Recycling and Waste Reduction in Construction Firms in Bayelsa State.

Darar Ekpariba Apiri., N. Gladson Nwokah and Gabriel A. Okwandu
Corresponding author: darapiri@gmail.com
Department of Marketing, Rivers State University

Abstract

The purpose of this study was to empirically investigate the influence of recycling on waste reduction within construction firms in Bayelsa State, Nigeria. One hundred and eight-five (185) copies of questionnaire were administered to respondents. After retrieval and data sorting, one hundred and forty-three (143) copies were subjected to data analysis. The hypothesis was tested utilizing simple regression method. After the data analyses, the major finding was that: Recycling has a positive and significant influence on the waste reduction in construction firms in Bayelsa state. The main conclusions drawn from the results of our empirical analysis are that recycling has a positive and significant influence on waste reduction in construction firms in Bayelsa state. Based on the findings and conclusions, this study recommended that construction firms should continue to apply recycling as a tool to reduce waste generation and to ultimately improve their environmental bottom line performance.

Introduction.

The current state of the global environment has necessitated considerations of the effects of all interactions between, 'man', his business activities (processes, materials, equipment, energy usage) on the environment. Consequently, a good percentage of developed nations have put forth legislations to mitigate the overall effects of industrial activities on the environment and communities. Firms are even mandated to publish annual reports on efforts made to achieve optimum triple bottom line performance. What this means is that with the growing awareness, on the long run, it will be counterproductive for firms if they have not integrated sustainable practices into their operations and supply chains. 75% of large corporations are under pressure to develop non-financial performance measures. Government and firms are forced to incorporate sustainable development agenda into their practices. Reverse logistics (RL) is one of the practices that firms are being mandated to adopt (especially in Europe) to mitigate environmental and social impacts of industrial activities.

The construction industry has gained a notoriety for being a large resource consuming industry as it consumes large amounts of raw materials, water and energy which in turn results in the generation of massive material waste, greenhouse gases and carbon dioxide. The construction industry consumes around 40% of total global energy, generates 30% of green-house gas emissions, utilizes 17% of freshwater resources, and exacerbates to deforestation, consuming 25% of harvested wood around the globe (Li et al., 2017). Construction materials are wasted at the rate of 20–30 per cent, by weight, of all total materials on construction sites (Banihashemi et al., 2018), generating 45–65% of disposed waste in landfills (Nikmehr et al., 2017), mostly through the construction and demolition sector (Chileshe et al., 2012).

The purpose of the study was to examine the influence of recycling (one of the dimensions of reverse logistics) on waste reduction (one of the measures of environmental performance) in construction firms in Bayelsa State, Nigeria. To achieve this, the following objective was considered specifically: *To ascertain the influence of recycling on the waste reduction in construction firms in Bayelsa state*. Consequently, the following research question was posed:

Does recycling significantly influence waste reduction within construction firms in Bayelsa state?

This research will provide a basis for the enhancement of construction operations within the country to catapult indigenous firms to be competitive participants on the global front. This research will be highly beneficial to policy makers, industry professionals and academics as its findings will provide useful knowledge that can be used in policy making, industry practices and a background for further research. The scope of this research was simply to investigate the relationship between recycling and the waste reduction specifically in construction firms in Bayelsa state. The geographical scope of the research was limited to Bayelsa state. It cut across thirty-six (37) construction firms in Bayelsa state. The unit for analysis in this research was the macro level of analysis.

The theory of ecological economics.

Underpinning this study, is the theory of ecological economics. Ecological Economics describes the relationships between ecosystems and economic systems in the broadest context, and this represents an interdisciplinary field of study (Aurdahl, 2016). Issues such as sustainability, global warming, wealth distribution, natural disasters were originally not covered by any academic discipline, in this way ecological economics was developed to extend into these areas of overlap (Costanza, 1989). This study area encompasses neoclassical environmental economics as well as ecological impact studies as sub disciplines and encourages new ways of addressing the links between ecological and economic systems (Aurdahl, 2016). Ecological economists argue that the growing economy cannot continue indefinitely, as the Earth and its resources are not infinite (Aurdahl, 2016). This can also be categorised under "technological pessimism" which assumes that technology will be unable to solve problems as humans are a part of nature and a healthy ecosystem is one that maintains a stable level of human population growth (Costanza, 1989). Costanza et al. (2015) highlighted basic environmental problems for which we need innovative policies and management instruments to address them. Costanza et al (2015) emphasize that the presence of these problems is all evidences that the material scale of human activity exceeds the sustainable carrying capacity of the Earth. According to Costanza et al (2015) these problems include: "Unsustainably large and growing human populations that exceed the carrying capacity of the Earth; Rapidly increasing inequality within and between nations; Highly entropy-increasing technologies that deplete the Earth of its resources and whose unassimilated wastes poison the air, the water, and the land; Land conversion that destroys habitat, increases soil erosion, and accelerates loss of species diversity." The aforementioned issues necessitate the use of strategies bordering on economically efficient allocation of resources that adequately captures the protection of the stock of natural capital as well as actions based upon a fair allocation/distribution of resources and opportunities between present and future generations as well as among groups within the current generation (Aurdahl, 2016). Hence the emergence of theory of ecological economics which should inform the design of policies and instruments capable of dealing with these problems.

Recycling – Recycling is a reverse logistics recovery process where the product is broken down, stripped for parts and subsequently used as raw materials for a different product or resold to customers that may use them as raw materials for different products (Elmas and Edogmus, 2011). The outcome of recycling is different from that of other RL recovery processes, as only the economic value of the raw materials is recovered, so the returned product loses its identity and original functionality (Adkogan and Coskun, 2012). Recycled materials are utilised in production of new parts, components, and products with entirely different functions, thus the identity of product is lost (Adkogan and Coskun, 2012). A typical example is the use of old coins to make ornaments. This process extends the end of use time frame of a product and mostly occurs when a product cannot be directly reused or reprocessed.

As a result of recycling, the waste originally meant for landfill generated from used products can be reduced, thereby leading to better utilization of scarce natural resources and virgin materials (Gomez et al, 2007). For instance, Nike (the footwear and apparel manufacturer) works with its materials suppliers to recycle factory wastes for new footwear manufacturing (Lai et al, 2013). These reverse logistics practices enabled Nike to cut down its waste disposed to landfill from 25% in 2007 to 13% in 2009, while benefiting from reduced purchase of new materials and overall consumption of new raw materials (Lai et al, 2013). Another example can be seen in China, where Lenovo emphasizes close-loop recycling, and the company recycles plastics from both end of life IT and non-IT sources to produce new products. In 2011 Lenovo managed the processing of 12,700 metric tons of customer returned computer equipment and these returns were mainly reused as products or parts, recycled as materials, incinerated with waste to energy recovery (Lai et al, 2013).

According to Blackburn et al, (2004), recycling networks are predominantly concerned is with the material recovery from rather low value products. Agrawal et al. (2016) also highlight that, in many cases, investment costs are high due to advanced technological equipment requirements necessary to enable recycling. Consequently, low recovery value and high investments require higher processing volume to make recycling ventures economically viable. As a result of this, recycling networks also tend to be highly vulnerable to the uncertainty concerning the supply volume (Fleischmann et al., 2000). Recycling network models are generally designed at the strategic decisions level and the decisions usually covered at this level include number of facilities, location, region to be covered, and their capacity or size (Agrawal et al, 2014).

End of use refers to when a product has come to to end of its initial use by its first or original user A product at its end of use stage still has value that can be reclaimed especially in a secondary market. A product at this stage experiences two S-curves. A first s-curve in the primary user and a second S-curve in the secondary market. A typical example is used cars that sold as secondhand cars.

End of life refers to when a product has been used for all the value it can generate. That means, the product has been used to the point that it can only be disposed of. It may have experienced a primary and secondary use. However, its primary user may also have used it to its ends of life. A product at the end of life stage cannot be used subsequently and will be headed towards final disposal. A product at this stage may not even possess components that can be recycled or used as a component.

Waste reduction (WR) refers to the overall decline in waste generated and disposed due to firm's operational activities. Waste is generated because of normal business activities, underutilization of materials, poor planning, over stocking, inadequate operational strategies, human factors etc. Waste reduction is prescribed by the United Nations global reporting initiative as an environmental measure, to be used for the evaluation of triple bottom line performance.

Waste reduction is critical to the achievement of optimum triple bottom line performance within the environmental spectrum (Nikolau et al, 2013). Reduced waste implies better natural resource management and increased retention of the natural capital (Lai et al, 2013). The reduction of waste is one of the major practical applications used to improve both profitability and environmental sustainability (Lai et al, 2013).

One of the most reoccurring questions under waste reduction (i.e. environmental spectrum) is, how can sustainable corporation work out whether it is environmentally sustainable? (Elkington, 1998). A critical first step is to ascertain what is meant by natural capital. The concept of natural capital is rather complex. If you attempt to determine the natural capital in a forest, for example, it isn't merely a question of counting the trees and trying to put a price-tag on the lumber they represent because one has to also account for the unseen natural wealth which supports the forest ecosystem to produce timber and other commercial products (Elkington, 1998).

According to Elkington, (1998), "natural capital can also be thought of as coming in two main forms: 'critical natural capital' and renewable, replaceable or substitutable natural capital". Waste reduction is critical especially when critical natural capital is involved. Even when the natural capital is reoccurring, the material usage cycle may run faster than the replacement or reoccurrence cycle (Nikolau et al, 2013). Even when the natural capital is reoccurring, the material usage cycle may run faster than the replacement or reoccurrence cycle (Nikolau et al, 2013). According to Elkington (1998), some of the common questions' corporations need to ask are:

- What forms of natural capital are affected by our current operations - and will they be affected by our planned activities?
- Are these forms of natural capital sustainable given these, and other, likely pressures?

Accountability

In various countries, firms are being held accountable by several regulators who consider certain aspects of their environmental performance (Elkington, 1998). In the US, the Toxic Release Inventory (TRI) mandates corporations generating above certain threshold limits of more than 600 chemicals to report their emissions (Elkington, 1998). It is worthy to denote that emissions are types of waste that are generated and deposited into the atmosphere, leading to other environmental issues. Other countries such as The Netherlands, also support their regulations with voluntary programmes designed to push firms towards sector agreed targets (Elkington, 1998). Environmentalist and media campaigns also do a great deal in holding firms accountable even though some of their campaigns bear little relation to regulated or voluntarily agreed targets and as a result corporations have begun to challenge and hold their supply chain partners accountable (Elkington, 1998).

Issues and indicators

There are grave number of potential environmental issues which in turn increases the range of possible environmental risks and these are reflected in potential indicators (Elkington, 1998). Additionally, there is also an increased need to measure environmental impacts in terms of certain metrics which include: "the number of public complaints; the life-cycle impacts of products; energy, materials and water usage at production sites; potentially polluting emissions; environmental hazards and risks; waste generation; consumption of critical natural capital; and performance against best-practice standards set by leading customers and by green and ethical investment funds" (Elkington, 1998). At the corporate level, the task is broken down continuously by the development and publication of international environmental management standards. Globally, there are schemes such as the ISO 14001; in Europe, there is the Eco-Management and Audit Scheme (EMAS), which takes a step beyond ISO 14001 by mandating corporations to produce an environmental statement for all registered sites. Both schemes are voluntary, however, it has been anticipated and relatively confirmed in some countries that market forces will drive them down through value chains in the same manner total quality management (TQM) approach has spread (Elkington, 1998).

Recycling and waste reduction.

A study carried out by Thomas (2003) titled, "Product self-management: evolution in recycling and reuse", found that increased recycling of products results in the reduced waste and reduced consumption of new products and materials (natural capital), simultaneously reducing costs for consumers and deriving more value from existing products. From the indicators highlighted by Nikolau et al, (2013) in their study titled, "A reverse logistics social responsibility evaluation framework based on the triple bottom line approach", reduced material use and reduced percentage of waste generation are indications that a firm is performing optimally on the environmental spectrum. Going by this it can be stated that material recycling is advantageous to firms as continuous recycling of materials and products directly implies that less materials would also be used and the date of final disposal would be postponed as a result of recycling. By so doing it is also aiding the reduction of the use of virgin materials. Other effects on indicators such as emissions and energy use as well as the conservation of natural capital associated with new purchases will also be reduced.

Lai et al (2013), in their study titled, "Did reverse logistics practices, hit the triple bottom line of Chinese manufacturers", it was highlighted that "recycling gives discarded materials a new life after some chemical or physical processes". They further found that recycling helps reduce overall waste, however, there is some argument about possible trade offs (which may be negligible) associated with the increased energy usage for the recycling process (depending on the industry) which may represent an adverse effect on the waste reduction relating to increased emissions. However, in certain industries recycling may have only positive impact on waste reduction.

Putting all this into perspective, it can be stated that recycling has a direct positive significant impact on waste reduction within firms. Contrarily, it may also have a "negligible" negative impact on the environmental performance. To ascertain the true impact of recycling, the effect should be measured across the different core indices. However, for the empirical study, the following hypothesis was proposed: ***Recycling has no significant impact on waste reduction within construction firms.***

Methodology.

The survey research strategy was adopted for this research. The explanatory research design through application of hypotheses testing, was utilised for this study. The hypotheses testing in a natural setting (construction firms) was utilised for this research because of its suitability for a causal investigation. The time horizon of this research was cross sectional as this research studied a phenomenon at a given time.

This study was characterized by the collection of standardized data from a sample selected from a population. The utilised sample is a representation and indication of the key characteristics of the population from which it was drawn. The study made use of quantitative research methods. This study is a macro-level study and thus it was carried out on an organisational level rather than an individual level. The population of the study was 37 firms. The population comprised of firms duly registered with the Bayelsa state ministry of works as contractors, who must have carried out at least two major construction projects (summing up to at least 500million naira) or a single project worth over 500million naira for the Bayelsa state government in the last 8years (dating back from the time of this research). In addition to the threshold amount, the categories of the government funded projects that qualified firms to be considered as eligible for study included: office complexes, skyscrapers, airports, design & consultancy, shopping centres, court houses, sports facilities, retaining walls, shoreline protection, hospitals, schools, universities, bridges and highways). The entire population of the study was adopted as the sample size of this study. The sample size of the study was 37 construction firms. The respondent population was five (5) respondents per firm, bringing the total number of respondents to one hundred and eighty-five (185).

Primary data was used throughout the course of this study. The research instrument (i.e. questionnaire) was constructed in a five-point Likert scale with options ranging from strongly disagree to strongly agree. The research instrument was tested for reliability using the Cronbach Alpha coefficient with the aid of the Statistical Package for Social Sciences (SPSS) version 23. After the collection of data, reliability test was done to test inter-item consistent reliability using a Cronbach alpha coefficient of 0.7 as the threshold as recommended by Nunnally (1978). This study made use of simple regression analysis, to establish the significance and level of influence between the criterion and predictor variables. It enabled us to respond to the research question. The Statistical Package for Social Science (SPSS) version 23.0 was utilised in the statistical analysis of this study. The decision criteria utilised were based on the following rule of the thumb:

If the p-value is less than 0.05, reject Null Hypothesis; otherwise, do not reject.

As earlier mentioned, our sample consists of 37 firms with five copies of questionnaires allocated to each firm bringing the number of copies of questionnaire administered to 185. These 185 copies of questionnaire were distributed to 185 employees across the 37 firms and out of this number one hundred and sixty (160) copies of questionnaire were retrieved. Furthermore, after error assessment, 17 copies were observed to have different categories of issues that render them inadequate for use. These issues range from blank sections, to missing pages and incomplete data. After preliminary assessments 143 copies of questionnaire were found to be in order and was therefore adopted as the representative sample for the study. This value represents approximately 77% of the total number of copies of questionnaire distributed. This number of acceptable retrieved questionnaire was found to cut across 37 firms out of the 37 firms. This represents a 100% participation on the firm level i.e. an 100% firm participation.

Field Report.

As earlier mentioned, our sample consists of 37 firms with five copies of questionnaire allocated to each firm bringing the number of copies of questionnaire administered to 185. These 185 copies of questionnaire were distributed to 185 employees across the 37 firms and out of this number one hundred and sixty (160) copies of questionnaire were retrieved. Every respondent was given a copy of our structured questionnaire to complete and it took approximately two weeks (2) to retrieve the completed questionnaire. This was since the respondents were not always static as they had several sites they were attending to. Respondents were given ample time to respond to the research instruments. Analysis of the retrieved questionnaire is provided in the following subsections.

Analysis of the retrieved questionnaire

The summary of the frequency of questionnaire retrieved is displayed in shown in Table 1.

Table 1. Summary of retrieved copies of questionnaire (n=143)

S/N	**DESCRIPTION**	**Number**
1	Total number of distributed questionnaire copies	185
2	Total number of retrieved questionnaire copies	160
3	Total number of usable copies of retrieved questionnaire	143
4	Total number of unusable copies of questionnaire	17

Source: field survey 2020

As earlier mentioned, 185 copies of questionnaire were distributed, however, as can be seen in Table 4.1, a total of 160 copies were retrieved from the field. Furthermore, after error assessment, 17 copies were observed to have different categories of issues that render them inadequate for use. These issues range from blank sections, to missing pages and incomplete data. After preliminary assessments 143 copies of questionnaire were found to be in order and was therefore adopted as the representative sample for the study. This value represents approximately 77% of the total copies of questionnaire distributed. This number of acceptable retrieved questionnaire was found to cut across 37 firms out of the 37 firms. This represents a 100% participation on the firm level i.e. an 100% firm participation.

Bivariate analysis

Table 2 below reports the regression analysis of the influence of recycling on waste reduction in construction firms in Bayelsa state.

	Variable (Model)		
		Beta Coefficient	P-Value
	Constant (WR)	15.160	0.000
	REC	0.344	0.000
R. 0.346a	R-Square 0.120	Adjusted R-square 0.113	Std. Error of the Estimate (F-Statistics) 2.576

Source: SPSS version 23 outputs

Table 3 displays the Anova statistics of the linear regression highlighting the regression fit of the predictor variables and the criterion variable.

Table 3 Anova of the linear regression

model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	127.099	4	127.099	19.152	0.000[b]
Residual	937.712	141	6.636		
Total	1062.811	142			

Source: SPSS version 23 outputs

a. Dependent Variable: WR. b. Predictors: (Constant), REC

Table 3 indicates that the regression model predicts the dependent variable significantly. It shows that $p = 0.000$, which is less than 0.05, and this implies that the regression model (recycling) statistically significantly predicts the waste reduction, and this means that regression is a good fit for the data.

Hypothesis 01

H_{01} Recycling does not significantly influence the waste reduction within construction firms.

Table 2 also referred to as the coefficient table provides the necessary information regarding the relationship between recycling and waste reduction. It also helps us determine whether recycling contributes statistically to the model by looking at the significant column.

To represent the regression equation on the prediction of the influence of recycling on waste reduction, we look at Table 2 and the regression equation is shown as:

Waste reduction (WR) = 15.160 + 0.344 (recycling)

From table 3 the F-statistic, which tests the joint significance of all the included regressors, has a probability value which is less than 5% (*p*-value = 0.000), suggesting that the estimated pooled regression and hypothesis five for waste reduction is statistically significant. The R-squared value of 0.120 indicates that about 12% of the changes in waste reduction of the selected construction firms are accounted for by the influence of recycling. While the remaining 88% changes that occur in waste reduction can be explained by other variables beyond recycling. Furthermore, as indicated in table 2, all the variables have positive coefficients. The coefficients of 0.344 suggest that recycling has a positive influence on waste reduction with a highly significant coefficient (*p*-value = 0.012)

Decision Rule:

Reject H_{01} if the *p*-value is less than 0.05. Otherwise, do not rejectH_{01}.

From table 2, the associated *p*-value of the t-statistic corresponding to REC (recycling) is 0.000 which is substantially lower than the stated 0.05. Therefore, we firmly reject the stated null hypothesis. Rejecting the null hypothesis implies that the recycling has a highly significant and positive influence on waste reduction within construction firms.

The Influence of Recycling on Waste Reduction within Construction Firms in Bayelsa state.

The statistical results show that recycling has a positive and significant influence on waste reduction, and this leads us to reject the null hypothesis that recycling does not significantly influence the waste reduction within construction firms. These findings suggest that recycling positively influences waste reduction and consequently leads to an increase in the environmental bottom line performance.

This result is consistent with the findings of Thomas (2003), who in his study found that recycling results in reduced waste and in the reduced consumption of the natural capital. Lai et al (2013) also found that recycling has positive and significant influence on waste reduction as it gives discarded materials new life. These findings also validate the recent empirical findings of Nikolau et al (2013) who, in their work highlighted that recycling does influence waste reduction positively, thereby resulting in optimal performance on the environmental spectrum.

To summarize our findings and in relation to previous studies, we can categorically state that the adoption of recycling results in environmental preservation and waste overall reduction.

Conclusion and Recommendations.

The main conclusions drawn from the results of our empirical analysis are:

Recycling has a positive and significant influence on waste reduction within construction firms in Bayelsa state.

Furthermore, the theoretical implication of the findings of this study also back up the applicability of the theory of ecological economics which seeks to find a balance between meeting the demands of production and environmental preservation. This is evident as this study proves that the application of recycling enables firms meet their production needs while demanding less raw materials as well as reducing overall waste – which is known to affect the environmental bottom line performance.

This study recommends that construction firms should continue to apply recycling as a tool to reduce waste generation and to ultimately improve their environmental bottom line performance.

References.

Adkogan, M. S., & Coskun, A. (2012). Drivers of reverse logistics activities: an empirical investigation, *Procedia – Social and Behavioural Sciences*. 58, 1640-1649.

Agrawal, S., Singh, R.K. & Murtaza, Q. (2014). Forecasting product returns for recycling in Indian electronics industry, *Journal of Advances in Management Research*, 11 (1), 102-114.

Agrawal, S., Rajesh K. S., & Murtaza, O. (2016). Triple bottom line performance evaluation of reverse logistics, *Competitiveness Review*, 26 (3), 289-310.

Aurdahl, I. (2016). *Adopting Circular Economy Principles in Supply Chain Management of Organisations: Reverse Logistics*. Unpublished Thesis, Nord University.

Banihashemi, S., Tabadkani, A., & Hosseini, M.R. (2018). Integration of parametric design into modular coordination: a construction waste reduction workflow. *Automation in Construction*. 88, 1–12

Blackburn, J. D., Guide, V. D. R., Souza, G. C., & Wassenhone L. N. W. (2006). Reverse supply chains and commercial returns. *California Management Review*. 46(2), 294-308.

Chileshe, N., Zuo, J., Pullen, S., & Zillante, G. (2012). Construction management and a state of zero waste. In: Lehmann, S., Crocker, R. (Eds.), *Designing for Zero Waste*. Routledge, Earthscan.

Costanza, R., (1989). What is ecological economics? *Ecological Economics,* 1, 1-7,

Costanza, R. Cumberland, H. J., Daly, H., Goodland, R., Norgaard, R. B., Kubiszewski, I., & Franco, C. (2015). *An Introduction to Ecological Economics*. Florida, United States, CRC Press.

Nikmehr, B., Hosseini, M.R., Rameezdeen, R., Chileshe, N., Ghoddousi, P., & Arashpour, M. (2017). An integrated model for factors affecting construction and demolition waste management in Iran. *Engineering, Construction and Architectural Management*. 24 (6), 1246–1268.

Elkington, J. (1998). Accounting for triple bottom-line. *Measuring Business Excellence*, 2 (3),18-22

Elmas, G., & Erdoğmuş, F. (2011). The Importance of Reverse Logistics. *International Journal of Business and Management Studies*, 3 (1), 17-29.

Fleischmann, M., Krikke, H. R., Dekker, R., & Flapper, S. P. D. (2000). A characterisation of logistics networks for product recovery. *Omega,* 28, 653-666.

Gomez, F., Guzman, J.I., & Tilton, J.E. (2007). Copper recycling and scrap availability. *Resources Policy*. 32 (4), 183–190

Lai K., Wu S. J., & Wong. C. W. Y. (2013). Did reverse logistics practices hit the triple bottom line of Chinese manufacturers? *International Journal of Production Economics*. 146, 106-117.

Nikolaou, E.I., Evangelinos, K.I. & Allan, S. (2013). A reverse logistics social responsibility evaluation framework based on the triple bottom line approach, *Journal of Production Research,* 56 (18/19), 173-184.

Nunnally, J. (1978), *Psychometric theory*, New York: Mc Graw-Hill

Thomas, V.M. (2003). Product self-management: evolution in recycling and reuse. *Environmental Science & Technology*. 37 (23), 5297–5302