FORUM GEOGRAFI
ISSN: 0852-0682 | E-ISSN: 2460-3945
HTTPS://JOURNALS.UMS.AC.ID/INDEX.PHP/FG/

Application of Green Economy Approach to Solid Waste Management in Minna, Nigeria

Yekeen Adeeyo Sanusi *, Sundat Gideon Owoyele, Samuel Medayese, Ndana Tanko Mohammed

Department of Urban and Regional Planning, Federal University of Technology, Gidan Kwano, P.M.B 65, Minna, Niger State, Nigeria

*) Correspondance : grandspace@yahoo.com

Citation:
Sanusi, Y. A., Owoyele, S. G., Medayese, S., & Mohammed, N. T. (2022) Application of Green Economy Approach to Solid Waste Management in Minna, Nigeria. Forum Geografi. Vol. 36, No. 2.

Article history:
Received: 02 April 2022
Accepted: 23 September 2022
Published: 05 December 2022

Abstract

This study is based on solid waste recycling activities in Minna, Nigeria. This study examines the potential for waste recycling to provide livelihood opportunities in Nigeria. The study identified two recycling centres in Minna and collected data through direct observation, measurements, questionnaire administration, and interviews. The collected data was analyzed using statistical packages for social sciences and livelihood approach to demonstrate the green value of recycling, identify impediments to green growth, and map the recycling cluster. The result shows that the recycling cluster occupies an area of 0.64 hectares that accommodates 141 recycling outlets, with about 40% of the outlets occupying below the standard shop size of 7.2m^2. The recycling outlets use 18 types of recovered materials to reproduce 27 varieties of products. Each recycling outlet engages about 3.4 persons and offers training to an average of 6 persons each. The study highlights the importance and potential of informal solid waste recycling as a sub-sector that fulfils social, economic, and environmental benefits associated with sustainable development. However, the lack of commitment by governments to waste recycling undermines the contribution of the recycling business. Moving towards the zero-waste policy can save public funds that can be invested in the waste disposal and reduce the threat to public health from solid waste. Furthermore, safety measures should be ensured among the scavengers and the recyclers, and the physical environment of the recycling cluster should be upgraded to take care of poor accessibility and the use of makeshift structures by most of the recycling units. Governments should focus on policies that encourage waste sorting, collection, sales, and solid waste processing at all scales. We underscore the need for creative and reliable government support to achieve green growth and development in the solid waste recycling sector.

Keywords: Solid waste, green economy, recycling, livelihood, outlets, products.

1. Introduction

Formal material recovery systems are scarce in Africa's public and private sectors. Instead, material recovery, which includes source separation and recycling, is largely carried out by the informal sector, operating at multiple levels (UNEP, 2005). In terms of solid waste management activities, developing countries, including Nigeria, perform poorly (Hoornweg and Bhada-Tata, 2012). Waste recycling is mainly done informally, through waste picking, while composting is seldom undertaken formally, despite the high percentage of organic material in the waste stream. Incineration is uncommon and unsuccessful, while landfilling is characterized by low-technology sites and open dumping (Hoornweg and Bhada-Tata, 2012).

The traditional view of waste characteristics is evolving. In Nigerian urban centers, solid waste generation is increasing due to urbanization, rising consumption levels, and product diversity. The growing number of retail outlets, development of large shopping malls, and re-entry of multinational supermarkets into urban centers are evidence of changes in consumption. Furthermore, Nigeria's GDP growth rate has risen over the years, making it the largest economy in Africa. From USD 297.46 billion in 2009, the nation's GDP rose to USD 460.95 billion in 2012 and USD 568.5 billion in 2014, although its 2021 value of USD 510.59 billion is below the 2014 value but higher than the 2009 value (Statista, 2022). These changes have significant implications for waste generation. Consumers now have a wider range of options, but products are designed with shorter lifespans, as the EU Commission (2010) observed. Additionally, there are more single-use and disposable products, while technological advances have resulted in more frequent use of personal and updated devices (EU Commission, 2010). These are global drivers of waste generation, from which developing countries are not immune.

Several studies in Nigeria have examined various aspects of livelihoods related to recycling activities. In the urban area of Nsukka, Nzeadibe (2009) found that the average monthly income of recyclers was higher than the monthly minimum wage for civil servants in Enugu State. Nzeadibe and Ajaero (2010), based on their study of recycling in Enugu and Onitsha, stated that a contemporary paradigm shift in waste management regards waste as resources, and recycling, driven by the informal sector, is a means of exploiting the resource value in waste. Oguntoyinbo (2012)

noted a contradiction in the perception of waste between informal waste recyclers and the public, as informal recyclers view waste as a means of livelihood and income, while the public sees it as an aesthetic issue. Obadina *et al*. (2015) identified five livelihood activities related to Lagos waste management: scavengers, dump waste collectors, cart pushers, waste merchants, and private sector participants who collect and transport waste to the dumpsite without sorting or recovery. These livelihood activities provide services that meet their employment and income requirements and fulfil basic human needs. Recovered materials, including scrap metals, plastics, bottles, textile materials, and aluminum cans, are reused directly or used as secondary raw materials or processed into intermediate products for sales across Nigerian cities such as Abuja, Kano, Enugu, Onitsha, and Lagos (Iorhemen *et al*., 2016). These studies aim to investigate the full range of livelihood opportunities and resilience that recycling can provide, in response to the growth of solid waste, poor waste disposal systems, and limited attention to the potential livelihood opportunities in solid waste management. It seeks to inventory recycling outlets, analyze inputs and products, evaluate the operating environment, investigate livelihood opportunities, and identify ways to promote pro-green recycling practices.

Waste recycling involves reusing, reprocessing, and remanufacturing used products, treating waste as a commodity with new resource value and a second life. The significance of recycling has grown due to declining waste collection and disposal capacity and the severe health hazards associated with waste disposal, even at properly managed landfills. This is particularly prevalent in developing countries, where open dumping is common, and municipal governments are often unable to cope with the vast amounts of waste generated by urban residents. Moreover, recycling offers opportunities for resource conservation, livelihood development, and cost reduction. Recycling in developing countries aims to extract remaining value from waste, prevent final disposal, and commercialize the waste by aggregating quantities, removing contamination, sorting by grade or type, storage, transport, and marketing. The advantages of solid waste for livelihoods have been recognized by several analysts. Furthermore, recycling is often more cost-effective than disposing of waste through landfilling and other means, and informal recyclers can save governments a substantial amount of money. Recycling also drives the development of new technologies and expands the horizon of knowledge and its applications.

The concept of the green economy is a development paradigm that seeks to balance differing views on the environment and development for practical expression in sustainable development (Sanusi, 2013). Therefore, it offers the promise of economic growth while protecting the earth's ecosystems and contributing to poverty alleviation (Ocampo, 2012). Ocampo states that the green economy 'underscores the economic dimensions of sustainability. Its origin is associated with the publication of the document Blueprint for a Green Economy, authored by Pearce, Markendya, and Barber in 1989 for the UK Department of the Environment. It is defined as the process of reconfiguring business and infrastructure to deliver better returns on natural, human, and economic capital investments while at the same time reducing greenhouse gas emissions, extracting and using fewer natural resources, creating less waste, and reducing social disparities (Dalal-Clayton, 2013). Bushehri (2012) sees it as the 'decoupling of unsustainable resource use and environmental impacts from economic growth' by emphasizing the economy of resource use. The objectives of the green economy are to achieve human well-being, reduce carbon emissions, and achieve equity.

The green economy is a multifaceted concept that encompasses a wide range of sustainable practices, from eco-fashion and eco-building materials to resource-efficient production and consumption patterns. As Ilić, Stojanovic, and Djukic (2019) explain, it seeks to balance economic growth with environmental protection and social equity. According to Dalal-Clayton (2013), a green economy is guided by principles of sustainability, inclusivity, good governance, and efficiency, among others, and aims to create wealth and employment opportunities while safeguarding the planet for future generations. Inclusive green economy initiatives, such as those advocated by the IIED (2017), prioritize job creation, especially for marginalized communities, and support environmentally responsible enterprises that can drive economic growth. Central to the green economy are concepts like zero waste and circular economy, which seek to reduce waste and promote the reuse and recycling of resources. Overall, the green economy represents a promising vision for achieving sustainable development and improving the well-being of people and the planet.

The circular economy is a concept that emphasizes the idea that waste can be turned into a resource again by forming a loop in the production-consumption chain (Institut Montaigne, 2016). The danger of a linear production system, where the emphasis is on extraction, production, consumption, and discard, has been recognized by various organizations (World Economic Forum,

2014; European Union, 2014; Club of Rome, 2015). The circular economy is seen as an alternative to the linear economic approach, where the end of life of a product end in waste and terminates its usefulness (Institut Montaigne, 2016). This approach becomes increasingly necessary with the risk of higher resource prices and supply disruptions. The circular economy is based on an industrial system that is restorative or regenerative by intention and design (Ellen MacArthur Foundation, 2013). In a circular economy, waste does not exist since products are designed and optimized for a cycle of disassembly and reuse (World Economic Forum, 2014). The objective is to extract maximum value from products before safely and productively returning them to the biosphere (Ellen MacArthur Foundation, 2013).

A circular economy emphasizes shared use, second-life products, and asset sharing, and has the potential to deliver simultaneously on four major political priorities: job creation, balance-of-payments support, supply chain resilience, and climate change mitigation and adaptation (Preston, Lehne, & Wellesley, 2019). In contrast to the linear "end-of-life" concept, a circular economy views redundant consumer goods as input, and therefore replaces waste with restoration, transforming the recycling industry (de Jong *et al.*, 2019).

The idea of zero waste aims to address the issues associated with incinerator-based integrated solid waste management, and has its roots in Japan's concept of total quality management, where the industrial process is designed to achieve zero defects (Murray, 2002). According to Zaman and Lehmann (2011), a zero-waste city has a 100% recycling rate and recovers all resources from waste materials. Similarly, Lehmann (2011) suggests that cities can embed these concepts into practice by redesigning urban systems with "zero waste" and material flow in mind, transforming existing cities and upgrading recycling infrastructure in low-to-no carbon city districts. This study aims to examine the potential for waste recycling to provide livelihood opportunities in Nigeria.

2. Research Methods

The study is based in Minna, the capital of Niger State (see Figure 1). Located approximately 156 km away from the Federal Capital Territory, Abuja, Minna is the closest state capital to the Federal Capital Territory. It originated as a railway station in 1905 and served as an administrative headquarters during colonial rule (Sanusi, 2009). The urbanization of Minna has been facilitated by the presence of large federal educational institutions, such as the Federal University of Technology and the headquarters of the National Examination Council (NECO). The population of Minna has grown from 59,988 in 1963 to 76,480 in 1979, 190,750 in 1991, and an estimated 346,670 people in 2006 (Sanusi, 2009). Using the national growth rate of 2.58% (World Population Review, 2020), the estimated population of Minna in 2021 is 507,992.

The study relies on both primary field data and secondary data sources. The secondary data was focused on analyzing the spatial patterns of solid waste management issues within the city. This included variables such as the number of waste dumps, their locations, distribution, and the area occupied by each dump. Additionally, the types of waste generated within the city were also included as part of the secondary data analysis.

The study conducted field research in Minna and identified two recycling centres: a multi-unit centre and a small-scale plastic processing unit. The data collection methods employed included direct observation, measurements, questionnaire administration, and interviews. For the multi-unit recycling centre, the study conducted an inventory of the existing units based on the recycled materials, and took the coordinates of the entire centre using hand-held GPS to establish its spatial characteristics. Physical observations were also made, including an assessment of the facilities within the centre, the working sheds, the working environment, and accessibility. The following checklist was used for the physical observations: a) Inventory: recycling types and recycling units per type, b) Size of work-shed: dimensions of each work-shed in metres, c) Facilities: observation of the presence of water and electricity, d) Working environment: observation of waste deposits and cleanliness of the work area, and e) Accessibility: assessment of the presence of an access road to the work-shed.

The administration of a questionnaire to the recycling units followed the physical observation. The questionnaire design covered the socio-economic characteristics of the recyclers, the type of training they have received, the products being recycled, the type and quantity of products produced from the waste materials, and livelihood services such as income, asset building, formal and informal networking, official support facilities, and training of others. In total, 50 recycling units were selected for the survey. Additionally, an oral interview was conducted with the Centre Leader. The interview focused on the administration of the Centre, cooperation among the

recyclers, the history of the centre, and the importance of the recycling activities to the operators. Similarly, the plastic processing plant survey included a physical survey of the work environment and facilities, including input and output storage. It also included an interview with the owner regarding the sourcing of the waste plastics, the unit's operation, training and workforce, as well as the benefits and problems facing the unit.

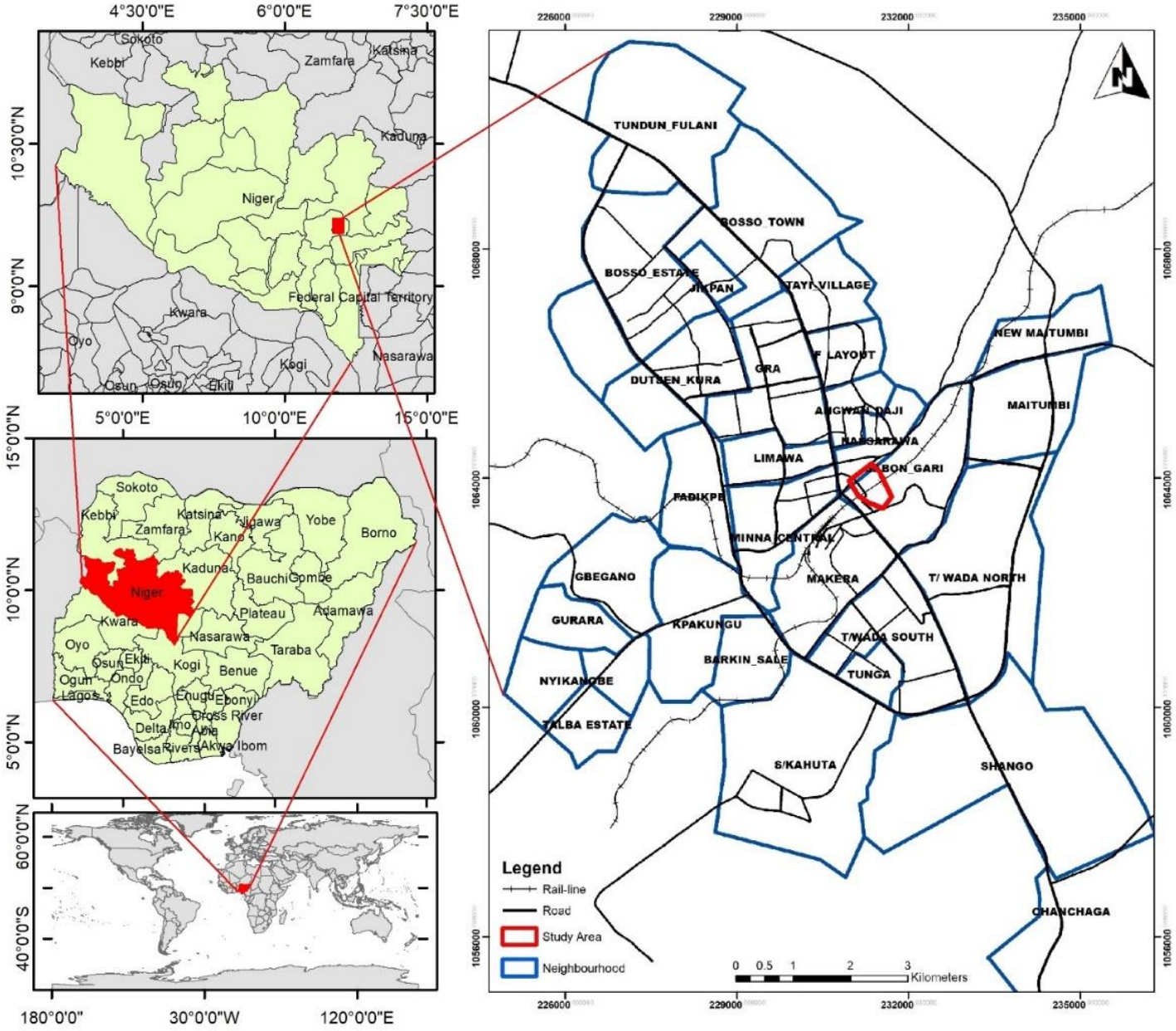

Figure 1. Location of the Study Area.

The data was digitally processed using Statistical Packages for Social Sciences (SPSS). The data was analyzed to demonstrate the green value of recycling and to show impediments to green growth. In the first instance, a livelihood approach was adopted to analyze the questionnaire-based data. In this case, the emphasis was on (i) people (their capabilities), (ii) activities (the recycling activities, the operation, changes over time), (iii) assets gained from engaging in recycling, and (iv) gains and output. These four areas were analyzed through descriptive means, following the four categories of parts of livelihoods suggested by Chambers and Conway in 1991. In addition, the livelihood analysis was supported by an environmental analysis that looked at the general operating environment, including operation area, appearance, the nature of the work sheds and the working environments, including safety, as well as disposal of their waste. The relationship between the length of operation (dependent variable) and the age of the operators (independent variable) was examined using regression analysis. Similarly, attempts were made to classify the

operating units according to the depth of livelihoods. Simple qualitative analysis was applied to analyze the data from the plastic processing plant. In doing this, livelihood opportunities and environmental issues involved in the operation of the recycling units were also analyzed.

The study also involved the mapping of the recycling cluster. To do this, a satellite image of Minna was downloaded from the Google Earth platform. The downloaded image was georeferenced in the ARCGIS 10.5 environment using four known points identified with a GPS. Additionally, the buildings and roads were digitized in the ARCGIS 10.5 environment. All features within the maps were represented with polygons and lines.

3. Results and Discussion

3.1. The nature of solid waste problem in Minna

According to recent records, it is evident that plastic and rubber products are the major components of the waste generated in Minna, accounting for 56% of the total waste generated in the city in 2019 (Table 1). This high percentage of plastic and rubber waste highlights the urgent need for proper waste management strategies and recycling initiatives to reduce the environmental impact of plastic waste. The remaining waste comprises paper and vegetable waste at 21%, and organic waste at 18%. These findings emphasize the potential for implementing effective waste management practices that target the segregation and recycling of recyclable materials, thereby reducing the amount of waste that goes to landfills. Furthermore, it is essential to recognize that most of the waste generated in Minna is recyclable, thus highlighting the importance of promoting recycling programs to minimize the negative impacts of waste on the environment.

Table 1. Types of Waste Generated in Minna.

Type of waste	Proportion (%) 2022
Plastic and rubber	56
Glass	2
Textile	3
Paper	21
Vegetables and organic	18
Total	100

Source: Abubakar *et al.* (2019).

Sanusi (2015) conducted a study on the spatial manifestations of the solid waste problem in Minna, highlighting the need for effective waste management strategies. Figure 2 presents the distribution of solid waste dumps in the city among nine neighbourhoods, demonstrating the areas occupied by the waste and their impact zones. The results of the study revealed that plastic and rubber products constitute the bulk of the waste generated in the city, accounting for 56% of the total waste generated in 2019. The impact of poor solid waste management in the city is not only limited to the presence of open dumps but also seen in the impact on neighbourhood serenity, emission of gasses and possible impact on flood drainage channels.

The Figure shows that the neighbourhood of Sauka Kahutra has the highest number of solid waste dumps (30), followed by Kpakungu with 29, and Angwa Daji with 20. While the SWDs occupy an area of 7818.00m^2 in Kpakungu, they occupy 6523.84m^2 in Angwa Daji. Overall, there are 167 SWDs from the nine neighbourhoods, occupying an area of 34482.96m^2. This represents an average of 19 SWDs per neighbourhood and an average area of 3831m^2 per neighbourhood.

The area occupied by SWDs in the nine neighbourhoods could potentially provide 153 residential plots of 225m^2 of high-density development. However, the current waste management practices demonstrate a waste of land resources and hindrance to other service delivery, such as housing development. Additionally, waste materials are frequently found in drainage channels and streams, obstructing the free flow of water and creating water reservoirs within streams and drainage channels (Figure 3). The burning of waste materials within the city also contributes to greenhouse gas emissions. It is therefore essential to adopt effective waste management strategies to reduce the negative impact of poor solid waste management in the city.

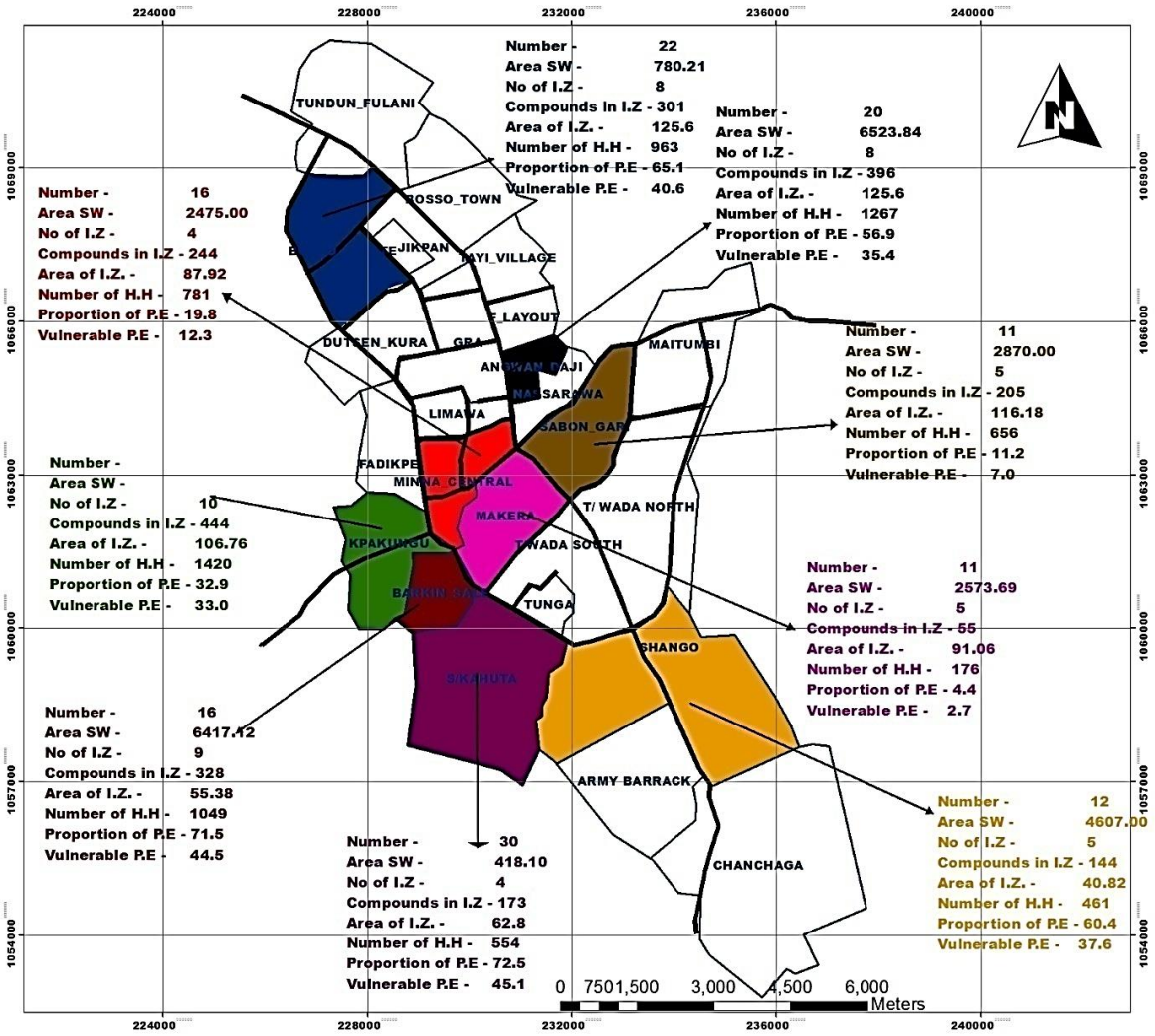

Figure 2. Indicators of Exposure to Solid Waste Hazards in The Neighbourhoods (Sanusi, 2015).

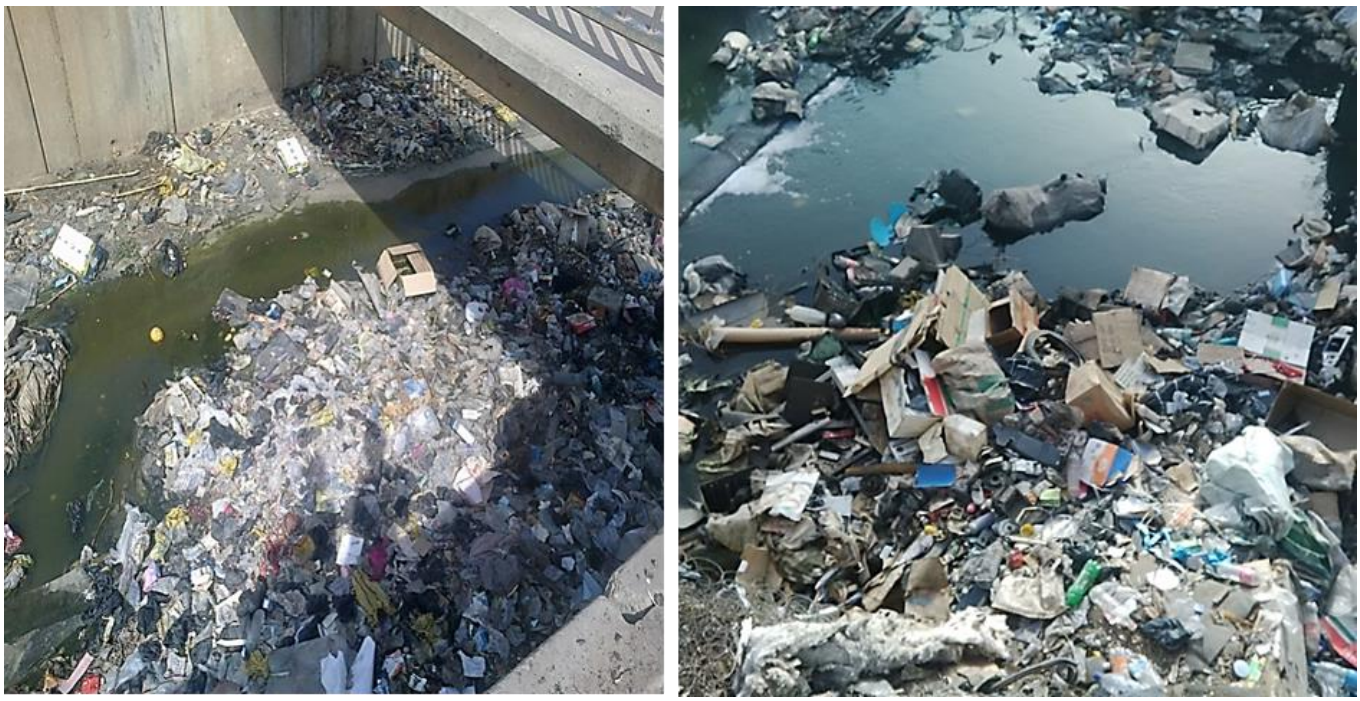

Figure 3. Wastes in Parts of The Main Drains of Minna (Source: own documentation).

3.2. Inventory of firms and types of materials being recycled

The list of waste materials inventoried from the recycling outlets (Table 2) highlights the diversity of materials that are being recycled in the area. Iron, steel and other iron-related materials are valuable resources commonly found in waste streams, and their recovery can contribute significantly to reducing waste and conserving natural resources. Aluminium is another valuable material that can be recycled indefinitely without losing its quality, and it is commonly found in beverage cans and other consumer products. Wood is a versatile material that can be used for various purposes, such as furniture and construction materials, and its recovery can help to reduce deforestation and greenhouse gas emissions. Discarded bags of cement, sugar and rice can be recycled and reused for other purposes, such as construction materials and packaging. Empty plastic and tin containers and bottles are also valuable resources that can be recycled into new products, reducing the amount of waste that goes to landfills. Water closets and baths are also recyclable and can be broken down into their constituent parts for reuse. The variety of materials being recycled in the area is a testament to the resourcefulness of the recyclers and the potential for waste reduction and resource conservation.

Table 2. Type of Material Being Recycled.

S/No.	Inventory	Total	Percentage
1	Aluminium Material	62	14.59
2	Cases of battery Cells	3	0.71
3	Plug Engine	7	1.65
4	Plank Wood	40	9.41
5	Used tubes of tires	10	2.35
6	Tires	16	3.76
7	Empty Can (Gongoni)	37	8.71
8	Steels (iron)	31	7.29
9	Flat Metal	39	9.17
10	Iron Rods	51	12.00
11	Empty Cement, salt, Sugar, Detergent bags	37	8.71
12	Empty Plastic container	26	6.12
13	Animal Skin	7	1.65
14	Robber ropes (flat)	19	4.47
15	Rug Carpets	7	1.65
16	WC/Bath	6	1.41
17	Empty Bottles	23	5.41
18	Motorcycles Scrap	4	0.94
	Total	**425**	**100**

These 18 categories of waste materials are found in 425 cases among the recyclers with an average of 3 materials per recycler. That is, there are about 141 recycling outlets. The most dominant waste material is aluminium (14.59% of the 425 cases), followed by iron rod (12%), plank wood (9.41%) and flat metals (9.17%). On the other hand, motorcycle scrap and battery cell cases that constitute less than one per cent each are less frequent.

3.3. Products from recycling

The production of a variety of products by recycling units has been highlighted in the literature as a sustainable solution to waste management. The findings presented in Table 3 suggest that the recycling units in Minna are producing a wide range of products that cater to different client needs. The production of household utensils, agricultural materials, house furniture, construction materials and baking pans indicates that the recycled products have diverse applications.

Table 4 shows a low monthly output per unit of firm for large products such as gate (4 units per plant or producer) iron bed (12 units per plant) and large units per firm for smaller products such as bread baking pan (1000 units per plant), bread baking pan (573 units) and cutlass (343 units per plant). The output of other products falls between 50 and 100 per plant, such as shoes (88 units per plant) and buckets (66 units per plant), while others range from 100 to 200 units per plant, such as 4-pots (149 units per plant), Abacha cooking stoves (104 units per plant), and funnels (120 units per plant). Most producers (74%) produce multiple products, while only 26% produce a single item. Some producers produce as many as 9 or 6 items, respectively, while another 17% produce two items each (Table 4). On average, each firm produces 2.4 items.

Table 3. Types of Products Produced per Month by The Recycling Units.

Product	Number of producers	Monthly output	Monthly Output per plant	Product	Number of producers	Monthly output	Monthly Output per plant
Aluminium pot	7	1044	149	Cutter	2	280	140
Abacha stove	9	976	108	Bread baking pan	4	4000	1000
Iron bed	1	12	12	Cake baking pan	3	1720	573
Iron chairs	1	48	48	Funnel	1	120	120
Shoes	5	440	88	Wooden chairs	2	68	34
Hoe	8	2744	343	Bags (from skin)	5	528	105
Cutlass	4	980	245	Sacks	4	420	105
Gates	2	8	4	Kerosene stove	5	156	31
Iron windows	4	144	36	Window frame	1	20	20
Iron doors	6	304	50	Buckets	1	60	60
Axe	4	720	180	Water Fetching ropes	2	32	16
Fan iron hook	3	620	206	Fetchers	3	432	144
Hammer	1	40	40	Coal pot	4	1328	332
Digger	3	416	138				

Table 4. Products per Firm.

Number of products per firm	Number of firms	Percentage
1	13	26
2	17	34
3	14	28
4	4	8
6	1	2
9	1	2
Total	50	100

3.4. Physical characteristics

The recycling cluster is an extension of the main market, Kaswan Gwari. Spatially, there are three sectors of the recycling cluster. One sector occupies the right of way (ROW) of the adjoining railway lines, another is adjacent to the market, and the third sector, developed for scrap collection and export, is located across the city's drainage channel bordering the market (see Figure 4). The area of the sector by the railway ROW is 0.24 hectares, the one by the market is 0.21 hectares, while the scrap collection centre is 0.20 hectares (see Figure 2). The three sectors together occupy an area of 0.64 hectares. However, the recycling cluster is not planned and lacks clear access, unlike the main market. The work-sheds are mostly made of corrugated iron sheets, with only a few being made of burnt bricks.

As the cluster is unplanned, work-sheds' sizes vary based on the owners' ability to acquire space for themselves. The work-sheds range from as small as 2 square meters to as large as 29 square meters. In general, 40 percent of the work-sheds have a size below the minimum standard of 7.2 m^2. Work-sheds from 7.2 to 10.79 m^2 make up 12 percent, while those from 10.8 to 29 m^2 constitute 48 percent. Overall, most work-sheds meet the minimum size standard, but the 40 percent that fall below the standard is unacceptably high and clearly reflects the informal nature of the cluster. In terms of facilities, water and electricity are available, although only 20 percent of the work-sheds claim to have access to water, in contrast to 80 percent claiming access to electricity.

3.5. Characteristics of the operators and the nature of the recycling business

The recycling business is an all-male affair. None of the operators is a female. In terms of education, only about 10 per cent had no education, while the rest spent various years schooling. The picture in Table 5 shows that most of the recyclers (52%) spent 6 years schooling while many others (18%) spent between 4 and 5 years in school. In general, only 2% spent the minimum of 9 years stipulated by the National Policy on Education schooling. The clear picture here is that people with low education characterize the sector.

Table 5. Years Spent Schooling.

Years spent schooling	Frequency	Percentage
None	5	10
4	5	10
5	4	8
6	26	52
7	1	2
8	1	2
9	1	2
10	3	6
11	1	2
12	2	4
15	1	1
Total	50	100

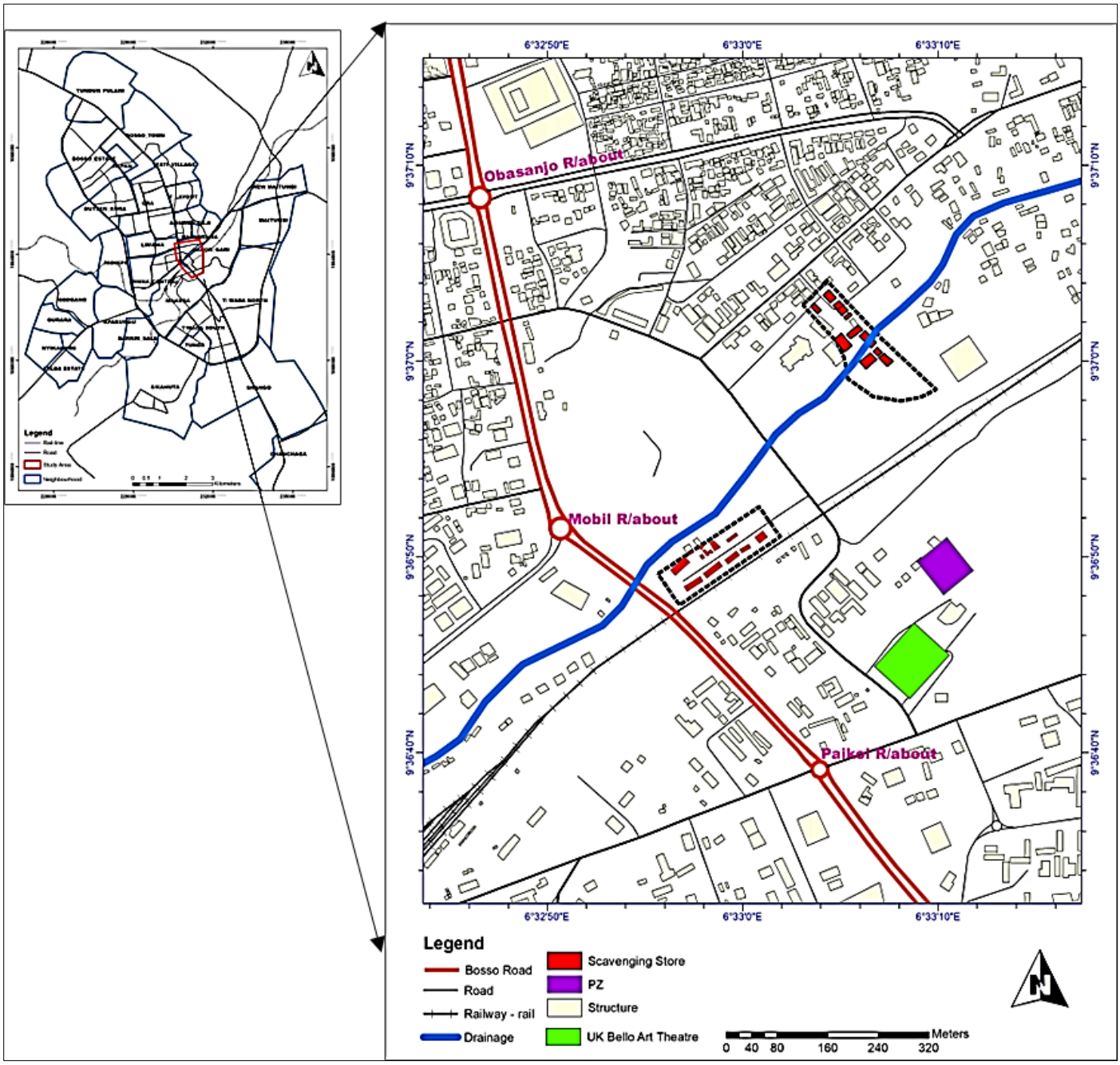

Figure 4. Location and Site Characteristics of the Solid Waste Recycling Cluster in Kaswan Gwari, Minna.

For all the operators, the recycling business is full-time work. The length of stay of the respondents in the business varies from about one year to as high as 41 years. The age in business reflects the age of the operators, ranging from 23 to 75 years old. In general, 37 percent are less than 30 years old, 23 percent are between 41 and 50, and 10 percent are more than 60. The length of stay in the business and the age of the operators correlate quite well. Regression analysis was conducted between the length of participation (age of business) and the age of the operators. The regression equation is -09.139 + 0.608 (age of the respondents). The overall regression was statistically significant, R2 is 53%; F is 53.83 with a p-value of 0.000. Furthermore, respondents explain about 53% of the variations in the length of participation in the recycling business. It was also found that the age of the respondents significantly predicted the length of participation in the recycling business; B is 0.603. The t-test of the constant is -2.628, and that of the predictor (age of the respondents) is 7.337. While the t-test of the constant is not significant (p=0.012), the t-test of the predictor is significant with a p-value of 0.000.

Between 2004 and 2014, twenty-three of the operators (46%) entered into the business, indicating the attraction of the business to some people within the city and the job opportunities that the recycling business offers for potential operators. With a 2004 base of 27 people, between 2004 and 2014, the recycling business grew at the rate of 6.35 percent per annum. This is high and points to the fact that giving due attention to the sector will enhance its ability to engage more people productively. Operators work long hours per day, ranging from 8 to 12 hours. Most people (20%) work 10 hours daily, while 14 percent work between 9 and 12 hours daily, and only about 6 percent work eight hours daily. Operators source materials from both within and outside Minna. While 78 percent of the operators claim to source material from Minna, others (22%) claim to source the waste materials from outside Minna. Scavengers are the main suppliers of waste products. The authors sighted the scavengers entering the cluster and delivering their products to the operators. To the scavengers, sourcing waste is a serious business. The recycled output is marketing through retail, wholesale, and a combination of the two. While 44 percent of the operators sell mainly by retail, 16 percent sell by wholesale, and 40 percent do both retail and wholesale sales.

3.6. Livelihood presentations

From the green economy point of view, while the recycling business reduces the quantity of solid waste available for disposal, the people engaged in the business experience some livelihood opportunities. These are assessed by examining employment roles, income generation, asset development and social capital. In terms of employment, the 141 owner-operators are full time self-employed people and they also engage some hands in the running of their businesses. Table 6 shows the total number of people engaged by 50 operators. In total, 170 people work in these work-sheds as employees of different categories. The number of workers range from one to nine. Majority of the firms, 17.8 percent engage three persons each while another 6.8 percent engage four, five and six persons each respectively. On the average 3.4 persons are engaged per firm. The concept of engagement embraces people who participate in the production system, whether or not remuneration is paid. The truth is that engagement has its attraction, and it may be because the persons involved are co-spenders who may not qualify for any remuneration apart from what they get from the household pool. Further break-down shows that assistants in the firms constitute 37 per cent while employees constitute 35 per cent (Table 7). Assistants are like co-owners or senior trainees awaiting dis-engagement as opposed to employees who are to collect remunerations. The household members (children, wives and other relatives) constitute 28 per cent.

Table 6. People Engaged by The Recycling Business.

Number per firm	Number of firm	Percentage
1	1	1.4
2	19	26
3	13	17.8
4	5	6.8
5	5	6.8
6	5	6.8
8	1	1.4
9	1	1.4
Total	50	100

Table 8 shows the income earned by the operators. Income is derived from sales of output with the belief that gains will vary according to output sold. The least income per month is NGN28,400 while the maximum is NGN1,810,000. The distribution of income confirms the fact that waste

business is a good business. Only four (8%) operators collect income of less than NGN50,000 per month. While 20 per cent get between 101,000 and 200,000 per month, 22 per cent get between 401,000 and 800,000 per month.

Table 7. Types of Engagement.

Type of engagement	Number	Percentage
Assistants (co-workers)	63	37
Children	30	18
Wives	5	3
Relatives	12	7
Employees	60	35
	170	100

Table 8. Income from The Sales of Recycled Products Per Month.

Income range in Naira	Frequency	Percentage
Less than 50000	4	8
51000-100 000	7	14
101000-200000	10	20
201000-400000	8	16
401000-800000	11	22
+800000	10	20
Total	50	100

With a median income of 355,000, 46 per cent of the operators earn below the median income, 4 percent earn equal to the median income while another 50 percent earn above the median income. The income profile is encouraging when this is viewed against the minimum national income of NGN18,500 as at early part of 2019 when the survey was concluded. However, against the back-drop of a large household size of 8.2 per household (Sanusi, 2008), and using 2 USD per day, the situation will change. At the current exchange rate, a typical household in Minna, will require 98,000 per month to survive. With a minimum income of NGN28,400.00 and 8% of the operators earning less than NGN50,000 per month, earnings in the sector sufficiently compare with earnings in the public sector where the current minimum wage is NGN30,000.00 per month.

Trainees are also part of the people engaged by the recycling business and represent the new crop of recycling entrepreneurs. It is seen that between 2014 and 2015, 50 per cent of the operators trained between 1 to 3 persons while another 30 per cent trained between 4 and 6 persons. Within one year, 290 persons were trained. This gives an average of about 6 trainees per operator.

Asset as a component of livelihood is believed to reflect the gains from livelihood activities and a reflection of the amount of income earned. Table 9 shows the assets acquired by the operators through their engagement in the recycling business. The Table shows that fixed asset and personalized mobility have priority in asset building by the people. Hence, with respect to different means of mobility, 72 percent of them own bicycles, 66 percent own motorcycles and 40 per cent own cars. These show evidence of cross-ownership of means of mobility. Similarly, 54 per cent have plots of land while 80 per cent own houses. Units of fixed assets per person vary from 1 to 5. It is not uncommon that people who own more than two cars use the extra for commercial purposes while extra plots of land are security in terms of future investments. Assets offer opportunity for individual's resilience against sudden economic shocks and against happenings that may affect the fortunes of their businesses. It is also important to note that the digital revolution has meaning to these people as 32 percent of them own computers. While this is low and indeed, the lowest proportion among the assets shown in Table 9, it is meaningful that computer ownership is not limited to the elite and to people in white collar jobs.

Table 9. Assets Ownership by the Operators.

Number of asset	Type/proportion of respondents								
	Bicycle	Car	Computer	Furniture	Motorcycle	House	Land	TV	Video
None	28	60	68	40	34	40	46	36	50
1	68	34	20	34	50	46	20	40	24
2	4	6	10	20	16	4	12	14	16
3			2	2		6	10	4	8
4				2		2	8	4	2
5				2		2	4	2	

Social capital: Social capital derived from the business represents a particular advantage in strengthening the livelihood opportunities. All the operators belong to the trade unions that bring all the operators together. Beyond this, about 20 percent of them belong to cooperative societies and none get any support from the government. The practical thing is that before the government, these operators did not exist; although government officials may as individuals have one thing or the other to do with the people. In 2006, the Niger State government constructed a recycling plant for organic materials, with the objective of getting fertilizer from the plant. However, more than fourteen years later, the plant is not in operation. In addition, there is no policy on ground to creatively engage the people in the business of solid waste recycling.

3.7. Scrap as tradable commodity

The third section of the Recycling Cluster is devoted to collection and export of scraps. There are thirty centres in this section with each centre employing an average of 30 persons. Their job is to sort all collected scraps into the different categories. The scraps consist largely of metal products from many sources, vehicles, electronic materials and construction materials. The scraps are sold in Lagos. Each week an average of one trailer load of the scraps goes to Lagos. The section is evidently busy with collectors, sorting, packaging and loading. The collectors believe that it is a good business with the claim that a few of them have trailers numbering about four for the purpose of the business.

The recycling business is having a new dimension with the establishment of a plastic crushing plant in Maitumbi neighbourhood of Minna. The plant is an example of a small-scale solid waste recycling business. The plant recycles plastic products by crushing and converting them into billets. These are then sold to other companies that use them as input for production of plastic products. For example, it has markets in Munirat Plastic Industry, Minna and in other companies in Kano, Kaduna, Onitsha and Port Harcourt. The plants depend on supply of input from scavengers. On the average, there are 10 scavengers supplying about 40 kg of waste plastics per person per day. On the average, a ton of crushed plastics is produced daily. The firm employed 10 persons and generated between NGN400,000 to NGN1,000,000 (USD 953.52 to USD 2383.79) monthly.

3.8. Discussion

The study demonstrates that the business of solid waste recycling is beneficial. The activities of the recyclers in this study are similar to what was observed in Nairobi by Hiltinen (2010), where solid waste recycling is also organized in centers and informal collector groups or waste recyclers separate the valuable material (Hiltinen, 2010). However, unlike the position held by Wilson *et al*. (2006) cited by Hiltinen (2010) that recycling is a waste picking activity carried out by the urban poor, this study reveals that waste recycling is more than just waste picking. It involves a whole range of activities that add value to waste and, in some cases, lead to product remaking or the creation of entirely new products different from the original waste materials. While pickers occupy the "bottom layer of waste recycling" (Hayami, Dikshit, and Mishra, 2006), the people covered by this study (re-makers) occupy the upper layer.

From an environment-climate change perspective, the recycling business addresses the fundamental problem of accumulated waste that leads to greenhouse gas (GHG) emissions and physical problems such as blocked roads and drainages, which exacerbate the impacts of climate change during high rainfall events. In addition, solid waste recycling can prevent issues related to the breeding of disease-carrying vectors and the attendant risk of epidemics. Asmah, Owusu, and Kankam (2013) recognized these advantages in their study on plastic waste recycling in coastal communities of Ghana, where both livelihoods and environmental quality were improved through two business models for plastic recycling.

Recycling is critical in achieving the zero-waste agenda outlined in the Post-2015 Sustainable Development Goals. This study demonstrates that existing waste recycling initiatives are highly effective and contribute to the capability and livelihoods of operators. In summary, waste recycling generates multiple livelihood engagements and benefits, as shown in Figure 5. The Figure highlights two broad sections: livelihood and benefits. The range of livelihoods gives rise to a range of benefits. Livelihoods include scavenging, recycling, transportation, and trading in solid waste. Each of these, except scavenging, also consists of a sub-system of livelihoods. For instance, recycling includes product repackaging, product conversion, new product creation, and crushing solid waste.

Similarly, benefits include economic, environmental, and governance benefits. Economic benefits are evident in micro and small-scale enterprise development, employment and income generation, and livelihood capability development. Governance benefits include a stronger base for individual and corporate taxation, reduced possibility of prosecution for sanitation offenses, and greater co-operation of stakeholders. Finally, environmental benefits include a reduction of waste available for final disposal, reduction of uncollected waste, prevention of blocking of drainage and roads, reduction of GHG emissions from solid waste dumps, reduction in other environmental effects arising from breeding of rodents, foul odour, and reduction of particles and materials for wind-storms.

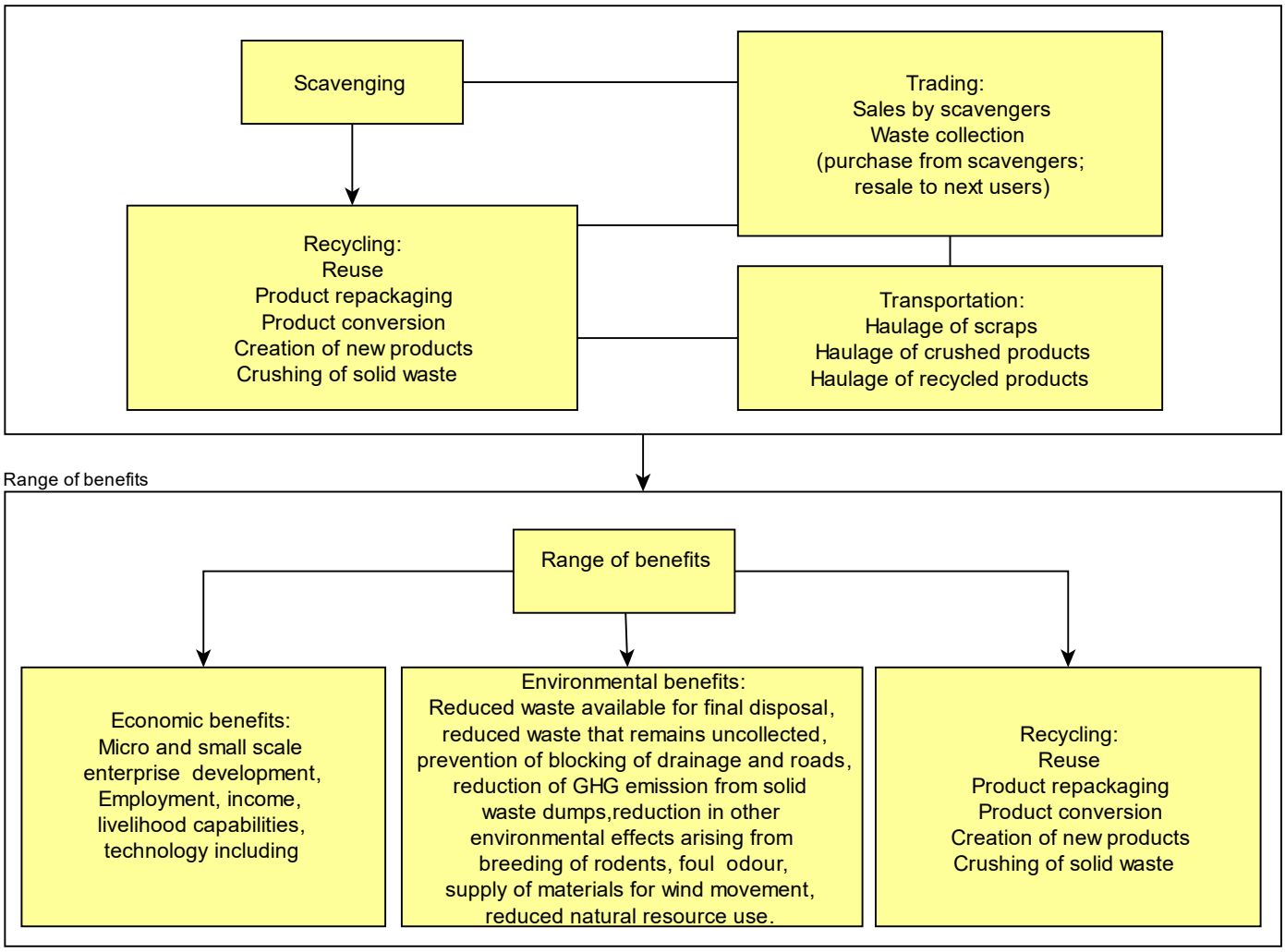

Figure 5. Multiple Possibilities from Solid Waste Recycling.

4. Conclusion

The study has revealed interesting findings on solid waste recycling in the study area. It is clear that the recycling business is not only informal but also largely micro at the individual level, although some traces of small-scale enterprises exist. It was found that 18 categories of solid waste were recycled in various forms by operators in the recycling business. The dominant materials were aluminum (14.59% of the total cases) and metal sheets (12% of the cases). In terms of products produced by the operators, 27 varieties of materials were produced by the recyclers. Bread making pans were the most dominant with 1000 pieces per plant. Products produced ranged from furniture (bed, chairs) to building materials (windows, doors), household materials (pot, cooking stove), and working implements (hoe, cutlass, digger). The recycling area is unplanned, and there is poor accessibility to the work-sheds, and about 40% of the work-sheds have a floor area of less than the minimum standard of 7.2m^2. It was also found that the length of participation varied with the age of the waste recycling operators. About 53% of the variations in the length of participation in the recycling business is accounted for by variations in the age of the operators.

With respect to livelihoods, 3.4 persons were engaged per firm, with the people engaged consisting of direct employees (35%), assistants (senior trainees, 37%), and family members (28%). The income level compares well with what is obtained in the public sector. The business is financially rewarding with a minimum income of NGN 28,000 and less than 8% earning NGN 50,000 or less per month. There is also evidence of value addition as in the case of a crushing plant that converts plastic into pellets for input into other manufacturing activities. Furthermore, asset ownership among the operators is high; 72% of the operators have bicycles, 60% have motorcycles, 40% have cars, and 80% own houses. The conclusion can be reached here is that the informal recycling system is an economic sub-sector that fulfils the social, economic, and environmental benefits of sustainable development.

The absence of a clear commitment by governments to waste recycling that can aid waste sorting, collection, and sales undermines the contribution of the recycling business. The governments have not realized that moving towards the zero-waste policy pays all the stakeholders and that for the government, it is going to save public funds that will be invested in waste disposal apart from reducing the threat to public health from solid waste. Other issues that will threaten achieving green growth are the safety of the operators. None of them use any protective kits despite the fact that they handle materials that are injurious to their bodies and liable to food contamination. Also, the working environment is poor, while the use of children as workers does not demonstrate compliance with ethics of green development.

The informal recycling activities encourage scavenging by children and make child exploitation quite easy. The physical environment of the recycling cluster is both unsightly and unhealthy. Having recognized these defects, the fact remains that a change of attitude by the governments will adequately direct the sector to green goals and development. Attention should be shifted to policies that encourage waste sorting, collection, and sales, and solid waste processing at all scales, micro, small, and medium. The example of plastic crushing in the city offers the hope that this can be developed on a fairly larger scale than it is currently experienced. Safety measures should be ensured among the scavengers and the recyclers. In addition, the physical environment of the recycling cluster should be upgraded to take care of poor accessibility and the use of makeshift structures by most of the recycling units.

Acknowledgements

We are gratefully acknowledge the anonymous reviewers for their valuable feedbacks**.**

Author Contributions

All authors contribute equally. All authors have read and agreed to the published version of the manuscript.

References

Abubakar, A., Umaru, K., & David, S. S. (2019). An appraisal of solid waste management in Minna, Niger state: policy and planning implication to Nigerian cities. *AU eJournal of Interdisciplinary Research* (ISSN: 2408-1906), 4(2).

Asmah, G.B., Owusu, A., Kankam, S. (2013). Improving Livelihoods through Cleanliness in the Coastal Communities of the Western Region of Ghana:

Achievements and Lessons Learned. Daasgift Quality Foundation. *USAID Integrated Coastal and Fisheries Governance Program for the Western Region of Ghana. Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island.*

Aderoju O.M., et al. (2014). A Geo-Spatial Approach for Solid Waste Dumpsites for Sustainable Development in Minna, Niger State, Nigeria, *Journal of Environmental Science, Toxicology and Food Technology* Volume 8, Issue 10 Ver. I, PP 16-28.

Bushehri, F. (2012). Green Economy in The Arab Region, a paper presented at *TEEB Capacity-building Workshop for MENA Region*, held in Beirut between 21-23 February 2012.

Chambers R. and Conrway, G. R. (1991). Sustainable rural livelihoods: practical approach for 21st century. *IDS Discursion Paper* 296.

Dalal-Clayton, B. (2013). *Turning green the strategic way; the role and potential of strategic environmental assessment in securing a green economy*. London: International Institute for Environment and Development (UK).

de Jong, S., van der Gaast, M., Kraak, J., Bergema, R., & Usanov, A. (2016). *The circular economy and developing countries: a data analysis of the impact of a circular economy on resource-dependent developing nations*. The Hague Centre for Strategic Studies.

Ellen-MacArthur Foundation. (2013). Circular economy: Opportunities for the consumer goods sector.

EU Commission. (2010). Being wise with waste: the EU's Approach to waste management. Luxembourg: Publications Office of the European Union.

Ezechi, E. H., Nwabuko, C. G., Enyinnaya, O. C., & Babington, C. J. (2017). Municipal solid waste management in Aba, Nigeria: Challenges and prospects. *Environmental Engineering Research*, 22(3), 231-236.

Gunsilius, E. (2011). Recovering resources, creating opportunities Integrating the informal sector into solid waste management, Eschborn: GIZ.

Hayami,Y., Dikshit, A. K. and Mishra, S. N. (2006). Waste pickers and collectors in Delhi: Poverty and environment in an urban informal sector, *Journal of Development Studies*, vol 42 No 1, pp 41-69.

Hiltunen A. (2010). Waste, livelihoods and governance in Nairobi, Kenya a case study in Kibera informal settlement. Institutionen för naturgeografi. Stockholm University, Stockholm.

Holt, D. and Littlewood, D. (2017). Waste Livelihoods amongst the poor – Through the lens of Bricolage. *Business Strategy and the Environment*, 26, 253-264.

Hoornweg, D. and Bhada-Tata, P. (2012). What A Waste: A Global Review of Solid Waste Management. Urban Development Series. Washington, DC: World Bank.

IIED. (2017). Pro-poor, Inclusive Green Growth: Experience and a New Agenda. Global Green Growth Institute. IIED. London.

Ike, C. C., Ezeibe, C. C., Anijiofor, S. C., & Daud, N. N. (2018). Solid waste management in Nigeria: problems, prospects, and policies. *The Journal of Solid Waste Technology and Management*, 44(2), 163-172.

Ilić, B., Stojanovic, D. and Djukic, G. (2019). Green economy: mobilization of international capital for financing projects of renewable energy sources. *Green Finance*, 1(2): 94–109.

Institut Montaigne. (2016). The circular economy: reconciling economic growth with the environment. Paris: Institut Montaigne.

Iorhemen, O. T. Alfa, M. I. and Onoja, S. B. (2016). The review of municipal solid waste management in Nigeria: the current trends *Advances in Environmental Research*, Vol. 5, No. 4 (2016) 237-249 DOI: https://doi.org/10.12989/aer.2016.5.4.237. Pp 237-249.

Lehmann, S. (2011). Resource Recovery and Materials Flow in the City: Zero Waste and Sustainable Consumption as Paradigms in Urban Development. *Sustainable Development Law & Policy*: Vol. 11: Iss. 1, Article 13.

Maclean, R., Jagannathan, S. and Panth, B. (2018). Education and Skills for Inclusive Growth, Green Jobs and the Greening of Economies in Asia Case Study Summaries of India, Indonesia, Sri Lanka and Viet Nam. Springer/ Asian Development Bank.

Murray, R. (2002). *Zero Waste*. Greenpeace Environmental Trust. London.

Nizar, M., Munir, E., & Munawar, E. (2018). Implementation of zero waste concept in waste management of Banda Aceh City. *In Journal of Physics: Conference Series* (Vol. 1116, No. 5, p. 052045). IOP Publishing.

Njoroge, K. S., Wokabi, M. S., Ngetich, K., & Kathuri, N. M. (2013). Influence of informal solid waste management on livelihoods of urban solid waste collectors: a case study of Nakuru Municipality, Kenya. *International Journal of Humanities and Social Science*, 3(13), 95-108.

Nzeadibe, T. C. (2009). Development drivers of waste recycling in Nsukka urban area, Southeastern Nigeria. *Theoretical and Empirical Researches in Urban Management*, 4(3 (12), 137-149.

Nzeadibe, T. C. and Ajaero, C. K. (2010). Informal waste recycling and urban governance in Nigeria: some experiences and policy implications, in Meijer, J. and der Berg, A. (eds) Handbook of Environmental Policy. Nova Science Publishers, Inc, .245-264.

Obadina, A.A., Fisher, J. and Sohail, M. (2015). Informal workers on Lagos dumpsites: an analysis of gender differences in sources of livelihoods. Paper presented *at 38th WEDC International Conference*, University of Loughborough, UK.

Ocampo, J. A. (2012). The Transition to A Green Economy: Benefits, Challenges and Risks from A Sustainable Development Perspective Summary of Background Papers in Report by A Panel of Experts to Second Preparatory Committee Meeting for United Nations Conference on Sustainable Development.

Oguntoyinbo, O. O. (2012). Informal waste management system in Nigeria and barriers to an inclusive modern waste management system: a review. *Public Health*. 126(5):441-447.

Preston, F, Lehne, J. and Wellesley, L. (2019). An Inclusive Circular Economy Priorities for Developing Countries. Research Paper, Energy, Environment and Resources Department. London: Chatham House.

Productivity Commission Report. (2006). *Waste management* No 38. Australia.

Sanusi, Y. A. (2009). Environment-poverty Nexus: Exploring the relationship Between Neighbourhood Environmental Quality and Poverty in Nigerian Urban Centres. *GRP Journal of Environmental Planning and Management*; 2009: 35-47.

Sanusi, Y. A. (2010). Capacity Issues of Private Sector Participation in Urban Solid Waste Management in Nigeria, Humanity & Social Sciences Journal S (1): 07- 18, 2010.

Sanusi, Y.A. (2013). Harnessing Urban Agriculture for Green Development beyond 2015: The case of Nigeria, paper presented at the International Conference on *Beyond Rio + 20: Emerging Challenges and Opportunities*, held at Institute of Statistics, Social, and Economic Research (ISSER) Conference Hall, University of Ghana, Legon Campus. Accra, Ghana. 20 - 22 November, 2013.

Sanusi, Y.A. (2015). Assessment of Exposure to Health Hazards from Solid Waste Dumps in Nigerian Urban Centres, Paper presented at *the 12th International Conference on Urban Health themed, Urban Health for a Sustainable Future: The Post 2015 Agenda* held in Dakar, Bangladesh, between May 24 to 27, 2015 and organized by International Society for Urban Health.

Scheinberg, A., M. et al. (2010). *Economic Aspects of the Informal Sector in Solid Waste*. GTZ (German Technical Cooperation), Eschborn, Germany.

Statista. (2022). Nigeria: Gross domestic product (GDP) in current prices from 1997 to 2027. https://www.statista.com/statistics/383118/gross-domestic-product-gdp-in-nigeria/.

UNEP. (2005). Solid Waste Management (Volume II: Regional Overviews and Information Sources). UNEP International Environmental Technology Centre International, Tokyo.

World Population Review, Nigeria Population. (2020). https://worldpopulationreview.com/countries/nigeria-population.

Zaman, A. U. and Lehmann, S. (2011). What is the 'Zero Waste City' Concept? Zero Waste SA Research Centre for Sustainable Design and Behaviour, University of South Australia, Australia.