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Research Article

Supply Chain Management as a Tool for Collection and Disposal of Organic Waste in Pune

*Gupte Deepak D. and ¹Saptarshi Praveen G.

* Hindustan Antibiotics Ltd. Pimpri, Pune.

¹Department of Environmental Science, University of Pune.

Corresponding author: dgupte1967@gmail.com

Abstract:

Supply Chain Management has become essential component of corporate management strategy. The technique may be applied to collection, segregation, processing and disposal of organic waste in a city. Present paper attempts to understand the current way of disposing organic waste in area of Pune Municipal Corporation (PMC) and the possibility to apply the technique of Supply Chain Management for the same task, by using stake holder model. Technologically stake holders bring about new communication, coordination and encapsulation frame works aimed in providing value to users. Researcher is interested in applying stake holder's technologies for designing and controlling the dynamic behaviour of supply chain.

Keywords: Supply chain Management, stake holders, simulation, coordination, design technology, Pune Municipal Corporation (PMC), segregation.

1.0 Introduction:

Growing population and growing needs waste generation has shown exponential growth in various cities like Pune. This is a well felt problem for researchers, planners and executors. It is observed that there is 1300 to 1400 metric tons (mt) of municipal solid waste generated every day in Pune city. It has found that the unscientific disposal of waste can create many environmental and health related problems (Mane T.T. et. al., 2011). It is also interesting to note that sizeable part of it (about 65%) is organic waste which can be degraded, decomposed and decayed. However, it requires a well designed system for collection and disposal of waste. On the basis of in-depth study of methods of disposal of waste in Pune and other cities it is observed that there is need to design proper system for the purpose. Supply chain management is a technique to design the system to monitor and control the flow of goods from production centers and further to consumption points, (Donald and David). Can we apply this technique to design the system for collection of segregated organic waste from more than 2,75,922 houses and more than 495 slum areas of Pune city? The present paper mainly state the need to develop such system and attempts to design the same, suitable for resolving environmental issues related to waste management. In addition to monitor and control

of goods, flow movement, supply chain optimizes the resources and action at each stage.

In order to operate efficiently supply chain functions must work in tight coordination. But actually many times due to some difficulties like material do not arrive on time, vehicular failure, worker's sickness, break-downs in the process and so on, may cause deviations from the plan. In some cases solution cannot be found locally, it may require two or more stake holders to coordinate in order to revise plans, decisions or schedules. It will be tested here that hypothesis in this research, technology and approach are correct or not?

2.0 Study area:

The Pune city is located at 18° 37' North and 72° 51' East. It is situated near western margin of Deccan Plateau and at 560 above mean sea level, at the confluence of Mula and Mutha River. Pune Municipal Corporation (PMC) has about 225 sq km of area with population of about 35 lakhs, according to 2011 - census data. The average waste generation is about 364 gm per capita per day (pcpd), in the city.

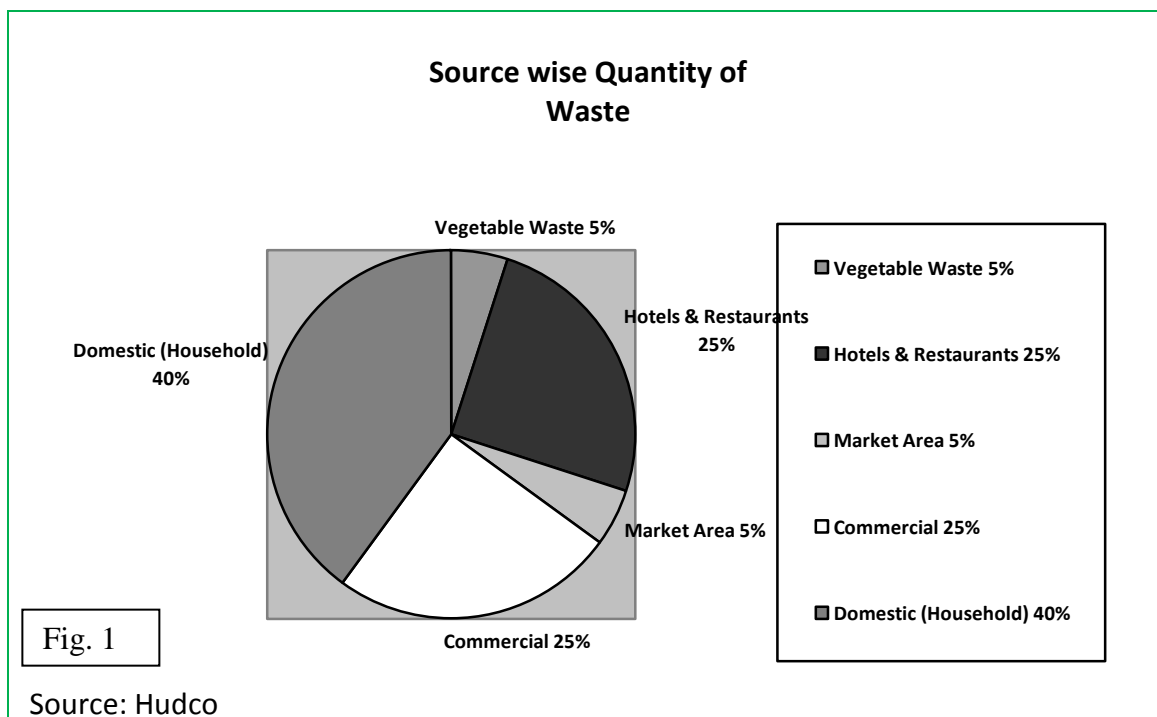
3.0 Municipal solid waste:

For class 1 cities in Maharashtra, the waste generation rates are in the range of 140 to 630 grams per capita per day (pcpd). The average highest waste generation rate in Mumbai is 0.630 kg (pcpd) and 0.364 kg (pcpd) in Pune. Organic waste often forms as much as 65% of household waste generated in developing countries,

compared to 30% in industrialized countries (Jonathan Rouse 2008).

3.1 Municipal solid waste generation In Pune:

Analyzing the available city wide information, the contribution of MSW from the various sources can be presented as in Figure 1.



3.2 Source of waste:

Organic waste in towns and cities is generated by households, business, industries and local authorities (Pune CDP 2006-2012). It consists of vegetable stem and left over, waste food from restaurants and residential areas, spoiled fruits, vegetables from markets, garden waste etc. The source is dispersed and spread over throughout the city area.

dump sites or banned sites polluting water resources and air (Mane T.T. et. al., 2008).

4.0 Present scenario:

According to United Nations Development Program survey of 151 mayors of cities from around the world the second most serious problem for city dwellers besides unemployment is solid waste disposal (UNDP 1997). 2/3 of the solid waste generated is not collected. The uncollected waste is dumped indiscriminately on the streets and in the drains, contributing to flooding, breeding of insects and rodent vectors and spreading of diseases. Even waste that is collected, is often disposed off in uncontrolled

Indian cities including Pune are not far from the above situation. In Pune garbage containers are overflowing they are not emptied regularly, situation painted by PMC authorities and in reality are different, Whether PMC have considered about maintenance, break-down timings, shut downs, vehicular failures etc. is the question. Present records show, the processing capacity and collection capacity match each other which are, between 1300 and 1400 mt/day. As per researcher's observations, the Phursungi plant of which treatment capacity is 1000 metric tons per day, is running very much under capacity.

The total process of garbage treatment from beginning to end is divided into following steps

A) Collection: The functional element of this is transport of collected material to the location where collection is emptied. This site may be a material processing facility, disposal for landfill site or a transfer station.

B) Waste handling, separation, storage and processing at source:

The step of waste handling and separation are the activities associated with municipal waste management, till the waste is placed in the storage containers, while collection and handling leads to the movement of loaded vehicles to the point of landfill area, processing or may be a segregation site. Separation of waste material in to different components, at source, is the bottle neck of the entire process (Pawar R. S. et. al., 2011)

C) Separation, processing and transformation of solid waste: Here comes the processing of separated waste material and the facilities available for the same.

D) Transfer and transport: In the beginning waste material is transferred from smaller to larger transport equipments. Then the waste is transported to longer distances for the processing at sites.

5.0 Types of treatment processes in Pune Municipal Corporation area:

In Pune Municipal Corporation (PMC) area more than 19 sites are in operation for processing waste. The types of processes like mechanical composting, vermin-composting, Anaerobic digestion (biogas generation), electrical energy generation are in practice and some experimentations on new techniques like bio-fuel preparation from organic waste etc. are on the verge of trials. Some of the above mentioned plants are in working condition and some are not. The process technologies might be the same but

this work is allotted to different agencies like Deccan Environmental consultants, M/s Hunger Biotech, Disha waste management, Melham, Ajinkya Biofertilizer, M/S Excell, M/S Green Leaf, Save environment and Gangotree Eco Technologies and so on. These agencies are doing the work on contract basis, which is under the agency control.

6.0 Allocation of work:

As mentioned above the process work is contracted to the different agencies the collection and segregation work is also allotted to different N.G.O.s or social agencies like SWACH, but they are doing hardly 20% of the job, remaining work is done by truck load by lifting the containers placed at different places through-out the city and by vehicle with bell (commonly called as ghanta gadies) from residential areas and other complexes. For the collection from hotels, daily 23 hotel truck trips are arranged by PMC. This waste is nearly the 25% of the total M.S.W. collected in Pune and contains maximum organic waste. The generated waste is not at all segregated. For the transportation of waste in Pune city the number of vehicles allotted are 296 and out of which, daily on road are about 250 (data source: PMC office Pune)

For the convenience of the work and work distribution, 144 wards of PMC are divided into 14 different zones, and these zones are allotted different larger vehicles in their 17 depots for daily work. The chart of the same is given below

Table 1: Allotment of larger vehicles for 17 depots under 14 different PMC zones,

Sr. No.	Zonal Office	Dumper Placer	B R C	Hotel Truck	Compactor	Ghanta Gadi
1	Aundh	4	7	2	1	5
2	Karve road	3	3	2	-	8
3	Ghole road	4	4	3	2	6
4	Yerawada	3	3	2	-	7
5	Varje, Karve Nagar	4	4	1	1	8
6	Dhole Patil	6	4	3	1	5
7	Vishrambaugwada	9	2	1	2	6
8	Sangamwadi	4	4	1	-	12
9	Dhanakawadi	3	-	1	-	3
10	Hadapsar	4	-	1	4	4
11	Bhawani peth	8	-	2	-	8
12	Tilak road	5	-	1	2	9
13	Bibwewadi	4	-	1	2	3
14	Sahakar Nagar	6	-	2	2	6
15	Katraj ramp	-	6	-	-	-
16	Hadapsar ramp	-	13	-	-	-
17	Mandai	1	-	-	-	-
Total		68	50	23	17	90

7.0 Stake holders:

The above arrangement is made by Pune Municipal Corporation (PMC), is heading towards the application of Supply Chain Management. Pune is the second largest city in Maharashtra, there is vast area and fast growing population (at present around 3200000 lacks) is under the PMC control. More than 20 units of waste processing sites, small and big, are distributed all over the city area and some more are coming up. This indicates in PMC already exist the decentralized system of Municipal Solid Waste Management (MSWM). As per the researcher's view, the persons directly participating in the above work are the stake holders and the administrative staff along with the supervisors, managers, and also corporators are the stake holders. Actually the citizens handing over the garbage to the rag pickers should be included in the stake holders list, as they are the part and parcel of the system, they might be paying rent to the landowners or may be direct owners, paying tax to PMC.

8.0 What is supply chain management?

Supply chain management is the systematic, strategic coordination of the traditional business functions and the tactics across business functions within a particular company across businesses within the supply chain, for the purposes of improving the long-term performance of the individual company and the supply chain as a whole (Mentzer J. T., 2001). In reality there is a gap in the literature available on supply chain management studies; there is no theoretical support for explaining the existence and boundaries of supply chain management. However the existing literature leads to a more comprehensive understanding that, what should be the critical supply chain components? That is, the kind of relationship components may have with respect to suppliers and customers. In a supply chain business process the emphasis on cooperation represents the synergism leading to the highest level of joint achievement.

The three principal elements of integrated supply chain management are,

- A) Information Systems:** Management of information and financial flow.
- B) Inventory management:** Management of product and material flow.
- C) Supply chain relationships:** Management of relationships between trading partners (Donald J. et. al., 2005 and G. Raghuram et. al., 2006).

In supply chain, the basis of integration can be characterized by cooperation, collaboration, information sharing, trust, partnerships, shared technology and fundamental shift away from managing individual functional processes (Akkermans H. et. al., 1999). The extent of integration can begin with the product design and incorporate all steps leading to the ultimate sale of the item (Damien Power 2005). Supply chains can be naturally molded, simulated and improved within a short time and with reduced human resources. The stake holder technology was primarily built for implementation and control of distribution system, the simulation models can be prepared and reused with minor modifications for actually controlling distributed supply chains.

9.0 Issues:

As per researcher's observations mentioned above, the system of collection, transportation and treatment and disposal of organic waste in the city has following issues.

9.1 General Waste Management Problems:

- a) There is no proper storage of waste at source.
- b) The partial or little segregation (as compare to large volume of the waste) of recyclable waste.
- c) Door step collection system is nearly absent. (Hardly 15% to 20% irregular door to door collection is done).
- d) Improper system of secondary waste storage system.
- e) Irregular transport of waste in open vehicles. (Recently it is observed that most of the vehicles carrying waste are covered).
- f) No treatment of waste.
- g) In appropriate disposal of waste at open dumping grounds.

9.2 The challenges ahead of PMC:

It is quite clear that almost all municipal corporations are failed in application of the Municipal Solid Waste Rules 2000. This failure leads to many initial but the bottle-neck problems of MSWM. The initial bottle-neck and critical problems are as follows:

- A) Storage of waste at source;
 - a) There is no public awareness, motivation and education about MSW.
 - b) No cooperation from households, hotels, commercial complexes etc.

c) No stringent legal action provision on breaking MSW Rule 2000.

d) People are very much reluctant to change their habits.

B) Segregation, of waste;

a) Very faint publicity through electronic media,

b) No understanding among the citizens about using separate bins for segregation of dry and wet waste.

c) No knowledge about the benefits of segregation.

d) Very difficult to educate slum dwellers.

e) No finance for creating public awareness.

C) Collection:

a) Less no. of vehicles for primary transportation.

b) Less awareness and motivation amongst workers.

c) Unavailability of stakeholders for collection and segregation work.

d) Lack of finance is common everywhere.

Availability of less treatment space and requirement of qualified and trained MSWM authorities is the demand of the situation.

9.3 Municipal solid waste management system:

In most of the cities of developing countries the individuals are working since long, in waste management department, and they are continued in the same department. A paradigm shift from conventional waste management practices to Integrated Solid Waste Management (ISWM) is essential for cities in order to effectively manage the waste stream. ISWM is a comprehensive waste prevention, recycling, composting, disposal and also includes protection of human health and environment (Dhupkar V. et. al., 2005)

Conventional waste management focuses largely on waste collection (without segregation), treatment (composting and incineration) and disposal (landfills). The resource value of waste cannot be realized unless separation of wastes is practiced effectively at the source. In many cities of developing countries, waste collection rates are low and the quality of collection services are poor and waste collection may not exist in slum areas. The health problems of waste handling workers are neglected. These disparities exist in the conventional management system.

10.0 How to Apply Supply Chain Management to the MSWM system:

Efficiency of the MSWM system can be improved by adopting supply chain management technique as outlined below.

The consideration of sustainable and integrated Municipal Solid waste management planning aspects including environmental, social, cultural, institutional, political and legal aspects and also the role of stake-holders (rag -pickers, informal recycling sectors, small scale enterprises, women heads of house-holds and other elements of the waste management system such as prevention, reuse, recycling, collection and disposal). The involvement of stake holders in decision making is of high priority, and keeping stake holders informed about the involved issues and proposals is very important, to involve individual and public for public cooperation. The stake holders should be provided uniform, safe working conditions, and medical services to uplift their moral. Supply chain management should be very strong to make MSWM very effective and efficient. Supply chain management should function in tight cooperation, coordination and conversation for the above purpose.

It is necessary to consider the general stake holder network and their coordination, cooperation and conversation, stake holder's list is as follows:

- 1) Stake holder 1 - Households, Hotels and restaurants, commercial complexes, vegetable markets.
- 2) Stake holder 2 - Rag pickers and collectors.
- 3) Stake holder 3 - Small vehicle's and large vehicle's staff
- 4) Stake holder 4 - Segregators and collectors.
- 5) Stake holder 5 - Large vehicles transporter's owners and staff
- 6) Stake holder 6 - Process workers, supervisors, managers.
- 7) Stake holder 7 - PMC administrative staff, heads of concerned departments, Corporators, planners, decision makers and executors.

It is a known fact that the success of supply chain management depends on the effective functions of stake holders. The vertical and horizontal both ways conversation, cooperation and coordination is required to be present on the top priority. The discussions about work load, working conditions, proper movement of the material in the process and many more problems, will lead to peaceful solutions. Through-out the supply chain

management system trust among the stake holders plays the important role.

10.1 Conversation plan:

Conversation plans are descriptions of, how stake holders acts and reacts in certain situation. A conversation plan consists of initial and final goal and rules governed with transition and control mechanism and local data base that are kept to continue the state of conversation. The execution state of a plan is retained in actual conversation. Here in the figure House-holds, i.e. Stake Holder 1 is handing over the organic waste along with dry waste; the dry waste can be recycled i.e. sold to the merchants by rag pickers or small and large vehicle staff workers (Stake Holder 2). The Stake Holder No. 3 are the transporters and their related staff. In reality there is a good interaction between stake holders 1, and 2, 3; because stake holders 2 and 3 are collecting dry waste along with wet waste from stake holder 1 and selling, so dry waste is their additional income. They can dialogue with each other for segregation of waste into dry and wet at source. If the stake holders 1 are not ready to accept the suggestion of stake holders 2 and 3 then they can approach to their higher authorities, stake holders 6 and 7 for arranging, training and awareness campaign in the area of stake holder 1. Then the material is loaded in the small and large vehicles transported by transport staff, stake holder 3, to the site, it can be a treatment site, segregation site, dumping site or landfill site. Pune is having two large sites two to three medium sites and remaining small sites. Here the waste is segregated by stake holder 4, they are segregators and collectors. The segregated waste is again loaded in the trucks or small vehicles as per the requirement and taken to treatment sites. This work is done by transport staff, stake holder 5. The organic waste is then handed over to process technicians at different treatment sites. These technicians, supervisors etc. are stake holder 6. Then PMC admin staff, corporators, N.G.O's and others are stake holder 7. Here in this conversation plan communication, coordination is of prime importance. If any break in the chain occurs it is essential to communicate to both the stake holders backward and forward so the preventive measures become possible. Other vehicles going to the same site can be diverted to another site so transport expenses can be avoided

at the same time unnecessary detention on non functioning site can be avoided next day delay in the functioning of chain can be avoided.

At this stage it is very essential to think about the field workers process, technicians, transporters and related persons how they can be motivated? They should be provided with good uniform they should be paid bonus, some incentives. The scheme like quality circle can make them think and they can give good suggestions to improve working conditions or even process. By adopting supply chain in this fashion it can become a very tight management system of conversation, coordination system. One more thing will boost up the moral of above workers is to arrange entertainment program for them once in a year. PMC is already having a decentralized system for waste handling; they have 14 zones with 17 transport depots for 144 wards. Proper delegation of power for creating funds is not there, for taking decisions MSWM people hesitate.

11.0 Conclusion:

Proper supply chain management strategy for segregation of waste at source and then collection of biodegradable waste, can be useful to resolve the issues associated with biodegradable waste. Treatment with increasing capacity plants to supply good quality manure and resolve the issues related to segregation, collection, treatment and also environmental quality. By over-viewing through the supply chain management it is necessary to improve the capacity by seven times and strengthen the management by absorbing qualified and experienced MSWM persons. Recently anaerobic digestion i.e. biogas generation technique is improved similarly electrical energy technique is also improved and better results are available, but both are costly. At the same time the experimentation on bio-fuel from bio-waste are in progress, bio-bricks and bio-sticks are being prepared. This may lead to cost reduction. At this point MSWM of PMC must take a viable decision to make available, organic waste, for different processes in appropriate manner and so the sufficient quantity of good quality manure can, also be made available to farmers, roof top gardens, nurseries etc.

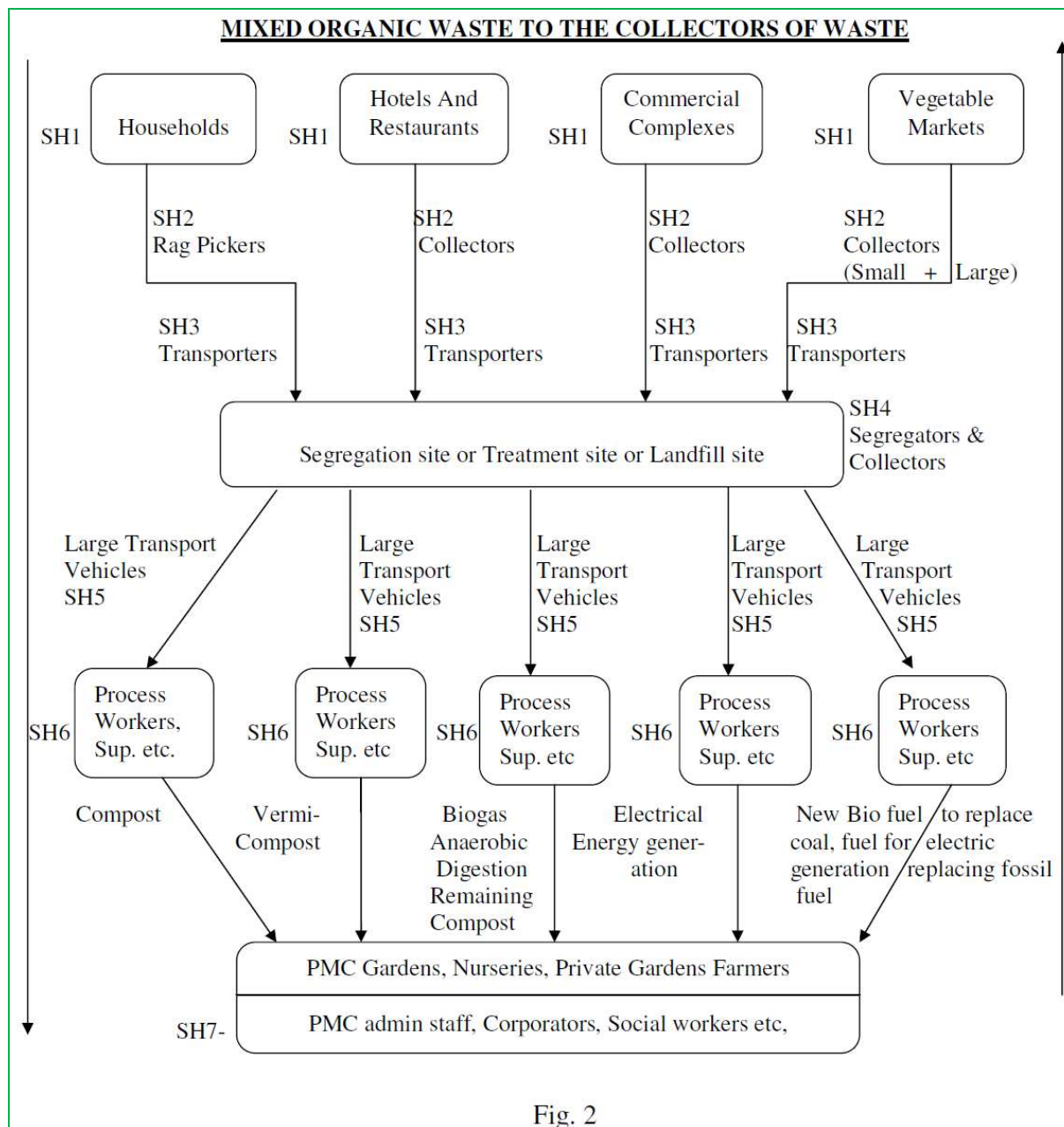


Fig. 2

12.0 Acknowledgement:

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