INTEGRATED MANAGEMENT OF MUNICIPAL SOLID WASTE

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ABSTRACT

Solid waste management is associated with the control of waste generation, from its storage to disposal while satisfying the principles of public health and other environmental considerations. However, rapid population growth coupled with the increased rate of unplanned urbanization in Indian cities have led to the tremendous increase in the amounts of solid waste (MSW). Mismanagement of solid waste leads to public health risks, adverse environmental impacts and other socio-economic problems. The problems derived from solid waste have a unique and complicated character; they are not only a potential source of pollution, but they can be used as a secondary source of raw materials. Municipal solid waste management (MSWM) is considered a serious environmental challenge confronting local authorities and several city administrators have realized that the way they manage their solid wastes does not satisfy the objectives of sustainable development. Therefore, there is a move to shift from traditional solid waste management (SWM) options to more integrated solid waste management approaches. The selection of priorities regarding the solid waste management has direct economic and environmental impacts. This procedure concerns not only the environmental policy but also technological, economic and purchasing policies. However, the lack of adequate resources to implement the necessary changes is posing a serious obstacle. Environmentally sound solid waste management involves

1. *Segregation of waste at source (separate organic and inorganic - recyclable, reusable fractions);*
2. *Door to door collection of waste with incentive based mechanism to enhance segregation at source: This entails (i) deploying appropriate mobile collection vans (for each locality) with an option to store segregated and unsegregated wastes, (ii) incentive of Rs 1 per kg of segregated organic waste and payment directly to the respective household account through bank transfer – Jan Dhan scheme with Aadhaar linkage, (iii) dis-incentive to unsegregated waste – individuals who refuse to segregate needs to pay Rs 5 per kg of unsegregated waste. Revenue generation would encourage many households to switch over to segregation.*
3. *Collection trucks to have GPS (global positioning system) which would help in online tracking and also in reducing malpractices associated with waste management.*
4. *Transparency in the administration though online availability of spatial information system, accessible to all including public.*
5. *Eradicating waste mismanagement lobby - nexus of contractors-consultants-engineers. Successful elimination of the mismanagement lobby would help in solving the waste problem in any city.*
6. *Setting up waste processing yards with decentralised treatment of organic fraction of waste in each locality (stop using parks and recreation spaces for this purpose).*
7. *Encouraging youth to take up innovative waste treatment options (suitable to handle Indian waste- rich in organic fractions)*
8. *Only inert materials shall go to landfill locations.*
9. *Implementation of SWM 2016, GoI and penalising the city administrator in-charge of city waste for dereliction of duties in cases of mixed waste reaching the landfill site or littering of wastes in city open spaces.*

INTRODUCTION :

Small communities in the primeval societies used to bury solid waste just outside their settlement, discharge aqueous waste into the local waterbodies and release gaseous pollutants into the atmosphere. The increase in community size, necessitated a more organised form of waste management to minimize the environmental impacts as the quantity of pollutants exceeded the system's threshold. The stabilization of health issues at personal levels gave impetus to the community health issues. The earliest records show that the city of Mahenjo-Daro (Indus Valley) had organised solid waste management processes, Crete had trunk sewer systems by 2000 BC and the burning of soft coal in kilns in 1285 BC was banned to mitigate air pollution. Health and safety issues have been focus of waste management since early

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years (Ramachandra, 2011). The general public is more concerned with the effects that waste has on the environment while for the waste managers and planners the cost of collection, processing and disposal gains importance with the growing problem. Thus different waste management practices gained utmost importance as human activities exceeded the assimilative capacity of the biosphere (Ramachandra, 2006). The Government of India introduced statutory waste minimisation, treatment and environmentally sound management to address the earth's dwindling resources and the growing mountains of waste (The Solid Waste Management Rule 2016, Government of India).

Over the last few decades, India is finding hardships in managing the wastes; this is due to the changing life styles of people and their negligence, urbanization and the improper planning of government in these activities. The physical and chemical composition of Indian city refuse shows that 80% of it is compostable and ideal for biogas generation, moisture content of 50-55% and carbon-nitrogen ratio of 25-40:1. The quantum of wastes being generated in India is increasing due to increase in population and it is now nearly 300-480 gms/day. All the major cities of India is generating about 3500 tonnes of wastes per day on an average. The composition of the waste is 60-70% of it is organic matter and the recyclables ranges from 9.56% to 17.18%. Plastics had a quantum jump from 0.69-3.69% which is 500% increase in the past years which is hazardous for human environment and for ecology (Ramachandra and Shruthi, 2007). The waste disposal methods used in India is 90% of them are dumped in low-lying areas outside city/ town limits, which has no provision for treatment and leachate collection which is a huge disadvantage to the environment and damages the ecology severely by heavy metals entering underground water and landfill gas entering atmosphere etc. (Ramachandra and Shruthi, 2007; Shwetamala et al., 2014; Chanakya et al., 2015). Recycling is highly organised in India compared to other developed nations. 40-80% of plastics get recycled. However due to lack of government policies, incentives, subsidies, regulations, standards, et.c, the technology and quality of manufactured goods are still far behind its western counterparts. Nevertheless recycling has become a profit-making venture, though informal in nature. Health impacts are severe in India in the recent years due to negligence of municipal workers and absence of standards and norms for handling municipal wastes. Respiratory ailments, gastro-intestinal ailments, skin lesions, eye problems are found by a survey (Ramachandra et al., 2013). Environmental impacts include decrease in air quality, water quality, psychological stress, cancer incidence for those living near incinerators and land disposal facilities. Increases diseases due to mosquito breeding and due to chemical reactions of these waste, mutations are also happening in the bacteria which are also resulting in new kinds of diseases (Ramachandra et al., 2014). As human needs and activities overload the assimilative capacity of the biosphere, the debate on the sustainable waste management has become paramount. Advances in the environmental measurement techniques have shown that the current demand on the earth's resources is not sustainable and needs addressing immediately (Ramachandra, 2011; Ramachandra and Saira, 2003). Solid waste management has evolved greatly since its early days and it now considers an interrelated series of options aiming at waste source reduction, recycling, treatment and final disposal.

A system analysis approach has become necessary while considering many options available and a system model is desirable because of the interactions between many factors within a waste management system. In a system approach the problems are multidimensional and multidisciplinary and so the solutions must reflect this complexity. The multidimensional aspect includes the economic and environmental sectors. A systems approach requires a long-term perspective, and analysis may need to extend across geo-political borders (Ramachandra, 2006). Thus, systems analysis plays an important role for regionalization assessment of integrated solid waste management systems, providing the decision makers with breakthrough insights and risk-informed strategies.

Appropriate waste management policy should be on the principles of sustainable development, according to which society's refuse should not be regarded simply as something to eliminate but rather as a potential resource. Solid waste management facilities are crucial for environmental management and public health in urban regions. Due to the waste management hierarchy, one of the greatest challenges that organizations face today is to figure out how to diversify the treatment options, increase the reliability of infrastructure systems, and redistribution of waste streams among incineration, compost, recycling, and other facilities to their competitive advantage region wide. Techniques for solving regional waste problems inevitably have a large number of possible solutions due to variable population densities, incomes, multiple (actual and potential) locations for waste management infrastructure, protected landscape areas and high value ecological sites. This requires creation of an integrated waste management plan that makes full use of all available technologies. This would entail an increase in material recycling and energy recovery, and landfill disposal option only for inert materials and residues from recovery and recycling as shown in Figure 1. In this context, SWM 2016 (Government of India) stipulate the reduction of the present levels of waste generation and the increase in energy and material recovery, which represent two of the most important future requirements for environmentally-sound waste management practices. Landfill is generally recognized as the final destination of the refuse that cannot be further segregated or recovered in any other way.

Despite the development of strategic planning models, the descriptions of source separation strategies of recyclables are usually insufficient to enable calculation of the amounts of materials separately collected. The amount of a material separately collected in an area depends on two factors: (i) the coverage of a collection system applied and (ii) the separation activity of waste producers, consisting of participation rate and

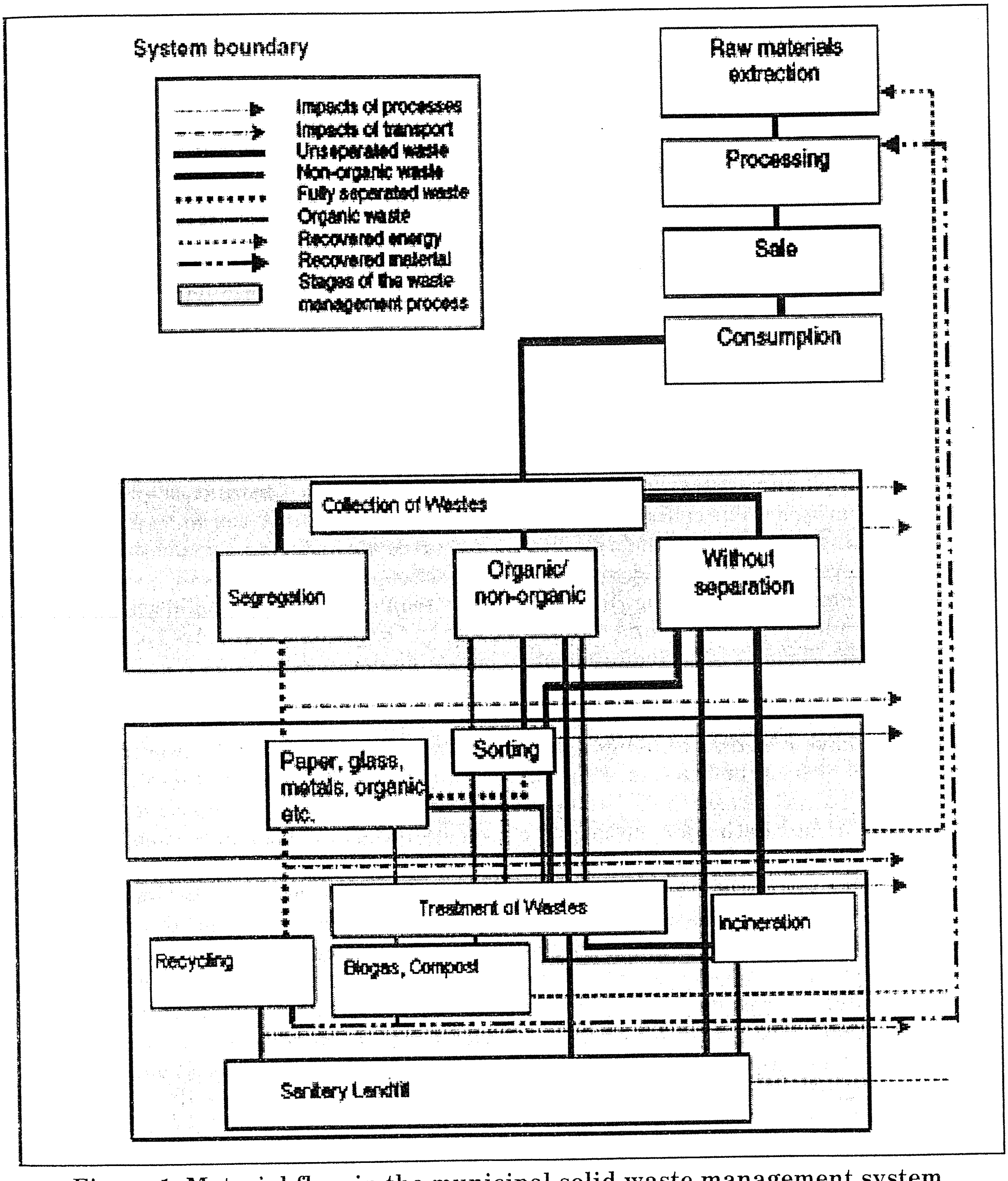

Figure 1: Material flow in the municipal solid waste management system

separation efficiency. The coverage of a collection system is defined as the ratio of (a) the amount of a material produced in those properties where separate collection is available and (b) the amount of the material in question produced in all properties of the area. Participation rate is defined as the share of people providing sorted material to bins in those places where this option is available. Separation efficiency is defined as the share of a material that is correctly separated by those participating in separation. In several strategic planning models, all of these factors have been ignored and the amounts of materials separated at the source are treated as input data. Solid waste management is particularly difficult and costly today due to the increasing volumes of waste and the need to control potential serious environmental and health effects of disposal. National planning for solid waste management is necessary for the development and implementation of a very long-term and reliable action. The current situation, which gives rise to the indiscriminate dumping of wastes, has a serious impact on air, land and water pollution and causes a dramatic increase in health hazards in the urban environment. In many cities non-governmental and community-based organisations (NGOs and CBOs) have started developing neighbourhood waste collection services as well as initiating composting and recycling activities. These moves are backed up by municipal solid waste management and handling rules (The Ministry of Environment, Forests and Climate Change, GOI, 2016). Among other requirements, this rule demands source segregation and waste recovery, the local authorities in charge of municipal bodies have a statutory obligation to collect and dispose of household waste. Efficient planning for municipal solid waste (MSW) management systems require accounting for the complete set of environmental effects and costs associated with the entire life cycle of the waste. Life cycle assessment (LCA) helps to evaluate the environmental burden associated with a product, process or activity and to consider opportunities that can effect environmental improvements. The International Organisation for Standardisation (ISO), a worldwide federation of national standards bodies, has standardised the framework on LCA. The main barriers include lack of awareness of the importance of using the life cycle concept, the quality of the data and a general lack of understanding of how to conduct the LCA correctly and interpret the results. The study indicated that integrated waste management would ultimately be the most efficient approach in terms of both economics and environment benefits (Ramachandra 2006; Ramachandra and Shruthi, 2007).

INTEGRATED SOLID WASTE MANAGEMENT SYSTEM : Integrated solid waste managemnt (ISWM) in its simplest sense incorporates the waste management hierarchy (Tchobanoglouset al., 1993; Ramachandra 2006) by considering direct impacts (transportation, collection, treatment and disposal of waste) and indirect impacts (use of waste materials and energy outside the waste management system). It is a framework that can be built on to optimize the existing systems, as well as to design and implement new waste management systems. ISWM is also a process of change that gradually brings in the management of wastes from all media (solid, liquid and gas). The collection of recyclable materials from households can reduce the emission of greenhouse gases. The use of recycled materials in place of virgin materials in production also leads to reduction in the demand for energy. IWSM also includes the fundamental issue of governance. It stresses the need for local bodies to be more aware of people's concerns and for citizens to be more involved in civic affairs. This highlights the need to develop a sound management structure, seek technical and institutional support, and possibly work more closely with the private sector in reclaiming the full value of the waste resource in order to finance and support the collection schemes.

Planning integrated solid waste management: Any city or town will be in need of an effective solid waste management system to ensure better human health and safety.

The system needs to be safe for workers and safeguard public health by preventing the spread of disease. In addition to these prerequisites, an effective solid waste management must be environmentally sustainable and economically feasible. It is quite difficult to minimise the environmental impacts and the cost simultaneously. The balance that needs to be struck is to reduce the overall environmental impacts of waste management as far as possible, within an acceptable level of cost. An economically and environmentally sustainable solid waste management system is effective if it follows an integrated approach i.e. it deals with all types of waste beginning from its generation to its disposal. The integrated approach must be based on a logical hierarchy of actions.

SOLID WASTE MANAGEMENT SITUATION IN BANGALORE :

Many corporation wards in Bangalore city are characterized by having a high degree of fermentable component in municipal solid wastes (MSW) from residential areas. These wastes are typified with low calorific value (800-1800 kCals/kg), high moisture content (50-80%, low net cal value), high proportion of organic matter (>60%) and low recyclable content such as paper, plastics, metals etc. The fermentable components of MSW are predominantly vegetable and fruit wastes that can range between 65 and 90% (Rajabapaiah 1998, Ramachandra and Saira 2003; Ramachandra 2006, 2011; Chanakya et al. 2007, 2009). As and when the city begins source segregation into fermentables, it is expected that a significant component of fermentable fraction will be produced and needs to be picked up on a daily basis. Only 68% of wastes generated is being collected by the agencies in Bangalore.

The quantum of waste generated in Bangalore city varies from 2300 to 3600 MT/day and the composition of waste is given in Table 1. The quantity is likely to grow in the next few years due to the increasing population and will present a formidable challenge to authorities unless an integrated approach is taken. As the daily per capita organic fraction of MSW production varies between 0.2-0.5kg (Ramachandra et al., 2013, 2014), depending upon lifestyles in the cities (indicated by city population). Thus, due to the small size of the total fermentable MSW generated at the household scale only composting and vermicomposting seem feasible at the household level. Many commercial and non-commercial devices for household composting and vermicomposting have been tried in Bangalore (Chanakya et al. 2007; Ramachandra 2006). Area or community scale options indicated above have been more successful in Bangalore and in various places in India. Area or zone wise collection has been shown to simplify collection systems and it enables collection of waste of similar composition (Sathishkumaret al. 2001). Leaf litter and garden waste, vegetable and fruit waste, domestic and kitchen waste, etc. thus are manually carted and treated at scales between 0.05-0.25 tpd scale. Composition of waste (Table 1) clearly shows the predominance of fermentable materials at all locations in the process of generation to its reaching the dump site. In the residential areas, parks and vegetable markets, the presence of a large fraction of fruit and vegetable waste (fermentable fraction, 70-90%) increases the moisture content of waste to about 70-80% (Shwetmala et al., 2014). When composting of such high moisture feedstock is attempted by the standard windrow method, there is excessive generation of leachates and its fermentation results in malodours. High levels of such waste arise even in the business districts where there is a concentration of fresh fruit juice vending shops in the area. Citrus fruit skins, pineapple cores, sugarcane bagasse, other fruit waste, etc. are generated in large quantities in certain pockets of the city. These form nearly 80% of the waste collection area (Sathishkumaret al. 2001). It is, therefore, important that such waste materials are treated rapidly in decentralized units and two options, namely, aerobic composting and biomethanation are available.

The steps, in order of priority, which must be taken for Bangalore are given below:

(i) Minimise the production of waste or source reduction: Source reduction is a basic solution to the garbage accumulation. Less waste means less of a waste problem. In many cases, source reduction can be done not necessarily by adopting a high technology but only by inculcation of better personal habits in the people. A reduction in the amount of waste can be achieved by change of consumption pattern and lifestyle, use of more recyclable materials,

Table 1: Composition of municipal solid waste at different stages

Components (%)	*Street bin, before rag picking*	*Street bin, after rag picking*	*Dump site*	*Bangalore overall*
Fermentables	65	78	70	72
Paper	8	4	11.4	11
Miscellaneous	12	15	8.7	1.9
Glass	6	1	0.5	1.4
Polythene /plastics	6	1.9	9.1	6.2
Metals	3	0.1	0.3	1
Dust and sweepings	NA	NA	NA	6.5

practice of waste segregation at source and change of manufacturing designs and packaging. Earlier studies indicate that nearly 20 percent reduction in waste generation is possible through simple housekeeping measure that requires no or marginal investment. Proper design and packaging of products with minimum volume of material and longer useful life can reduce the waste considerably.

(ii) Maximise waste recycling and reuse: Though recycling of solid wastes is extensively practised in Bangalore, the full official recognition of the need for promotion of recycling is yet to come. It is only in recent years that the role of this sector has received some attention. Municipal authorities should actively support recyclables at source schemes by strengthening the informal sector, for example by the provision of sites for sorting of recyclables or perhaps by developing bonus schemes for the workers in the informal sector. There are considerable benefits of increasing solid waste recycling and reuse. Source separation and recycling of waste reduces the volume of the waste to be disposed. Promoting recycling as an alternative to the existing forms of waste disposal may be economically gainful. Authorities may seek competitive bids as the recycling may be a profitable commercial operation generating a net income. Further, thousands of poor people may support themselves and their families by directly or indirectly participating in waste collection and recycling. Many organisations such as Clean Environs, Waste Wise and Centre for Environmental Education in Bangalore help street children and other unemployed people to collect waste from households and give them a right to sell it too.

(iii) Encourage waste processing at decntralied levels: Organic waste in Bangalore constitutes around 70 percent and is therefore amenable to composting and biogas generation for energy. It is a form of source reduction or waste prevention as the materials are completely diverted from the disposal facilities and require no management or transportation. Diverting such materials from the waste stream frees up dumping space for the material that cannot be composted. Currently composting is provided for only two markets in Bangalore which should be extended to other markets, hotels, restaurants, and households. Composting is quite viable if there is a market for compost. Thus a better understanding of the process, benefits to the environment and public education can promote the practice of composting at least in the cities where sites and skilled manpower are available and markets can be developed. It is also essential to provide basic training and education of workers in technical, health, and safety aspects. City municipality should compost garden and park waste to reduce the quantum of waste for final disposal. Many resident associations in Bangalore have set up their own composting plants. Biogasification is an excellent option in handling the organic wastes. Once the MSW is segregated into fermentable and non-fermentable fractions, even at a >90% efficiency of sorting, MSW becomes amenable for biogas production. Biogasification has several advantages like net energy output and low odour emissions during treatment. Digested material, compost, with or without a post-composting stage, is safe for disposal as manure. A study carried out at Centre for Sustainable Technologies (formerly ASTRA) at Indian Institute of Science revealed that plug flow digesters are very good for biogasification of MSW as it is an excellent feedstock for biogas production and has a very high gas production (both gas production rate as well as specific gas production) to warrant viable decentralized treatment by anaerobic fermentation to biogas. It also requires very little pre-treatment.

(iv) Promote safe disposal of wastes: Wastes are either burnt or dumped in open spaces and these practices should be restricted as they are deleterious to health and the environment. Landfilling occupies the lowest rung in the integrated waste management, though it is a better option than dumping the waste in open spaces. It relies on containment rather than treatment (for control) of wastes. The purpose of landfilling is to bury or alter the chemical composition of the wastes so that they do not pose any threat to the environment or public health. Landfills are not homogenous and are usually made up of cells in which a discrete volume of waste is kept isolated from adjacent waste cells by a suitable barrier. Commonly used barrier is a layer of natural soil (clay), which restricts downward or lateral escape of the waste constituents or leachate. Sanitary landfilling normally has a double liner to prevent leaching into the groundwater. Appropriate run-off controls, leachate collection and treatment, liners for protection of the groundwater (from contaminated leachate), biogas recovery mechanism (landfill gas contains high percentage of methane due to anaerobic decomposition of organic wastes), monitoring wells, and appropriate final cover design constitute integral components of an environmentally sound sanitary landfill. Proper and regular monitoring should be done at landfill sites.

v) Spatial Decision Support systems: GIS-GPS-MIS systems have proved to be efficient spatial decision support systems (Figure 2) for revolutionizing the waste management systems in Bangalore. A management information system (MIS) aids to manage large amount of spatial and attribute data related to the wards and generate reports (daily, weekly etc) at various levels (city, zone, range etc.) with details of the waste, types of vehicles etc. In Bangalore, trucks are the only means of removing garbage and other waste materials from the city. These vehicles perform multiple trips in a day and it is essential to monitor and track these trucks to improve efficiency. In this regard, global positioning system (GPS) would be helpful and cost effective. It also helps in optimising truck routes thereby increasing the efficiency of the transport mechanism. Analysis of spatial data i.e. land use and land cover pattern, transport network, collection network etc., along with information related to quantity and quality of wastes (through GIS: Geographic Information System) enable the authorities involved in waste management to come out with feasible options. These tools have been selected because 80% of information used by the health official has spatial components (city, zone, range and health ward level). Training can be imparted to its personnel in handling and updating the data.

The ISWM approach is designed to minimize the initial generation of waste materials through source reduction, then through reusing and recycling to further reduce the volume of the material being sent to landfills or incineration compared to the conventional approach of simply focusing on disposal of solid waste. Good municipal solid waste management practices require collection of critical information which is not just for keeping the records up to date but for taking corrective measures as well as proper planning for the future. There is also a need for integration and assimilation of information from various levels of jurisdiction. Thus, the strategic approaches for ISWM involve the integration of available data, guidelines and framework and elimination of the constraints. The main objective here is to arrive at a proper storage with least negative environmental impact, efficient collection system, engineered processing and disposal according to the constituents present in the waste stream. Analysis of spatial data, i.e. land use and land cover pattern, transport network, collection network etc., along with the information related to the quantity and quality of wastes (through Geographic Information System) enables the authorities involved in the solid waste management to come out with feasible options. To keep a city clean and maintain healthy environment, the administration has to adopt this approach and set goals for installations to reduce the amount of solid waste being generated, increase the solid waste diversion rate and comply with the existing regulations.

Focus of the ISWM program includes the following:

1. Asses present condition and organizational set up
2. Reduce, reuse and recycle solid waste to the greatest extent possible.
3. Cooperate to the extent practicable in recycling programs conducted by the civilian community (on installations that do not have recycling programs).
4. Pursue the use of joint or regional solid waste management programs and facilities with the government and non-government agencies.
5. Arrange for financial support towards infrastructure and maintenance
6. Facilitate community participation in solid waste management activities Intellectual input – research on design, materials, concept
7. Privatize solid waste management facilities or contract for waste disposal services, including recycling.
8. Divert 60% of non-hazardous solid waste from incineration and landfills. Integrated solid waste management programs can demonstrate an economic benefit (when compared with only landfill and incineration disposal).
9. Comply with applicable regulations regarding solid waste management and recycling.
10. Overall monitoring and coordination are to be exercised in a sustained manner.

CONCLUSION :

Rapid population growth coupled with the increased rate of unplanned urbanization in many cities of the developing world, led to the tremendous increase in the amounts of municipal solid waste (MSW). Mismanagement of solid waste leads to public

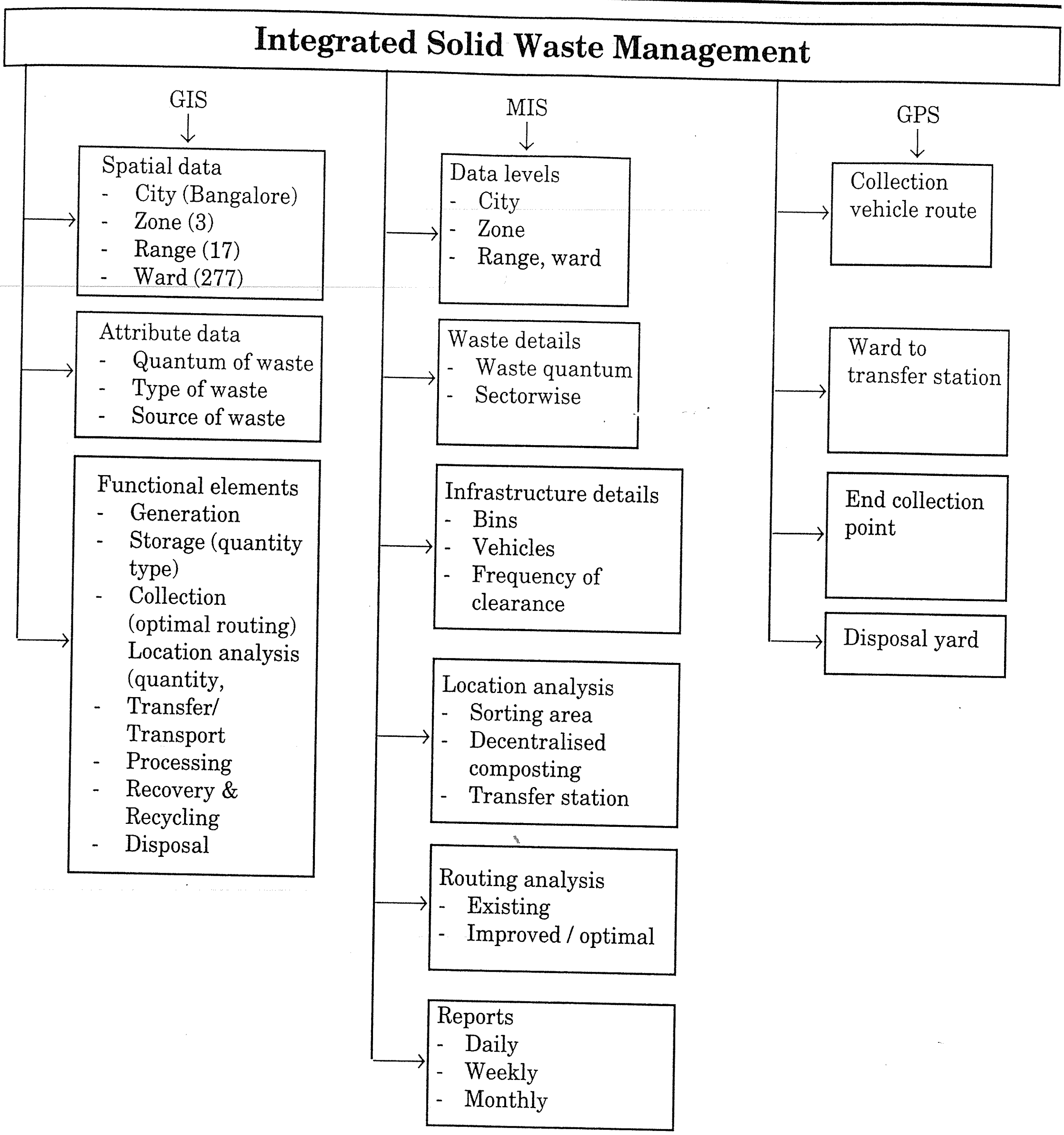

Figure 2 : Integrated solid waste management using Geographic Information System (GIS), Management Information System (MIS) and Global Positioning System (GPS)

health risks, adverse environmental impacts and other socio-economic problems. The problems derived from solid waste have a unique and complicated character; they are not only a potential source of pollution, but they can be used as a secondary source of raw materials. Municipal solid waste management (MSWM) is considered a serious environmental challenge confronting local authorities, especially in developing countries. Currently, several countries have realized that the way they manage their solid wastes does not satisfy the objectives of sustainable development. Therefore, there is a move to shift from traditional solid waste management (SWM) options to more integrated solid waste management approaches. The selection of priorities regarding the solid waste management has direct economic and environmental impacts. This procedure concerns not only the environmental policy but also technological, economic and purchasing policies. However, the lack of adequate resources to implement the necessary changes is posing a serious obstacle. The application of planning tools such as Geographic Information System and Geospatial modelling for integrated management of municipal solid waste aided to conserve both natural and man-made resources while achieving economic viability through sustainable options in management and averting ecological risks. Developments in the waste management systems in Bangalore is slow paced nevertheless a sincere one; however it needs upgradation in the areas of processing and disposal. Political and financial hurdles and lack of cooperation by the public in general has created bottlenecks in improving it's efficiency. The potential of community participation, human resource development and legal mandates has to be realised and subsequent changes brought about. Adoptions of latest spatial analytical technologies such as MIS-GPS-GIS system have to be taken into consideration while developing a waste management system for Bangalore. The study on IISc campus can be used as a model for the wards in Bangalore. However for any waste management to be successful, the government should step up and take the required initiatives. Even though financial constraints are a part of the system, the government can make a formal and sincere commitment for an integrated SWM approach, fully recognising the advantages of the existing informal recycling network. Waste recycling can be promoted through consumer campaigns that will encourage citizens to co-operate in waste separation and to purchase recycled products. Also, waste authorities should encourage composting and biogas generation of wastes, which will reduce the volume of waste to be disposed of. Finally, no SWM can be effective without proper monitoring of its disposal activities. Therefore its effectiveness should be tested on a regular basis. Environmentally sound solid waste management involves

1. Enhancement of awareness among public about mishandling of waste;
2. Segregation of waste at source (separate organic and inorganic - recyclable, reusable fractions);
3. Door to door collection of waste with incentive based mechanism to enhance segregation at source: This entails (i) deploying appropriate mobile collection vans (for each locality) with an option to store segregated and unsegregated wastes, (ii) incentive of Rs 1 per kg of segregated organic waste and payment directly to the respective household account through bank transfer – Jan Dhan scheme with Aadhaar linkage,
   a. dis-incentive to unsegregated waste – individuals who refuse to segregate need to pay Rs 5 per kg of unsegregated waste. Revenue generation would encourage many households to switch over to segregation.
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7. Setting up waste processing yards with decentralised treatment of organic fraction of waste in each locality (stop using parks and recreation spaces for this purpose).
8. Encouraging youth to take up innovative waste treatment options (suitable to handle Indian waste — rich in organic fractions)
9. Only inert materials shall go to landfill locations.
10. Implementation of SWM 2016, GoI at all levels and penalising the city administrator (in-charge of city waste) for dereliction of duties in cases of mixed waste reaching the landfill site or littering of waste's in city open spaces.

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