Conversion of Solid Waste into Wealth within Bauchi Metropolis (Waste Paper Recycling)

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Abstract: Waste paper recycling is a process by which waste paper, agricultural residues, waste cotton, old rugs, tailor cuttings, waste jute, hosiery cuttings, are processed together with some chemicals like caustic soda, dry staffs, resin, etc. The residential area in Bauchi metropolis generate an average volume of waste of about 0.003m3/person /day for high density areas, 0.005m3 /person /day for high density areas. This bring about the needs to recycle the waste in order to protect the environment. The study was conducted based on linker scale questionnaire primary and secondary data collection. And using some selected tertiary institutions such as, Abubakar Tafawa Balewa University, Federal poly technic, Abubakar Tatari Ali Poly technic, College of Agriculture Bauchi and Bauchi state secretariat were used as sampling size. The study also revealed that the average paper waste generated weekly is 10kg. Also the cost of the finance when it starts to operate at full capacity within 3 years, and the project's initial investment will be fully recovered within 8 years. And the total amount of waste paper generated in the year 2016 within the study area was 68 tones. The recycled waste obtained from the solid waste will be used to generate new valuable products, sanitize the environment and also lead to job creation for the teaming unemployed youth.

Keywords: Bauchi Metropolis; Conversion of Solid; Waste into Wealth within

Introduction

Waste paper recycling is a process by which waste paper, agricultural residues, waste cotton, old rugs, tailor cuttings, waste jute, hosiery cuttings, are processed together with some chemicals like caustic soda, dry staffs, resin, etc., to produce file covers, greeting cards, writing paper, paperboard, filter paper, drawing paper, filter paper & pads duplicating paper, tissue paper among others (Yusuf, 2018). The process of waste paper recycling involves mixing used paper with water and chemicals to break it down. It is then chopped up and heated, which breaks it down further into strands of cellulose (Baird & Cann, 2005; Bajpai, 2024). A type of organic plant material; this resulting mixture is called pulp, or slurry. It is strained through screens, which remove any glue or plastic that may still be in the mixture then cleaned, de-inked, bleached, and mixed with water. Then it can be made into new recycled paper. The share of ink in a wastepaper stock is up to about 2% of the total weight. Industrialized paper making has an effect on the environment both upstream (where raw materials are acquired and processed) and downstream (waste-disposal impacts). Today, 40% of paper pulp is created from wood (in most modern mills only 9-16% of pulp is made from pulp logs; the rest comes from waste wood that was traditionally burnt). Paper production accounts for about 35% of felled trees, and represents 1.2% of the world's total economic output.

Recycling one ton of newsprint saves about 1 ton of wood while recycling 1 ton of printing or copier paper saves slightly more than 2 tons of wood (Abramovitz et al., 1999). This is because Kraft pulping requires twice as much wood since it removes lignin to produce higher quality fibers than mechanical pulping processes.

Relating tons of paper recycled to the number of trees not cut is meaningless, since tree size varies tremendously and is the major factor in how much paper can be made from how many trees. Paper products that are made of several materials require special equipment to be recycled. These products are mostly food and beverage packaging, and include UBCs. Tetra Pak is a Swedish company that makes containers for milk, juice, and other food packaging, made up of layers of paper board, polyethylene, and aluminum (Todorova et al., 2015).

However, if these materials are collected with other paper products such as clean cardboard, they will also lower the quality of the recyclables. Paper mills not equipped to remove oil and grease will return any collected paper with too much contamination. Mixing higher grade paper, such as office paper, with lower grade material, such as corrugated cardboard, may be easier for residents to gather, but will lower the overall quality of the recycled paper. Municipalities can sell a mixture of newspapers and magazines containing a minimum of 60% newspapers. Quality plays an important role in the use of recycled paper. Higher quality paper, such as graphic paper and stationery, often consists of higher-grade material and does not contain much recycled material. More common, lower grade paper, such as newspaper, paper napkins, and toilet paper, can easily be made with recycled paper.

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Mixing higher grade paper, such as office paper, with lower grade material, such as corrugated cardboard, may be easier for residents to gather, but will lower the overall quality of the recycled paper. Municipalities can sell a mixture of newspapers and magazines containing a minimum of 60% newspapers (European List of Standard Grades of Paper and Board for Recycling, 2013). As such, they must keep in mind the quality of the collected paper and cardboard when they develop a system for recycling.

Waste papers are among the largest sources of waste in the waste stream. Very large amount of waste paper is packed and discarded into the waste streams. The papers are created to print and write edible substances and but after usage are dumped into the environment which in turn litters and pollute the environment. With the rapid and large increase of waste quantities burning of waste paper related materials contributed to global warming and hence, leads to climate changes. However, there are several critical issues facing Bauchi metropolis such as poor awareness on waste minimization, less developed policy and strategic planning, lack of technology support, and lack of financial investment on solid waste conversion.

Method

Research Design

The research used survey research design adopted a quantitative method because of its appropriateness to the topic under investigation. Survey design is a scientific method which involves observing and describing the characteristics of the subjects without influencing of data for the purpose of answering research question under study (Baird & Cann, 2005). The study is based on Conversion of Solid Waste into wealth within Bauchi metropolis. It is based on an in-depth investigation of individual group, or even to explore causation in order to find the underlying principles.
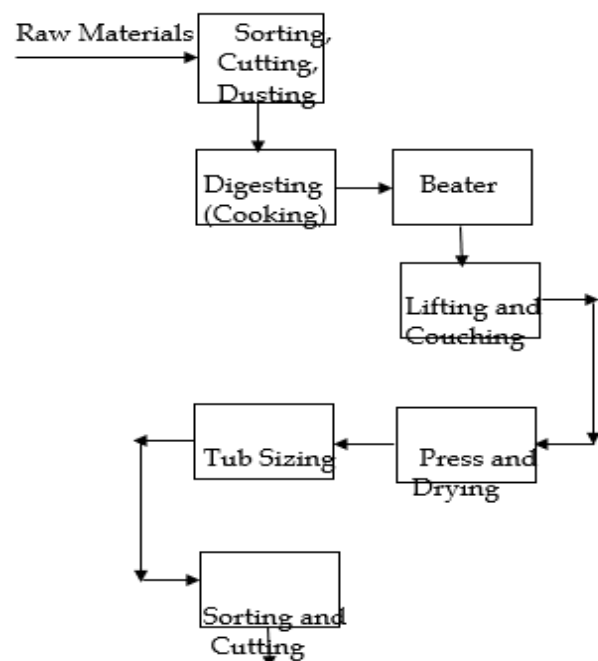

Figure 1. Waste paper recycling Flow Diagram

Observation Method

This includes visitation of the dumpsites (landfills) at Gombe road and some of the hotspots roadside dumps so as to be able to identify, separate, characterize Samples of freshly disposed municipal solid wastes to know more of what they are composed of, the study considered of all the households in Bauchi metropolis.

Interview Method

The Bauchi environmental and protection Agency (BASEPA), private, residents and scavengers involved in municipal solid waste management were interviewed to update information in the document and records collected.

Extrapolation of Population of Bauchi Metropolis

Bauchi metropolis, the headquarters of Bauchi metropolis, is located between latitudes 9″ 00′ and 9″ 30′ North of the Equator and longitudes 10″ 25 and 11″ 20′ East of the Greenwich Meridian It occupies a total land area of 3.604.0 hectares. It has a total population of 356.923 as of 1991 and 493,730 as of 2006, NPC, (2006). Furthermore, based on the average household size of 8 persons per household as revealed by the 2006 census there are 39.675 households in the metropolis. Extrapolation was carried out due to the lack/scarcity of data on population; an appropriate projection method is used to determine the population. Exponential growth method is used which is as follows;

$$\text{Pop proj} = \text{pop last} (1 + \text{Growth rate}) \quad (1)$$

Where:
(1 + Growth rate) = (Pop last / pop first) 1/ (Last year – First year)
Popproj = population projection
Pop last = Last population
Pop first = First population
Last year= Last year
First year = First year

The equation was used to determine the growth rate which is multiplied by the last year to obtain the current population.

Municipal Solid Waste Generation

Average waste generation per person is 0.86 kg/per capita/per person/day (Bogoro Audu Gani & Bwala, 2014), which was multiplied by the total population of Bauchi metropolis which gives the solid waste generated/day as well as per year.

$$\text{MSW} = \text{per capita generation} \times \text{No. of days in year} \times \text{population} \quad (2)$$

Description of Unit Operations
Sorting, cutting and Dusting

The various raw materials (waste paper, rugs, waste cotton, etc.) are sorted thoroughly for removal of all impurities, that is, all non-fibrous materials such as nails, buttons, wood chips, etc. are eliminated. The useful materials are then cut into small pieces of approximately 2x2 cm and dusted through a dusting frame covered with four to six mesh wires.

Digesting (Cooking)

The cooking or digestion of the rags and other materials is carried out with a mixture of 1 to 3% of caustic soda or lime and kept at boiling point for about five to six hours. Then they are washed thoroughly and sent to the beater.

Beating

The beater is filled with the required quantity of water, and the digested materials are added gradually. Bleaching power (1 per cent) is then added. After allowing sufficient time for bleaching, the materials are washed thoroughly by lowering the washing drum. The time required for pulping is about six to eight hours where good hydration is desired. Titanium dioxide or other fillers are then added along with dyes (for colored paper) or optical bleaching agents (for white paper). Rosin soap and alum are added later.

Lifting and Couching

From the beater the pulp is sent to storage vats near the lifting vat and mixed with sufficient quantity of water to dilute it to form a uniform suspension and free it from clumps, knots, etc. A certain quantity of diluted pulp is then lifted from vats on a wire screen, and the resulting sheets are covered by felt.

Pressing and Drying

When a sufficient number of sheets have been formed, they are put under a press to remove the water. The sheets are then separated and, to avoid shrinkage, placed under absorbent boards and pressed again. The sheets are then hung to dry in bunches of three to six, according to thickness.

Tub Sizing

For strong durable paper, tub sizing or surface sizing is carried out. The sized papers are again dried and cleaned with a brush or cotton wadding to remove dirt specks.

Calendaring

The sheets are then placed alternately under metal plates to form a "post", which is then passed to and fro

in between calendar rolls to obtain the desired smoothness.

Sorting and Cutting

After calendaring, the sheets are carefully sorted and cut to size (110 x 66 cm = 0.726 m2). These sheets are taken off the machine and built up into a stack with interleaved felts. In most cases almost 100 per cent of the input raw materials end up in the finished product. In some cases there will be a loss of up to 50% of the dry weight when the non-cellulose element in some agricultural wastes is extracted in the cooking and washing stages. Some of the process water will go to waste. How much waste water is produced depends on the amount of washing and bleaching to be carried out. The waste water contains only very small traces of chemicals and would be safe to use for irrigation. If the cost of water justifies it, the waste water can be purified and used again.

Result and Discussion

In this chapter tables were presented, which includes; amount of waste paper generated yearly within municipal. This table includes the projection of population as well as solid waste generations in tones were tabulated. Table 1 amount of waste paper generated in the study areas.

Table 1. Amount of waste paper generated in study areas

Area	Year	Waste paper generate (tone)
A.T.B.U	2016	30.000
Fed Poly Bau	2016	20.000
Sec. Sch.	2016	5.000
Ministries	2016	10.000
Wards	2016	3.000

Projection of Population

Bauchi metropolis census was carried out in the year 1991 and 2006 were tabulated in the Table 2.

Table 2. Conducted population census

Variable	1991 census	2006 census
Population	356.923	493.730

The two censuses were used to obtain a population growth which is as follows;

Growth rate

(1 + Growth rate) = 1.0218669

The following data's were used in estimating the waste generation.

1 year = 365days

Average waste generation per capita = 0.86 kg/capita/person /day (Bogoro Audu Gani & Bwala, 2014).

Approximate waste generation per person/annum = 314 kg/capita/person/annum

The Table 3 shows the waste emission from the year 2006 to 2050, this increase signifies that as the waste is generated in the municipality every year so also there will be increase in waste which will results in litters the environment.

Table 3. Population projection and the Amount of waste

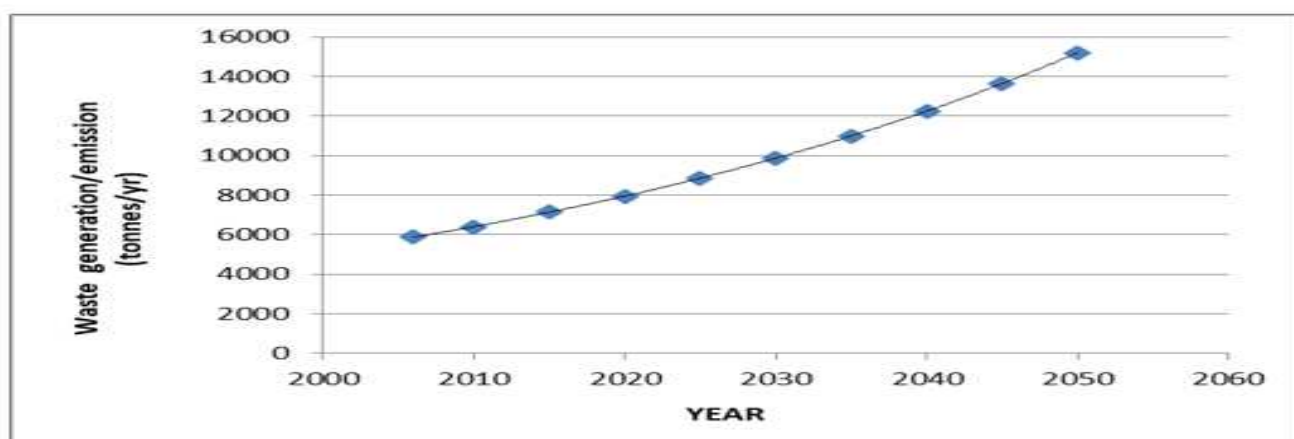| Years	Growth rate	Projected population	MSW (tones)
2006	1.022	493730	155031
2010	1.022	538353	169043
2015	1.022	599844	188351
2020	1.022	668360	209865
2025	1.022	668360	323464
2030	1.022	829762	60545
2035	1.022	924539	290305
2040	1.022	030141	323464
2045	1.022	1147806	360411
2050	1.022	1278910	401578

Figure 1. Quantity of LFW generations/captured in tones using IPCC methodology

Discussion

Therefore the estimated amount of waste paper that will be generated from the study area for year 2012 is 169043t and is projected to reach 209865 and 401578 t by 2022 and 2050, respectively.

It could be seen that as the population increases every year so also does the MSW increase every year (Chen et al., 2020; Valavanidis, 2023). Table 2 shows that the population of Bauchi metropolis is increasing year by year which has an approximate population of 744.701 in 2025 and has a projection of which will reach up to 1.27 million in 2050. This population led to a growth in Municipal solid waste 'MSW' with a generation of 233,836 thousand tonnes in 2025 and as well 401.578 thousand tonnes in 2050, these increase in thousand tonnes in 2050, these increase in population and MSW is due to the development of Bauchi metropolis. An appropriate projection method called the Exponential growth projection was use to project the population but the bases are from 1991 and 2006 censors. Below are the graphs for waste generation/year.

Conclusion

Waste paper recovery will provide a highly effective means of reducing overall waste paper disposal from our street. The recycling contained in the collected several solid waste will be used to generate new product or directly which is an environmental benefit and lead to job creation. The NGW Association and municipalities in increasing waste paper and cardboard recycling rates. Our matrices assume that recycling directly benefits the environment and therefore only evaluates the impacts implementing different techniques will have on the economic and the service pillars. The project can create employment for 52 persons. In addition to supply of the domestic needs, the project will generate N 17.190 million in terms of tax revenue. The establishment of such factory will have a foreign exchange saving effect to the country by substituting the current imports.

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