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Public Private Partnershipin Municipal Solid Waste Management

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Abstract : **Solid Waste Management refers to supervised handling of waste in an eco-friendly manner. Solid waste is the major bottle-neck for the advancement of sanitation of our country. In India, yearly waste generation has been increased by 5% in last 3 years. Hence, the discussion is about the progress on the implementation of effective Municipal Solid Waste Management (MSWM) through the joint venture between government and private entity.**

In this study, the generated wastes are calculated on the basis of volume with the purpose of estimating the material and thereby assessing the human resource. The overall financial support necessitated to implement the effective MSWM are computed based on the functional elements such as collection, transportation, waste processing and disposal with respect to men and material. SWOT analysis has been done and referred to formulate their planning of private entity for successful completion of project. The marginal fee has been fixed based on the result obtained from survey among local people. Financial analysis is done to look-into future of private entity. The benefit-cost ratio proves the project to be feasible.

1. INTRODUCTION

Solid Waste Management means the superior handling of wastes by the process followed by collection, segregation, transportation, treatment and safest disposal. The main objectives of solid waste management are minimizing the quantity of solid waste generated and effectively controlling the solid waste without affecting the environment. The present-era needs an effective SWM in both environmentally and economically sustainable way.Public Private Partnership is the combined working of government and private sector in order to create infrastructure for the welfare of the people. It creates the track for rapid development. The benefits of the PPP are vast investment, more efficiency, proper maintenance of asserts, use of advanced technology, etc.

1.1. Aim & Objectives

The main aim is to study the effective implementation of MSWM in sub-urban area involving private sector. This can be done by completing following objectives,

- To estimate the volume of waste generation
- To estimate overall financial support to implement effective SWM
- To analyse SWOTs of PPP in SWM
- To prepare the PPP model

1.2. Study Area

The area chosen for our study is Pattukkottai Municipality which is a selection grade municipality in Thanjavur district, located at 10.43°N 79.32°E along the southeast coast of India in the east-central region of Tamil Nadu. It covers an area of 21.83 sq. km. and has an average elevation of 27 m from MSL. It is 50 km away from the city of Thanjavur while the coast of Bay of Bengal is just 12 km away. It receives an annual rainfall of about 1075 mm. According to the census 2011 of India, it has a population of 73,097 in which both males and females constitute 50% each of the population. The literacy rate of this town is 83% which is much higher than the national average rate of 59.5%. Tamil is the official language and is predominantly spoken. English is widely understood in the town area.

2. CALCULATION OF WASTE IN VOLUME BASIS

Solid waste is calculated on the basis of volume to approximately find out the materials as well as the human resources required for effective implementation. The amount of waste generation per day in the municipality is around 35MT. The materials used are digital weigh balance, basket and waste samples.A box of normal size is taken and its

dimensions are clearly noted down. The food waste is filled inside the box without much compaction and is weighed in a digital weigh balance. The weight for the corresponding size of the box is noted down. Based on the readings taken, the volume of food waste generated per day is calculated. In the same manner, generation of total volume of waste is calculated.

Table.3.1 Summary of waste in volume basis

Sl. No.	Type of waste	Percentage (%)	Weight (kg)	Volume (cu. m)
1	Food waste	35	12250	55.43
2	Paper	9	3150	21
3	Grass	15	5250	85.43
4	Plastic	2.5	875	53.68
5	Glass	1	350	0.28
6	Metal	0.5	175	0.022
7	Inert material	37	12950	14.38

3. ESTIMATION OF OVERALL FINANCIAL SUPPORT REQUIRED

The overall amount necessitated to implement effective MSWM is calculated on the basis of functional elements such as collection, sorting, transportation, waste processing or recycling and disposal.

3.1. Collection

Methods followed for collection of waste are door to door collection and through waste bins over road side. Waste generated from residential area is brought by door to door collection while the commercial is brought through waste bins. The waste generated in residential areas and commercial places are assumed to be taken at a ratio of 4:1 i.e. 80% of waste goes to door to door collection and 20% of waste goes to waste bin.

- The door to door collection is done through tricycle waste bin which has a volume of 0.972 cu. m. The total number of available tricycles is 47 no. Therefore, it has the ability to collect waste of 45.7 cu. m only but the total amount of waste generated is 184 cu. m. per day. So, we need to have 118 tricycles more for complete collection of waste. Considering the cost of single tricycle is 5000, the total amount required is 5.9 lakhs.
- The waste bins are responsible for waste generated along roadsides. Among total amount of waste generated, 20% of waste goes to waste bin. The waste collected from bins is done weekly twice since it is small town. The volume of each bin is 2.6 cu. m. There are 50 waste bins available which has the ability to collect 130 cu. m. only but the total amount of waste generated for half of a week is 161 cu. m. so it is necessary to have 45 waste bins more. Considering the cost of single bin is 8000, the total amount required is 4.5 lakhs.

Table 3.1. Details of estimation of cost needed for material resource

Sl. No.	Type of material	Tricycle	Waste bin
1	Volume (cu. m.)	0.972	2.6
2	Available	47	50
3	Required more	118	47
4	Cost(in lakhs)	5.9	4.5

Only door to door collection needs labours to collect waste. Considering two labours per tricycle, the total numbers required are 204 labours. The salary is given on the basis of daily wages of 150 per day. The total amount of workers salary is 111.7 lakhs pa.

Table 3.2. Estimation of worker's salary

Method	Door to door collection
Workers per tricycle	2 workers
Total number of tricycles	165
Total number of workers	330
Wages per head per day	150
Total amount	180.675 lakhs

The total amount of money required for effective collection process is mixture of material cost, worker's salary and operational & maintenance cost. Earlier, the amounts required for material and worker's salary is calculated while the operational & maintenance cost is taken as 80,000 pa. Hence, the amount required for collection process is 1.92 crore.

Table 3.3. Estimation of amount needed for collection

Sl. No.	Type of Investment	Amount (in lakhs)
1	Material resource	10.4
2	Human resource	180.675
3	Operation & maintenance	0.80
4	Fixed investment	10.4
5	Varying investment (pa)	181.5

3.2.Sorting

Sorting is the process of segregating the waste into each component. If the sorting is done as biodegradable waste and non-biodegradable waste separately during the collection process itself, there is no need to spend money for this process. So, source sorting should be followed.

3.3. Transportation

Transportation is the process of transferring the waste from waste bins to landfill site and compost yard or waste recovery centre. The total amount of money required for effective transportation process is the mixture of material resource, worker's salary, fuel and operational & maintenance. Here, the transportation is done using two dumper placers which is enough. Considering two labours per vehicle with salary 5000 per head, the amount of worker's salary is 4 lakh pa. Another one major expenditure is fuel for vehicle to run which need a cost 50 lakhs pa. The total amount needed for transportation is 54 lakhs pa.

Table 3.4. Estimation of amount required for Transportation

Availability of vehicles	Two dumper placers
Requirement of labours	2 per vehicle
Worker's salary (a)	4 lakhs
Fuel cost (b)	50 lakhs
Fixed investment	-
Varying investment (a+b)	54 lakhs

3.4. Waste Processing

Waste processing is a process of making alternatives from waste instead of dumping in landfill. It can help in reducing the burden of landfill as well as making revenue. Different kinds of processing adopted in which the bio-degradable waste goes for vermi-composting and non-bio-degradable goes for waste recovery centre.

3.4.1. Vermi-composting: Vermicompostingis the process of using the earthworms to convert the organic material (usually wastes) into humus like material called vermi-compost which has lot of applications such as bio-fertilizer, improvement of soil aeration, prevention of erosion, control plant disease, etc.,

Table 3.5. Summary of income from vermicomposting

Total amount of waste generated	35 Ton
Percentage of bio-degradable waste	50%
Amount of bio-degradable waste	17.5 Ton
Amount of vermi-compost	7 Ton
Cost of vermicompost per unit weight	2
Total income per day	14000
Annual income	51.1 lakhs

3.4.2. Waste Recovery Centre: Waste recovery centre is the place where recyclable non-biodegradable wastes are collected and resale for recycling. Recyclable non-biodegradable wastes are comprised 13% of total waste generation i.e. 4.55 MT.The details of revenue getting are listed.

Table 3.6. Summary of revenue from recyclable wastes

Sl. No.	Type of waste	Amount of waste (kg)	Unit cost ( )	Income (in lakh)
1	Paper	3150	5	57.49
2	Plastics	875	8	25.55
3	Glass	350	2	2.255
4	Metals	175	20	12.775
Total : 98.375 lakhs				

3.4.3. Investment: Infrastructure needed for vermicomposting plant is steel roof truss for an area of 150000 sq. ft. and brick composting pits of designed size 20*3*2 ft. having capacity of 100 kg of 800 quantities while for waste recovery centre is stock room of larger size with partitions to keep different kinds of waste individually.

Table 3.7. Estimation for the construction of infrastructures for waste processing

Sl. No	Description	Amount(in lakhs)
1	Steel Roof truss	180
2	Composting pit	64
3	Stock house	50
4	Miscellaneous	6
Total fixed investment = 300 lakhs		

3.5. Landfill

Landfill is the place where the disposal of non-recyclable waste (inert materials) is done. Presently, there is a lack of sanitary landfill to dispose inert materials properly. Design of landfill has been done to create landfill and also to estimate the amount required to build the sanitary landfill.

3.5.1.Landfill Design

I. Landfill capacity

- Percentage of waste undergo landfill = 37%
- Waste generation per day = 12.95 T
- Current waste generation per year(W)=4726.75 T
- Estimated rate of increase in waste generation per year (r) = 2.5%

- Proposed life of landfill (n) = 20 years
- Waste generation after 20 years
  $W_o = W(1+r/100)^n = 7745.35$ T
- Total generation of waste in 20 years
  $T = ½(W_o+W) = 6236$ T
- Total volume of waste in n years
  $V_w = T/0.85 = 146730\ m^3$
- Total volume of daily cover in 20 years
  $V_d = 0.1\ V_w = 14673\ m^3$
- Total volume required for components of liner system and of cover system
  $V_c = 0.25\ V_w = 36682\ m^3$
- Volume of Settlement $V_s = 0.05\ V_w = 7336\ m^3$
- First estimate of landfill capacity
  $C = V_w + V_d + V_c - V_s = 190750\ m^3$

II. Landfill Dimensions

- Assumed landfill height (H) = 10m
- Area required for landfilling separations
  $A_i = C/H = 19075\ m^2$
- Total area required $A = 1.15\ A_i = 21936\ m^2$
- Plan area of Landfill = 125m x 300m

III. Landfill Phase

- Active life of landfill = 20 years
- Duration of one phase = 1 year
- Number of phases = 20
- Volume of one phase $V_p = C/20 = 9540$ cu. m.
- Volume of phase = $V_p/H = 954$ cu. m.
- Plan Area of phase = 22 m x 45 m
- Number of daily cells = 365
- Plan area of one cell = 1.3 m x 2 m

3.5.2. Investment

Table 4.9. Summary of investment of landfill

Sl. No.	Type of Expenditure	Amount (□ in lakhs)
1	Cost of Infrastructure	103
2	Surface water drainage system	30
3	Leachate management facility	23
4	Environmental monitoring facility	8
5	Miscellaneous	6
6	Varying Investment	30
Total cost = 200 lakhs		

3.6. Overall Estimation of money required

The total amount of financial support required to fulfil all needs for implementing the effective MSWM is □ 7.7 crore (i.e. including capital investment and varying cost for one year) which is computed by summation of expenditures to be done for its functional elements such as collection, transportation, waste processing and disposal .

Table 3.10.Overall estimation ofmoney required

Sl. No.	Functional element	Fixed investment (□ in lakhs)	Varying investment (□ in lakhs)	Total amount (□ in lakhs)
1	Collection	10.4	120.5	131
2	Transportation	-	54	54
3	Waste Processing	300	50	350
4	Disposal	170	30	200

4. SWOT ANALYSIS

SWOT analysis is structured planning method to evaluate the characteristics of an organization by identifying its strength, weakness, opportunities and treads.

	POSITIVE	NEGATIVE
INTERNAL	*Strength* • Easy implementation of infrastructures • Stringent source sorting • Reduce lanfill burden • Social impact	*Weakness* • Heavy investment • Need money for awareness programs • Takes time to reach people
EXTERNAL	*Opportunity* • Good turn - call from other places • Appreciation from govt. • Creation of new jobs. • Expansion/penetration of business	*Threat* • Job insecurity for workers • Collection of fair charges • Community participation • Illegal dumping

5. FIXATION OF MARGINAL FEES

Marginal fee is a kind of mandatory charge collected from the waste generators. There are many waste generators in the locality including residential places, commercial, educational institutions, marriage halls, hotels and small scale industries. So it is mandatory to collect atleast minimum amount of fair charges. In order to know the acceptance of people regarding the payment of charges, face to face interview has been conducted with the people to get their opinion. The survey shows that the majority of the people (60%) are pleasured to pay the fair charges. If the fair charges are collected with the

co-operation of people, there is possibility to get an income up to □ 2.1 crore.

Table 5.1. Summary of marginal fee

Sl. No	Area	Marginal fee (□ per month)	Income pa (□ in lakhs)
1	Residential	50	109.5
2	Commercial places	100	73
3	Educational institutions	500	15
4	Marriage hall	1000	3
5	Hotels	500 to 1000	5.5
6	Industries	1500	1.8

6. FINANCIAL ANALYSIS

Financial analysis has been done to look-into future career of private entity. It involves total expenditure including fixed and varying investment, income earned through compost, recyclable waste and user fee, profit obtained, percentage on ROI and break-even analysis.

Table 6.1. Summary of Financial analysis

Sl. No.	Description	Amount (□ in crore)
1	Fixed investment	4.81
2	Varying investment	49.89
3	Total expenditure	54.7
4	Waste conversion's income	30
5	SWM user fee	42
6	Total Income	72
7	Profit earned	17.3
8	Fixed cost (pa)	2.7
9	% of return on investment	64.45% (pa)
10	Break-even analysis	46.55% (pa)

7. FEASIBILITY EVALUATION OF PROJECT

Feasibility evaluation of project means the prediction of possibility of the execution of project economically. It is valued by combing the benefits obtained directly & indirectly, expenditures and scarp value of materials at the end of life time of the project.

7.1.Benefits- MSWM involves both direct and indirect benefits in favour of society as well as private entity. Direct benefit means that the gain goes directly to the entity while indirect benefit goes to the environment and people.

- Direct benefits are money obtained waste processing and User fair charge for SWM service. The total amount obtained by private entity is □ 3.6 crorepa.
- Indirect benefits are healthy life& hygienic environment for public, new employment opportunities, conservation of resources by converting waste into alternatives, reducing emission of GHG by proper disposal,etc.

7.2. Benefit-Cost Ratio (BCR)- BCR is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project or proposal. It is the ratio attempting to identify the relation between the expenditures and profits of the proposed project. It is also used to verify the feasibility of the project. If BCR is equal to or greater than 1, the proposed project is feasible. In case lesser, the proposed project is not feasible i.e. impossible to execute the project successfully.

$$BCR = (Benefits + Scarp\ value^{*}) / Expenditure$$
$$= (x+y)/z = (30+42)/54.7 = 1.32$$

* Scarp value is assumed to be zero

Since the Benefit cost ratio is more than one (i.e. BCR > 1), the proposed project is feasible for successful completion.

8. CONCLUSION

Every year, the amount of solid waste generated increases. In Pattukkottai municipality, current waste generation is 35 MT while in volume, it is 230 cu. m. It is necessary to implement effective SWM. Though it is little late, atleast by now, necessary actions to be taken to improve it. Major obstacle is funding which can be eliminated by nvolving private sector. By estimation of money required for implementation, it comes around 7.7 crore initially, among it fixed investment alone needs 4.8 crores. Analysis of internal and external positive factors of private entity & local people clearly depicts successful implementation of project. The contract put in-between government and private entity is BOOT for 20 years which gives more time for entity to come with innovative ideas for better service. Since fixation of user charge has been done based on the acceptance of people by survey, hopefully people will also give their part effectively. Financial analysis clearly shows the path by which entity has to travel profitably. So, they can produce their effect to the best. A brick has been laid to bring improvement in solid waste management while growth depends upon co-ordination of government, private entity and people.

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