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# Determining Spatial Locations of Major Recyclable Solid Waste Collection Points, Using GIS in Minna Metropolis, Nigeria

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## ABSTRACT

In Minna, both toxic and non-toxic wastes are dumped in the same trash dump by the residents. Lack of requisite data on accumulated waste, which includes a lack of awareness of the existing collection points where large volumes of recyclables can be sourced from and dumped, has contributed to the low level of recycling practices in Minna metropolis. The goal of this study therefore, is to determine the spatial locations of existing recyclable solid waste collection points in the study area, so as to provide requisite data for easy accessibility to waste collection points. Data were sourced from field survey and Google Earth Imagery. Seven locations within Minna Metropolis were areas considered for this study. Coordinates of recyclable waste collection points were imported to Quantum Geographic Information System (QGIS) environment on the georeferenced base map of Minna, which was used to generate point maps that show the location of existing solid waste recycling facilities/collection points. It is concluded that there are Sixteen (16) major waste collection points within seven (7) areas of Minna, which are all managed by informal recyclers. Proper environmental awareness and Government intervention to promote waste recycling by drafting policies and offering support to private waste management companies will improve the level of recycling practices within Minna.

## 1.0 Introduction

Resourceful treatment of waste is a vital factor in the developmental evolution of any nation and the wellbeing of its people. Recycling is a method of municipal solid waste management and is environmentally desirable because it involves classification, sorting, grading, reduction and reuse of wastes (Bonnie, 2006). Recycling decreases the volume of waste that is required to be collected, transported and discarded, in addition extends the lifespan of disposal amenities such as landfills/dumps (Ruzi, 2001).

Solid waste is defined as any unwanted waste discarded by people in dry form, which could be from residential, commercial, institutional, industrial or agricultural activities. Solid waste is further categorized into municipal solid waste (MSW) and industrial waste （Miller and Spoolman, 2012). The activities of man in the environment result in generation of different kinds of wastes, the most obvious are Solid Wastes. So many parts of our cities have become chaotic due to indiscriminate disposal and poor management of solid wastes, leading to environmental degradation and

pollution (Abubakar *et al.,* 2019).

Environmental contamination due to solid waste mismanagement is a global issue. Open dumping and open burning are the main implemented waste treatment and final disposal systems, mainly visible in low-income countries (Ferronato and Toretta, 2019). The management of solid wastes presents particular challenges to city authorities in Nigeria, because the volume of wastes generated in different cities has been increasing over the years (Abubakar *et al.,* 2019).

Services of waste collection are mainly offered by the public sector although some States engage in public - private participation. Informal waste collection using push carts are also common, rendering door to door waste collection services takes place in some parts of Nigerian cities. In Nigeria, there is an obvious absence of formal recycling of metropolitan solid waste. Consequently, the informal sector has assumed the role of "critical but unacknowledged gap filler" in the waste recycling system, attaining low but significant recycling rates (Tobore, 2012).

Recycling permits salvaging considerable amounts of waste that would then end up in landfills or spoiling natural spaces; and also allows producing raw materials and avoid wasting natural resources. Various countries have succeeded to increase their levels of recycling in recent years through investment in technology, and awareness campaigns, as well as introducing policies intended to encourage citizens and businesses to recycle more and better (García-Rubio, 2020).

Waste recycling has vast economic prospects that include job creation, poverty alleviation, and sustainable development. Recycling and reuse have several returns: they lessen energy and mineral use, air and water pollution, greenhouse gas emissions, solid waste, and also save landfill space (Miller and Spoolman, 2012). Resourceful handling of waste would safeguard human health, protect the environment and preserve natural resources (USEPA, 2009).

Recyclable materials in low, medium, and high-income countries comprise about 17%, 43%, and 62% of the total waste stream, respectively (Olukanni *et al.,* 2018). Agunwamba(1998) observed that a well-planned recycling program in Nigeria could result in savings of up to 78% in waste management costs and 79.5% in landfill avoidance costs. Aside from the economic gains of recycling, environmental benefits, such as the reduction of greenhouse gas emissions, air, and water pollution associated with production from virgin raw materials, are likely to accrue from waste recycling.

Solid waste management is a principal environmental problem in Minna, just like it is in many developing towns. Even though stern regulations on the management of solid waste are in place, primitive disposal approaches such as open dumping and discharge into surface water are still being used in various parts of the town (Adeoye *et al*., 2011). The waste generated are not sorted, both toxic and non-toxic wastes are frequently dumped in the same dumpsite and the so-called sanitary landfills, in close proximity to communities, constituting a challenge to human health (Abubakar *et al.,* 2019). Recycling is still at a basic level in Minna due to lack of requisite data on accumulated waste, unavailability of facilities to transform waste to useful products, lack of proper environmental awareness and inability of the government to promote waste recycling by drafting policies and offering support to private waste management companies (Adeoye *et al*., 2011).

In order to design waste management systems and their various components, accurate data on quantity and composition as well as the chemical and physical properties of waste materials are required (Bilitewski *et al*., 2014). Locations of solid waste collection points which is necessary for determining the number of places involved in recycling within the study area, level of accessibility to these places, types of solid wastes collected and the scale at which recycling is being done, is not available as a reference material to be used in improving recycling within the metropolis.

The goal of this study therefore is to determine the spatial locations of existing recyclable solid waste collection points in the study area, through maps that will provide requisite data for easy accessibility to waste collection points. To achieve this aim, the following objectives were set: (i) to establish various categories of solid waste collection points in the study area; (ii) to identify the types of recyclable solid waste collected in waste collection points; (iii) to map out the spatial locations of existing recyclable solid waste collection points.

*1.1 Study Area*
Niger State is one of the 36 states in Nigeria. Minna town is the capital of Niger State and is located between latitude $9^0 71^1$ North and Longitude $6^0 33^1$ East (Figures 1 and 2). Archaeological facts presume that Minna was created due to the infiltration of Muslims by the ancient Saharan trade routes. Due to the opening of the Kano-to-Baro railway in 1911 and the expansion of the Lagos-to-Jebba line(1915), Minna grew into a key accumulation location for agricultural products comprising Ginger, Cotton, Yams, Tropical fruits and Shea nuts. It has been the capital of Niger state since 1976 and has expanded as an administrative centre.

Minna is one of the largest cities in the country with two large ethnic communities, Gbagyi and Nupe as the predominant tribes. There are two major religions in the study area, and they are Christianity and Islam, with only a few traditional worshippers. The township of Minna is estimated, to comprise 463,000 people, with an estimated growth rate of 3.5%, the population is shown to be consisting of 54% males, and 46% females (Niger State Planning Commission, 2021).
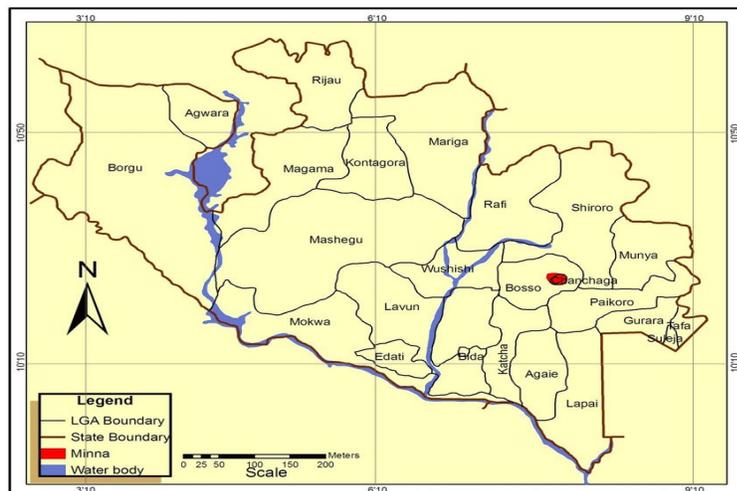


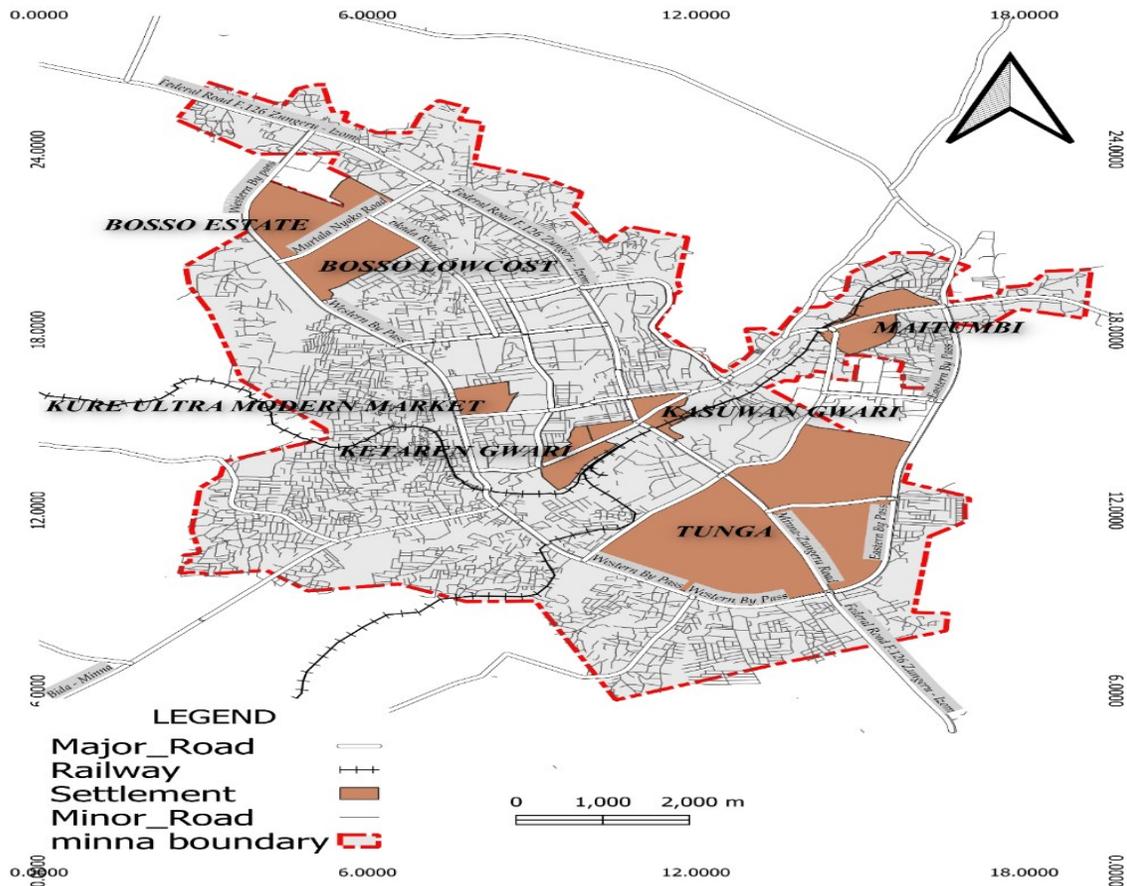**Figure 1:** Map of Niger State
**Source: Ministry of Lands and Housing, 2012**

**Figure 2:** Map of Minna
**Source: Author's 2022**

## 2.0 Review of Related Literature

Waste materials in the contemporary world are generated from different sources either with the same or different compositions and types. However, on general terms, irrespective of compositions, five main sources have being identified based on land-use and practices. These are; Domestic or Residential, Commercial. Agriculture, Industrial and Educational and Administrative centres （Rouf *et al.* , 2018).

Solid waste also called junk in some cases cannot be differentiated from municipal wastes. Mishra *et al.* (2013), define solid waste as the useless, unwanted and discarded material resulting from day-to-day activities in the community. Solid waste can therefore be referred to as substances not in the liquid or gaseous form that are no longer useful and need to be thrown away or discarded (Abubakar *et al.,* 2019).

Waste can be classified into Bio-degradable and Non-biodegradable wastes, which can further be broken down into municipal wastes, Industrial wastes, Hazardous wastes, etc. Industrial wastes are from manufacturing industries. It comprises of many different streams arising from wide range of industrial process. There are many different types of hazardous industrial waste, such as mine tailings, fly ash, waste from the production of chemicals, residues from coal mining, acidic waste rock, carbide slag, among others (Ferronato and Toretta, 2019).

According to Adeoye *et al.* (2011), biodegradable wastes are waste that decompose into their constituent elements by reaction of microorganisms or bacteria i.e waste that can be broken down. It can be applied to both liquid and solid waste and includes animal wastes, human, paper agricultural wastes, and food waste. Non-Biodegradable wastes are those that cannot be broken down or decomposed into their constituent elements by microorganisms and bacteria. Most plastics are non- biodegradable in nature and create environmental problems because they remain unchanged over a long period of time. Examples of nonbiodegradable materials are: glass, metals, plastics, batteries and tyres.

Abdul-Rahman (2014) outlined the 3 main recycling collection points, which are curbside collection, drop off centres and buyback centres:

**Curbside collection:** this requires homeowners to separate recyclables from their garbage. Clean recyclables may need to be placed in special containers, while the garbage goes in standard containers. Both are placed at the curb for collection by separate trucks.

**Drop-off centers**: these are one of the simplest forms of collecting recyclable materials; people can drop off their used glass, metal, plastic, and paper at a designated recycling drop-off site. These centers are usually placed in an easily accessible location near a high-traffic area such as the entrances of supermarkets and parking lots.

**Buy back centers**: these purchase aluminum and other metals, glass, plastic, newsprint, and sometimes batteries and other materials. The "Three Rs" (Reduce, Reuse, and Recycle) effort to promote better waste management needs to be done in an effective manner.

## 3.0 Methodology

For this study, seven locations within Minna were considered which include Bosso Low-cost, Bosso Estate, Keteren Gwari, Kasuwan Gwari, Kure Market, Tunga, and Maitumbi. These areas were chosen because of the obvious presence of small-scale recycling activities, as well as concentration of activities which will make it easier to pinpoint waste collection points.

Primary data were collected. The primary data were sourced from field observation/survey and direct measurement. A handheld GPS was used to record coordinates and locations of recyclable solid waste collection points in the study area. A camera was also used to snap pictures of these collection points to corroborate findings. An image of the study area was also extracted from Google Earth Imagery, georeferenced and digitized to produce a base map of Minna. Information obtained were analysed using descriptive statistics. Coordinates of major recyclable waste collection points were imported to QGIS environment on the georeferenced base map of Minna, which was used to generate point maps of the area, that show the location of existing solid waste recycling facilities/collection points. Results were presented using maps, images and tables.

## 4.0 Results

### 4.1 Categories of Solid Waste Collection points

Findings reveal that all scavengers dispose their materials at three major types of solid waste collection points within Minna, which include Junk Shops, Waste Dealer's Associations/Companies and Waste Fabricators Association. Recyclable solid wastes are managed solely by informal recycling companies and individuals without the involvement of Government agencies such as Niger State Environmental Protection Agency (NISEPA) and Ministry of Environment (NISEPA, 2021)

### Junk Shops

These are shops that are owned by individuals for the purpose of collection of waste materials from scavengers. The shop owners or middle men buy waste from various scavengers and accumulate them in large volumes for subsequent sale to waste dealing companies within the town. They handle waste by sorting into different components, and then transporting them to the various waste dealing companies, using tricycles or small pickup trucks, depending on the volume of waste for transport. The transport of these materials is done at intervals-about twice a week-based on the rate of accumulation.

Current activities (sorting and transport) carried out in these junk shops in Minna are in line with Rousta (2008), that separation and processing, are methods that are closely associated with recovery and recycling. Separation, could be; manual, shredding by machinery, ferrous materials separation via the use of magnets, or even volume reduction by compacting and combustion. Processes of transport of waste materials in junk shops are in agreement with Everett (2012) that solid wastes should be accumulated from points of generation and then transported to transfer stations, facilities of treatment, disposal locations, or even recycling facilities. Twelve (12) major Junk shops were observed at different locations within the study area.

### Waste Dealers' Companies

These are primary collection or accumulation points of solid waste within the town, owned and managed by private indi-

viduals for the purpose of collection of accumulation of large volumes of recyclables for sale, within or outside the metropolis. After accumulation, these waste materials are further evaluated to ascertain those that are recyclable and those that are not. Recyclable materials are then processed, weighed, packaged and transported to recycling companies outside the state, for sale using a weigh bridge (Plates I and III). These waste materials are transported in small or large tipper trucks, with a capacity to carry about 10-50 tonnes of waste per trip and these trips take place one or twice, every week based on the rate of accumulation (Plate IV). In line with Rousta (2008), separation and processing are methods that are closely associated with recovery and recycling. Separation, could be; manual, shredding by machinery, ferrous materials separation via the use magnets, or even volume reduction by compacting and combustion. The reduction in quantity and weight of waste, prior to disposal is known as transformation. This is done by converting them to a usable state via biological or chemical treatment.

All waste dealers sell recyclables to companies outside Niger state which include companies in Lagos, Aba, Kano, Abuja, Nasarawa, Kaduna and Kwara states. There are three (3) major waste dealing companies within the town and they include; Scrap Dealers Association (Old Gwadabe), Berger.

There is one (1) waste fabricators association that deals mainly with collection of waste for the purpose of refurbishing and recycling them at a small scale, in order to sell back to individuals and residents within the metropolis, for instance, kitchen ware are fabricated from aluminium and metal scraps and sold to the residents (Plate IV). According to Everett (2012), one of the final waste disposal methods is recycling-which is a process of manufacturing a new product from waste. Forms of recycling involve re-use of an already used product and also avoidance of creation of waste, termed source reduction.



**Plate I:** A weigh bridge at Gidan Bola

**Source: Author's Survey, 2022**

**Plate II:** Metal scraps being transported away

**Source: Author's Survey, 2022**



**Plate III:** Shredded plastic at Berger Junction
**Source: Author's Survey, 2022**



**Plate IV:** Fabricated Kitchen Ware
**Source: Author's Survey, 2022**

*4.2 Types of Recyclables collected in Waste Collection Points*
Interviews with middle men and waste dealers reveal the various types of waste accumulated by each collection point. Recyclable solid wastes of interest collected in Minna include Plastic, Glass jars, Carton, Paper, Metal scraps, Tin and Metal Scraps, Aluminium Scraps, Automobile parts, Tyres, and sacs. This is due to the potentials they have and can be transformed into various useful products as opposed to disposing it in an improper manner, causing problems in the environment. This is in agreement with Olukanni *et al.* (2018) that; Textiles, waste from manufacturing, plastic, metals, glass and paper are substances that represent recyclable solid waste. Plastic is generally shredded into pellets through plastic recycling organizations, from which different plastic and allied merchandise could be synthetized. Certain recycling companies remodel newspaper, waste paper, cardboard paper, tissue paper and bulk materials for packaging. Glass businesses in addition to terrazzo companies process waste glass, Aluminium smelters transform nonferrous metals and at the same time, tin is gotten from aerosol cans



**Plate V:** Plastic Recyclables at Berger Junction
**Source: Author's Survey, 2022**



**Plate VI:** Plastic Recyclables at a junk shop
**Source: Author's Survey, 2022**

*4.3 Spatial Locations of Existing Recyclable Solid Waste Collection Points*

Table 1 shows the various spatial locations of existing recyclable solid waste collection points in Minna, as well as the types of recyclables preferred by each collection point

***Table 1: Spatial Locations of Recyclable Solid Waste***

| S/N | Recyclable Waste Collection Points | Location | Coordinates | | Types of Recyclables Collected |
|---|---|---|---|---|---|
| | | | Latitude | Longitude | |
| 1 | Junk shop | Kure Market | 9.617781 | 6.533489 | Plastic bottles and containers, glass jars |
| 2 | Junk shop | Kure Market | 9.617745 | 6.533491 | Carton |
| 3 | Junk shop | Kure Market | 9.617689 | 6.533494 | Plastic, paper and carton |
| 4 | Junk shop | Kure Market | 9.617811 | 6.529801 | Metal scraps and Plastic |
| 5 | Junk Shop | Fadikpe (Opposite Kure Market | 9.619145 | 6.527682 | Tin and Metal Scraps |
| 6 | Junk shop | Fadikpe (Opposite Kure Market) | 9.619884 | 6.527452 | Plastic, Tin and Metal Scraps |
| 7 | Junk Shop | Tunga | 9.597083 | 6.558629 | Metal and Aluminium Scraps |
| 8 | Junk Shop | Tunga | 9.596859 | 6.558706 | Metal scraps and Plastics |
| 9 | Junk Shop | Maitumbi | 9.635881 | 6.574384 | Metal and Aluminium Scraps |
| 10 | Junk Shop | Maitumbi | 9.635346 | 6.574742 | Metal Scraps and Plastic |
| 11 | Junk Shop | Maitumbi | 9.636610 | 6.574982 | Metal Scraps |
| 12 | Junk Shop | Maitumbi | 9.634041 | 6.573962 | Metal Scraps |
| 13 | Berger Junction Dealers | Maitumbi | 9.630603 | 6.56261 | Plastic |
| 14 | Gidan Bola Waste Dealers | Maitumbi | 9.637065 | 6.583824 | Plastic, Metal Scraps, Automobile parts, Tyres, Aluminium scraps |
| 15 | Scrap Dealers Association (Old Gwadabe) | Kasuwan Gwari | 9.613362 | 6.550039 | Plastic, Metal Scraps, Automobile parts, Tyres, sacs, glass, Aluminium scraps, carton |
| 16 | Waste Fabricator's Association | Kasuwan Gwari | 9.617512 | 6.550954 | Plastic, Metal Scraps, Automobile parts, Tyres, sacs, glass, Aluminium scraps, carton |

Source: Author's Survey, 2022

Solid waste collection points include twelve (12) Junk Shops and three (3) Waste Dealing Companies/Association and a Waste Fabricator's Association (Table 1). This implies that there are existing actors in various capacities that participate solely in collecting large volumes of recyclable solid waste and benefit from the wealth offered by waste in different areas of the metropolis

Twelve (12) Junk Shops are identified on figure 3. Six junk shops were identified around Kure Market, two in Tunga and four in Maitumbi. Junk shop owners are also referred to as middle men. This implies that there are existing actors that participate solely in collecting large volumes of recyclable solid waste, serving as middle men between scavengers and major waste dealers, within Minna town.

Three (3) Waste Dealing Companies/Association and One (1) Waste Fabricator's Association were identified on Figure 4. Two waste dealing companies are located in Maitumbi, one in kasuwan Gwari and one Waste Fabricator's Association at Kasuwan Gwari. This implies that there are existing actors that participate solely in collecting large volumes of recyclable solid waste, serving the role of raw material providers to recycling companies outside Minna.

Findings revealed that majority of actors in solid waste recycling within Minna have no support from the government in ways that will improve recycling, which explains how many of them lack the adequate machinery to carry out necessary tasks in an efficient manner, but rather resort to crude means of processing waste. They also have difficulty in transporting accumulated waste due to how expensive it is to hire trucks in certain situations. Minna with over 400,000 residents does not have a single truck dedicated to collecting solid recyclables and there is no single recycling plant in the entire metropolis, though solid waste is generated in large volumes daily. Actors in solid waste recycling have reported having little knowledge on the ways in which they could transform these wastes to useful products, although they recognize their potentials. This simply implies that although a number of collection points exist, an organized structure for recycling solid waste does not exist. According to Uchendu (2016), managing solid waste in Nigeria is problematic due to lack of funding, inefficiency, inadequacy and poor operational capacity. Solid waste is usually generated at a rate beyond the capacity of municipal authorities to handle.
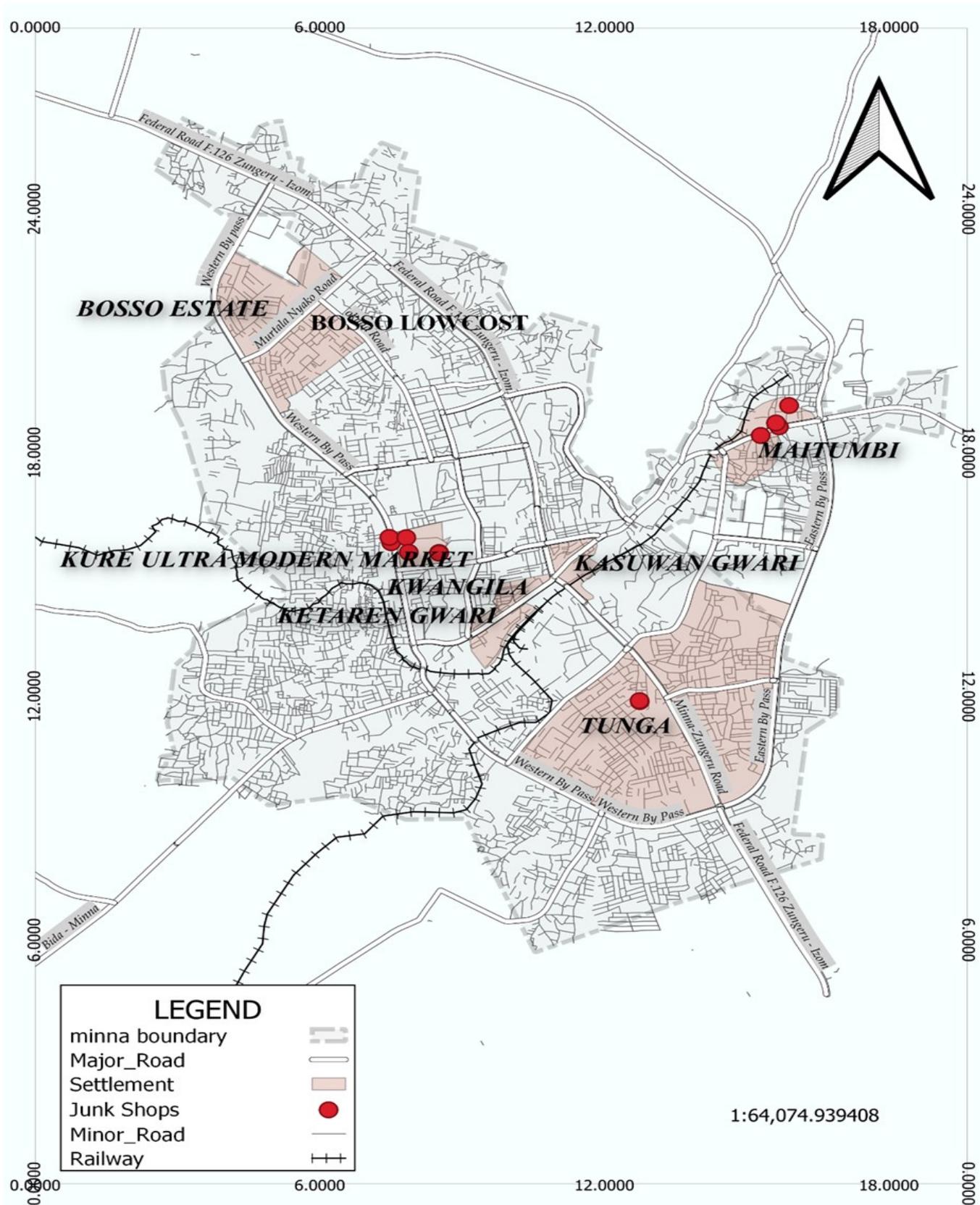
**Figure 3:** Spatial locations of junkshops
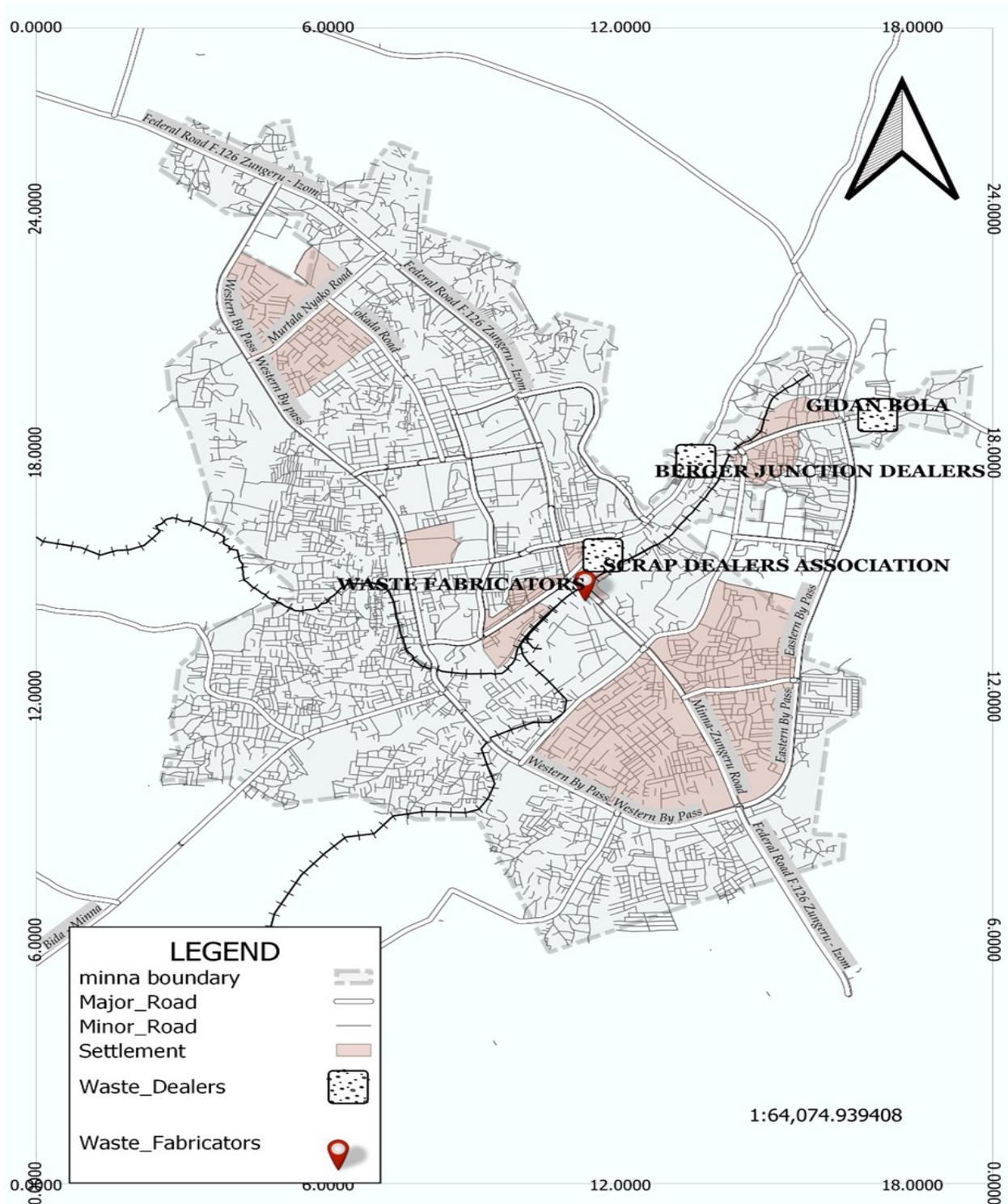
**Source: Author's Analysis, 2022**

**Figure 4:** Spatial locations of Waste dealers and Fabricators

**Author's Analysis, 2022**

## 5.0 Conclusion

Recyclable solid wastes are managed solely by informal recycling companies and individuals without the involvement of Government agencies. Informal waste collectors/ recyclers manage solid waste by selling recyclables sourced from scavengers through middle men. Lack of adequate knowledge on proper recycling processes, as well as lack of adequate equipment and machinery have led to a reduced level of benefits accrued from waste. Informal recyclers in Minna have not undergone any form of modern training on the best global practices to be employed to ensure effective recycling of waste materials.

The study therefore recommends that enlightenment and public awareness on good recycling practices should be incorporated in the Solid Waste Management Program of Minna and Niger state as a whole. Government participation and Intervention through; drafting policies, Public private partnership, Provision of separation bins for segregation of waste, Introduction of Curbside collection, Drop-off centers,

and Buy-back centers, Provision of Loans and Support for Informal Recyclers, and Organized Workshops and Training for Stakeholders on current trends, with regards to best practices for recycling activities, will promote growth and expansion of recycling within Minna.

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