: Wood, especially those that have been previously used on construction sites can be recycled for energy generation. The main cause of wood waste is pallets, crates, beams, window and door frames, doors, floor boards, shuttering, fencing and panels, such as chipboards. It is also used for animal bedding, mulch for gardens and golf courses, landscaping pellets and chipboard for new kitchen units.

Gypsum plasterboard is expensive to throw away but can be reprocessed to make new plasterboard. Most of the gypsum plasterboards are manufactured into plaster boards, plaster and other specialist boards for fire protection. The causes of gypsum plasterboard waste are damaged due to poor design, poor storage, and handling, over ordering, disposal of unused materials and off-site cutting. The plasterboard wastage can be generated on the construction site during the installation. The options for recycling waste plasterboard produced on your construction site include: sending waste to independent plasterboard recyclers to make into new plasterboard and cement; sending waste to household waste recycling centers; using gypsum as a soil conditioner; using gypsum to make bathroom furniture mouldings etc.

Metal can be recycled to make new high-quality metals, a process that uses less energy than making metals from scratch. Metals such as aluminum, copper, and steel are widely being utilized on a construction site. It is an element, compound, or alloy characterized by high electricity conductivity. Metal is usually used in building steel home, steel roofing, clear span building, and other construction works. They usually have high density, ductile, malleable, have a high melting point and can conduct electricity and heat well. Metals have the highest recycling rates among the materials recovered from the construction sites. Good markets have been in existence for ferrous metals as well as copper and brass. The recycling rate for construction steel is about 85 percent (18.2 out 21.4 million tons generated) (Franklin Associates 1998). Reinforcing steel used in foundations, slabs, and pavement is usually recovered and sold to scrap dealers, processors also reclaim non-ferrous scraps such as aluminum window frames, screen doors, gutters and siding and copper pipe and plumbing fixtures. Plastics waste, most of the plastic that has been used on construction sites are mainly pipe-work, window frames, interior fittings and so

on. The main cause of plastic waste is over-estimated of ordering and disposal of off-cuts and unused materials, over –specified project design, poor storage and handling and so on. The range of plastic waste that is obtained on construction sites can be used to recycle as polyethylene terephthalate (PET), high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyvinyl chloride (PVC) and also ABS (a copolymer of acrylonitrile, butadiene, and styrene) polymers. It is also used in construction projects or to make street signs and landscaping materials.

Glasses that have been previously used on the construction site can be processed into a usable material. The main causes of glass wastage are over ordering of materials, breakages during installation and damage during storage. The glass is a very fragile material which requires careful handling. Therefore, the storage for glass materials should plan smartly and wisely in order to minimize or hopefully to prevent it from breaking. The glass waste on construction sites can be used to reuse and recycle by going through a process of crushing, screening to remove contamination, air classification, and size classification, washing, and drying of the glass waste. After the glass has been all through the process stages, the glass can be known as recovered glass. The recovered glass can be used as decorative materials, filtration medium, insulation, containers and so on.

Bricks and blocks lifespan can last for almost a hundred years. The bricks and blocks that have been previously used on a construction site can be used to reuse and recycle. Most of the sources of brick and block turned up to waste mainly cause by damage during on and off loading, excessive of over ordering and so on, the waste of brick and block mostly come from walls, column etc. the undamaged brick and block can be reused in another new project. Other than reusing the brick and blocks, the brick and block that is damage can also be used to recycle: to make aggregate for the use of general fill or highway sub-base in landscaping; to manufacture new bricks and blocks; to make thesure surface as tennis courts and athletics tracks as plant substrate. Insulation material, the insulation that has been previously used on construction sites can be used to recycle as well. Insulation materials such as fiberglass, mineral wool, polystyrene, spray foam, polyurethane, fiberboard and so on. These insulation materials are very fragile which required careful installation. The causes of

insulation waste mainly due to over-estimate of ordering and damage of unused materials, ordering the wrong specifications or types of insulation, over-designed projects, poor storage, and handling. These are the main causes of wastage for insulation on construction sites. The options for recycling waste insulation produced on construction sites include direct reuse of off-cuts; returning materials through take-back schemes offered by manufacturers; compressed rock wool ceiling tile manufacturer; reclamation and reprocessing after removing impurities such as screws and nails.

SAFETY ON CONSTRUCTION SITE

Waste generated on construction sites is not only unsightly but hazardous as well. People can fall, twist, strain, or scrape and cut themselves. You must plan ahead to reduce waste when performing construction. Many of these materials can be hazardous and must be handled and disposed of properly. George (2008) cited the following as safety waste management system on construction sites:

Personal protective equipment, when working on construction sites, wear protective clothing and equipment that is appropriate for the job. Handling construction waste will require the use of important items such as hard hats, safety goggles, dust masks, respirators, hazardous materials suits, rubber boots, heavy-duty gloves, and steel-toed boots as many of the materials disposed of at a construction site are sharp and have irregular shapes. Some of the materials can be small and relatively easy to handle while others are large and require special handling. Waste items can include the following materials: Nails , Screws Pipe , Wire, Steel , Rebar, Concrete, Rocks,Wood, Fiberglass, Tile Tar, Paper, Carpeting, Drywall, Bricks, Glass etc.

Handling construction waste, special care must be taken when handling certain types of construction waste. Concrete can be very heavy and may require a skip loader. Rebar, steel, wire, and pipe may be bent into irregular shapes and will require extra care when loading into a disposal bin. Exposed nails, glass, and tile can cause severe injury. Wood, drywall, and carpeting are sometimes in large pieces and may need to be cut into smaller sizes before safely lifting into a disposal bin. Many items contain dust and other particles such as fiberglass. Wear a dust mask to reduce the risk of inhaling the harmful dust.

Always place barricades, barriers, and signs around piles of construction waste material. Barricades and signs are affixed or placed at locations on the job site where hazards exist. There should be a clear area of five feet between a waste pile and the barricade. Signs and symbols must be visible at all times around waste piles. Construction waste piles should be removed as quickly as possible. Toxic waste, construction trades produce many toxic waste materials. Some of the materials will include lead paint, tar, glue, caulking, and asbestos insulation. Some building materials may contain hazardous mold. Construction waste materials that contain toxic substances must be disposed of properly. When construction waste is suspected of containing toxic substances it must be disposed of at a hazardous waste facility. Most city dumps will not accept materials that contain toxic waste. Handling and disposing of hazardous toxic waste materials will require the use of personal protective equipment including a full body jumpsuit and a respirator.

Waste recycling, the technology to recycle many construction waste materials into new products is rapidly progressing. Many states recycle drywall and carpet. Several kinds of glass can be made into new windows. Cardboard, paper and agricultural fibers can be pulped and turned into lightweight home insulation or particleboard. You may find a solution for your waste at a recycling center. Local charities can benefit from leftover construction materials. For example, Habitat for Humanity accepts unused portions of paints and solvents. In conclusion, managing waste on construction sites is a hazardous job. When the correct safety precautions are taken, the risk of injury to employees and the public is greatly reduced. Know what the material is and what it contains before you start a clean-up job. Always dispose of construction waste at an approved site. Use a cover when transporting construction waste to prevent hazardous debris from being blown out onto the roadway. Utilize these safety guidelines when handling construction waste.

PROSPECTS OF WASTE MANAGEMENT

Construction waste management will provide economic benefits by decreasing the cost of the project through proper implementation of a waste management plan. Apart from economic benefits, waste management may positively contribute to the following aspects (Bon-gang 2010):

Cost saving and profit maximization, an increased emphasis on waste reduction, reuse and recycling may produce favourable outcomes such as cost saving. Generating less waste from construction projects results in are duction in disposal costs and landfill charges; eventually cutting down the construction cost which can furthermore, as a result of saving, in turn, can maximize profit. Reduced demand for landfill spaces, minimizing the amount of waste sent to landfills for disposal can lead to less demand for landfill and reduction of negative environmental effects such as noise, pollution effects of the landfill as well as emission and residues from incinerators. Rising disposal costs and reduction in a number of landfills create a need to search for alternatives to reduce, reuse, recycle and replace of construction waste being generated on construction sites. Hence the implementation of construction waste management which can be one of the apparent solutions for construction sites to minimize waste and waste disposal, ultimately reducing costs incurred during the process

Productivity and quality improvement can be improved by avoiding delays caused by re-ordering and repurchasing of materials that have been wasted once. By selecting the material of good quality and durability, a significant amount of poor quality material during the life cycle of facilities can be avoided. Improved resource management because waste management also involves planning and control of resources committed to construction sites in order to control the amount of waste generated. Therefore, better control of resources may be achieved with a reduction in waste as well as improvement of entire resource management performance (Bon-Gang 2010). Image improvement, implementing waste management as a company policy may allow companies to enhance their public images as 'environmental-friendly companies'' enhancing their impression on clients. Government legislation should own, provide waste incinerators and manage landfills (located outside the cities) for proper management of final disposal sites. If there is an efficient and effective legislation to govern and monitor construction site operations including quality control on building materials and practices and also sufficient oversight of construction site operations from the relevant authorities, as well as sufficient enforcement to eliminate illegal disposal of construction site waste into landfills, a common occurrence especially in transitory and developing countries.

CHALLENGES OF WASTE MANAGEMENT

Landfills receive the brunt of un-recycled construction waste. Debris from construction site operations forms approximately 10-30% of the waste materials that are delivered to landfills. The construction site waste management challenges that arise from its high volume and density are compounded by its generally larger size, lack of malleability and the hazardous nature of the airborne particles associated with it. Many industrialized economies such as Finland, Germany, Australia, and Denmark have existing legislative policies that encourage reduce/reuse/recycle (3Rs) initiatives of construction site waste management. Tighter laws in the European Union governing the landfilling of solid waste also contribute to sustainable construction waste management. However, reports from several countries imply that 3R initiatives for construction waste management are still insufficient: for example, in the USA, the Hong Kong SAR, Canada, and the UK, construction waste currently takes up 33-65% of the existing landfill space. The most important single instructional problem facing construction waste management is finance (Sade1984) the problem of finance is regarded as an imposed problem: imposed in the sense that the task of construction waste management has been assigned to a level of government which although rightly closer to the source of generation, is the more financially incapacitated. The more viable state government has had to intervene and or take over construction waste disposal from the local council: management has continued to be a serious problem.

Egunjobi (1983) observed that lack of motor-able roads and streets hampers construction waste collection and proper evacuation by authorizes especially in the traditional core areas. Okafor (1983) noted another problem which is structural. This problem is a lack of satisfactory (formal) provision for final disposal sites. One thing is to remove construction waste from the site and another is to dispose of them properly without causing any harm to the environment and society at large. The third challenge is the lack of explicit legislature governing construction site waste management. This is a common issue in many transitory and developing economies such as Czech Republic, Cyprus, India etc. there is weak or ineffective legislation to govern and monitor construction site operations including quality control on building materials and practices. If there is insufficient oversight of construction site operations from

the relevant authorities, the resulting structures could suffer from reduced quality, which leads to the building structure becoming compromised. Insufficient enforcement also leads to illegal disposal of construction site waste into landfills, a common occurrence in transitory and developing countries.

The fourth challenge lies in the categorization of construction site waste. In many transitory and developing economies (whose construction waste generation could possibly be higher than industrialized economies), there are no explicit laws governing generation, management, and disposal of construction sites waste. Instead, it is considered part of municipal solid waste and is planned for as such. There are many physical and chemical differences when construction waste and municipal solid waste are compared. The differences lead to vast gulfs in management options and in the financial commitments necessary for sustainable management. When this difference is not acknowledged, there is a break down in removal/disposal services for construction site waste.

The fifth challenge is in the contingency of construction site waste management. Sustainable management of construction waste must incorporate provisions for large-scale emergency situations. Although construction waste is part of contemporary waste management thought, it becomes a greater problem after the occurrence of a large-scale destruction event in which life-saving operations must be immediately mounted. Ideally, rescue and rubble clean-up must commence simultaneously as they complement each other. The contingency of construction site waste management can also be strategically planned to address long-term pertinent waste management issues: obtaining funds for operations, proper waste collection/disposal, re-development of local waste management infrastructure, local capacity building, spreading awareness, etc.

Lastly, reframing of construction site waste as sources of raw materials (a form of urban mining), rather than as solid waste. Uncontrolled disposal of construction waste into landfills, as currently practiced in transitory economies, is a dire waste of finite natural resources. For example, it has been stated that 40% of natural resources harvested in the USA have been used in construction operations. Construction waste materials, if produced correctly (by

deconstruction rather than demolition) could serve as a rich urban mine. Deconstruction is time-consuming and not economically sustainable. However, so effective mining of construction site waste can only be achieved as a compromise between costs and income earned from raw materials (Agamuthu 2009).

CONCLUSION

There must be more concerted efforts placed into sustainable management of construction site waste, which has a better chance of being controlled in comparison with municipal solid waste. Construction site waste has fewer emission points and construction waste generators, being profit driven, can be quickly brought in order to comply with the necessary legislature and enforcement. Furthermore, illegal disposal of construction waste is actually difficult given its conspicuousness. With the landfills in many countries already reaching a saturation point and much more expected to do so in the near future, construction waste should be considered a realistic option for worldwide sustainable management and be focused upon accordingly. The international solid waste association (ISWA) can contribute to sustainable construction site waste management by playing a vital role in spreading awareness on the importance of the issue and by providing increased academic and technical expertise through capacity building.

REFERENCES

Agamuthu Periathamby (2009) Challenges in Sustainable Management of Construction and Demolition Waste: Article in Waste Management and Research, January 2009, University of Malaya, Malaysia. http://sagepub.com.

Alam M. S. (2012). An Overview of Construction and Demolition Waste Management in Canada: A Life Cycle Analysis Approach to Sustainability. Published Online. Retrieved 1 December 2016 from http://www.researchgate.net/.../2574789.com.

Bon-Gang Hwang (2010).Performance Metric Development for Pharmaceutical Construction Projects. International Journal of Project Management April 2010, Vol. 28(3): 265-274.

Coventry, S. & Guthrie, P.M. (1998). Waste Minimization and Recycling in Consideration: Design Manual. CIRIA SP134 London: Construction Industry Research and Information Association (CIRIA).

Duran X., Lenihan, H. & O'regan, B. (2006). A Model for Assessing the Economic Viability Of Construction and Demolition Waste Recycling-The Case Of Ireland, Resources, Conservation and Recycling, 46, 302-320.

Egunjobi, T.O. (1983). Problems of Solid Waste Management in Nigeria.

Ekanayake L.L. (2000). Architects' Perspectives on Construction Waste Reduction by Design: Waste Management 2008, Vol. 28(7):1147-1158.

Esin, T. &Cosgun, N. (2007). A Study Conducted to Reduce construction Waste Generation in Turkey. Building and Environment, 42(4), 1667-1674.

Faniran, O.O. & Caban, G. (1998).Minimizing Waste on Construction Project Sites. Engineering Construction and Architectural Management, 5(2), 182-188.

Ferguson J. (1995). Managing and Minimizing Construction Waste: A Practical Guide by J Ferguson, Institute of Civil Engineers (Great Britain).

Flaomo, A.A. (1995). City Waste as a Public Nuisance. Paper Presented at the 1995 Annual Conference Of The Nigeria Environmental Society. Lagos.

Franklin Associates (1998). Characterization of Building-Related Construction And Demolition Debris In The United States. Retrieved December 1, 2016,From http://psp,sisa.my/elibrary/attachments/086-cptr-21.pdf.

George Davis (2008) Construction Waste Management: Posted April 3, 2008: www.safetyservicecompany.com.

Hao, J.L., Hills, M.J. & Huang, T. (2007).A Simulation Model Using System Dynamic Method for Construction and Demolition Waste Management in Hong Kong. Construction Innovation, 7(1), 7-21.

Khalil, N., Khan, M. (2009).A Case of a Municipal Solid Waste Management System for a Medium-Size India City, Aligarh. Management of Environment Quality: An International Journal, 20(2), 121-14.

Kofoworola, O.F, and Gheewala, S.H. (2009).Estimation of Construction Waste Generation and Management in Thailand. Waste Management, 29 (2), 6731-738.

Ling, Y.Y. & Loe, K.C. (2000). Reusing Timber Framework: Importance of Workmen's Efficiency and Attitude: Building and Environment, 35(2), 135-143.

Lu, M., Poon, C.S. & Wong L. C. (2006).Application Framework for Mapping and Stimulation of Waste Handling Processes in Construction. Journal of Construction Engineering and Management, 132 (11), 1212-1221.

Magdich, P. (1995). Construction and Demolition in Higgins, T. E. Ed. Pollution Prevention Handbook. Florida: Lewis Publishers. 389-394.

Okafor, N. (1983). Urban Solid Waste Generation and Management in Nigeria: Towards an Environmental Sanitation Policy.

Osmani, M., Glass J. & Price, A.D.F. (2008). Architect's Perspectives on Construction Waste Reduction by Design. Waste Management, 28(7), 1147-1158.

Peng, C.L., Scorpio, D.E. &Kibert, C.J. (1997).Strategies for Successful Construction and Demolition Waste Recycling Operations. Construction Management and Economics, 15(1), 49-58.

Poon, C.S., Yu, A.T.W., Wong, S.W. & Cheung, E. (2004).Management of Construction Waste in Public Housing Projects in Hong Kong. Construction Management and Economics. 22(7), 675-689.

Sade, P.O. (1984). Urbanization and Living Conditions in Nigerian Cities; Research Triangle Institute.

Shen, L.Y., Tam, V.W.Y., Tam, C.M. & Drew, D. (2004).Mapping Approach for Examining Waste Management on Construction Sites. Journal of Construction Engineering and Management, 130(4), 472-481.

Tam V.W.Y.& Tam C.M. (2006).A Review on the Viable Technology for Construction Waste Recycling. Resources, Conservation and Recycling, 47(3), 209-221.

Tam V.W.Y. (2008). On the Effectiveness in Implementing a Waste Management Plan Method in Construction. Waste Management, 28(6), 1072-1080.

Teoh Su Ping (2009).Material Waste in the Malaysian Construction Industry: International Conference on Economics and Administration Proceeding: Nov2009, P257.

Yuan, H.P. (2008) Construction and Demolition Waste Management Model Based on System Dynamics, Master Thesis of Shenzhen University, China.