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SOLID WASTE TRANSPORTATION PRACTICE AND CHALLENGE OF ADDIS ABABA CITY

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Abstract: Uncontrolled growth of the urban population in developing countries in recent years has made solid waste management an important issue. Very often, a substantial amount of total expenditures is spent on the waste transportation of solid waste by city authorities. Optimization of the routing system for collection and transport of solid waste thus constitutes an important component of an effective solid waste management system. The transportation system of waste management must be effective to solve 3 important things one was the amount of waste to transport fast; timely and minimum cost. Second transportation the waste with protective and managing of the environment and the waste generation area.Thridly always transporting waste publitization waste generation reduce as the source and segregation was applicable because of keeping your car mantainace time long. In Addis Ababa the waste transportation system happened always two things:-1.the inefficient carried amount of waste, 2.due to traffic jam, car maintenance and worker discipline problem around 25% of the city waste did not transported. So to solve those problem to use different practical measure:-1.To change the transportation system from government to privatization with incentive.2.To apply strong law of waste collection, storage and transportation system to save our environment and the minimum capital of the country.3 To appreciate the waste recycling and reusing waste from the source to industrazation practice in the city because of we cost more than 70 million dollar to used the transportation of waste in Addis Ababa city to change this modality by using sound resource society principle and methodology. In Addition to this advanced the collection and transporting waste control system by using GIS and other controlling technology to determine the minimum cost/distance efficient collection paths for transporting the solid wastes to the landfill or recycling center. The transport trips save time, money(maintenance, fuel e.t.c) ,energy, health of the car, sound environmental impacts (emission of waste transportation) and increase efficiency and effectiveness of the work practice definitely and changeable.

Keywords: efficient, transport, short path, clean city, cost effective, emission

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1. Introduction

Solid waste management (SWM) may be defined as the discipline associated with the control of the generation, storage, collection, transfer, transport, processing and disposal of solid waste in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes [3].

It is an essential service that is provided for the protection of the environment and public health, as well as to promote hygiene, recover materials, avoid waste, reduce waste quantities, emissions and residuals, and prevent the spread of diseases [11].

The capital city of Ethiopia is Addis Ababa ("New Flower"), located almost at the centre of the country. Addis Ababa is the diplomatic capital for Africa(OAU, ECA), regional headquarters like UNDP, UNICEF, UNHCR, FAO, ILF, ICO, and ITU. According to the Central Statistical Agency, the population of the city is 6.6 million inhabitants in 2017 that live in 10 sub-cities1 and 119 woreda divided for administrative purpose Addis Ababa is a centre for modern economic and social activities that infrastructure services are found relatively in better situation than other cities of Ethiopia.

As in many African cities, Addis Ababa suffers from insufficient infrastructure and deficient services to guarantee sanitation and waste management for the level of development expected by its status of diplomatic Capital city of Africa. The level of coverage of refuse collection is estimated at around 75%, while the remainder of the waste ends up on streets, public areas, water courses and the surrounding environment.

Like in most future megacities under fast development, in Addis Ababa the fate of postconsumer materials, organic waste and other residuals are not well known. This is a result of the lack of a system of data collection along the whole waste management chain. Since in the past years there were no systematic recording and assessment of the amount of waste collected and transported by the municipal or private enterprises, and the final disposal site is lacking a weighing bridge to register the amount of residues landfilled, almost no robust data that helps assess the performance of the waste management, or to determine to what extent the streams of valuable materials recovered and recycled is available.

The previous situation is compounded by the fact that large amounts of recyclables are recovered by an army of informal waste pickers, which is practically invisible to the waste management authorities, who buy materials from households or scavenges for recyclables on the streets and at the final disposal sites.

However just collecting the waste from different parts of city does not solve the problem; it requires

disposing the waste in environmentally safe and economically sustainable Poor collection and inadequate transportation are responsible for the accumulation of MSW at every nook and corner. The management of MSW is going through a critical phase, due to the unavailability of suitable facilities to treat and dispose of the larger amount of MSW generated daily in metropolitan cities. Unscientific disposal causes an adverse impact on all components of the environment and human health manner. An effective solid waste management system is needed to ensure better human health and safety.

In general, an effective solid waste management system should include one or more of the following options: waste collection and transportation; resource recovery through waste processing; waste transportation without recovery of resources, i.e., reduction of volume, toxicity, or other physical/chemical properties of waste to make it suitable for final disposal; and disposal on land, i.e., environmentally safe and sustainable disposal in landfills (19&20; 9; 3).

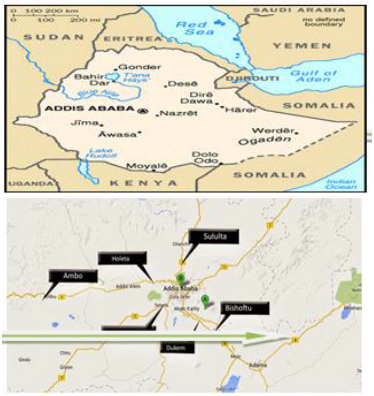
Most often, it appears difficult to minimize two variables - cost and environmental impact - simultaneously. Hence, the balance that needs to be struck is to reduce the overall environmental impact of the waste management system as far as possible within an acceptable cost limit. The new Paradigm for sustainable solid waste management, as it stems from the need for resources conservation and is best expressed in the EU policy from those stated that to increase level of service will need to be provided at the minimum possible cost, as the public will not be able to bear large increases in its waste charges. Therefore, the sector of waste collection and transport (WC&T) attracts particular interest regarding its potential for service optimization as: (a) waste management systems with more recyclables' streams usually require more transport [17]; and (b) this sector already absorbs a disproportionably large fraction of the municipal budget available to waste management [10]. Service optimization, both in terms of quality and costs can only be achieved using advanced decision support tools, modeling the many different components of an integrated waste management system [1, 12, 16and 18]. Optimization of WC&T making use of the GIS (fleet management method) may provide large economic and environmental savings through the reduction of travel time, distance, fuel consumption and pollutants emissions [18], [2],[4,7,8,13,14,15], but in our case we selected the fleet management collection and transporting service management.

The aim of this work was to develop a methodology for the optimization of the waste collection system from house to house, institution to institution and transportation system based on our resource, our waste amount and

fleet management technology. The strategy consisted of replacing and reallocating the waste collection bins as well as rescheduling waste collection via the resource of the city, the amount of waste concentration and using fleet management routing technology optimization and its benefits of practice such transportation solving technology. To minimize the collection speed of waste time, to use short path distance travelled to transport waste, To adjust the man power, To get primary continuous data and etc. General consequently, to reduce the cost or financial budget about it, To protect the society in the right way and To clear manage the environmental costs To scarify by the waste transportation system.

2. Material and method

2 .1.The Municipality of Addis Ababa and its waste collection scheme



Graph 1:-Addis Ababa was the central part of Ethiopia and its saw map

Geographically, Addis Ababa is located between 8055'and 90 0 5'N Latitude and 380 40' and 38050' E Longitude. The city is located at the center of Ethiopia with an area of 540 km2 of which 18.174 m2 is rural and its altitude ranges from 2000m - 2800 masl (6).

Addis Ababa is a seat both for Federal Democratic Republic of Ethiopia (FDRE) and Oromiya National Regional State Government. It is bordered with Oromiya National Regional State in all directions. There are 10 sub-cities (Kifle ketema) and about 119 woreda (AACA 2010).

2.2. Waste collection in the Municipality of Addis Ababa city

Waste amount, way of collection, method of collection used and other related activities to list them. A better development of the recycling system in the future will require a restructuring of both collection and transportation systems in order to minimize costs and optimize waste collection resources and transportation activities and its default [3]. The system was to identify how the waste easily collected and transported at the initial point or the optimum scenario for waste collection and transportation from stored waste, in terms of minimizing collection time, travelled distance, man-power, and other costs to protect our life.

Finally, The researched believed that to modified the collection and transportation system in the new modality from compared as the current practice from the city of

Addis Ababa might be important because the new ideology could be changed the waste collection and transportation modality from the house level and there is no soil and air direct contamination and minimize transportation, disposing and other side cost may be reduced directly and indirectly more than this save the health of society and the environment surely.

2.3. Method

To develop the collection, the transportation system, the whole information of the system and present primary data generated

3. Result and Discussion

3.1. Practice of waste transportation system

3.1.1 Government practice

Table 1. types of car in each subcity either side loading container or compactors and its generation

s.no	subcity	woreda	Share enterprise and skip point	Generation solid waste m^3	Types of care to transport waste			
					Cargo carrier	Side loader	renolet	compactors
1	Arada	10	3	606.27	3	1	0	5
2	lideta	10	3	575.14	1	1	1	5
3	kirkose	11	3	634.18	1	1	0	6
4	Addis ketma	10	6	731.83	6	1	1	5
5	gulele	10	5	767.00	23			3
6	yeka	14	10	970.88	20	2	0	4
7	Akaki	11	6	519.47	15			3
8	nefassilek	14	10	906.6	19	0	0	4
9	kolefe	15	15	1229.17	19	1	1	4
10	Bole	15	13	885.72	25	0	0	4
total		**119**	**74**	**7826.26**	**132**	**7**	**3**	**44**

From the above table the share enterprise numbers were 74 in 119 woreda and 10 subcity to tal of waste without private instutions 7826.26 m3 waste transported daily by using 132 cargo conaing cars,7 side loader,3 reanolet rolling and 44 compress compactors cars.No to understand that the number of car was almost nice but the transportation was ineffient because of different expression what the system was in active from those I explain some practice and problem in Addis Ababa.:

1.The maintanace system that was the car mantained when they stoped before that nothing to pre-mantanace,washing,greace and other practice not to do so the car disfinctioning than working time.To solve this problem the transportation system simple privatazation to reduce the goveremental brocracy , inefficent follow up and undesciplene workers,other way to increase the number of compactors car this way was waste of time,money and enviroment so to used the 1st sytem to change business based work and clearly difine the responsiplity body take off and paid situation and follow

strongly,contiously and straight.

2.To appreciate and prepare incentive the waste reduction and recycling applicable technology producers

3.To strictly negotiate the take off organazation to change the manual system to technological system and easily acess in the citezen.in addition to this to prepare waste road map and when and where to change full system and creat clean city how the moter and how to drive the car in what speed to reach the plan

4.To change the payment system and way of waste handling practice to minimize the transportation cost,the disposing and mitigation cost of the enviroment at the school,household and each institutional responsiplity to do something to produce waste and how to hand or to pay the handlers how much cost it before started any activities like other mandatory instrument.that means to applied pollutor pay principle and extended produce responsibility of their producing or generated waste.

5.To change the eductional modality of enviroment to minimize the biodaversity pollution by waste generated,collected,transported,recyled and disposing sound law and puanality must be measered properly

Figure 1:-when waste stored the consequence environment pollution and how used the compactors

Figure 2:-Loading of side loader cars and the problem of the enviroment

Figure 3:-Old model waste load and rolled it

Table 2:-Waste transportation by monthly average and the vehicle trip

no	subcity	Total waste dispose	Average used car	Trip of the average	Use of resource average
1	Arada	214314	8	521	22,286,305
2	lideta	152148	8	3600	20,681,332
3	kirkose	235032	8	5484	25,152,880
4	Addis ketma	20120400	13	2160	30,120400
5	gulele	235472	26	2880	25,127,480
6	yeka	299127	26	10440	40,921,454.5
7	Akaki	159056.1	18	2520	25,315049
8	nefassilek	563698.8	23	3960	65,702,892
9	kolefe	523800	25	4860	60,140,000
10	Bole	459630	29	5760	55,366,700
total	10	22,962,678	184	42,185	370,814,493

From the above table the total routine trip was 42,185 time it average city wise and the amount of waste transported by 184 cars was 22,962,678 m3 or 6,062,147 tone waste collected and disposed from this those amount of waste transported by compactors it took 119 trip daily the cost of transportation was the minimum 5 millions and maximum 20 millions. Understanding from the table to increase the size of the car minimize the trip and the transportation cost and kept the emission of waste production gas and the fuel of the transported car also decreased at the same times clean the storage and house hold waste timely and efficiently. Changing the transport system mean to reduced pollution, the cost of transportation and Energy. So the relation between handling, collection, maintenance of the cars, the cost, the trip and the emission of the environment by the carrying material and the car emission simple minimized the whole waste management and operational activities.

The case of used advance and practical technology increased the transportation efficiency, effectiveness and clear nd quality information how much carried, transported and cost to compare day today to manage and organize when and where the mistake happed.

3.1.2. Private practice

Table 3: private association types of car, institution number

no	Private Ass.name	#of cars	Trip of cars for one month	Working institution #	Disposing waste average	Payment monthly average
1	Dynamic	9	571	115	17474	1568466.24
2	Rose	9	837	71	17067	1531933.92
3	Solomon G/kidan	2	72	47	233.76	210038.40
4	ATE	3	128	66	3552	318827.52
5	Serkalem &Aschalew	2	144	40	3068.18	302940
6	yes	5	449	118	6986	627063
7	Hedas	2	72	51	1297.53	116777.76
8	Anteneh	6	655	122	14022	1258614.72
9	Tigest &muleya	4	230	79	11240	1011600
10	Helen	2	33	47	259	23247.12
11	Melekamna AMAN	2	104	44	1812	162645.12
12	Adoliyan	2	252	33	7387	663057.12
13	Gedelawit	2	85	25	3043	273139.68
14	Yesakore	4	122	34	976	87605.76
15	Ach.ti.Ach	5	196	91	8176	734057.28
16	Ach.As.A.f.	2	48	40	1936	173775.36
17	Eteyoland	2	61	48	2095.4	188585.76
18	konjet	1	24	44	911	81771.36
19	Genet	2	57	37	3752	336779.52
20	Webet	2	145	40	6154	552383.04
21	Dawit	2	82	42	2767	249030
22	Amae &tekele	4	51	40	2070	185803.2
23	Selamawite	2	5	4	156	14002.56
24	Haile Alemayhu	2	69	57	2173	195048.48
total	24	86	4,492	1,335	118,607.9	10,867,193

From the above table the private association to contribute the waste collect and transport in the minimum standard of their payment means the share enterprise paid the government only the waste from house to temporary place 90 birr for 1 m3 and the same payment paid the private association to collect and transport to disposal site. Therefore 4492 trip and 1,335 institution and 118607.9 m3 waste collected and transported from each institutions in below twice a week. So the government to save two things the waste collection and transportation should be privatized and paid depending of the efficiency and quality of service upgrade the payment to solve the trip and any storage waste collect and transport timely and save way.

3.1.3. The Division of the car and the transport system

Divided the vehicle into 3 types:

1. A-type vehicle: far from the disposal and recycling center are selected from the Temporary storage area. The order in which stored wastes have to be visited and is calculated based upon the proximity of stored wastes. Then the optimal path is generated for each vehicle from the specific storage and pile areas. In this process, clusters of stored wastes are formed and each cluster is allocated to a vehicle. The clusters are made by taking the time into account, which may be plus or minus the total working hours for the day. In such cases, the last cluster may be merged with other clusters by increasing the total working hours. The subcity under such circumstance yeka, Bole, Akaki and Gulele total skip points in those area are 34.they needed the types of car more waste car because of far from the disposing area So they had to use more that 100 m3 containers collected waste from 34 near far area easily transported more amount of waste to analyze the cost effective and the efficiency of waste transported means to change the payment system based on distance and effectiveness of the waste collected and transportation either recycling and disposing centers. The Proposed payment will be 1.8 birr by 1 kg or 180 birr for 1 m3. The allowed car types were larger size because of collection and transportation of the waste major effect for cost, Time and quality.

2. B-type vehicle: meddle of the disposing area is performed as done for the A-type vehicle. Based upon the distance of the stored waste are formed, which is the maximum capacity that a B-type vehicle can clear at a time because of near the disposing place. The total time required to clear each cluster through the optimal path is calculated and displayed to the user. Now the user can select a subset of clusters to be cleared by a vehicle. Once the user enters the group of clusters to be cleared, a final optimal path between these clusters is generated. The total time required and other results are calculated. In addition to this the cluster used low cost of transport because it near to the disposing or recycling center

and including Kirkos,lideta,Arada and Addis Ketema. Totally, they had 15 transfers station and skip point. It also far from the disposing center thinks the cost effective and the efficiency of waste collected and transported timely and protects the environment. The payment system also differs from the far and the nearest because of their own cost to demonstrate and production of waste due to the market area and international sound activities happened. The proposed payment practice will be 1.6 birr by 1 kg or 160 birr by 1m3.The allowed car types was medium size because of collection and transportation of the waste major effect for Time and quality.

3. C-type vehicle: the optimal path is calculated for each C-type cluster attached each other. Based upon the total working hours, the number of vehicles required to clear the C-type stored waste is then calculated. In addition to this the cluster used low cost of transport and the quality of transporting because it near to the disposing or recycling center and including Nefasselek and kolef. Totally, they had 25 transfers station and skip point.It also closed to the disposing center thinks the cost effective; the efficiency of waste collected, transported timely and protects the environment. The payment system also differs from the far and the medium because of their own cost to demonstrate and production of waste due to the most dense and life area of the society happened. The proposed payment practice will be 1.45 birr by 1 kg or 145 birr by 1m3.The allowed car types was medium or small types size because of collection and transportation of the waste major effect for speed, Time and quality.

3.1.4. Financial expenditure

Being a "public utility" and an essential service, investment in solid waste management does not require a justification in terms of "positive return on investment" or "minimum profits"(5). Such an investment, however, needs to be justified on the basis of being "the least cost technologically feasible option" for achieving the required degree of efficiency and paid to maximize the collection, transportation, timely, clear environmental and other practice clearly applicable.

3.2. Challenges of Transportation

3.2.1. Governmental transportation challenges

3.2.1.1. Efficiency

Figure 4:-waste stored and not yet transported timely

From the above figure observed that the waste collected from each household by using cars, pushcarts or other means. Now the waste already collected and stored next step to transport either disposing or recycling centers in this case and other occasion in Addis those happening occurred due to six practice 1.the poor management of activities, 2 the inefficiency of the present drivers, 3.the unmanageable waste storage area, 4.The inefficiency of the car working hours, maintenance and types of car used time, 5.The distribution of car in the subcity because in some subcity the cars idle in some case severe so to amend it due to the waste generation, the distance from disposing and the number of transfer station.6.The participation and awareness of the public still now poor and low practice appreciation. From this observation to increase the efficiency of waste handling, collection, transporting recycling, reusing and disposing waste management system must be planed and road map preparation and change the whole mind set of the society and institutional arrangement of the sectors and used technology depending up of our effort and appreciate the new invented technique practice and applied law and regulation without interruption strongly and seriously.

3.2.1.2. Poor Resource management

1 car:-The maintenance part of the government bought car very in dangers because of weak follow and control, the brocracy of the procurement system, the budget management and general no attention to give value after buying the cars due to the continuous checked and test the maintenance of those resources

2. Fuel:-In the government car paid more money for subsidiary the Share enterprise to share the subsides of either of the transportation cost. The consumption of fuel is 3 different situations like higher 20 million years used, minimum 5 million per years. It is the practical management of fuel and manntainace under question in governmental cars so to solve this problem used two chose:-

1. Used the previous system and strongly managed, organized and followed up with effectively and efficiently

2. Privatized the transport system and add some payment to the privatization activities .The researcher observation in that appreciate the privatization management of waste collection and transportation because of strict control, follow up and effective efficiency management applicable if used the first chose the sound clean city vision did not attend the reason behind the poor follow up, control and management system of important the transportation motors of mantainace and fuel availability unsolved so it is important to show the nice city to practice and give responsibility the whole system to privatization or partial method also possible.

3.2.2 Private

3.2.2.1. Distribution of waste

Figure 5:-The private cars types

From the figure observed that the compactors car used those 33 private association to transport waste from 1335 institutions what the problem in heard the amount of waste in the association was very small related to the Share enterprise that is 18% of the city waste transported by those association but in the city has more than 91 goveremental and privet institution the agency provided only 1335 institutions due to this the waste amount collected and transported very small is that the payment amount also different company with company .To solve this problem used to way:-

1.To give additional 91 institution distribut for those associations

2.To Change the system of waste collection and transportation system as privatazation either method used to increse the waste collection and transportaion effeciency to creat clean enviroment and clean city or world.

3.2.2.2. Car types

The recommended car for private association all have compactors from small to bigger size, but selection the size and types of cars depending of the waste types, the distance of the transported area and the production time of the car was importance to determine the size and types. Now the privatization appreciation was happened the private association must have enough preparation and capacity to take off the city waste collection and transportation activities properly.

3.3. Finding of the paper

1. To change inefficient waste collection and transportation system by changing altitude, sytem and strict control and follow up activities

2. To integrate the waste system without interruption management and organization that is from handling to recovery (disposing ore recycling activities

3. To improve the poor resource management in the institution like the car fuel, the maintenance of the car, the payment of workers, the health protective material of workers, the whole procurement system must be changed otherwise to appreciation privatization to give the work from handling to transportation by contractual activities and strict follow up that is share of resource management system

4. To appreciate the recycling activities to minimize the collection, transportation and disposing waste at the source by continuous aware the society during waste collection or other transferring method of knowledge and skill.

4. Conclusions and Recommendation

4.1. Conclusion

Results indicate that the optimal

sytem is more efficient in terms of collection waste time and distance travelled or waste transportation system. These savings are highly related to waste collection speed, gas emissions, car maintenance cost and fuel consumption. The 3 types of car arrangement based on the optimal activities such as population density, waste generation capacity, road network and the types of road, storage bins and collection vehicles, etc., is developed and used to trace the minimum cost/distance efficient collection paths for transporting the solid wastes to the landfill. The proposed efficient management of the city was daily operations for moving solid wastes, load balancing within vehicles, managing fuel consumption, manitenace and generating work time schedules for the workers and vehicles in either was governmental or privatazation.Due to this practice effective transportation was applicable in the city the environment sound situation must be observed unless otherwise the waste management ineffective like the present practice the environment polluted the health of life endanger for the city, Africa and the world because Addis Ababa the capital city of Ethiopia and Africa and the 3rd tourism center of meeting country. So we are luck to think more approval of waste management special the transportation practice must be improved it is mandatory continues or back.

4.2. Recommendations

1. Future work should focus on reduction the waste at source to cover wider waste collection areas, based on spatial analysis rather than empirical approaches, as well as adaptation of the collection system to the introduction of separate collection schemes for different waste streams and quantification of fuel and emission savings.

2. Appreciate privatation of waste collection and transportation activities both case might be practiced.

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