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Evaluating Haul Container System of Solid Waste Collection in Enugu Municipal

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Abstract
Over the years, studies have shown that rapid population growth and the growth of urban centers result in the substantial increase in the amount of wastes generated hence the demand for a sustainable collection system.This research aims at evaluating haul container system of waste collection in Enugu Municipal which comprises 10 zones with the view of determining the zone with higher efficiency and better cost. The data for the research was obtained through the ten zone collection crews, questionnaires (through random sampling) and oral interview. The result indicates that there is problem of unregulated waste dumping, as a result of ineffective waste collection and inadequate number of waste bins in the said zones. The weekly operational cost of the haul system in the zones as obtained from the analysis carried out are N72,000, N71, 000, N66, 000, 62,000, N60, 000, N59,000 and N58, 000 for Emene, (New Haven and Agbani Road), (Independent layout and Coal Camp), GRA, (Trans-Ekulu and Ogui) Achara-Layou t andAbakpa respectively and the efficiency of the collection crew in the zones are also 88% , 83%, 78%, 73% and 68% for Abakpa, Achara- Layout , (Trans-Ekulu, GRA and Ogui Road), (Independent layout and Coal Camp) and (Agbani Road, New Haven and Emene) respectively.
Therefore the haul container system of waste collection can be improved by provision of the required basic infrastructural amenities by Government through the waste management agency (ESWAMA).

Keywords: *Solid waste, Haul Container, ESWAMA, Enugu*

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I. Introduction

Human activities create waste, and the disposal of these wastes has been an important issue to the society. Increased waste generations in our cities are unavoidable because of human activities arising from industrialization. This is more worrisome now that waste composition is changing from vegetable-based refuse to manufactured/synthetic materials resulting from new packaging techniques and consumption pattern. These wastes cannot be ignored; cities have to accept responsibility for the waste arising from within them by properly and safely disposing them in acceptable engineered structures in order to protect not only the surface but also the geo-environment [1]. In Nigerian towns and cities, solid wastes of different kinds are generated and disposed indiscriminately causing lots of environmental and health hazards. A good example of such cities include: Enugu, Lagos, Kano, Calabar, Port Harcourt, Uyo, Aba, Yenagoa, etc. This results in an unsightly mountain of refuse that has become a common feature of Nigeria's urban landscape [2]. Solid waste mismanagement is a global issue in terms of environmental contamination, social inclusion, and economic sustainability [3,4], which requires integrated assessments and holistic approaches for its solution [5]. The haul container system of waste collection which is made up of conventional and Exchange container mode are ideally suited for the removal of wastes from sources where the rate of generation is high because relatively large containers are used. The use of large containers reduces handling time as well as the unsightly accumulations and unsanitary conditions associated with the use of numerous smaller containers [6]. Conventional mode of haul container system of waste collection was adopted in this research and it have the advantage of requiring only one truck and a driver to accomplish a collection cycle. And waste generated at different places like households (domestic wastes), streets, markets, industrial establishments and so on are collected and transmitted to transfer or final disposal site as required through the haul container system.

Study area

Fig 1.0: Map of Enugu Showing the study location.

II. Methodology

Source of Data

The solid waste generated by inhabitants of thirty residential buildings per day were weighed and divided by the total number of people living in these buildings. This enabled the author determine the total solid wastes generated per person per day. The population figure of the three local governments that made up Enugu urban was obtained from the national population commission and used for the computation of daily residential solid waste generation. Also the waste generated by different industries in Enugu urban was calculated using a table adopted from U.S EPA(1999). The author also Participated in the collection crew of the ten zones at an average of six times, and distributed questionnaires randomly to civil servants, traders, students, waste handlers and government officials within the city from where raw data were collected and the results analyzed.

Method of Analysis

Method of finding a and b

For the case of two variables x and h, 6 pairs of reading were taken, then the simple linear regression equation is given by $hi = a + bxi + \mathcal{E}i$, $(i=1,2,3\ldots6)$……1.0

Where hi is the dependent variable; xiis the independent variable; Ɛ is the random error; a and b are the unknown parameters of the linear relationship called regression constants and may be interpreted as the intercept and slope of the line respectively.

Method of finding the number of bins, capacity and efficiency

The number of bins for haul container system in a particular zone is determined by the expression $N_d = \frac{(H(1-W)-(t_1+t_2))}{T_{hcs}}$……2.0

Where N_d= number of trips per day (trips/d), H= length of work per day (h/d), W = off- route factor, expressed as a fraction, t_1= time to drive from dispatch station to first container location to be serviced for the day, t_2 = time to drive from the last container location to be serviced for the day to the dispatch station, and T_{hcs} = pick up time per trip (h/trip).

The capacity of the haul container system can be computed with the formula thus

$$C=\frac{Vw}{NwF} \quad \ldots\ldots 3.0$$

Where c= volume of the container, V_w = Volume of waste per week, N_w = number of trip/wk, f = container utilization factor. Also the efficiency of the haul container system can be computed thus E=

$$\frac{(1-w)T_{hcs}+W_oT_{hcs}}{T_{hcs}} \quad \ldots\ldots 4.0$$

Where E = Efficiency of the collection crew, w =off-route factor, W_o =allowable off-route factor, and T_{hcs} = Time taken (minutes)

III. Result and Discussion

Efficiency and cost variation at different zones

The variation in the efficiency and cost of operation of haul container system of waste collection in the ten zones that constitutes the study area might not be far from the corresponding variation in the total haul time and round trip distance of the said zones. The zones like Agbani Road, New Haven, and Emene with average uniform round trip distance and total haul time of 24km and 1.10 (hr/trip) respectively recorded 68% efficiency and weekly operation cost of N 71,000, N 71,000, and N72,000 respectively while Abakpa and Achara layout zone with total haul time and round trip distance of 0.30hr/trip, 0.35hr/trip and 16km, 16.5km respectively recorded efficiency and weekly operational cost of 88%, 83%, and N58,000, N59,000 respectively. Also in Trans- Ekulu, GRA, Ogui zone with the average uniform total haul time, and round trip distance of 0.45hr/trip and 17km respectively recorded efficiency and weekly operational cost of N60,000, N62,000, and N60,000 respectively while Independent-Layout and Coal Camp with average total haul time and round trip distance of 0.55hr/trip and 21km respectively recorded efficiency and total weekly operational cost of 73% and N66,000 respectively. It is noted that that an increase in total haul time and round trip distance decreases the efficiency of the collection crew and increases the total weekly operational cost and vice versa.

Abakpaand Achara-Layout zone

From figure 4 and 5 above, it could be deduced that weekly operational cost increases with corresponding increase in round trip distance.In Abakpa (fig 4) the maximum weekly operational cost (N58,000) is recorded at the maximum round trip distance of 16km/trip. Also in Achara- Layout (fig 5) the maximum weekly operational cost (N59,000) is recorded at 16.5 km/trip.

Trans-Ekulu, GRA and Ogui Road

The maximum weekly operational cost of Trans- Ekulu, GRA and Ogui Road as shown in fig 6,7 and 8 above, are N60,000, N62,000 and N60,000 respectively recorded at the maximum round trip distance of 17km/trip respectively. The maximum weekly operational cost of N62,000 as recorded in GRA(fig 7) is slightly higher than that of Trans –Ekulu, and Ogui Road which recorded N60,000 respectively but still in confirmation that the higher the round trip distance the higher the weekly operational cost.

Independent Layout and Coal Camp

In fig 9 and 10 above, the maximum weekly operational cost of hauling municipal solid waste in independent Layout and Coal Camp is N66,000 respectively achieved at the maximum round trip distance of 21km/trip respectively.

Agbani Road, New-Haven and Emene

The maximum weekly operational cost of hauling municipal solid waste in Agbani Road, New- Haven andEmene as shown in fig 11,12 and 13 are N71,000, N71000 and N72000 respectively recorded at the common maximum round trip distance of 24km/trip respectively. These three zones recorded the maximum weekly operational cost of hauling municipal solid waste among the ten zones in consideration which is as a result of the round trip distance of 24km/trip recorded in the said zones which surpassed other zones.

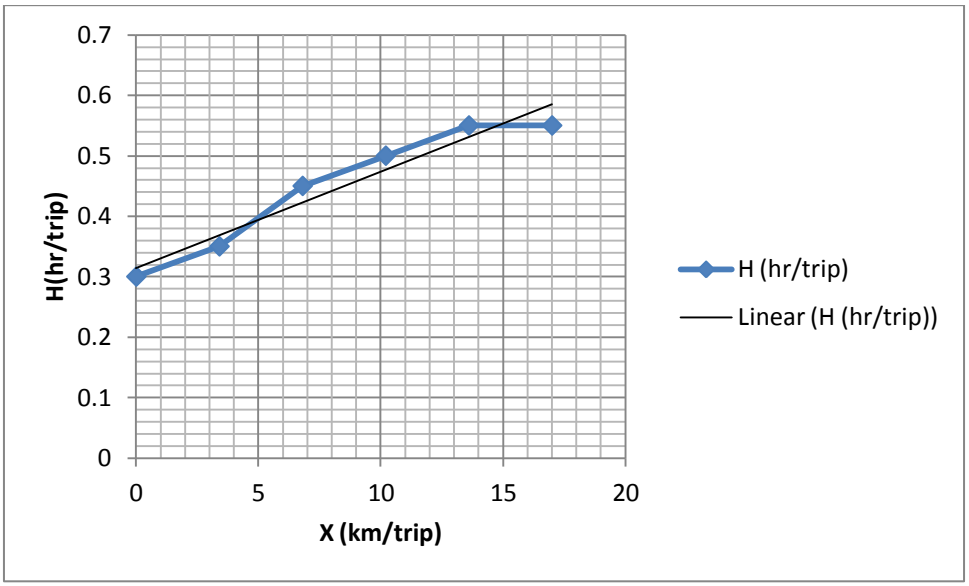

Fig 2: Relationship between haul time and haul distance as expressed in equation 1.0 above

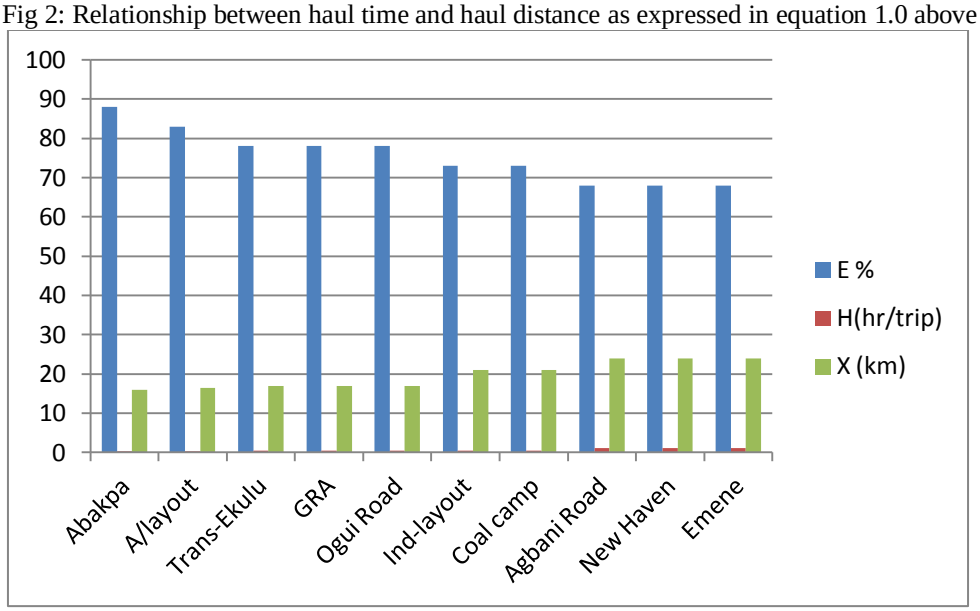

Fig 3: Comparison of round trip distance, total haul time and efficiency at different zones

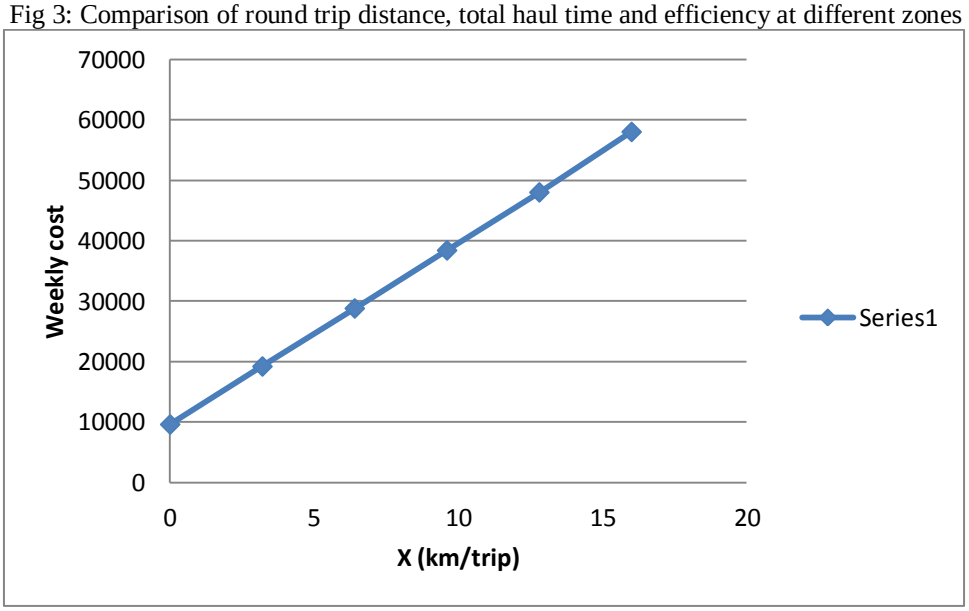

Fig 4: Relationship between haul weekly cost and round trip distance at Abakpa

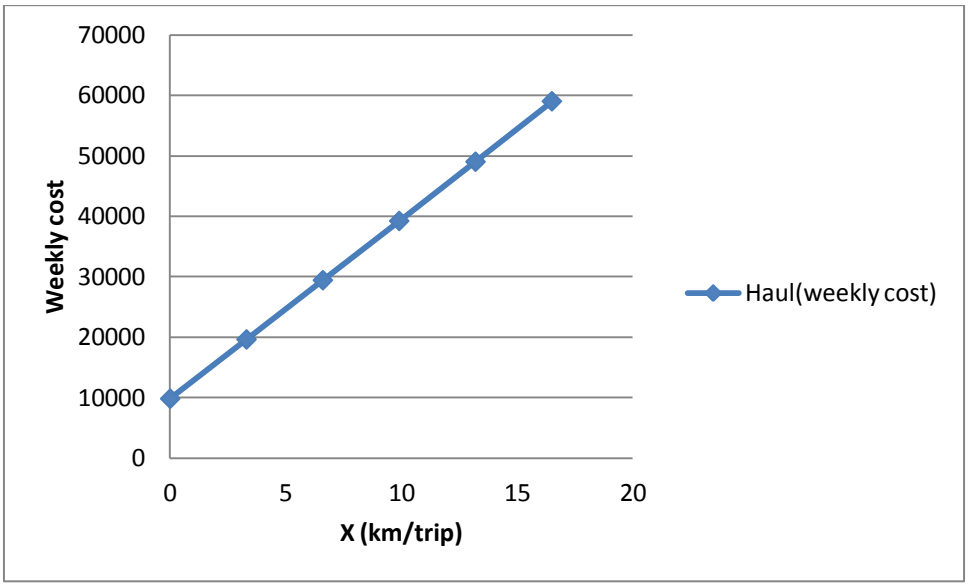

Fig 5: Relationship between Haul weekly cost and round trip distance at achara-layout

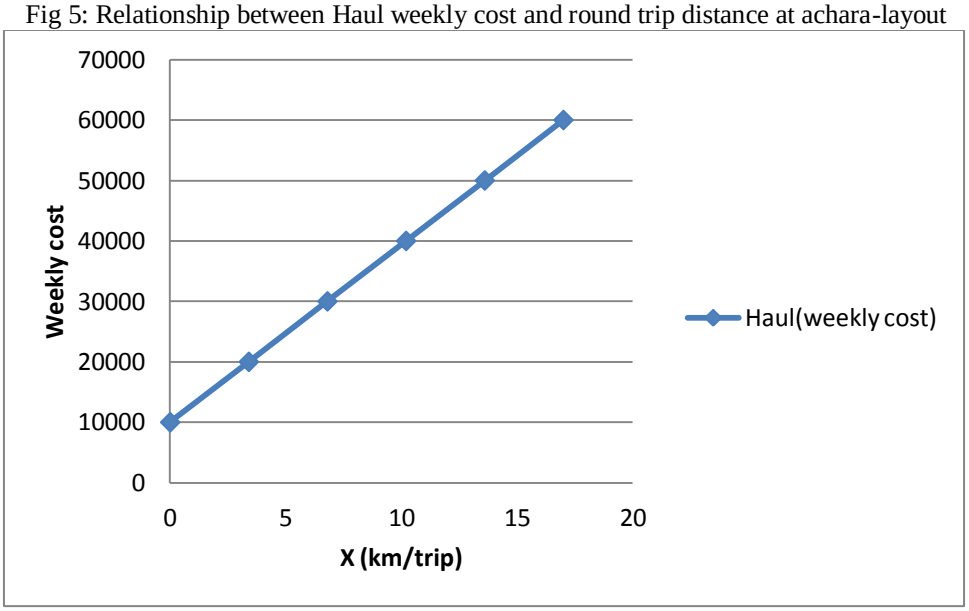

Fig 6: Relationship between Haul(weekly cost) and round trip distance at Trance-Ekulu

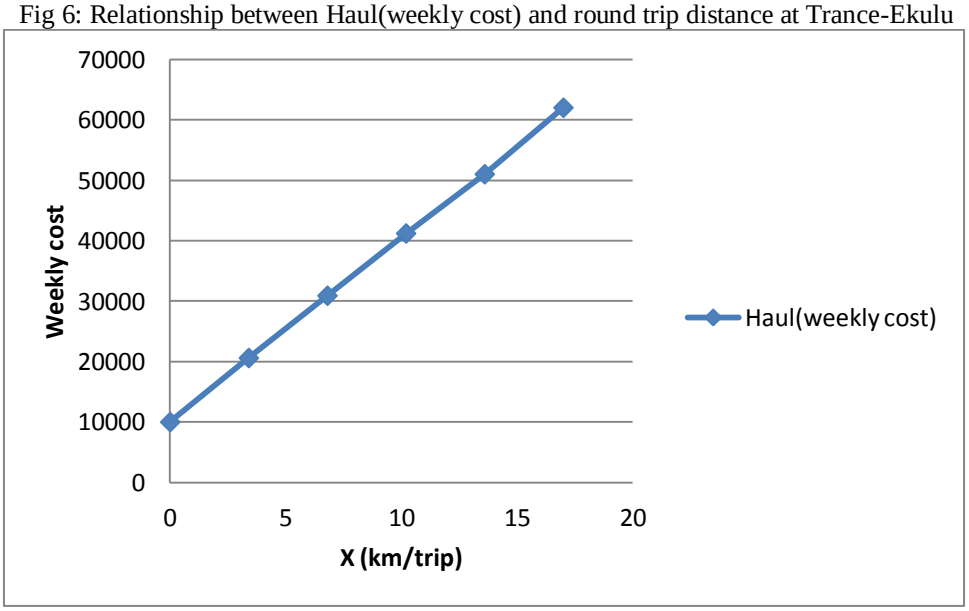

Fig 7: Relationship between Haul (weekly cost) and round trip distance at GRA

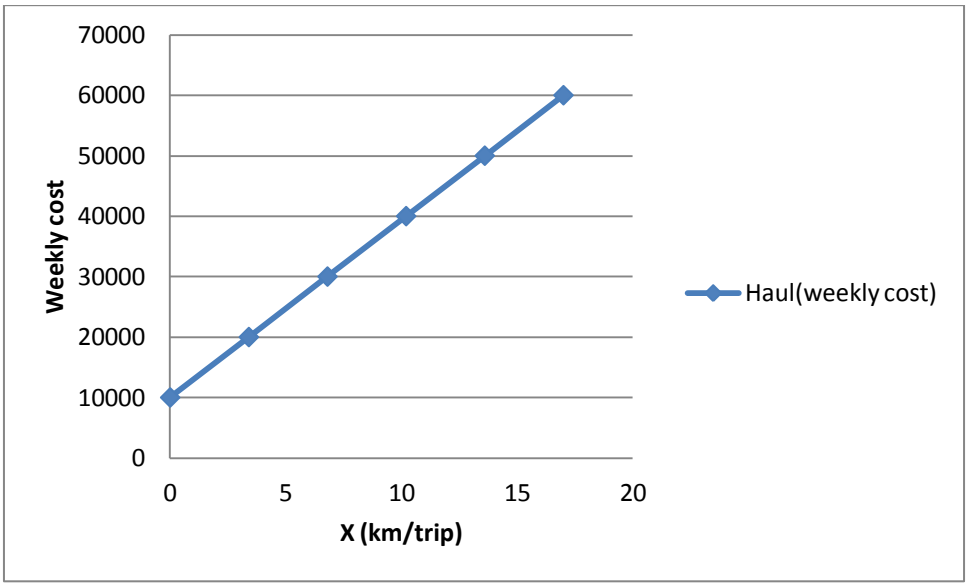

Fig 8: Relationship between Haul(weekly cost) and round trip distance at Ogui

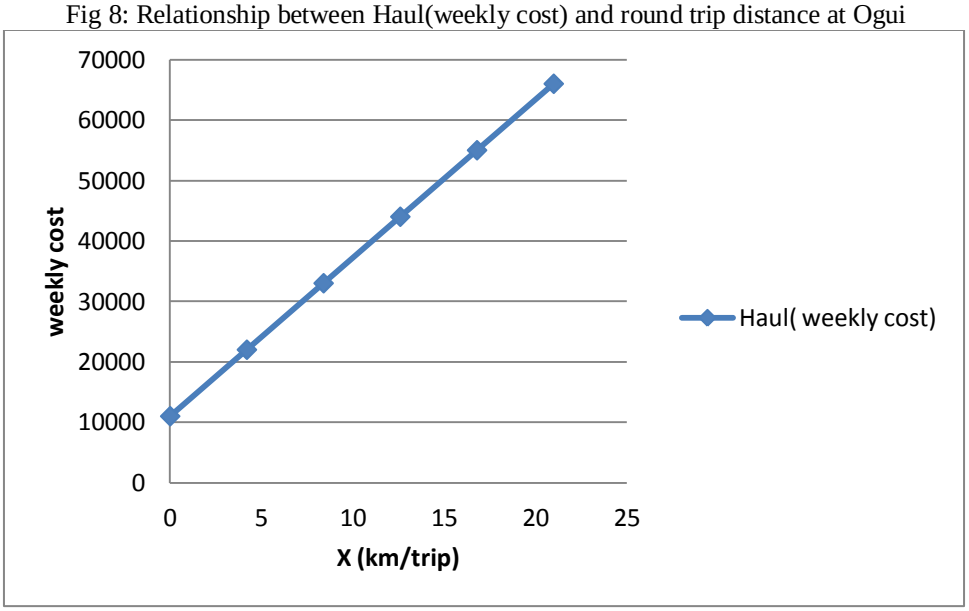

Fig 9: Relationship between Haul (weekly cost) and round trip distance at Ind-Layout

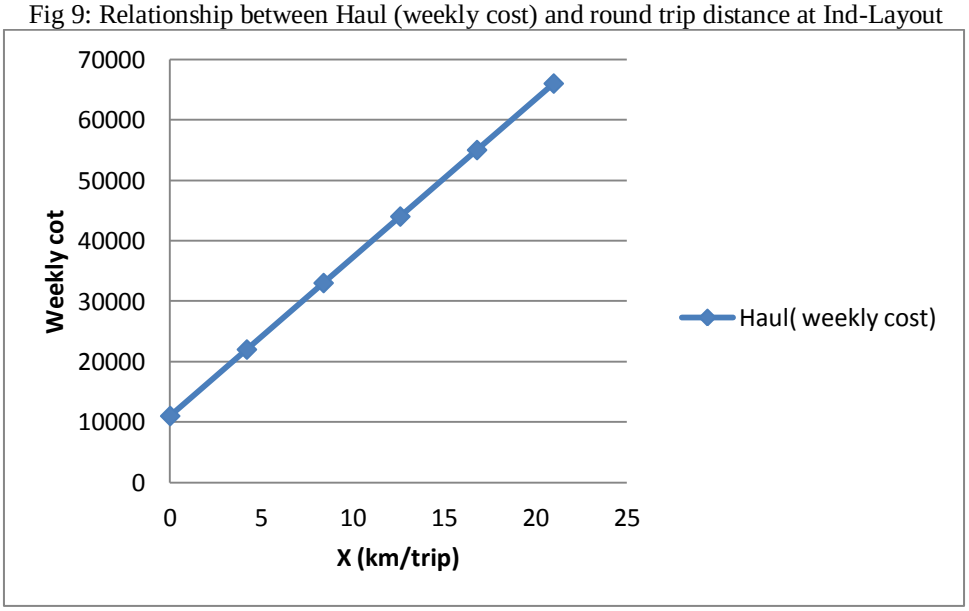

Fig 10: Relationship between Haul(weekly cost) and round trip distance at Coal –Camp

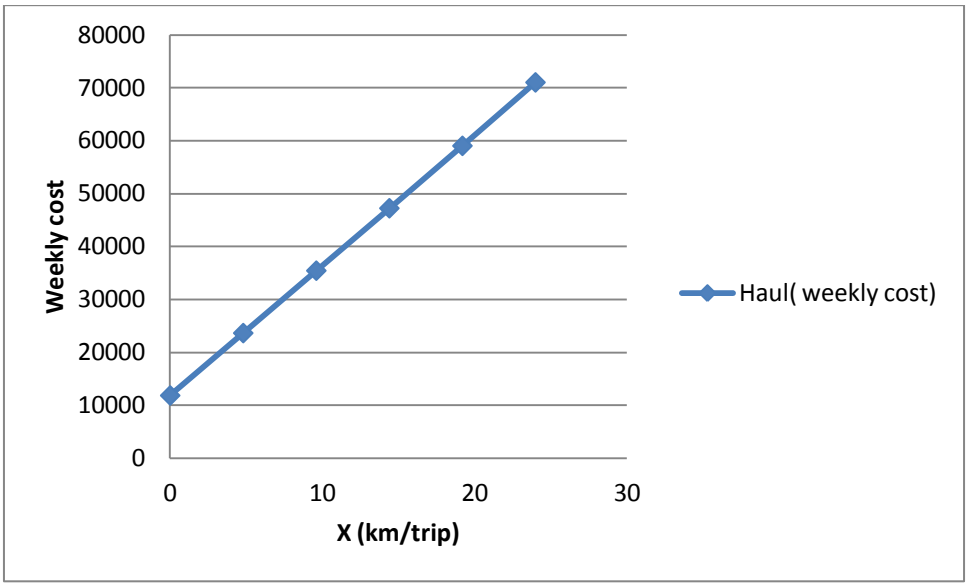

Fig 11: Relationship between Haul(weekly cost) and round trip distance at Agbani Road

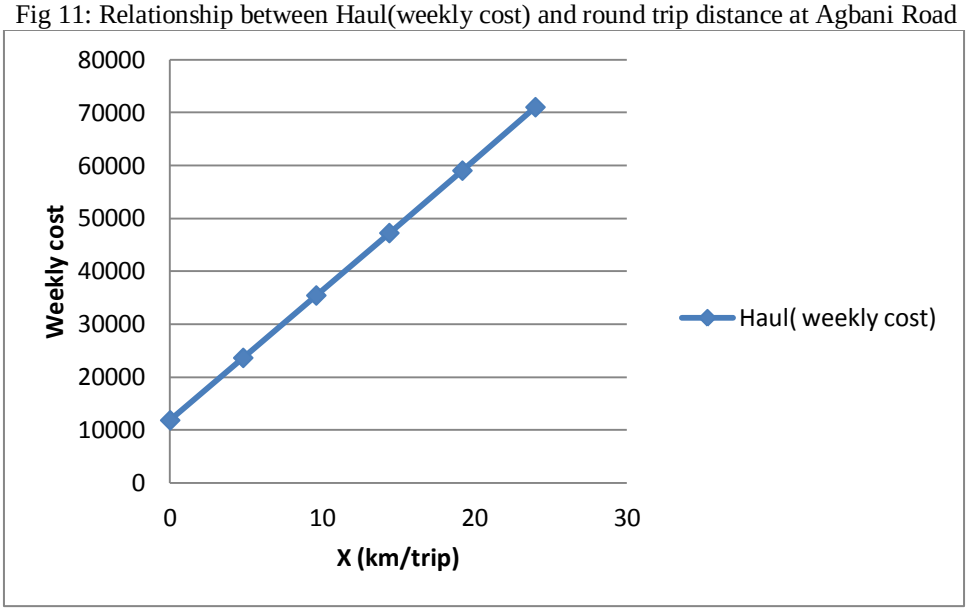

Fig 12: Relationship between Haul(weekly cost) and round trip distance at New Haven

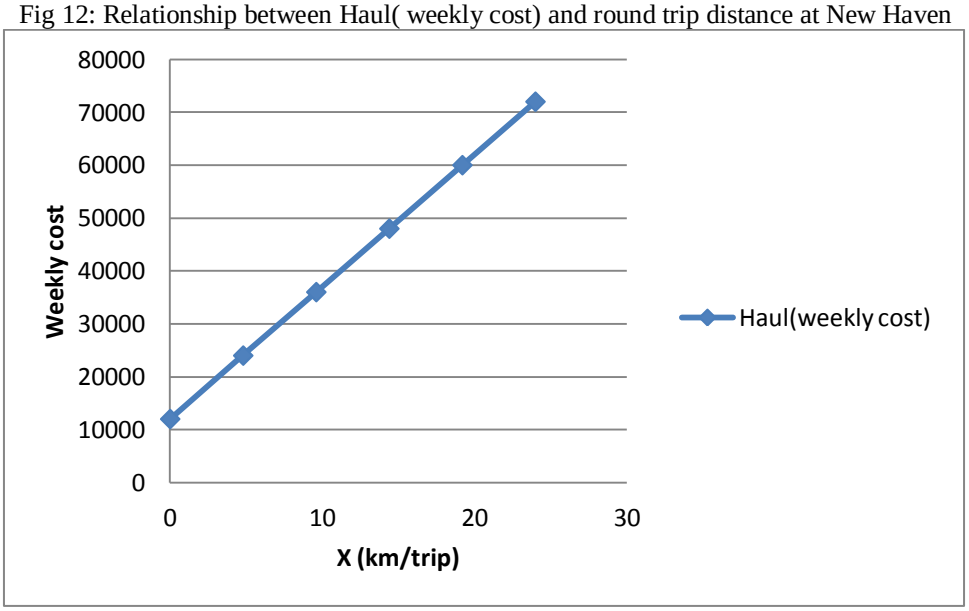

Fig 13: Relationship between Haul(weekly cost) and round trip distance at Emene

IV. Conclusion

The detailed study of haul container system of waste collection and disposal by the Enugu state waste management authority (ESWAMA) was the target of this research. Generally adequate attention is not presently paid to solid waste collection in most Nigerian towns including Enugu municipal. This leads to deteriorated public health, outbreak of epidemics and environmental pollution. The study area was divided into ten zones to enable the author make an in-depth research of the said area and obtain quality result. Natural peculiarities influenced greatly the discrepancy in the results obtained from the zones and zones with similar natural peculiarities had similar result.

From the result of the analysis carried out, it could be deduced that haul container system of waste collection differ from zone to zone in terms of the efficiency of the collection crew and weekly operational cost of the haul system. It was also found from the analysis carried out that the haul container system of solid waste collection was inadequate in number and size for all the zones in question.

The maximum weekly operational cost of hauling municipal solid waste in Agbani Road, New- Haven and Emene as shown in fig 11,12and 13 are N71,000, N71000 and N72000 respectively recorded at the common maximum round trip distance of 24km/trip respectively. These three zones recorded the maximum weekly operational cost of hauling municipal solid waste among the ten zones in consideration which is as a result of the round trip distance of 24km/trip recorded in the said zones which surpassed other zones. In fig 9 and 10 above, the maximum weekly operational cost of hauling municipal solid waste in independent Layout and Coal Camp is N66,000 respectively achieved at the maximum round trip distance of 21km/trip respectively. The maximum weekly operational cost of Trans- Ekulu, GRA and Ogui Road as shown in fig 6,7 and 8 above, are N60,000, N62,000 and N60,000 respectively recorded at the maximum round trip distance of 17km/trip respectively. In Abakpa (fig 4) the maximum weekly operational cost (N58,000) was recorded at the maximum round trip distance of 16km/trip. Also in Achara- Layout (fig5) the maximum weekly operational cost (N59, 000) wasrecorded at 16.5 km/trip. The weekly operational cost of the haul system in the zones are in the descending order of N72000 > N71, 000 > N66, 000 > 62,000 > N60, 000 > N59000 > N58, 000 for Emene> (New Haven and Agbani Road) > (Independent layout and Coal Camp) > GRA > (Trans-Ekulu and Ogui) >Achara-Layou t>Abakpa respectively and the efficiency of the collection crew in the zones are also in the descending order of 88% > 83% > 78% > 73% > 68% for Abakpa>Achara- Layout > (Trans-Ekulu, GRA and Ogui Road)> (Independent layout and Coal Camp) > (Agbani Road, New Haven and Emene) respectively.

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