EFFECT OF CONSTRUCTION WASTE RECYCLING PRACTICES ON BUILDING PROJECT SITES IN ENUGU METROPOLIS, ENUGU STATE

Moses Onyekachi Ikechi and Peter Uchenna Okoye
Department of Building, Faculty of Environmental Sciences, Nnamdi Azikiwe University, Awka, Nigeria
*Corresponding Author: pu.okoye@unizik.edu.ng

Abstract

The study determined the effects of construction waste recycling practices on building project sites in Enugu Metropolis with a view to promoting sustainable building practice in the study area. The study was conducted through a descriptive and inferential survey research method where two hundred and twenty-eight self-structured questionnaires were distributed to building professionals, project clients and staff of Enugu State Waste Management Authority while 173 copies were retrieved back. The results were analyzed using frequency count, mean score and standard deviation while Kruskal H-Test was used in testing the stated hypothesis. The study revealed that contribution to circular economy and sustainable construction (1st, 4.09), energy saving was ranked (2nd, 3.98), reduction in environmental pollutions (3rd, 3.88), conservation of natural resources was ranked (4th, 3.79), improvement of construction health and safety was ranked (5th, 3.72) and reduction in green house emission was ranked (6th, 3.67) are the notable effects of construction waste recycling practices on building construction sites in the study area. It further showed that construction waste recycling practices has significant effect on building construction sites (α: 0.05; 0.06 < 5.991). The study concludes that only by proper recycling of construction wastes can energy be saved, natural resources be conserved and waste minimized. It further concludes that recycling of construction waste contributes to circular economy and helps foster sustainable construction. The study recommends that waste recycling practices should be adopted on all construction sites and by all categories of building construction firms. Also, building project clients and construction professionals should adopt the idea of using recycled material as an alternative source for building materials in order to reduce any potential risk and costs associated with wastage from construction materials.

Keywords: Building Sites, Construction Materials, Construction Waste, Recycling Practices, Waste Management

Introduction

The construction industry has long enjoyed immense benefits for its significant contribution to the built environment, creating job opportunities, and maintaining economic growth (Lee, Nguyen, Crossin and Verghese, 2020); However, in spite of the benefits it brings, it is equally known for producing immense amounts of wastes (Thurnau, 2013). Construction waste especially material waste is a major concern for the construction projects due to the overwhelming rate of its increase, leading to request for landfills (Hao, Yuan, Liu, Chin and Lu, 2019). As stated in Prakash and Rao, 2016) there is growing interest in the waste generated and how the large volumes of waste can be turned into an opportunity through recycling.

Recycling is the process of turning waste resources into new goods. In comparison to new manufacture, it minimizes the use of energy and raw materials, saves the waste of valuable resources, and thereby lowers greenhouse gas emissions (Demirbas, 2010). Building construction industry is said to be making use of considerable amount of resources; steel, timber and crushed concrete (Dania, Kehinde and Bala, 2016), these materials during and after construction works are being littered and disposed recklessly. This has resulted to degradation of water, air and land resources which negatively affects the health of Enugu residents and has also polluted the aesthetic city of Enugu.

Various approaches for waste disposal and recycling have been studied during the last few decades (Zaharieva, Dimitrova and Bodin, 2003). Recycling of building construction waste has been identified as the possible solution to save our environment while also meeting housing demand. Most construction stakeholders and building practitioners notably in Enugu Metropolis are still fleeceable on the practices to control and re-cycling construction waste and this is very detrimental to sustainable development. This study will serve as benefit not just to these building practitioners but also to residents in Enugu Metropolis and its environs who has greatly affected by recklessly disposed waste from construction activities. Adopting appropriate construction waste recycling practices would lead to significant reductions in various issues related to these construction wastes (Islam, *et al.*, 2019).

Recycling practices, of course, need to be properly designed based on the kind of material that needs to be recycled, taking into account all relevant factors such as air pollution, gas emissions, and environmental effects. It is in view of this that this study seeks to examine the effect of construction waste recycling practices in Enugu Metropolis, Nigeria with a view to promoting sustainable building practice in the study area.

Literature Review

Construction waste (CW) recycling

Prevention of waste, reuse of waste and recycling, separation of recyclable materials from the waste, the use waste as an energy resource development processes and methods of waste disposal, remediation of unregulated dumps, and developing awareness of waste management all involves waste management. The biggest problem is the collection of waste for recycling, i.e, waste sorting, because some parts of the process must be performed manually, which increases the cost of recycling (Berkun, Aras and Anilan, 2014).

Construction waste (CW) recycling is the process of disassembling used materials used in construction to create new materials. Basically, it is the process of turning waste into new resources for use. However, immature management of CW recycling, unsuitable recycling technology, and an undeveloped market for recovered products are obstacles to CW recycling (Hoang, Ishigaki, Kubota, Yamada and Kawamoto, 2020). Construction material recycling ultimately saves a significant quantity of CO2 that would otherwise be emitted during waste removal and the frequent transportation of natural construction materials over great distances. Construction waste recycling offers a number of advantages, such as reducing the need to extract new raw materials, preserving landfill capacity, reducing the need to use new landfills and the associated costs, saving energy, and reducing the negative environmental effects (Ghisellini, Ji, Liu and Ulgiati, 2018).

Generally, construction waste recycling can be divided into two types: off-site/centralized and on-site/decentralized recycling. When construction waste is

generated on-site, sorting/segregation is often conducted quickly to decide whether on-site reduction/reuse/recycling can be performed or not. Otherwise, the segregated waste, in particular the non-inert portion, will be landfilled, and the inert portion will be sent to public fill banks. Burgoyne (2003) deemed on-site waste recycling as one of the most efficient recycling strategies for greatly saving transportation, storage and some processing expenses.

Nevertheless, some studies have identified certain drawbacks of recycling on-site, including low quality recycled products generated due to scarce available cleaning facilities as well as vulnerability to possible noise and dust pollution to nearby residential areas (Ulubeyli, Kazaz and Arslan, 2017; Kühlen, Volk and Schultmann, 2016).

Waste recycling (WR) techniques

In light of the nation's increasing infrastructure development and urbanization, understanding of the need to adopt an appropriate management strategy for construction wastes is promising (Marrero, Puerto, Rivero, Freire, and Solís-Guzmán, 2016). Construction waste recycling techniques are essential to the management of construction waste (Bao, Lee and Lu, 2020). This will lead to a decrease in the number of instances of illicit disposal sites, which cause environmental issues for the local community. Furthermore, Liu, Gong and Wang (2021) note that the profitability of construction waste recycling is also heavily dependent on available technology, economics, contract specifications, regulatory policy, and project management methods. WR improvement techniques are therefore crucial to building projects. Some of these techniques include;

1. **Incineration:** Incineration likewise known as thermal treatment, is a recycling technique that involves the destruction of waste material through heat (Kan, 2009). Incineration can be adapted to the destruction of a wide variety of wastes. Unlike many other methods of waste disposal, incineration is a permanent solution. The major benefit of incineration is that the process actually destroys most of the waste rather than just disposing of or storing it.
2. **Combustion:** Combustion involves the process of converting waste materials to inert mineral ash and gases under certain constant conditions; temperature, turbulence, oxygen and residence time) which must be present (Evaggelia and Scott, 2007). During the process, the combustible parts are converted to their oxides while the non-combustible parts are deposited at the bottom as ash.
3. **Corona discharge and electrostatic discharge:** The corona-electrostatic method is perhaps the most effective separation technology for the metallic and non-metallic fractions at present (Guo, Guo, and Xu, 2009). The metallic components removed must be reduced to very small particles which can be achieved by accelerating them at high speed to impact on a hardened plate. Then the small particles, typically less than 0.6 mm are passed along a vibratory feeder to a rotating roll to which is applied a high voltage electrostatic field using a corona and an electrostatic electrode (Lu, Li, Guo and Xu, 2008).
4. **Composting:** Also called nature's own way of recycling, is the controlled decomposition of organic material into a valuable fertilizer that can enrich soil and plants. Composting is the most practical and convenient way to handle yard wastes. It can be easier and cheaper than bagging these wastes or taking them to the transfer station. When compostable waste goes to a landfill, it gets buried under massive amounts of other wastes, cutting off a regular supply of oxygen for the decomposers. The waste then ends up undergoing anaerobic decomposition, being broken

down by organisms that can live without free-flowing oxygen (Environmental Protection Agency, 2015).

5. **Plasma Gasification:** Plasma gasification is another form of waste recycling technique. Plasma is a primarily an electrically charged or a highly ionized gas. During the treatment of waste by plasma gasification, the waste's molecular bonds are broken down as result of the intense heat in the vessels and the elemental components. This form of waste recycling technique provides renewable energy and an assortment of other fantastic benefits.

Effects of Construction Waste Recycling on Building Construction Sites

Waste recycling and disposal are two complementary activities in waste management and also the basis for cost minimization during project execution. Project success is measured by project efficiency and project effectiveness. Nowadays, especially in large cities, the disposal of building material waste has become a problem for the environment. Every day, a significant amount of diverse building waste types with unique properties are produced (Singh, 2015). Due to its detrimental effects on the environment, the economy, and social issues, it has become a matter of great concern to ensure proper recycling system. Ineffective waste management has had negative effects on both the environment and human health. One of the biggest issues facing the construction sector is material waste (Sawant and Hedaoo, 2016), though through recycling, a huge percentage of this problem can be curbed.

Some notable effects of construction waste recycling include:

Energy conservation

It takes energy to create and transport construction materials. You can envision poorly managed construction waste as a fuel supply that depletes as a project progress. When materials are thrown into landfills, it's like pouring away all the spare fuel supply. Once thrown away, this supply can't be reused for your following projects. This energy can be conserved and the environmental impact reduced by optimizing material usage. Combining this with effective waste recycling strategies contributes to these efforts.

Cost implications

Being an inevitable part of production (Adewumi and Otali, 2013), waste contributes as high as 15% additional cost to construction projects (Tam, Shen and Tam, 2007). Material wastage during construction works accounts for between 20 and 30% project cost overruns, it is therefore glaring how much threat the economic loss from construction material waste could pose to the economic growth of the nation. For the past 70 years, built environment experts, project owners, and users have been debating how to cut down on or eliminate cost overruns from building projects (Allahaim and Liu, 2012), and this can be achieved through proper waste recycling system. Construction projects has long been plagued by cost overruns and these foreseen expenses can be minimized if crucial attention is being paid to the usage of building materials during construction activities, and the appropriate recycling system to be adopted to regulate the said wastes.

Economic implication

In economic terms, plenty of studies have been conducted on the economic situation of construction waste recycling such as (Coelho and de Brito, 2013; Zhao *et al*., 2010). Both of these studies confirmed the economic feasibility of recycling construction waste, but with different results due to the conditions of each study. Coelho and de Brito (2013) revealed that despite the absence of regulatory government policy,

the initial investment required for recycling may be high but there is a high profit potential for construction waste recycling with the return of invested capital in around two years. Zhao (2010) concluded that fixed and mobile recycling centers with used equipment have higher economy viability than centers with new equipment and that is due to their ability to achieve a higher profit margin in contrast to the second case. Also, the revenue increases owing to the location advantage (e.g. mobile stations) and the recycling cost decreases with the economy of scale (e.g. fixed centers). This study has also suggested that waste recycling has its economic effect on construction projects.

Increase in labour productivity

The broad definition of productivity is the ratio of outputs to inputs. Since labour costs account for 30% to 50% of the total project cost, construction projects are mostly labour-based and use simple hand tools and equipment (Saari, 2006). Labour productivity is one of the most important factors that affect the physical progress of any construction project. Construction is a relatively expensive process, and labour becomes a more crucial input during the manufacturing and processing stage. Furthermore, labour costs account for 20% to 50% of the whole project cost, and productivity growth is the most effective way to reduce these costs (Abdel, Elshakour and Abdel, 2006).

However, in today's competitive industry, a construction firm's ability to succeed mostly rests on its ability to accurately manage construction materials, and this is will essential improve construction project delivery. When there is minimal loss or wastage in construction materials as a result of efficient recycling techniques applied on building sites, productivity will increase massively.

Environmental implication

Much of the environmental consequence of waste is on the effective disposal of them; reports of overburdened landfills in Hong Kong by Poon, Yu and Jaillon (2010) is an attestation to environmental concerns that would arise in the future for unbridled generation of construction wastes. The environmental implication about construction waste proceeds from the fact that most construction materials are extracted from the earth's resources leading to so many of them being in danger of depletion (Reardon, Fewster and Hearkeness, 2013), processed by methods that pollute the environment and contributes residues that fill the limited landfill spaces available.

Regarding these environmental implications from recycling, several studies have been conducted to evaluate the environmental impacts from construction waste recycling. Coelho and de Brito (2013) conclusion of his study is that recycled materials always have significant environmental benefits where the avoided impacts of CO2eq emissions are always higher than the generated impacts and energy savings exceed the energy consumed during the operating lifespan. It is, therefore important that steps must be taken to reduce dependence on construction resources that have depleting potential as it will result to further reduction of the pollution generated during the manufacturing process, construction process and wastes disposed to landfills.

Sustainable development

Implementing recycling and waste reduction measures in construction projects fosters sustainable urban development. Strategies to reduce construction waste can enhance resource efficiency and promote the use of recycled materials, contributing to greener cities. Recycling and upcycling play a vital role in managing construction waste sustainably (Troschinetz, 2005).

Construction companies can actively implement recycling programs on-site to sort and separate waste materials like concrete, metals, and plastics. These materials can then be recycled into new products, reducing the need for virgin resources and diverting waste from landfills. Recycling can reduce the depletion of landfill space, save energy and natural resources, provide useful products and provide sustainable development. It involves minimizing waste generation, maximizing material recovery and reuse, and reducing environmental impact.

Reduction in environmental pollution

The result of deteriorating environmental situation in various countries and regions where environmental pollution is the most intense climate is warming, ozone layer is depleting, desertification. According to the definition adopted by the UN organization, pollution are exogenous chemical substances encountered on a suitable place, at the appropriate time and in inadequate quantities (Bjelajac, 2011). According to the analysis (taken in early 20th century), it is concluded that the most polluted spheres are atmosphere and hydrosphere. Even the state of cosmic space around our planet raises serious concerns. In order to define the concept of the environment, we must consider the basic ecological unit that has its own laws, which is characterized by complex factors of animate and inanimate nature. This unit is called an ecosystem. Human activities on earth has a great influence on the environment.

The impact of economic and other activities on the environment may be different in character: direct (immediate) and indirect synergy. From the perspective of environmental effects of pollution are usually described in terms of which we have already pointed out: degradation, devastation, endangering the environment, in different time periods. It is possible to perceive the effects of pollution in air, water, soil, wildlife, human health, and so on. We can speak of long-termed and short-termed effects of pollution. It can be very important to understand the concept of the working environment, if it is connected with the concept of environmental protection in the context of discussions on environmental management. This can be done for many reasons. First, because of the connection of the working environment as part of the environment, there are connections and processes related to the operation and are of importance to the issue of the environment.

There are several provisions in the law on safety and health at work and other regulations governing an area or a state, which are directly relevant to the understanding of the relationship between the working environment and the environment. It is necessary to know not only the notion of working environment but also to bear in mind the definition of a number of other terms such as; hazardous materials, dangerous phenomenon, risk, risk assessment, and so on. Unfavorable changes in the environment caused by human activities, causing a change in the inflow of energy, radiation levels, physicochemical and microbiological composition of environment can be defined as environmental pollution. The harmful effect of pollution; their effect is manifested in the anatomical and morphological structure, metabolism, growth process, at all levels of cellular organization, from the molecular to the cellular level, through individual and population to biocenosis and ecosystems.

Methodology

A descriptive and inferential survey research design was adopted for the study. The study was carried out in Enugu Metropolis, Enugu State; comprising of Enugu East, Enugu North and Enugu South. The study focused on key professionals (Architects, Builders, Civil Engineers and Quantity Surveyors) in the construction industry, building project

clients and staff of Enugu State Management Authority (ESWAMA).

A total sample size of 228 was determined from the total population of 808 using the Taro Yamane formular and split-half reliability test was used to determine the internal consistency of the 5-point likert scale question items. The data for the research were collected through questionnaires. Stratified random sampling technique was used in the selection of the 228 respondents for the study. The collected data were analyzed using frequency count, mean score and standard deviation. Kruskal H-Test was used in testing the significance of the effects of recycling on building construction sites.

Result

Table 1: Effects of construction waste recycling practice on building construction sites in the study area

S/N	Variables	$\bar{x}$	S.D	Rank
1.	Energy saving	3.98	.03	2nd
2.	Reduction in the need to use landfill	3.65	.04	8th
3.	Improvement of labour efficiency and productivity	3.62	.05	7th
4.	Conservation of natural resources	3.79	.03	4th
5.	Improvement of construction site organization	3.57	.03	11th
6.	Reduction in Environmental pollutions	3.88	.04	3rd
7.	Improvement of construction health and safety	3.72	.04	5th
8.	Reduction in construction waste disposal costs	3.55	.05	12th
9.	Preservation of landfill capacity	3.65	.04	8th
10.	Reduction in green house emission	3.67	.03	6th
11.	Contribution to circular economy and sustainable construction	4.09	.03	1st
12.	Enhancement of better management of hazardous materials	3.58	.04	10th
13.	Enhancement of compliance with construction and environmental regulations.	3.51	.06	13th

Table 1 ranked the overall mean scores of the respondent's perception on effects of construction waste recycling practices on building construction sites in the study area. According to the table, the most frequently embraced among the parameters listed on effects of construction waste recycling practices on building construction sites according to overall mean were: contribution to circular economy and sustainable construction (1st, 4.09), energy saving was ranked (2nd, 3.98), reduction in environmental pollutions (3rd, 3.88), conservation of natural resources was ranked (4th, 3.79), improvement of construction health and safety was ranked (5th, 3.72) and reduction in green house emission was ranked (6th, 3.67).

Table 2: Kruskal Wallis H-Test for effects of construction waste recycling practice on building construction sites in Enugu Metropolis.

Variable	Rank sum (R)	Mean rank sum ($\overline{R}$)	Ranking value ($\sum_R$)	Rank variance (O^2R)	H_{value}	$H_{critical}$
Building Professionals (A)	155	15.5	15.5	29.97	0.06	5.991
Project Clients (B)	156	15.6				
ESWAMA Staff (C)	154	15.4				

α: 0.05

Result in Table 2 shows the H-value (0.06) using the mean score responses from the three categories of respondents on effects of construction waste recycling practices on building construction sites. Since the calculated H-value (0.06) is below the H-critical value of 5.991, the null hypothesis is rejected and the alternative which states that construction waste recycling practices has significant effect on building construction sites is accepted.

Discussion

The result presented on Table 1 revealed that contribution to circular economy and sustainable construction, energy saving, reduction in environmental pollution, conservation of natural resources, improvement of construction health and safety, and reduction in green house emission. This result as well agrees with the hypothesis tested in Table 2. This implies that waste recycling practices has huge effect on building construction sites.

The result from the analysis corresponds with the findings of Troschinetz (2005) that recycling and upcycling play a vital role in managing construction waste sustainably and conserving natural resources. These building materials when recycled into new products, reduces the need for virgin resources, diverts waste from landfills and conserves energy, hence fostering sustainable urban development. The result from the finding agree with the analysis of Abdel, Elshakour and Abdel (2006) who revealed that productivity growth and improvement of labour efficiency is the most effective way to reduce construction costs and can be achieve through a proper recycling system.

The findings also revealed that environmental pollution from construction waste proceeds from the fact that most construction materials are extracted from the earth's resources leading to so many of them being in danger of depletion, processed by methods that pollute the environment causes greenhouse emission and contributes residues that fill the limited landfill spaces available. These could all be reduced through appropriate recycling. This is in agreement with Coelho and de Brito (2013) who revealed that recycling building materials always have significant impact on the environment, reducing environmental pollution and protecting the health and safety culture of the working environment.

Conclusion and Recommendation

The tested hypothesis proved that recycling of construction waste has significant effect on building construction sites. It concludes that only by proper recycling of construction wastes can energy be saved, natural resources be conserved and waste minimized, as it reduces the need for virgin resources and diverts waste from landfills to where it can be managed sustainably. It further concludes that recycling of construction waste contributes to circular economy and helps foster sustainable construction, and this has significant benefits to the construction.

The study recommends that waste recycling practices should be adopted on all construction sites and by all categories of building construction firms, whether large, medium or small. This approach will help in identifying and reducing possible sources that could lead to construction wastes. Building project clients and construction professionals should adopt the idea of using recycled material as an alternative source for building materials in order to reduce any potential risk and costs associated with wastage from construction materials. Also, the use of modern waste recycling technology should be accommodated by contractors and site managers. This will assist in switching out obsolete materials for a new one that is more durable and sustainable.

Reference

Abdel-Razek, R.H., Elshakour, H. and Abdel-Hamid, M. (2006). Labour productivity: Benchmarking and variability in Egyptian projects. *International Journal of Project Management*, 25,189–197.

Allahaim, F.S. and Liu, L. (2013). Toward a typology: Cost overrun causes framework in infrastructure projects. *Conference: CIB World Building Congress WBC*.

Bao, Z., Lee, W.M.W. and Lu, W. (2020). Implementing on-site construction waste recycling in Hong Kong: Barriers and facilitators. *Journal on Environmental Total Sciences*. https://doi.org/10.1016/j.scitotenv.2020.141091.

Bjelajac, Z. (2011). *Ecological Policy of the European union and its Criminal-Legal Draft.* MP4.

Burgoyne, D. (2003). *Construction & Demolition (C&D) Waste Diversion in California. California*: Services SOCDOG.

Coelho, A. and Brito, J.D. (2013). Economic viability analysis of a construction and demolition waste recycling plant in Portugal – part II: Economic sensitivity analysis. *Journal of Cleaner Production*, 39, 329-337.https://doi.org/10.1016/j.jclepro.2012.05.006.

Dania, A.A., Kehinde, J.O. and Bala, K. (2016). A study of construction material waste management practices by construction firms in Nigeria. *Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment,* Glasgow, 121-129.

Environmental Protection Agency (EPA) (2015). Summary of Expert Discussion Forum on Possible Human Health Risks from Microplastics in the Marine Environment, EPA Reports.

Evaggelia, P. and Scott W. (2007). *Incinerated Sewage Sludge Ash in Facing Bricks*. University of Leeds, Mineral Industry Research Organization.

Ghisellini, P., Ji, X., Liu, G. and Ulgiati, S. (2018). Evaluating the transition towards cleaner production in the construction and demolition sector of China: A review. *Journal of Cleaner Production*, 195(5), DOI:10.1016/j.jclepro.2018.05.084.

Guo, J., Guo, J. and Xu, Z. (2009). Recycling of non-metallic fractions from waste printed circuit boards: A review., *Journal of Hazardous Materials,* 168, 567–590.

Hao, J., Yuan, H., Liu, J., Chin, C. S. and Lu, W. (2019). A model for assessing the economic performance of construction waste reduction. *Journal of Cleaner Production*, 232, 427–40.

Hoang, H., Ishigaki, T., Kubota, R. and Yamagata, M. (2020). A review of construction and demolition waste management in Southeast. *Journal of Material Cycles and Waste Management*, 22(3). DOI:10.1007/s10163-019-00914-5.

Islam, M.T., Abdullah, A.B., Shahir, S.A., Kalam, M.A., Masjuki, H.H., Shumon, R. and Rashid, M.H. (2016). A public survey on knowledge, awareness, attitude and willingness to pay for WEEE management: Case study in Bangladesh. *Journal of Cleaner Production*, 137, 728-740. https://doi.org/10.1016/j.jclepro.2016.07.111.

Jayamathan, J. and Remeezdeen, R. (2014). Influence of labour arrangement on construction material waste generation. *Structural Survey*, 32, 76-88.

Kan, A. (2009). General characteristics of waste management: Review. Energy Education Science and Technology, 23, 55–69.

Kühlen, A., Volk, R. and Schultmann, F. (2016). State of the art of demolition and reuse and recycling of construction

materials. *Proceedings of the CIB World Building Congress*, 664–678.

Lee, S., Nguyen, H., Crossin, E. and Verghese, K. (2020). Recycling the construction and demolition waste in Vietnam: opportunities and challenges in practice. *Journal of Cleaner Production*, 133, 757-766.

Liu, J., Gong, E. and Wang, X., (2021). Economic benefits of construction waste recycling enterprises under tax incentive policies. *Journal of Environmental Science Pollution Research,* 29,1–15. https://doi.org/10.1007/s11356-021-13831-8.

Lu, H., Li, J., Guo, J. and Xu, Z. (2008). Movement behavior in electrostatic separation: Recycling of metal materials from waste printed circuit board., *Journal of Material Processing and Technol*ogy, 197:101–108.

Marrero, M., Puerto, M., Rivero-Camacho, C., Freire-Guerrero A. and Solís-Guzmán, J. (2017). Assessing the economic impact and ecological footprint of construction and demolition waste during the urbanization of rural land. *Journal of Resource Conservation and Recycl*ing, 117,160–174. doi: 10.1016/j.resconrec.2016.10.020.

Oyenuga, A. (2016). Economic and environmental impact assessment of construction and demolition waste recycling and reuse using LCA and MCDA management tools. London South Bank University.

Poon, C.S., Yu, A.T.W. and Jaillon, L. (2010). Reducing building wastes at construction sites in Hong Kong. *Journal of Construction Management and Economics*., 22(5), 461-470. http://dx.doi.org/10.1080/01446190420000202816.

Reardon, C., Fewster, E. and Hearkeness, T. (2013). Waste Minimization. [online]. http://www.yourhome.gov.au/materials/waste-minimisation.

Sawant, S.B. and Hedaoo, M. (2016). Impact of the construction waste on the cost of the project. *International Journal of Engineering Research*, 5(1),126–128.

Singh, S.T. (2015). Management of construction waste materials: A review. *International Journal of Geology, Agriculture and Environmental Sciences*, 3(4),23–28.

Tam, V.W., Shen, L.Y. and Tam, C.M. (2007). Assessing the levels of material wastage affected by sub-contracting relationships and projects types with their correlations. *Journal of Building and Environment*, 42(3).

Thurnau, D. (2013). Reducing construction site wastes. http://ecovisionslc.org/reducing-construction-site-waste.

Troschinetz, M. (2005). Sustainable recycling of Municipal solid waste in developing countries. *Waste Management*, 29(2), 915-923.

Ulubeyli, S., Kazaz, A. and Arslan, V. (2017). Construction and demolition waste recycling plants revisited: Management issues. *Procedia Engineering*,172, 1190–1197.

Zaharieva, R.H, Dimitrova, E. and Bodin, F.B. (2003). Building waste management in Bulgaria: challenges and opportunities, *Waste Management*, 23(8),749-761.

Zhao, W. (2010). Evaluation of key factors influencing construction waste recycling in China: The case of Chongqing. Resources, Conservation and Recycling.