KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

PROJECT REPORT ON:

ASSESSMENT OF QUANTITY OF COCONUT WASTE GENERATED AND MANAGEMENT IN THE KUMASI METROPOLIS, GHANA.

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE BSc. (AGRIC. ENG.) DEGREE

BY:

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MAY, 2016

DECLARATION

I hereby declare that this submission is my own work towards the BSc. Agric. Engineering and to the best of my knowledge, this work or any part thereof, has not been previously submitted for the award of any degree of the University and it contains no material previously published by any other person except where due acknowledgement has been indicated in the text.

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ABSTRACT

Coconut is nutritious, rich in fiber and has two distinct varieties produced in 92 countries worldwide. Coconut waste has become a very useful substance in light of today's environmental and economic concerns. Most sub-Metros were surveyed to determine the quantity of coconut waste generated and assess coconut waste management in the Kumasi Metropolis. The research gathered data from secondary and primary sources using preliminary field investigation and questionnaire survey. Results of the survey showed that between 2.9 and 4.5 tonnes of coconut waste could be generated per month in the Kumasi Metropolis out of which 91% are dumped, 8.9% used as energy and 0.1% used for doormats. In light of these findings, the research recommends regular collection and processing of coconut waste for health, domestic, agricultural and industrial purposes.

DEDICATION

I dedicate this work to my parents Mr. and Mrs. Ofori-Agyeman and the entire Ofori-Agyeman family.

ACKNOWLEDGEMENT

I wish to express a heartfelt gratitude to the Almighty God for his grace through my educational ladder to this level of education which marks the completion of my studies in the quest of attaining a Bachelor of Science degree in Agric. Engineering. My gratitude also goes to the supervisors of this project, Prof. Ebenezer Mensah and Dr. George Yaw Obeng for their time, unflinching support and guidance put into this project to ensure its success and for imparting into me great knowledge. I am so grateful to my family, friends and colleagues and all who assisted me in diverse ways in getting to this level of the education.

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LIST OF ABBREVIATIONS

CRC- Coconut Research Center

EITC- The East India Trading Company

UNCTAD- United Nations Conference on Trade and Development

FAOSTATS- Food and Agriculture Organisation Statistics

SGP- Small Grant Programme

GSS- Ghana Statistical Services

GPS- Global Positioning System

KMA- Kumasi Metropolitan Assembly

NPCS- NIIR Project Consultancy Services

BHWC- Be Healthy with Coconut

CHAPTER ONE

1.0 Introduction

1.1 Background

Coconut (Cocos nucifera) is highly nutritious and rich in fiber, vitamins, and minerals (CRC, 2004). There are only two distinct varieties of coconut in Ghana, the tall varieties and the dwarf varieties. Wastes that are generated from this fruit are classified as agricultural waste or solid waste. Researchers all over the world today are focusing on ways of utilising agricultural wastes as a source of raw material for the industry. The wastes utilisation would not only be economical, but may also result in foreign exchange earnings and environmental pollution control (Aigbodion *et al*., 2010). Coconut shell is an agricultural waste and is available in very large quantities in most tropical countries. Moreover, coconut is becoming an important agricultural product for tropical countries around the world as a new source of bioenergy (Bamgboye *et al*., 2007). The problems caused by solid waste in urban Africa is largely due to the explosive growth rates, particularly in sub-Saharan Africa, which eventually translates into generation of copious amounts of solid waste (Monney *et al*., 2013). Coconut is produced in 92 countries worldwide on about 11.8 million hectares' land. World production has been estimated at 62,450,192 tonnes with an average yield of 5.14 tonnes per hectare (FAOSTAT, 2015). Out of the 92 coconut producing countries in the world, Indonesia is the largest producer with 18,300,000 tonnes of coconut and Ghana is ranked 16th producing 366,183 tonnes of coconut (Factfish, 2010). Coconut tree can adapt to a wide range of soil types although it thrives on sandy soils and is highly tolerant of salinity. It prefers areas with abundant sunlight and regular rainfall (1500 mm to 2500 mm annually). In Ghana, although coconut was first introduced in the Volta region, the

bulk of its production now comes from the Western region, particularly the Jomoro District. Apart from the coastal areas the crop performs well inland (Yeboah, 2010).

Coconut is known for its great versatility as seen in the many uses of its different parts and found throughout the tropics and sub-tropics. There are hundreds of quality properties in coconut that can only be described as amazing. Coconut is used for many purposes in fields such as agriculture, health, environment, mining and industry. In Ghana, coconut is used for some agricultural, domestic and health purposes.

1.2 Problem Statement

Coconut sellers dump coconut shells and husks after close of business and this has contributed to the waste problem in Ghana. Solid waste management in Ghana has become a challenge affecting the lives of every ordinary person of the country as well as the environment. The potential of coconut crop has been grossly under-utilised in Ghana. Many Ghanaians have not fully discovered the enormous economic potential and uses of coconut, five centuries after the crop was introduced into the country. It is very ironical that such an economic crop grows in communities where thousands of people are stricken with poverty. There is a huge economic potential of coconut and its waste products which has remained largely untapped in Ghana. For example, activated charcoal produced from coconut shells, has a huge economic value in the mining industry. Therefore, there is the need for continuous research into the quantity of coconut waste that can be generated and how the wastes are managed using Kumasi Metropolis as a case study.

1.3 Justification

This study will determine the quantity of coconut waste available in the Kumasi Metropolis. It is to help determine the quantity of coconut waste produced in Kumasi and how best the waste can be put into industrial use.

1.4 Aims and Objectives

1.4.1 Aim

The aim of this study is to determine the quantity of coconut waste generated and assess coconut waste management in the Kumasi Metropolis.

1.4.2 Specific Objectives

The specific objectives of the research are:

1. To determine the quantity of coconut waste generated in a day, month and year.
2. To determine the current management and utilisation of coconut waste.
3. To know the sources of the coconut varieties and means of transporting within Kumasi.
4. To map out locations of sites and sales points in Kumasi.

CHAPTER TWO

2.0 Literature Review

2.1 Waste

Waste is defined according to the Waste Framework Directive of the European Union as "substance or object which the holder discards or intends or is required to discard" (WFD, 2008). Every day humans generate waste. It is estimated that about 3 billion urban residents generate about 1.2 kg of waste per person per day making it 1.3 billion tonnes per year (Hoornweg and Bhada-Tata, 2012). The government is spending substantial amount just to sustain the treatment and management of municipal waste. As the world moves ahead the amount of municipal solid waste is surpassing the rate of urbanization.

Solid waste management is very challenging in the Kumasi Metropolis. The designated public dumps receive solid waste from about three quarters of dwelling units. The proportion of households that dump solid waste indiscriminately may seem small at about 2%, but the practice is more than a nuisance and unhygienic and has broad repercussions for public health and the environment (GSS, 2014). According to the local Government Act 1971, the Kumasi Metropolitan Assembly-Waste Management Department (KMA-WMD) is the sole body responsible for waste management in Kumasi Metropolis.

Kumasi records a daily solid waste generation of 1,200 tonnes. The Tuk Tuk, or in popular parlance used here in Ghana "***Motor king***", has recently become a popular form of urban transport for goods due to its maneuverability and agility. This has increased in the number of cartridges that can be safely transported to processing sites (Clean Team, 2013).

Figure 2.1 presents data on the method of solid waste disposal by households in Kumasi Metropolis. About 58.8% of the households reported that they dispose of their solid waste into containers at public dump sites and another 15.6% of the households use public dumps (open space). The use of the services of KMA and other private companies such as Zoomlion, Royal Asadu in collecting solid waste is patronized by 17.2% of the households. Other methods used are burning (4.4%), indiscriminate disposal (1.9%), burying (1.6%) and other (0.4%) (GSS, 2014).

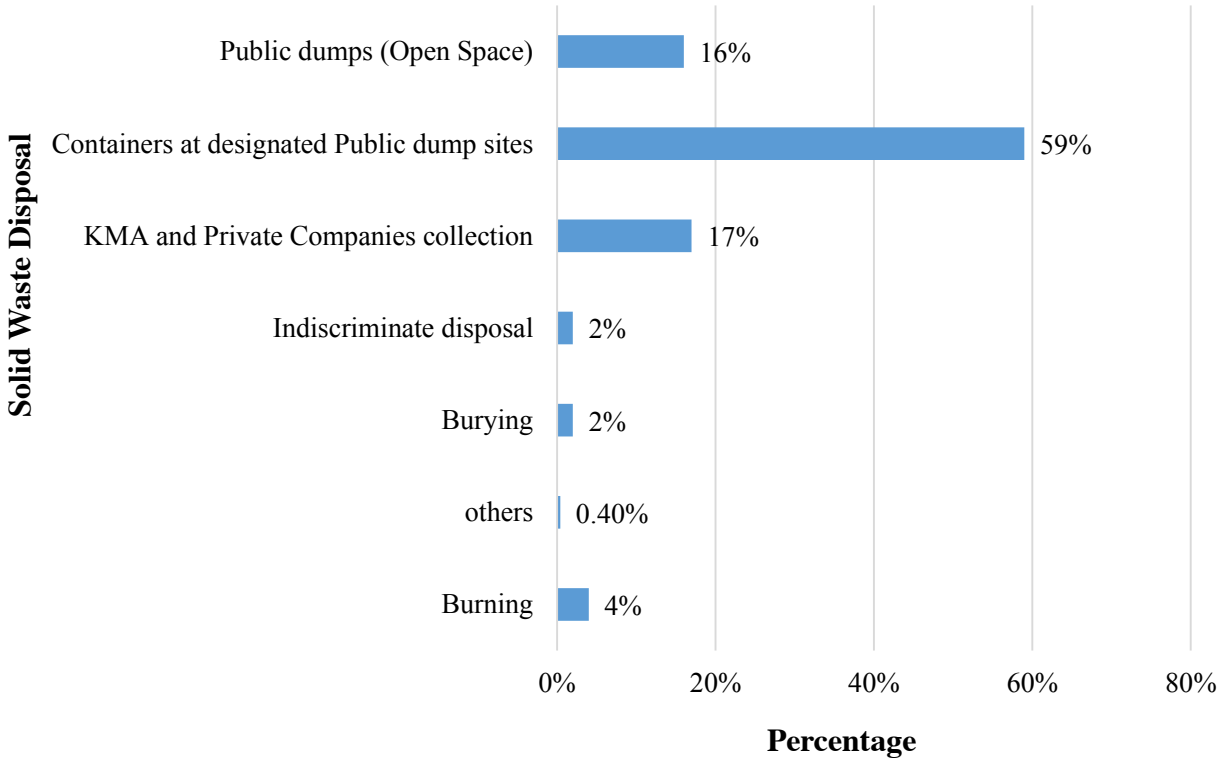

Figure 2.1: Percentage of solid waste disposal by households in Kumasi Metropolis
Source: (GSS, 2014)

2.2 Types of Solid Waste Management

2.2.1 Collection

Two types of methods are employed for the collection of municipal waste in Kumasi. These are house-to-house (curbside) solid waste collection utilising compactor truck sand communal solid waste collection. Eighty-five percent (85%) of the waste generated is collected in the municipality. The waste collection service in the city is carried out by the private sector under various agreements with the Metropolitan Assembly (Asase *et al*., 2009). In Kumasi, the bulk of household waste is found to be organic waste with an overall average of 55% from three residential areas (Ketibuah *et al*., 2004).

2.2.2 Transportation

The mode of refuse transport in the Kumasi metropolis is by direct haul and waste transfer. Direct haul is affected by the compact trucks (compactors) and waste transfer by the roll-on-off container trucks. Waste transfer handles about 99% of waste for disposal in the metropolis (James, 2011). The communal collection system involves the location of metal containers (skips) at designated sites known as transfer stations, which are shared by a number of houses within that community. Skips are transported and emptied at final disposal sites by skip loading trucks (Asase *et al*., 2009).

2.2.3 Recycling

Recycling of the disposed material is one method of treating the agricultural waste. Recycling is defined as the process by which materials destined for disposal are retrieved from the waste, used as raw materials and reused (Addo, 2013).

2.3 Coconut Shell and husk

Coconut shell is an agricultural waste and is available in very large quantities throughout the tropical countries of the world (Madakson *et al*., 2012). The husk and shell, which are by-products of the coconut oil and water industries, are typically discarded or burned (Cimons, 2014). Coir is a natural fibre conventionally obtained from mature coconut husks. However, green husks, an agro-waste are available in large quantities and recent experiments have indicated that good quality coir fibre can be extracted from green husks (Basak et al., 2014). The coconut husk, also known as coir, has become a very useful substance in light of today's environmental and economic concerns. It has some common and not so common uses. Coir is a key component in the production of some popular products (BHWC, 2015).

Figure 2.2: Coconut shell and coconut husk

Table 2.1: Residue from coconut in Ghana

Coconut Residue on wet basis *(tonnes)*	**Coconut Residue on dry basis** *(tonnes)*
189,600	174,640

Source: (Duku *et al*., 2011)

2.4 Coconut waste Management and utilisation

The coconut is a 'no-waste tree' because even its waste products provide ample opportunity to augment farmers' income. Wastes have been put into use and even turned up to be an income generating industry (Eyzaguirre, 2016). Coir dust, the major by-product of coir production and considered a pollutant, is now being sought to conserve the environment (Eyzaguirre, 2016). It is now used as substitute for peat as a potting medium for plants. Coir peat or dust is now being exported and is becoming a significant foreign exchange earner in Sri Lanka. Coconut waste are by-products produced during cultivation and processing of coconuts. Waste management is the collection of all thrown away materials in order to recycle them and as a result decrease their effects on our health, our surroundings and the environment and enhance the quality of life (Eyzaguirre, 2016). Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers (Golush, 2015).Waste Management flows in a cycle: monitoring, collection, transportation, processing, disposal or recycle. Through these steps a company can effectively and responsibly manage waste output and their positive effect they have on the environment (NPCS, 2008). According to Monney (2014), wastes generated in Ghana are collected to the landfill sites. However, solid waste management goes way beyond just collecting the solid waste generated to a landfill site. Waste management deals with the control of generation, storage, collection, transfer and transport,

processing, and disposal of solid wastes in a manner that conforms to the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also reactive to public attitudes (Monney, 2014). According to Fiagbenu (2014), coconut sellers in Ghana are unknowingly carrying a whole industry that can potentially turn around Ghana's economy. It is time for coconut growers to begin to think about the coconut industry and its ability to generate wealth, offer employment, and nurture people in the art industry. Coconut industry can be an oxygen for Ghana's economy or a solution to the unemployment situation (Fiagbenu, 2014).

2.4.1 Industry

Industrialists in most of the coconut producing countries hail the economic, environmental and technological benefits of utilizing coconut farm wastes (UCOL-GANIRON JR, 2013). The use of coconut husks, which are now most often considered as waste, is used as a resource to produce building materials to substitute wood products offers many advantages. The coconut husks are processed into fuel, mulch and coir while the shells are also processed into charcoal, handicrafts and activated carbon. Some of these products have not been fully commercialized but have the potential to increase the overall productivity of the industry (UNCTAD, 2009). Activated charcoal is also used for water filtration and cleaning machines that expel air (Yeboah, 2010).

2.4.2 Agriculture

Coconut husks are the rough exterior shells of the coconut. While the husks are not used for food, like the meat and liquid found within the exterior shell, the husk can be used in several

ways, including creating enriched potting soil and as chips that can be used to provide ground cover for flower beds (Exporters, 2011).

2.4.3 Energy

The shell provides fuel for various purposes. According to Madakson *et al*.,(2012), coconut is becoming an important agricultural product for tropical countries around the world as a new source of energy (biofuel). Previously, coconut shell was burnt as a means of solid waste disposal which contributed significantly to CO_2 and methane emissions. However, as the cost of fuel oil, natural gas and electricity supply has increased and become erratic, coconut shell has come to be regarded as source of fuel rather than refuse. Presently in Nigeria, coconut shell is used as a source of fuel for the boilers and residual coconut shell is disposed of as gravel for roads maintenance. Black smiths also buy the coconut shell as fuel material in their casting and forging operation (Madakson *et al*., 2012). Researchers estimate that replacing synthetic polyester fibers with coconut husk fibers, known as coir, will reduce petroleum consumption by 2 to 4 million barrels and carbon dioxide emissions by 450,000 (Cimons, 2014).

2.4.4 Domestic Use

It is possible to purchase mass produced husk products or create the products at home using the shells of fresh coconuts (EITC, 2011).

2.4.5 Health Benefits

In contemporary medicine, study is now confirming the use of coconut in treating many health conditions due to its wide range of health benefits (Nonor, 2016). A study on coconut in modern

medicine and modern medical science, conducted by scientists of the Coconut Research Centre in Colorado Springs, in the United States of America (USA), has confirmed the use of coconut in treating many health problems, including abscess, asthma, baldness, bronchitis, bruises, burns, colds, constipation and cough. It is also used in treating dysentery, fever, flu, irregular or painful menstruation, jaundice, kidney stones, lice, malnutrition, nausea, rashes, scabies, scurvy, skin infections, sore throat, swelling, syphilis, toothache, tuberculosis, tumors, typhoid, ulcers, stomach upset, body weakness and wounds (Aklorbortu, 2013).

2.5Coconut Production

World production has been estimated at 62.4 million tonnes with an average yield of 5.17 tonnes per hectare (FAOSTAT, 2015). According to UNCTAD (2012), production is often estimated using reported copra production, area planted or administrative estimates, since by the very nature of coconut production, it is virtually impossible to do an accurate count of the number of coconuts. Desiccated coconut is a well-established product and a larger number of countries can produce it than coconut oil. Production falls between the levels of coconut oil and coconut milk in revenue terms. Global production of desiccated coconut averages between 180 and 290,000 tonnes annually. This is dominated by the Philippines, Sri Lanka and Indonesia. While production is waning in Vietnam, Thailand, Brazil and Sri Lanka, new capacity is being developed in Papua New Guinea (UNCTAD, 2012).

Global production of coconut husks has been estimated at 23 million tonnes. This is the largest potential growth area for coconuts. It is used in the production of some 6 million tonnes of coir fiber and 14 million tonnes of peas (UNCTAD, 2009). The world's production share by regions

are Africa(3.3%), Americas (8.6%), Oceania (4.8%) and Asia (83.3%) (FAOSTAT, 2015). From this statistics, Africa produces the least of the total world's production of coconuts.

Ghana is the 16th largest producer of coconut in the world with a production commodity of 366,183 tonnes cultivated on an area of 26,100 hectares with a yield of 14.03 tonnes per hectare as shown in Table 2.2 and 2.3.

Table 2.2: Production of coconut in Ghana

Production ***(tonnes)***	Yield ***(tonnes / ha)***	Area Harvested ***(ha)***
316,000	14.03	26,100

Source; Factfish 2013

Table 2.3: Coir Production commodity (tonnes)

Region	World	Africa	Ghana
Quantity of coir *(tonnes)*	1,205,620	41,500	39,400

Source; FAOSTATS 2013

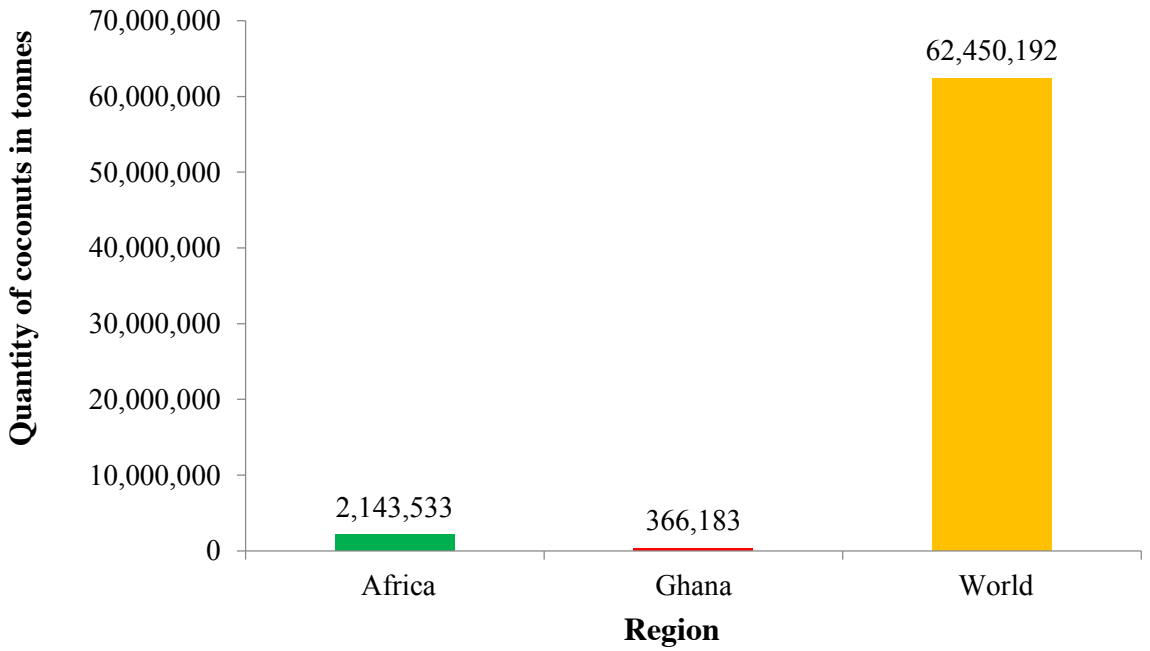

Figure 2.3: Coconut Production (tonnes) *Source:* FAOSTATS 2013

2.6 Varieties and Sources of coconut

The coconut palm is the most important cash crop in the four coastal regions of Ghana that is Greater Accra, Central, Volta and Western Region (Quartey, 2011).

2.7 Transportation

Currently, the raw coconut is harvested and transported over long distances to the villages for processing. This practice entails high cost of transportation, considerable drudgery and deprives the coconut trees of the benefit of the organic matter in the husk The current method of coconut farming does not harness the economic and financial benefits inherent in on-farm processing of the coconut, as is done in countries such as Cote d'Ivoire, Sri Lanka and Philippine (SGP, 2012).

CHAPTER THREE

3.0 Materials and Methods

3.1 Study Area

Kumasi Metropolis is one of the thirty districts in Ashanti Region. It is located between Latitude 6.35ºN and 6.40ºS and Longitude 1.30ºW and 1.35ºE and elevated 250 to 300 meters above sea level. It is approximately 270km north of the national capital, Accra. It has a surface area of approximately 214.3 square kilometers which is about 0.9% of the region's land area(GSS, 2014). According to the Population and Housing Census of 2010, the population of Kumasi Metropolis is 1,730,249 which represent 36.2 percent of the total population of Ashanti Region which is 4,780,380. Less than 10 percent, (8.5%) of households in the Metropolis are engaged in agriculture (GSS, 2010).

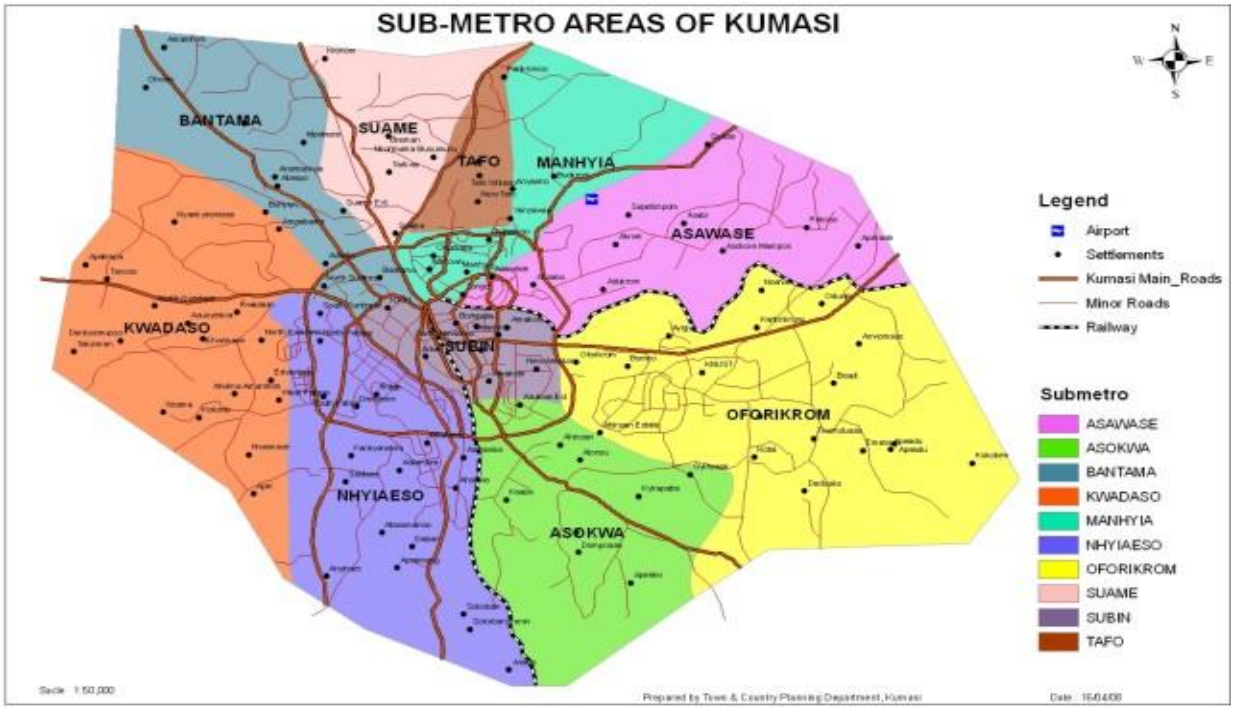

Figure 3.1: Map of Kumasi Metropolis

3.2 Materials

The following materials were used in executing the research project:

- Coconuts
- Weighing scale
- Garmin GPS
- Questionnaires
- Mobile phone with camera

3.3 Methods

3.3.1 Primary and Secondary data

Primary data were collected through preliminary field investigation and questionnaires administration. These are further discussed in the sub-sections below. Secondary data were collected from the crops and Research Department under the Ministry of Agriculture in Kumasi.

3.3.2 Preliminary Field Investigation

The field observation involved scouting through the study area to assess the following

- Dump sites in some of the sub-metros
- The Kumasi Landfill site

In the process of this observation, pictures were taken of heaps of coconut waste in some dump sites. This process provided a clear idea on the management of coconut waste.

3.3.3 Questionnaire

Hundred (100) questionnaires were administered to coconut sellers in most sub-metros of the Kumasi Metropolis.

The primary purpose for interrogating the coconut sellers was to find out the following:

- Sources of coconuts and varieties
- Management
- Quantity sold in a day
- Residues generated
- Location of the sellers

Coconut sellers that were interviewed gave minimum and maximum number of coconuts that were sold out in a day. Coconut wholesale points in Kumasi such as the "Abenchi" Market, Tafo and Suame Roundabout were visited to find out number of coconuts that were brought into Kumasi each day.

3.3.4 Pretest of Questionnaire

Questionnaires for assessing the management of coconut waste in Kumasi were pretested on 10 coconut sellers who were randomly selected. This was done to find out how effective the questionnaire would be for the main survey. The pretesting was carried out in the following study areas: Tech-Junction (Ayigya), Amakom and Adum.

3.3.4.1 Varieties and Sources

Coconut sellers in these locations were dealing in these types of coconuts; The West African tall and the Sri-Lankan Green Dwarf. Half of the sellers had their sources of coconuts from Central Region and Western Region. The other five sellers at Adum had their sources from Abenchi in Kumasi where most coconuts on wholesale transported into Kumasi from other Regions are sold out to retailers.

3.3.5 Simple Random Sampling

This is considered to be the ideal random method because respondents were randomly selected from an entire population of coconut sellers. Every coconut seller had an equal chance of being selected. Commercial areas and vantage points for coconut sellers were taken into consideration in order to arrive at the targeted number. Table 3.1 shows the various selected areas under their sub-metros.

Table 3.1: Sub-Metros and selected area of study

Sub-Metros	**Selected Areas**
Bantama	Bantama
Kwadaso	Sofo-Line
Manhyia	Dr. Mensah
Oforikrom	Ayigya
Suame	Suame Roundabout
Subin	Adum, Pampaso, Asem, Roman Hill, Kejetia
Tafo	Tafo, Ahwiaa

3.3.6 Field Measurements

1. The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. This was used to map out the locations of sales points of coconut sellers and coconut dumping sites.

2. On-field measurement: The weight of the coconut residue was measured with a weighing scale. The crop residues in some study area were put on a weighing scale to determine its weight which involves the measurement of agro by- product of the coconut.

Calculation of coconut sold out daily, monthly and yearly

Average coconuts per day (Maximum) = 134

Average coconuts per day (Minimum) = 86

Average coconuts per month (Maximum) = 134×30

= 4,020 Coconuts

Average coconuts per month (Minimum) = 86×30

= 2,580 Coconuts

Average coconuts per year (Maximum) = 4,020×12

= 48,240 Coconuts

Average coconuts per year (Minimum) = 2,580×12

= 30,960 Coconuts

Calculation of coconut waste generated daily, monthly and yearly

Average weight of a coconut husk= 1.14 kg

Maximum Quantity of coconut waste per day= 1.14 kg × 136

=155 kg

Minimum Quantity of coconut waste per day= 1.14 kg × 86

=98.04 kg

Maximum Quantity of coconut waste per month= 155 kg × 30

=4,650 kg (4.6 tonnes)

Minimum Quantity of coconut waste per month= 98 kg × 30

=2,940 kg (2.9 tonnes)

Maximum Quantity of coconut waste per year= 4,650 kg × 12

=55,800 kg (55.8 tonnes)

Minimum Quantity of coconut waste per year= 2,940 kg × 12

= 35,280 kg (35 tonnes)

3.3.7. Data Analysis

This research data was analysed with SPSS version 16.0 and excel 2016 using the simple descriptive statistics and analytical methods, percentages, bar charts and pie charts.

CHAPTER FOUR

4.0 Results and Discussion

4.1 Socio-demographic data of the respondents

Analysis of the socio-demographic characteristics of respondents revealed the dominance of male sellers across the supply chain as indicated in Table 4.1. The majority of the Respondents were between the ages of 19 and 29 representing 39.6% as shown in Table 4.2. Majority (representing 56.4%) of the Respondents had their educational level at the Junior High School and is further revealed that majority (62.4%) of the respondents were not married.

Table 4.1: Statistics of sex of respondents

Gender	Frequency	Percentage (%)
Male	80	79.2
Female	21	20.8
Total	101	100

Table 4.1**,** shows the difference between males and females in the coconut business. Coconut business is very stressful and therefore the males are more attracted to this business than the Females.

Table 4.2: Statistics of age of respondents

Age	below 19 years	(19-29) years	(30-39) years	(40-49) years	(50-60) years
Frequency	14	40	27	17	3
Percentage (%)	13.9	39.6	26.7	16.8	3.0

Majority of the respondents in Table 4.2 fall between the ages of 19 to 29 indicating that coconut sellers in the Kumasi Metropolis are mainly youth .

Table 4.3: Percentages of the educational level of respondents

No education	Middle school	Primary	JHS	SHS	Tertiary
12.9%	10.9%	6.9%	56.4%	12.9%	0%

Table 4.3 indicates that coconut sellers are mostly graduates from the Junior High School. This signifies that greater number of coconut sellers get attracted to this business due to lack of funds to continue their education. With this, they trade in coconut business for a living.

4.2 Quantity of Coconut

According to respondents, coconut marketing differs with seasons in Kumasi, reaching its peak of sales in the dry season and low in sales in the rainy season. The quantity of coconuts is in abundance in the rainy season but low in the dry season. Quantity of coconuts in the Kumasi Metropolis is not as large as compared to that of the coastal areas. Table 4.4 indicates the total number of coconuts brought into Kumasi each day.

Table 4.4: Quantity of coconuts transported to Kumasi each day

COCONUT DISTRIBUTORS	DRY SEASON		RAINY SEASON	
	Maximum	Minimum	Maximum	Minimum
Abenchi Wholesale	10,000	5,000	20,000	15,000
Suame Roundabout Wholesale	3,000	2,000	5,000	2,000
Tafo Wholesale	2,500	1,000	3,000	2,000
Total of wholesale	14,500	8,000	28,000	19,000

This signifies that “Abenchi” Market is the largest distributor of coconuts in Kumasi.

4.3 Varieties and Sources of Coconut

Coconut sold in Kumasi are of two varieties, that is the Local (West African Tall) and the Exotic (Sri Lanka Green Dwarf). Respondents sell any type of coconut that is available to them at wholesale markets. However, some sellers sold either one type of coconut or both. Figure 4.1 shows the percentage of coconut varieties sold by coconut sellers in Kumasi.

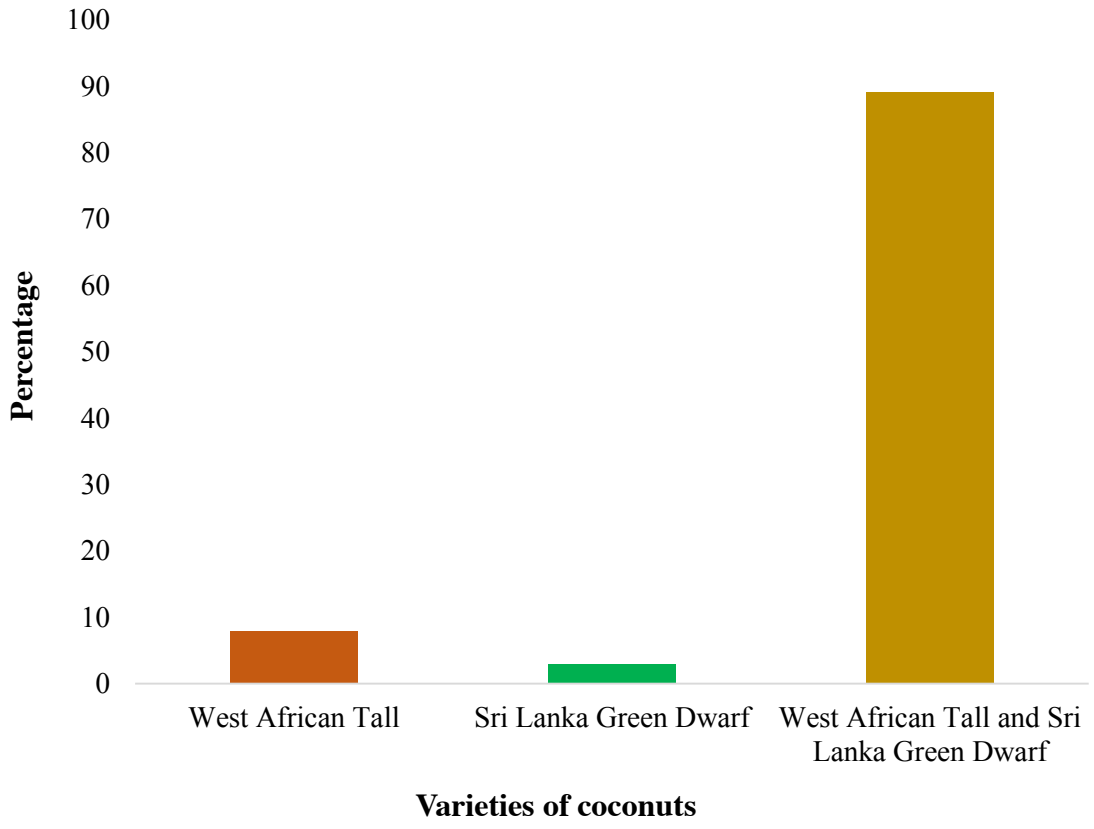

Figure 4.1: A graph of coconut varieties sold in Kumasi

Figure 4.1 indicates that 89% of the Respondents sell both of the coconut varieties, 7.9% of the Respondents sell only the local type (West African Tall) and 2.9% sell only the exotic type (Sri Lanka Green Dwarf). According to the literature, coconut is mainly found in the coastal areas of Ghana. From survey made, greater portion of coconuts brought into the Kumasi Metropolis are

from Western and Central Regions. This is due to the fact that, coconut wholesales points in Kumasi get most of their sources of coconut from either Western or Central Region. Greater portion of coconut sellers in Kumasi get coconuts from wholesale points in Kumasi except a few who travel out of Kumasi to get coconuts. Figure 4.2 shows the percentage of sources of coconuts for coconut sellers in Kumasi.

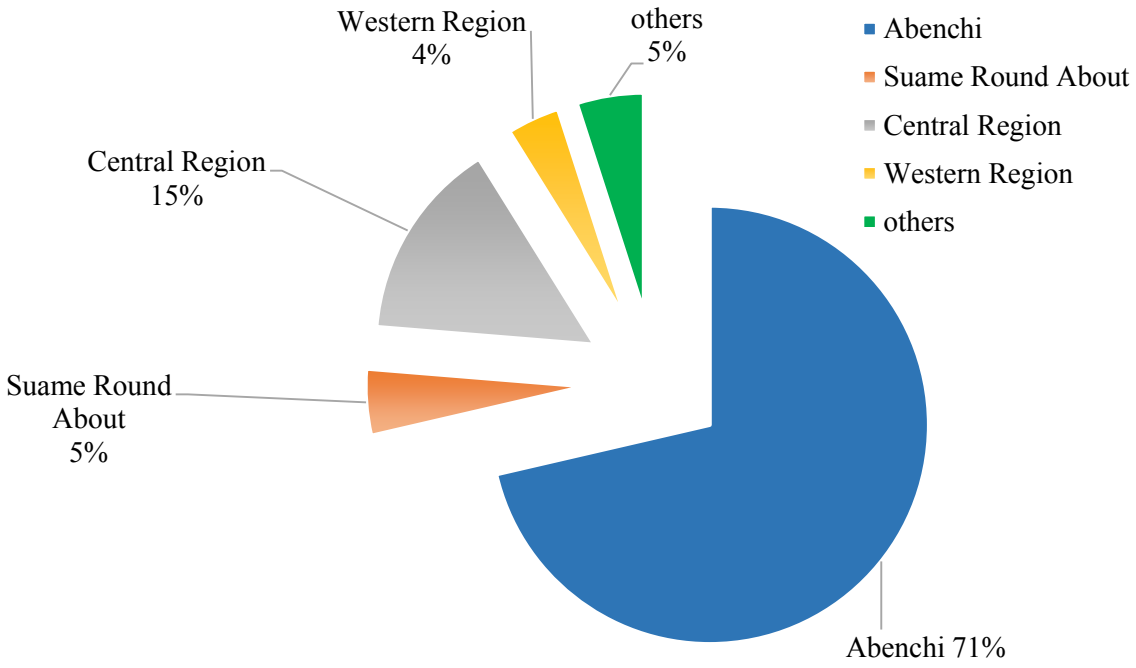

Figure 4.2: Sources of coconuts sold by coconut Sellers in Kumasi.

Majority of coconuts sold in Kumasi have their source from "Abenchi" according to the respondents. Moreover, every coconut that comes to these wholesale points stated above are from Western and Central Region.

4.4 Transport

Pretest on questionnaire conducted showed that, coconut sellers who made sales at a fixed location transport coconut to point of sales with either a taxi or tricycle from the coconut distribution points in Kumasi. At their fixed locations, they made sales on either traditional trolleys or wheel barrows. The other sellers who do not sell at fixed location transported their coconuts during business daily in wheel barrows and pans.

Means of transport of coconuts in Kumasi are either by trolley, pans and wheel barrow. 75.2% of Respondents had their trade in a fixed location out of which 50.1% and 25.1% sold on trolleys and in pans respectively. 24.8% sold at unfixed location out of which 19.2% and 5.6% also made sales in pans and wheelbarrows respectively**.** Table 4.5 shows percentages of type of coconut location and means of transport during sales. Due to the stress nature in coconut business, majority of the Respondents tend to sell at a fixed location.

Table 4.5: Percentages of means of transport in coconut sales in Kumasi

Location	**Means of Transport**		
	Trolley	**Wheel barrow**	**Pans**
Fixed location (75.2%)	50.1%	16.7%	8.38%
Unfixed Location (24.8%)	0%	19.2%	5.6%

Furthermore, coconuts are also transported on tricycles, in buses or trucks, wheel barrows, taxis, and trolleys from wholesale points to point of sales. Means of transport of coconut produce from distributors points are mostly by tricycle (43%) followed by taxi (29%). Majority of sellers use the tricycle because it is cost effective. All sellers who go to the outskirt of Kumasi transport coconuts either by bus or truck. Figure 4.3 shows the percentages of means of transport from wholesale points to sales points.

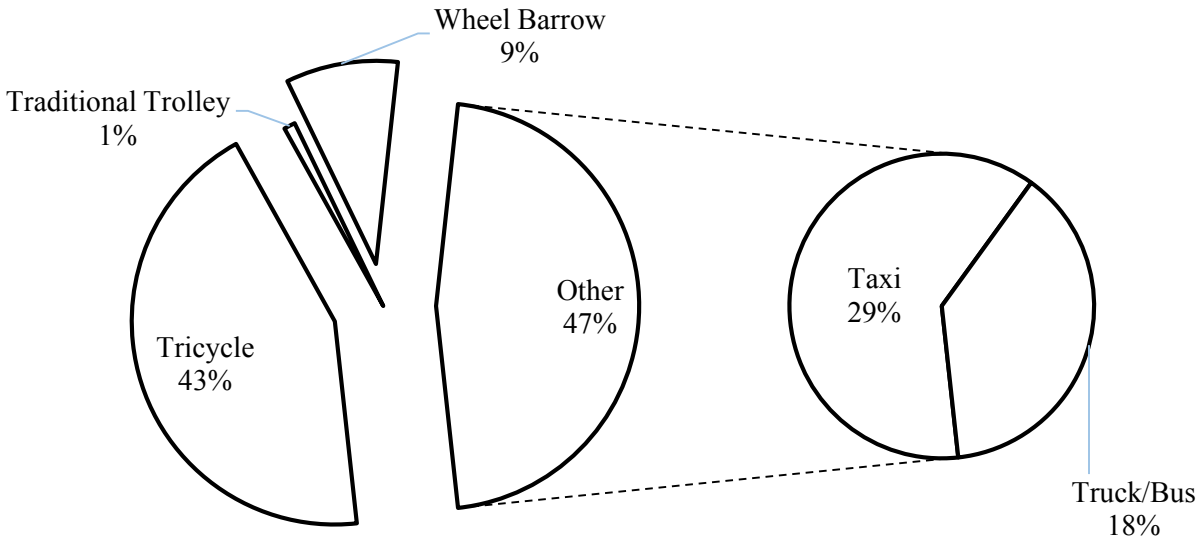

Figure 4.3: Means of transport of coconuts from wholesale points to sales points

4.5 Location

Out of the 10 sub-metros in the Kumasi Metropolis, 7 sub-metros were studied. Figure 4.4shows locations of each area of a respondent that was taken with the Garmin GPS. Majority of sellers in Kumasi are found at the commercial area of Kumasi that is Adum and Kejetia and vantage points like roundabouts such as the Ahodwo Roundabout, Santasi Roundabout and Suame Roundabout.

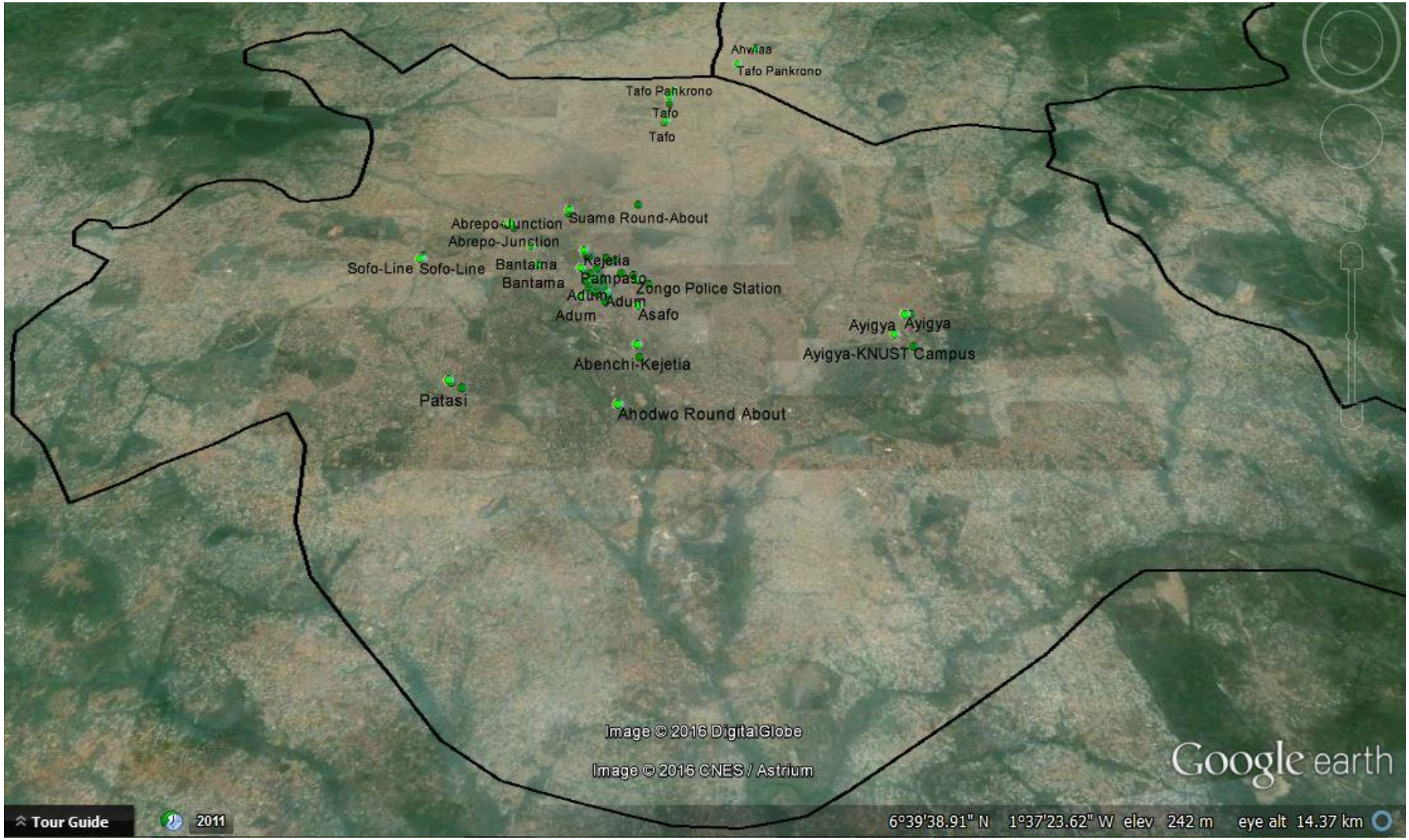

Figure 4.4: Map of Kumasi depicting locations of coconut sellers.

4.5.1 Quantity of Coconuts Sold

The total number of coconut sold out by Retailers in Kumasi daily are presented in Table 4.6

Table 4.6: Quantity of coconut sold out daily in Kumasi.

Range of coconuts sold in a day	Percentage of the average of coconuts sold in a day
(0-50)	8.9%
(50-100)	47.5%
(100-150)	25.7%
(150-200)	12.9%
(200-250)	5%
(250-300)	0%
(300-350)	0%

Table 4.6 shows that on the average, the highest range of coconuts sold out each day ranges between 50 and 100 representing 47.5%. This indicates that there are more coconut sellers who sell between 50 and 100 coconuts in a day. However, only 5% of coconut sellers in Kumasi sell between 200 and 250 on average in a day. The average mean of maximum and minimum coconuts sold in a day are 134 and 86 respectively. Table 4.7 shows the quantity of coconuts sold out by respondents daily during pretest on questionnaire.

Table 4.7: Number of coconuts sold out daily

Name of Respondent	Number	Sales Point	Management
Richard Amandaga	60	Tech-Junction (Ayigya)	For Energy/ Burning
Akwesi Agyeman	100	Adum	Dumped
Kwesi Frimpong	75	Adum	Dumped
Stephen Attah	100	Adum	Dumped
Shadrach Owusu	250	Adum	Dumped
Bernard Afrifah	125	Adum	Dumped
Opoku Emmanuel	50	Asokwa	Dumped
Osei Bonsu	100	Tech-Junction (Ayigya)	For Energy/burning
Kwame Oware	100	Tech-Junction (Ayigya)	For Energy/ burning
Kofi Yesu	150	Adum	Dumped

4.5.2 Coconut Waste Generated

Table 4.8: Coconut Waste generated in the Kumasi Metropolis

Coconut Waste	Weight per Husk *(kg)*	Day *(kg)*	Month *(tonnes)*	Year *(tonnes)*
Maximum coconut waste generated	1.2	155	4.6	55.8
Minimum waste generated	1.2	98	2.9	35

Waste generated from coconut in Kumasi is 55 tonnes which as compared to the waste generated in Kumasi is very insignificant. In view of this, coconut wastes that end up in the Kumasi landfill site are not sorted out. Figure 4.5 shows the dump sites for coconut waste in Kumasi including the Kumasi landfill site. Those who have no dump sites close to their point of sales either give out their coconut waste to Zoomlion or food vendors as firewood. The waste sent to these dump

sites are not taken into consideration with respect to their economic value but are mixed with other waste both organic and inorganic which finally ends up at the Kumasi Landfill site. The various coconut dump sites that were captured are the Kejetia dump site, Abenchi dump site, Santasi dump site, Railways dump site and the Kumasi landfill site.

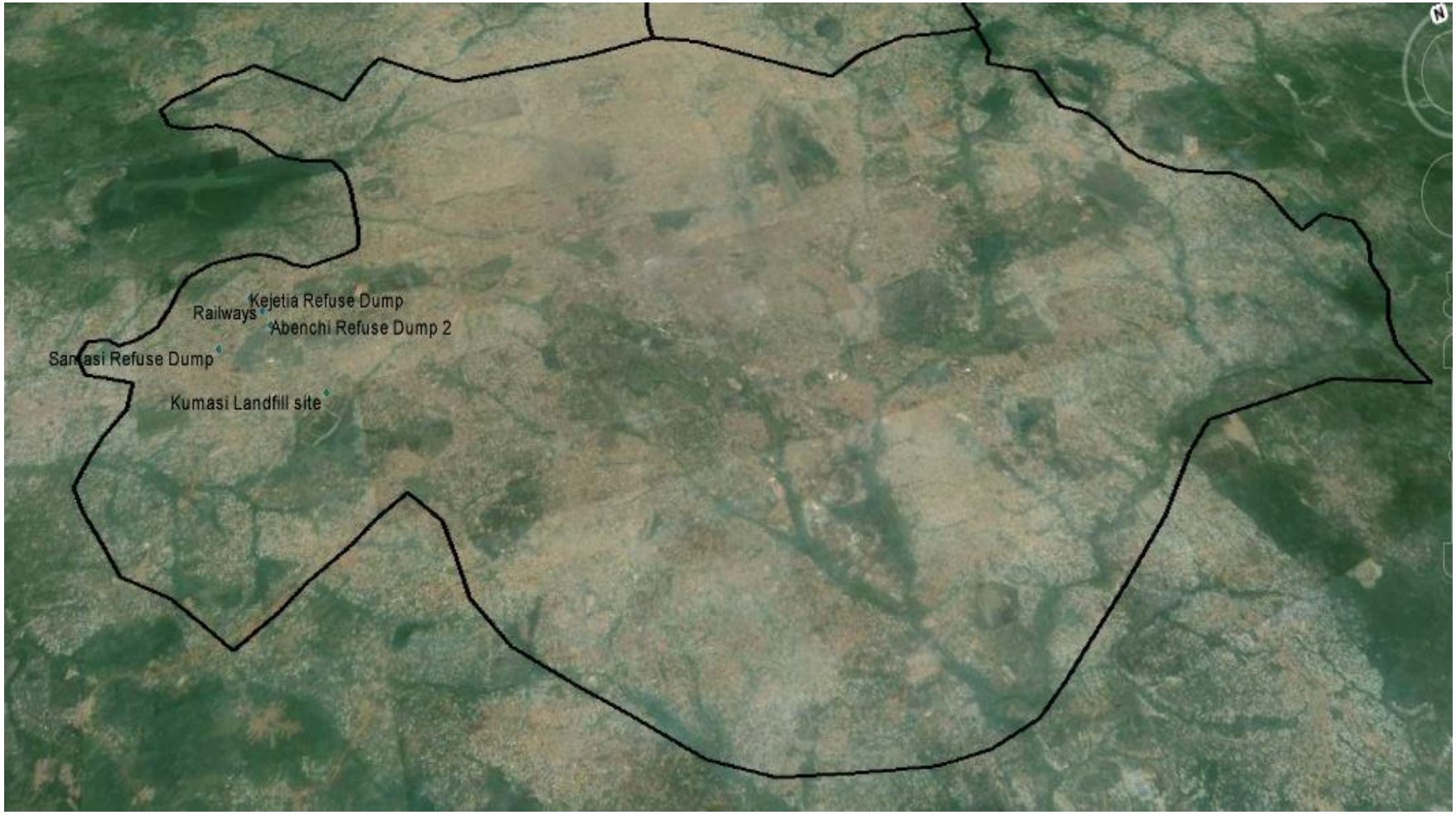

Figure 4.5: A Sectional Map of Kumasi coconut dump sites

4.6 Management and Utilisation of Coconut Waste

Results on pretest conducted showed that, 10 coconut sellers generate waste from an average of 153 coconuts by each person each day. Three coconut sellers gave their coconut waste out to palm wine sellers and a kenkey seller as a source of energy in preparation of their food. The rest also dumped their coconut waste at the Prisons and Railway landfill sites at Adum at some expenses

Waste generated by the coconut sellers have become a burden for some of them. Coconut sellers pay out part of their daily sales made for their waste generated when dumped in any dump site in Kumasi. 8.9% of the respondents give their waste out to food vendors as a source of energy for their food preparation. 91.1% of the respondents either give out their waste to Zoomlion or dump them at dumpsites in areas such as Santasi, Bantama, Kejetia, and Abenchi to be transported to landfill site. The Figure 4.6 shows the percentage of the management of coconut waste in the Kumasi Metropolis

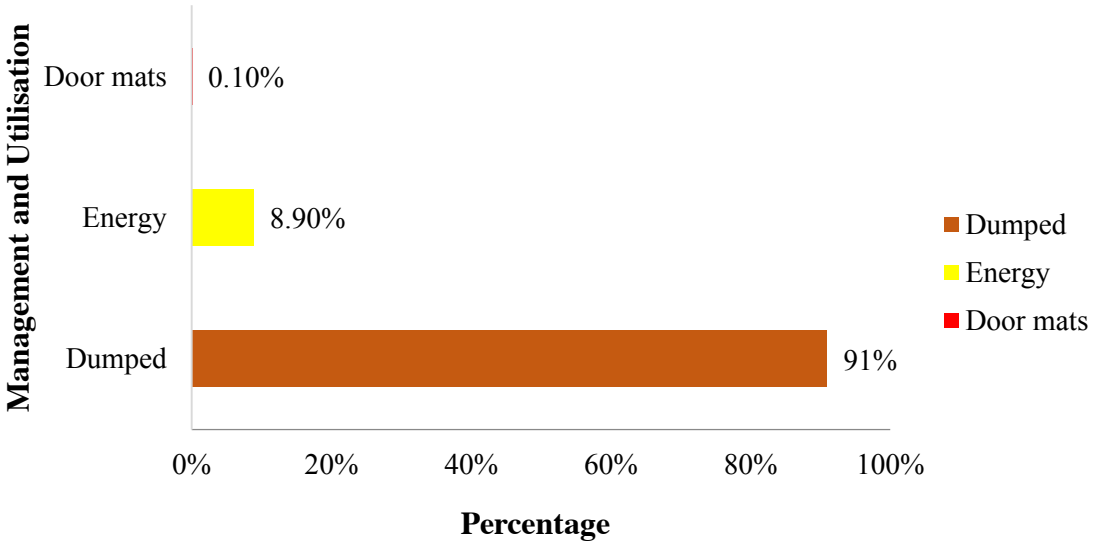

Figure 4.6: Percentage of coconut waste management

Figure 4.6 indicates that coconut waste is under-utilized. About 0.1% of the waste is used as doormats and carpets as compared to the percentage dumped. The knowledge of Respondents on the use of coconut waste in Ghana is illustrated in Table 4.9

Table 4.9: Uses of coconut waste in Ghana

Sector	**Uses**
Health	For curing diseases like tooth plaque, abdominal pain, hypertension and headache
Agriculture	It is used as mulch, fertilizer
Domestic	For making door mat, carpet, cushion, mosquito repellants, sponge, glue, brush, broom
Fuel	It is used as firewood in smoking of fish and preparing of local drinks and food
Ammunition	For making of local bullets
Industry	For textiles

Table 4.7 indicates management of coconut waste in Ghana which is practised in the coastal areas in Ghana. Furthermore, there are lots of uses that the coconut waste can be used for such as car seat covers, bags, boards, biomass, which are practised in the Asian countries. Figure 4.7 indicates the management and utilisation of coconut waste in Kumasi Metropolis based on pretest carried out on ten respondents. Majority of respondents representing 75% dumped their coconut waste.

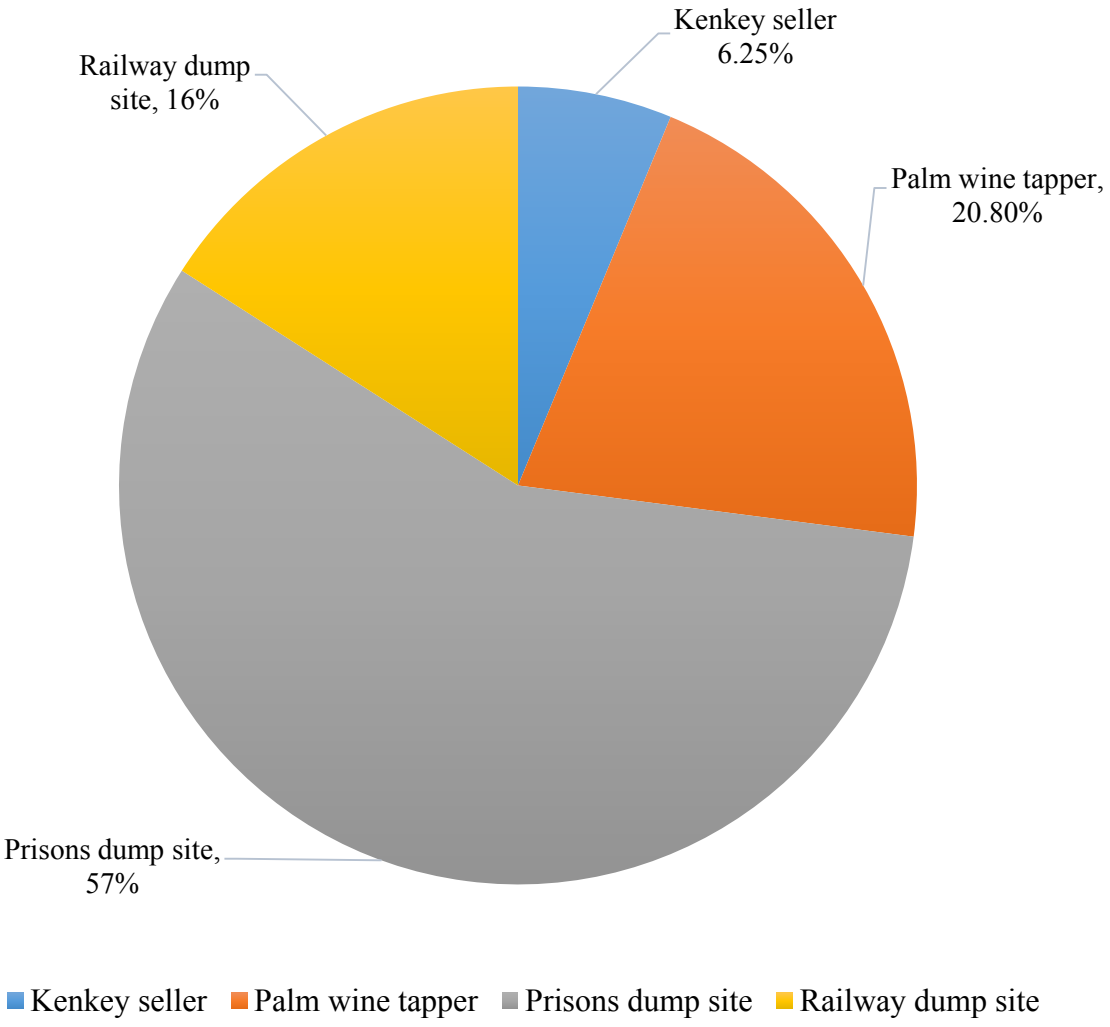

Figure 4.7: A Chart of coconut waste utilisation

CHAPTER FIVE

5.0 Conclusion and Recommendations

5.1 Conclusion

Coconut is a fruit that is not produced in Kumasi as compared to Takoradi and Cape-Coast. After the survey has been conducted and results analysed, the following conclusions are drawn:

1. Between 2.94 and 4.58 tonnes of coconut waste could be generated per month in the Kumasi Metropolis.
2. Coconut waste generated by sellers are either dumped or used as firewood at the expense of its great versatility.
3. Varieties of coconut sold in Kumasi are the local type (West African Tall) and the Exotic type (Sri Lanka Green Dwarf). The coconuts are mainly from the "Abenchi" wholesale market which has its primary source from the Western and Central Region.
4. Coconut businesses are mainly done in commercial areas and other locations such as roundabouts in Kumasi.

5.2 Recommendations

The following recommendations arose out of the research:

1. Proper measures should be put in place to ensure that coconut wastes are collected from coconut sellers.

2. Coconut waste should be separated from general waste at dump sites before transporting wastes to the Kumasi Landfill site to help process the waste for domestic, health, agricultural and industrial purposes.
3. Coconut waste should be processed into biofuels to support energy in Ghana.

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APPENDICES

Appendix A

RESULTS OF SURVEY ON QUANTITY OF COCONUTS SOLD

MAXIMUM AND MINIMUM QUANTITY SOLD IN A DAY

Name of respondents	**Number of coconuts sold in a day**	
	Maximum	**Minimum**
AttahAkwesi	325	75
Kofi Boabeng	100	75
Joseph Attah	150	100
Isaac Osei	200	150
Cynthia Ampofo	150	100
Emmanuel Asu	200	100
Stephen Kofi	250	175
Kofi Yesu	200	150
PhinihasAttah	300	200
Shadrach Owusu	250	100
Bernard Afrifah	200	125
Richard Amandaga	60	60
Kwame Oware	100	70
OseiBonsu	150	100
AkwesiAgyeman	100	60
Opoku Emmanuel	50	50
Eric Agyapong	100	50
Nana Yaw	50	50
Pokuaa	100	75
Rita Boadu	100	50
ForsenPartrick	150	75
KwekuBonku	125	50
Kofi Eric	200	75
Charity Araba	50	20
Appiah Yaw	150	100
Akwesi	200	100

Cecelia Badu	100	50
Quansah Philemon	75	60
Yaw Duodu	200	100
Raymond Abeka	125	75
Yaw Agyeman	100	50
Maxwell Gyasi	300	150
Kwame Ansah	200	150
Emmanuel Okyere	50	50
Dominic Akwah	100	100
KwabenaAwisi	150	100
PaaKwesi	200	150
KojoTweneboa	150	100
KwadwoAbadu	200	120
Nana Poku	200	100
Nana Yaw	50	50
Kwadwo Mclean	200	150
Samuel Owusu	100	60
Joe	75	50
Gariba Juliet	50	50
OwusuGodfred	150	150
Rita Morgan	100	50
Agyeiwaa	100	75
Charity Acheampong	75	50
Samuel Attah	150	100
SumilaOseiKuffuor	100	75
Joseph Donkor	175	100
AkuaAfiriyie	100	75
Daniel Osubu	100	50
Kwame	100	75
Patrick Obosu	100	100
Gladys Owusu	60	60
Kwame Amankwah	150	120
Ibrahim Sule	100	80

AmaBokoma	75	75
Grace Abudu	65	65
YaaAdoma	75	50
SafiaAbugravani	200	100
Kwame	150	100
Emmanuel Eduafo-Ansa	200	100
KwadwoNyamonah	200	50
Stephen Tawiah	100	70
KwesiBlankson	150	75
Georgina Amagashe	300	150
Cecelia Arthur	200	150
Kwesi Mensah	150	100
AkwesiAddai	200	175
Francis Mensah	100	75
OseiKweku	70	50
Abigail Donkor	50	50
MaameSerwaa	50	50
Boah Eric	150	70
James Andoh	150	75
Kofi Annan	125	75
Agyei Adams	100	75
KwabenaYeboah	120	100
AkosuahNsoh	100	50
Frank Munko	100	75
Kwame Adabor	200	150
Kofi Tete	100	80
Kofi Danso	200	70
Juliana Arthur	100	50
Kwame Acheampong	100	50
Manu Kwabena	100	60
Enoch OwsuBoadi	100	70
Agya Asante	50	30
Mary Agyei	75	50

Mohammed Sheriff	200	150
Kwabena Stephen	100	75
OwieAgustine	300	200
Clement Freeman	100	50
Yaw Amponsah	100	70
KwadwoAbeiku	100	75
Afirifah	100	75
Bashiru Ahmed	100	100
KwesiFrimpong	75	75

Appendix B

CORDINATES OF LOCATIONS SURVEYED

Sales Point(s)	**Coordinates (North, UTM, Elevation)Eastern**	**Northern**	**Elevation**
Adum	30N 0652490	UTM 0739944	258m
Adum	30N 0652392	UTM 0740283	248m
Adum-Kejetia	30N 0652389	UTM 0740196	247m
Adum	30N 0652507	UTM 0739673	273m
Adum-Kejetia	30N 0652238	UTM 0740304	279m
Adum	30N 0652238	UTM 0740304	279m
Adum	30N 0652249	UTM 0740074	279m
Adum	30N 0652191	UTM 0740107	292m
Dr. Mensah	30N 0652534	UTM 0740709	
Adum	30N 0652410	UTM 0740248	240m
Adum	30N 0652450	UTM 0740066	241m
Ayigya	30N 0657621	UTM 0739382	274m
Ayigya	30N 0657621	UTM 0739393	268m
Ayigya, KNUST Campus	30N 0657395	UTM 0738914	279m
Adum	30N 0652143	UTM 0740173	271m
Asafo	30N 0653077	UTM 0739592	268m

Abenchi-Kejetia	30N 0653088	UTM 0738670	263m
Abenchi-Asafo Market	30N 0653143	UTM 0738379	253m
Abenchi-Asafo Market	30N 0653143	UTM 0738379	253m
Asem	30N 0653238	UTM 0740117	292m
Zongo Police Station	30N 0653016	UTM 0740234	289m
Zongo Police Station	30N 0652956	UTM 0740343	286m
Roman Hill	30N 0652745	UTM 0740384	276m
Adum	30N 0652362	UTM 0739871	276m
Roman Hill	30N 0652746	UTM 0740386	295m
Adum	30N 0652541	UTM 0739850	270m
Adum,Kejetia, Central Mkt.	30N 0652500	UTM 0739954	271m
Adum,Railways	30N 0652387	UTM 0740292	251m
Adum PZ, Kejetia	30N 0652296	UTM 0740363	254m
Adum	30N 0652304	UTM 0740230	263m
Adum	30N 0652318	UTM 0740055	260m
Adum	30N 0652360	UTM 0740012	264m
Adum,Bantama	30N 0652384	UTM 0739942	263m
Adum	30N 0652335	UTM 0739904	273m
Adum	30N 0652284	UTM 0739926	280m
Adum	30N 0652248	UTM 0739944	304m
Adum	30N 0652071	UTM 0739807	287m
Adum	30N 0652239	UTM 0740202	274m
Adum	30N 0652191	UTM 0740380	278m
Adum PZ	30N 0652320	UTM 0740484	274m
Adum PZ	30N 0652302	UTM 0740494	267m
Adum PZ	30N 0652329	UTM 0740466	265m
Adum	30N 0652289	UTM 0740354	251m
Ayigya, Kentikrono	30N 0657721	UTM 0739385	268m
Adum-Prisons	30N 0652182	UTM 0740024	283m
Pampaso	30N 0652024	UTM 0740518	285m
Pampaso	30N 0652056	UTM 0740496	286m
Bantama	30N 0651256	UTM 0740611	300m
Bantama	30N 0651273	UTM 0740645	299m

Bantama	30N 0651079	UTM 0741095	306m
Bantama	30N 0650722	UTM 0741582	299m
Abrepo-Junction	30N 0650662	UTM 0741722	295m
Abrepo-Junction	30N 0650607	UTM 0741717	295m
Abrepo-Junction	30N 0650546	UTM 0741684	294m
Suame Round-About	30N 0651688	UTM 0741988	291m
Suame Round-About	30N 0651723	UTM 0742060	304m
Suame Round-About	30N 0651694	UTM 0741993	292m
Suame Round-About	30N 0651698	UTM 0741992	294m
Suame Round-About	30N 0651690	UTM 0741992	296m
Suame Round-About	30N 0651727	UTM 0742054	304m
Suame Round-About	30N 0651687	UTM 0742107	303m
Krofrom	30N 0652964	UTM 0742252	302m
Krofrom	30N 0652966	UTM 0742263	293m
K.O	30N 0652455	UTM 0740785	292m
Kejetia	30N 0652041	UTM 0740991	281m
Kejetia	30N 0652081	UTM 0740918	281m
Kejetia	30N 0652081	UTM 0740859	277m
Kejetia	30N 0652078	UTM 0740862	274m
Kejetia	30N 0652078	UTM 0740862	274m
Kejetia	30N 0652163	UTM 0740833	272m
Tafo	30N 0653420	UTM 0744909	304m
Tafo	30N 0653393	UTM 0744849	307m
Tafo	30N 0653380	UTM 0744819	307m
Tafo	30N 0653384	UTM 0744854	306m
Tafo	30N 0653380	UTM 0744879	308m
Tafo	30N 0653480	UTM 0745472	312m
Tafo	30N 0653469	UTM 0745725	311m
Tafo Pankrono	30N 0653541	UTM 0745954	308m
Tafo Pankrono	30N 0654888	UTM 0746945	320m
Ahwiaa	30N 0655289	UTM 0747516	318m
Ahwiaa	30N 0655298	UTM 0747595	312m
Santasi Round About	30N 0650305	UTM 0737688	278m

Santasi Round About	30N 0650325	UTM 0737686	269m
Santasi Round About	30N 0650327	UTM 0737693	265m
Santasi Round About	30N 0650120	UTM 0737812	268m
Patasi	30N 0650069	UTM 0737863	269m
Sofo-Line	30N 0649135	UTM 0740757	280m
Sofo-Line	30N 0649178	UTM 0740766	290m
Sofo-Line	30N 0649183	UTM 0740843	285m
Sofo-Line	30N 0649161	UTM 0740736	281m
Dr. Mensah	30N 0652501	UTM 0740692	277m
Dr. Mensah	30N 0652617	UTM 0740734	274m
Dr. Mensah	30N 0652607	UTM 0740709	278m
Ahodwo Round About	30N 0652839	UTM 0737351	275m
Ahodwo Round About	30N 0652860	UTM 0737385	274m
KNUST Campus	30N 0657680	UTM 0738621	281m
Adum	30N 0652389	UTM 0740196	247m

Appendix C

STATISTICS OF COCONUTS SOLD OUT IN A DAY

Statistics	**Maximum quantity of coconuts**	**Minimum quantity of coconuts**
Mean	134.4059	86.08911
Standard deviation	64.31674	37.69353
Coefficient of variation	0.478526	0.437843

Appendix D

QUESTIONNAIRE FOR SURVEY

SECTION A: SOCIO-DEMOGRAPHIC DATA

1. Name of respondent …….
2. Age (years): …….
3. Sex: Male [ ] Female [ ]
4. Educational level: No education [ ] Middle school [ ] Primary [ ] JHS [ ] SHS [ ] Tertiary [ ] (*please specify*) ……..
5. Marital status: Single [ ] Married [ ] Divorced [ ] Widowed [ ] Separated [ ]
6. Location……

SECTION B: COCONUT WASTE GENERATED AND MANAGEMENT

1. How long have you been selling coconuts here? .....
2. On average, how many coconuts do you sell in a day?.....
3. What varieties of coconuts do you sell? ……., ……., ……
4. Where are the sources of the coconuts you sell?.....
5. Which Region do you get the coconuts?

   1. Greater Accra Region 2. Western Region 3. Central Region

   4. Volta Region 5. Others……
6. What happens to the coconut waste you generate?

   1. Recycle 2. Reuse 3. Dumped (*Please specify*) ……..

   4. Other…….

7. How much do you pay for dumping the coconut waste?.....Ghana cedis.

8. Do you know any uses of coconut waste?

    1. Yes [ ] 2. No [ ]

9. If Yes, then what are the uses?.....

10. Which group do you give your waste to?

    1. Companies *(Please specify)* ……. 2. Individuals (*Please specify*) ……

11. How much do you sell your coconut waste?.....Ghana cedis

12. How do you transport the coconuts from the wholesalers to your point of sales?

    1. Tricycle 2. Traditional trolley 3. Wheel Barrow 4. Taxi

    5. Others…….

13. Do you join any Coconut Sellers Association?

    1. Yes [ ] 2. No [ ]

14. Which season do we have coconuts in abundance?

    1. Wet Season (April to November) *Please specify* ……

    2. Dry Season (December to March) *Please specify*……...

15. Which period do you have your worst sales?.....

16. Which period do you have your best sales?.....

17. Do you sell at a fixed location?

    1. Yes [ ] 2. No [ ]

18. If No, what are the location (s) that you work within?.....