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SOLID WASTE MANAGEMENT-A STEP TOWARDS SUSTAINABLE DEVELOPMENT

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Abstract

Rapid population growth, urbanization and industrialization has led to severe waste management problem around the world. Sustainable development has become the key element in the work of national and international companies. From this perspective along with production the focus is more and more on protecting the environment and society. So, waste management is a sensitive area for organizations. Solid waste management is the process of controlling and reducing the volume and toxicity of solid wastes through the proper collection, treatment, and disposal. Sustainability is environmentalism that seeks to use natural resources while minimizing negative impacts on the environment. Solid waste management is a growing problem around the world. The size of the problem and the lack of sustainable solutions is causing pollution, energy shortages and health problems. The key to sustainable development is finding ways to reduce the amount of solid waste that is produced. This can be done by changing how people use resources, encouraging reduction, reusing, recycling and composting, or developing new technologies. Sustainable solid waste management can save municipalities money, reduce greenhouse gas emissions, improve public health, and create job opportunities. It can also help communities meet their legal obligations to protect water resources and improve air quality. So, there is a need to develop strategies to reduce, recycle and reuse it. Waste can be turned in to a resource with proper management.
Key words: Sustainable development, Solid waste, management, Resources, Recycling.

INTRODUCTION

India is having second largest population in the world after China with more than 1.27 billion population contributing 17.6% of world's total population (Official population clock). On the contrary, India is sharing only 5% of world's area accounting 3,185,263 km. Out of total population, 68% lives in rural areas, while 32% lives in urban areas (World Bank, 2014). Urban population is increasing day by day since last few decades. In modern society, industry becomes an essential part. Large number of people is migrating towards city area for better opportunities Socio-economic changes like population pressure, industrialization, migration and urbanization within vibrant society of India has led a significant increase in municipal solid wastes in India. Overall solid waste from most cities is collected and stored in landfills, where it attracts flying creatures, rodents, and bugs, resulting in unsanitary conditions and release CO2, CH4, and other obnoxious gases. Furthermore, open dump sites affect the quality of drinking water and contribute to illness such as cholera (Chaturvedi and Singh, 2021). Even the most developed metropolitan areas and super urban areas in India lack efficient and effective trash collection, segregation and treatment facilities (Chauhan et al., 2021)

The key to effective waste management is to make sure proper collection and segregation at the source (Rakib et al., 2021) and that the garbage passes through various recycling and recovery channels. Unsegregated municipal solid trash has become a difficult problem for India (Shukla et al., 2021). The SWM system has several issues with waste treatment options such as composting, recycling and energy generation (Joshi and Ahmed, 2016). If the existing SWM system does not offer the solution to these problems, the entire mixed waste will end up at dumpsites and therefore causing the SWM system to be dependent upon landfill sites (Ahluwalia and Patel, 2018). A huge amount of dumped municipal solid waste (MSW) is becoming the main reason for groundwater pollution, soil contamination, and environmental pollution (Kanhai et al., 2021). About 80 percent of the total generated waste is being collected by various means while the rest 20 percent is again mixed up and lost in the urban environment. About half of the total trash generated is sorted at the source and is amenable to further processing. As a result, approximately 40 percent of the total generated trash is treated in the existing SWM system, with the remainder deposited into landfill sites (Shukla et al., 2021). The majority of the time, garbage sorting is done by the unorganized sector (Kumar and Agarwal, 2020).

The segregation and sorting process is carried out in extremely hazardous and unsafe conditions and the effectiveness of segregation is logically low because the unorganised sector segregates only the most important disposed of constituents from the waste stream, which can offer them a higher monetary return in the reusing market (Shukla et al., 2021). Due to a lack of space for inventory many waste processing industries are utilizing the waste from the dumpsite, which essentially contains mixed waste. This leads to an increase in the cost of waste processing and poor quality of recyclable materials and compost. Approximately 80% municipal solid waste (MSW) gets collected and only 28% is used. Currently, India produces approximately 70 Mt MSW per year and by 2030 it will reach 165 Mt if the pace is continuing, it could be reached around 436 Mt by 2050 (Planning Commission Report, 2014). Continuous and indiscriminate disposal of MSW is linked to unscientific utilization, urbanization, population rate, and ethics of living and lack of ecological responsiveness. Open dumping of MSW causes severe negative impacts on all aspects of the environment and human health (Sharholy et al., 2005). Unscientific assemblage and improper transportation are mainly linked to the accumulation of MSW everywhere. This is imperative to the sustainable management of MSW and is one of the main environmental problems of Indian mega cities. It also involves activities relevant to the generation, storage, collection, transfer and transport, processing and disposal of solid wastes. Organic fraction of MSW is about 48–50%, which is becoming a serious challenge in the country (Annepu, 2012; Meena et al., 2022).

Environmental pollution, human health risk, and shortage of disposed area are the main cause of its improper disposal. MSW in Indian mega- cities is largely pre disposed in the landfill; nevertheless, a very less fraction of MSW (6–7%) is to be used for composting (Annepu, 2012). Therefore, effective management of solid waste is major issue for cities having high population density. The informal sector played an important role in extracting values from MSW, with about 90% of residual waste dumped than appropriate landfilling. There is a need of the day for scientific sustainable management of SW, which requires an advanced management system and infrastructure. Present technologies for the management of solid waste are incompetent and have a negative impact on human health, environment and the economy of the country. In recent years, it is the need of the hour to prepare strategic and detailed management of SWM plans by the urban local bodies (ULBs) and proper collection, segregation and disposal at rural localities. Production potential of MSW in India Population pressure is a major contributing factor to increasing quantities of MSW. It includes residential, municipal, mining, agricultural, industrial etc. Classification of solid waste Solid wastes can be categorized based on its source, composition, phase, treatment and others. Rubbish may include a variety of materials which may be combustible (paper, plastic etc.) or incombustible (glass, metal etc.). There are special wastes such as construction debris, leaves and street litter, abandoned automobiles, and old appliances that are collected and managed separately. It consists of organic matter (51%), recyclables (17.5%) and others i.e., inert (31%) (Annepu, 2012). Notably, the actual composition may differ due to the informal separation of recycling wastes at the source.

Solid waste is being generated due to various household activities and other commercial & institutional activities (CPCB, 2012). Municipal waste and certain industrial waste have comparatively significant impact on environment. A substantial amount of these wastes is extremely dangerous to the living organisms including human beings (Misra and Pandey, 2005). It may downgrade groundwater quality by leachate percolation and also cause air pollution by emission of greenhouse gases through various course of treatment. Nowadays, E-waste and nuclear waste are other waste streams which are requiring attention due to fastest growing electronics & nuclear sector. To overcome this problem, effective solid waste management must be implemented. The objectives of solid waste management are to control, collect, process, utilize and dispose of solid wastes in such an economical way which protects health of human being and natural environment. Proper management strategies will generate resources and employment opportunities. In this regard, in 1989, the U.S. Environmental Protection Agency (U.S. EPA) adopted hierarchy of waste management practices. The elements of hierarchy are as Source reduction, Recycling of materials, Combustion and Landfilling.

In India, initially there has not been much awareness about solid waste management and its hierarchy. However, since last few years, the scenario of solid waste management has been changing continuously. Still, there is a long way to implement an effective solid waste management practice. Even today, only few portions of solid waste generated is disposed through proper treatment. Lack of waste segregation is the biggest obstacle in implementing effective solid waste management. Though, Plastic and paper recycling sector is growing due to huge market demand for these commodities. Improper collection, unavailability of transportation in some areas, lack of advancements in treatment technologies, financial shortage in municipalities are other factors for poor solid waste management practices. It is important to recognize the fact that there are varying degrees of hazards associated with different waste streams and there is economic advantage for ranking wastes according to the level of hazards they present (Misra and Pandey, 2005). In this study, comprehensive review regarding Issues Challenges and opportunities associated with SWM has been provided. It also summarizes future trends to make SWM effective.

TYPES OF SOLID WASTE

It includes industrial, mining, municipal and agricultural wastes. It mainly consists of a large organic matter, ash and fine earth, paper and plastic, glass and metals (Sharholy et al., 2006). Composition of solid waste however varies depending on various factors such as weather, living standards, locality etc. Solid waste can be classified in many ways according to its source, composition, phase, treatment required etc. Wastes on basis of its source it includes residential, municipal, mining, agricultural, industrial etc.

- ***Residential waste:*** Household activities, Food waste, paper, cardboard, plastics, wood, glass, metals, electronic items etc.
- ***Industrial waste:*** Released from manufacturing units, power plants, process industries etc. Types of waste include housekeeping wastes, hazardous wastes, ashes, and special wastes depending upon the manufacturing unit.
- ***Commercial & Institutional waste:*** Source of this kind of wastes are Hotels, restaurants, markets, office buildings, schools, hospitals, prisons etc. Types of waste generated are bio-medical waste, food waste, glass, metals, plastic, paper, special wastes etc.
- ***Construction and Demolition:*** New construction sites, demolition of existing structures, road repair etc. generate wood, steel, concrete, dust etc.
- ***Municipal services***: Services like street cleaning, landscaping, parks and other recreational areas, water and wastewater treatment plants produce tree trimmings, general wastes, sludge etc.
- ***Agriculture:*** In agriculture waste contributors are Crops, orchards, vineyards, dairies, farm etc. Agricultural wastes include hazardous wastes such as pesticides.
- ***Mining***: Open-cast mining, underground mining produce mainly inert materials such as ash. Solid waste can be classified into putrescible solid wastes as garbage and non-putrescible wastes as rubbish. There are special wastes such as construction debris, leaves and street litter, abandoned automobiles, and old appliances that are collected and managed separately. It consists of organic matter (51%), recyclables (17.5%) and

others i.e., inert (31%) (Annepu, 2012). It should be noted that actual composition may differ due to informal separation of recycling wastes at source. The main concern is regarding municipal waste management as the waste collected from all other areas are also sold by the kabadis in the cities to the collection, segregation or recycling units.

SOLID WASTE MANAGEMENT

Solid Waste Management Rules, 2016 stipulate that the local authorities shall prepare a strategic plan for solid waste management, as per state policy and strategies on solid waste management within six months from the date of notification of state policy and strategy and submit a copy to respective departments of State Government/Union territory administration or agency authorized by the State Government/Union territory administration. These rules have been revised after sixteen years. Solid waste management is mandatory function of municipal; it is compulsory for all municipal authorities to execute this service effectively to maintain cleanness in the cities and towns, as well as to dispose the solid waste management in an environmentally well acceptable manner, complying with the solid waste management Rules, 2016.

Integrated solid waste management system (ISWM): Integrated solid waste management (ISWM) basically depends upon the characteristics and quantities of solid waste produced in ULBs, financial liabilities and capabilities of authorities to effective project implementation. ISWM provides a framework to develop a sustainable system approach that should be economical, socially well acceptable as well as environmentally efficient and effective. ISWM system involves several treatment techniques and functioning of system for effective collection and sorting of MSW for improving social, economic, and environmental conditions of the municipality. Based on 3R concept ISWM is very much relevant to the 3R approach emphasizing on the importance of waste reduction, reuse and recycling over other forms of waste processing.

WASTE COLLECTION AND TRANSPORTATION

In early 1980s solid waste generation and management was paid very little attention. But, implementation of Hazardous Waste Management Rules (1989) under Environment Protection Act - 1986 has changed the attitude of government and local authorities. According to Municipal Waste Management Rules (2000), it is the responsibility of municipalities to prohibit littering of solid waste in cities, towns and in urban areas notified by governments. To facilitate compliance, municipal authority has to organize house to house collection through any of the methods- Community bin collection; House to house collection; Collection on regular time interval (which must be pre-informed); Scheduling by using bell ringing of musical vehicle (without exceeding the noise levels).

To increase collection efficiency, the integration of these methods is required (Talyan et al., 2008). The transportation of municipal solid waste is generally carried out twice in a week or weekly basis by container carriers. However, in small towns and rural areas, open trucks, dumper trucks are used for waste collection. In recent times, with support of NGO and local communities, waste collection efficiency has increased remarkably in few rural areas. Since collection costs are 50-70% of solid waste budget, it is the most significant area for cost reductions.

Waste segregation: Waste segregation has been considered as the biggest obstacle to effective solid waste management. Waste segregation is popularly used by developed countries, but countries like India mostly collect MSW in a mixed form. Reasons for this can be attributed to a lack of public awareness and less advancement in source separation techniques. Source separation is essential to increase recycling effectively and efficiently, this improves the performance of waste treatment units due to good quality of feed and lesser number of impurities. The following are some of the most crucial waste segregation criteria:

- *Segregation at source:* segregation at source is the first and most crucial waste management principle. Garbage separation at the source ought to be practiced at home, in schools, offices, and markets. Separate bins can be used to dispose of trash.
- *Different treatments for various solid waste types:* one must use the methods that are appropriate for the particular type of trash. For instance, a technique that works for waste from general markets might not work for waste from slaughterhouses.
- *Treatment at the closest location:* the treatment of solid waste should be as decentralized as feasible. The best place to treat the waste produced is at the place where it was created, which is every home.
- *Reduce:* The use of green elements as raw materials, extension of waste life cycle, reducing energy, optimum design and heat losses, replaces of raw materials can help to reduce the amount of waste generation. The 'Reduce' step has been considered the top-ranking step of MSW management due to effectively in reducing economical costs and environmental impacts associated with handling.
- *Reuse:* Reuse means usage (or utilization) of a product in the same application for which it was originally used. This involves disassembling the product, cleaning and refurbishing the useful parts and stocking those parts in inventory.
- *Recycling:* The recovery of materials is given second priority in the solid waste management hierarchy after source reduction. Recycling includes the collection and separation of recyclables and processing them into useful raw materials for other products. This step can be classified as pre-consumer and post-consumer recyclable materials. Integrated solid waste management hierarchy ranks according to their environmental benefits (CPHEEO, 2000).

- *Source reduction and reuse:* The most preferred route for waste management in the ISWM hierarchy has been reducing the generation of waste at various stages including design, production, packaging, use, and reuse of products. Waste prevention helps to reduce handling, treatment, and disposal costs and various environmental impacts such as leachate, air emissions, and generation of GHGs. Minimization of waste generation at source and reuse of products are the most preferred waste prevention strategies.
- *Waste to energy:* Where material recovery from waste is not possible, energy recovery from waste through the production of heat, electricity, or fuel is preferred. All over the world, landfills which integrate the capture and use of methane are preferred over landfills which do not capture the landfill gas. As per the hierarchy, the least preferred option is the disposal of waste in open dumpsites. In cases where old dumps are to be closed, there is a possibility of capturing methane gas for further use.

Municipal solid waste management in India: India seriously revetment the resource and technical expertise which are necessary to handle huge quantities of solid waste disposal (Kausal et al., 2012). Fortunately, India has leading innovative techniques of waste disposal which are being used, composting (aerobic composting and vermicomposting) and waste to energy (WtE) (incineration, palletisation, bio-methanation). An incineration and bio methanation type of waste-to- energy system of solid waste disposal has also been worked in India but contributes at a minor level in the present scenario.

BARRIERS FOR SUSTAINABLE MSW MANAGEMENT:

These are some of the common barriers to sustainable MSW management across the globe. These barriers are common for all countries, although the number and extent of obstacles may be different.

- ***Technical and physical barriers:*** Lack of waste collecting points, irregularity of waste collection, inadequate waste collection vehicles, inadequate access to waste bins, alternatives to final waste disposal (burning and illegal dumping), improper waste separation facilities, the volume of waste, space limitations etc. create technical and physical barriers for sustainable MSW management.
- ***Organizational barriers:*** Lack of planning and strategy, inadequate policy, lack of people's engagement with programs, poor public communication, lack of information, inappropriate media etc. stand against sustainable MSW management.
- ***Socio-cultural barriers:*** Lack of participation, lack of engagement with waste separation activities, lack of cooperation, negative attitudes, lack of concern for waste management, insufficient communication etc. initiate problems for sustainable MSW management.

- ***Financial barriers:*** Waste management fee collection, insufficient funding, "waste has no value" concept, lack of private players, a poor income of people etc. provide financial barriers to sustainable MSW management.
- ***Legal and political barriers:*** Inadequate and weak legislation, conflicting interests among participants, population growth etc. are the major legal and political barriers to sustainable MSW management.

METHODS/TECHNOLOGIES FOR SOLID WASTE TREATMENT

The objective of waste treatment is to improve physical and/or chemical characteristics of waste, reduce toxicity and reduce its final volume (Misra and Pandey, 2005). In India, different treatment methods are practiced depending on the type of waste. They are characterized by their capacity to treat specific type of waste, residues generation, cost, risk associated, safety and other environmental aspects. The various treatment methods practiced for MSW and other similar type of waste are Composting, landfills, Thermal processes (incineration, pyrolysis) etc. However, the same is not effective for hazardous industrial waste. There must be separate consideration to handle hazardous waste. Common methods which are adopted for hazardous waste are chemical fixation, volume reduction, detoxification, degradation, encapsulation etc. (Dawson and Mercer, 1986).

- **Composting:** Composting is the decomposition of organic matter by microorganisms in warm, moist, aerobic and anaerobic environments. Therefore, composting of MSW is the simplest and most cost-effective technology for treating the organic fraction of MSW (Meena et al., 2019). Scientific disposal of MSW is essential to reduce its pollution potential and several recycling methods are proposed for this purpose. During aerobic composting, aerobic microorganisms oxidize organic compounds to Carbon di oxide, Nitrite and Nitrate. In anaerobic decomposition, the anaerobic microorganisms metabolizing the nutrients, also breaks down the organic compounds via process of reduction. Recently, composting of MSW is being encouraged and used by researchers and farmers for sustainable crop production across the world (Gautam et al., 2010). Composting in the frame of integrated MSW management, the most accepted option of integrated solid waste management (ISWM) strategy i.e., adoption of resource recovery strategies and composting, ensures that waste is processed appropriately to facilitate further use of the material. Processing of MSW by this process yields humus rich compost (organic manure) along with macronutrients and micronutrients for plants. And with more and more operating plants, the bulk of the compost had to be sold to the farmers, who could not afford it. The number of quality parameters to evaluate the compost maturity: physical, chemical and biological, including microbial activity, C/N ratio, pH, EC, CEC, organic chemical constituents, reactive carbon, humification parameters, temperature, color, odor, structure, specific gravity, plant assays, respiration, enzyme activity and others (Bazrafshan et al., 2016).

- **Vermicomposting:** Organic fractions or biodegradable portions of waste can easily convert into nutrient enriched products by worms. In composting heat is generated during the composting process, which is very harmful and would kill the worms; whereas in a vermicomposting, a conducive environment is maintained thus worms thrive and reproduce very well. In vermicomposting, worms properly processed an organic fraction of waste excreting them as an organic material which is well matured and contains high amount of plant available nutrients. As far as nutrient concentration is concerned vermicompost is much higher than ordinary composts (Srinivasarao et al., 2014).
- **Aerobic Digestion:** As name suggest, aerobic composting means bacterial conversion of organics in presence of air. It yields compost as final product which is extensively used as fertilizer. It can reduce waste volume to 50-85%. Mechanical controlled plants are being installed in metropolitan cities, while manually control plants are set in relatively smaller urban township (Bhide and Shekdar, 1998).
- **Biomethanation:** It is the process of conversion of organic matter into stable, inert residue by microorganisms in the oxygen-free environment. It yields methane-rich biogas which can be used for electricity, cooking and inert residue which can be used as manure. Microorganisms used in this process are known as methanogens. The biggest advantage of biomethanation is that it can reduce the release amount of methane – a powerful greenhouse gas and simultaneously generates electricity. Another important aspect of this technology is its relevant use in rural areas for cooking foods (Annepu, 2012). There are several bio-methanation technologies have been executed in various cities for vegetable wastes and fruit waste (Prakash and Singh, 2013).
- **Incineration:** Treatment of waste by the thermal process in which raw waste materials can be recycled as feed stock known as incineration (Zaman, 2010). Incineration contrasts the bio-methanation process; it occurs in the presence of air at 850 °C temperature, and are converted into CO2, water and non-combustible product along with solid residues (DEFRA, 2007; Zaman, 2010). Incineration reduces the final waste up to 75% approximately. This process releases large amount of heat which if recovered properly can turn out to be a potential source of energy generation (Tan et al., 2015). Bio-medical waste and certain toxic industrial waste are also treated by this method having small capacity incinerators (Sharholy et al., 2005). In most of the Indian cities, incineration is less common due to solid waste composition i.e., high organic matter, high moisture content, presence of inert material and low calorific value (800 to 1100 kcal/kg). Calorific value must fall between 1200-1400 kcal/kg for energy generation (Talyan et al., 2008). However, modification in design of incinerator and scientific waste management leads to avail large scope of this technology in recent times. Delhi was the first city to have MSW incineration plant. In 1987, But, its poor performance led to shut down of plant after 6 months of operation. The disadvantage

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with this process is that it releases compounds containing Sulphur, nitrogen and halogens deteriorating air quality. To overcome the problem, scrubbing, filtering is used to dilute concentrations to acceptable level prior to release into atmosphere (Misra and Pandey, 2005).

- **Pyrolysis:** Pyrolysis is an effective waste-to-energy concept refers to destructive distillation of the solid waste to recover its constituents and energy. In other words, pyrolysis is a thermal degradation process in absence of air which yields recyclable products such as char, oil/wax and combustible gases (Chen et al., 2014). It is generally preferred for treatment of waste having less moisture content like paper, cloth, plastic; yard wastes etc. as waste containing high moisture content require more heat supply. In this process, the solid waste is heated in a pyrolysis reactor at 600-1000 °C which yields oil phase i.e., methanol, acetone, acetic acid etc.; gaseous phase i.e., H_2, CH_4, CO, CO_2 etc. and solid phase i.e., carbon char and inert materials. Various reactors employed for pyrolysis are fixed bed reactor, rotary kiln, fluidized bed reactor and other innovative reactors. It depends on various factors such as temperature, heating rate, residence time in reactor zone, material size etc. (Chen et. al, 2014). The biggest advantage of pyrolysis over incineration is very little effect to environment in terms of air pollution. Though, high initial cost and operation cost make this process difficult to emerge as commercially sound practice.
- **Landfilling:** Landfilling has been the most convenient way to dispose municipal solid waste in low-laying areas. Penetration of leachates from landfills poses very serious problem for crops grown near landfills, the leachates can contaminate the ground water and ultimately it might be taken up by plants. Landfilling sites produce harmful gases and leachate, thus there is a possibility to harm human and natural eco- systems. Methanogens degrade the complex molecules in landfill of waste, and produced CH_4 and CO_2 (90%), leachates released from landfills can cause surface and ground water pollution. Landfills In India like many developing countries, waste is disposed in an open area without any precautions. Open dumping of solid waste leads percolation of leachate to underground water and gas emissions resulting into excessive air pollution. It also disturbs aesthetic surrounding by its odors. Various study reported that groundwater of residential areas near landfills is significantly contaminated by leachate percolation. NEERI (1996) reported that only 25-30% gas can be recovered in the absence of base liner and top covering. Compaction, leveling of waste and final covering by earth materials are rarely observed practice in these waste handling sites (Talyan et al., 2008; Sharholy et al., 2007). To overcome this problem, secure and sanitary landfill must be included in landfilling practices. But their efficiency towards pollution reduction is still a matter of concern. Considering rapidly increasing waste generation, the land requirement will increase in coming years in urban areas. As secure landfilling is expected to be the ultimate disposal option which receives residues

remained after other treatments, further improvements in its design and planning are necessary (Sharholy et al., 2008). Landfill should be provided composite liners to restrict leachate percolation to underground water level. It must be equipped with proper collecting and ventilating system in order to recover gas produced. Under the MSW rules, Government of India has made it mandatory to install Land Fill Gas (LFG) control system. LFG should be used either for energy generation or direct recovery of heat or should be flared to avoid air quality degradation (Talyan et al., 2008).

RESULTS AND DISCUSSION

There is an urgent need to implement the provisions of Municipal Solid Waste Rules2000 adequately. Poor waste management practice must be shifted to scientific approach. Waste Collection and Waste Segregation are two components of ISWM which require prior attention and can open up market for waste management sector. However, for source reduction, public awareness is equally important. The amount of waste remaining after treatment should be disposed of in closed landfills. Not only in urban cities, Effective Solid Waste Management should be implemented to rural areas as well. However, in recent years, government with support of local authorities has accelerated the implementation of better waste management practices. Various NGOs play a vital role in spreading awareness among public and involve citizens for better waste management practices. The most recent initiative is 'Swachchh Bharat Abhiyan', also known as 'Clean India Mission'. One of the objectives of this initiative is to aware citizens about the importance of proper waste management approach. It aims to involve citizens in the campaign of Clean India & to clean urban cities and also rural areas with public support. Government has also changed its policies to make waste management sector open for private companies, Public Private Partnership (PPP) model has been practiced for various services such as collection, transportation, treatment, development of landfill sites, operation and maintenance of units etc. PPP model can help to generate and increase revenues and eventually competency level which are essential for effective solid waste management. However, lack of finance, institutional deficiency and lack of public support are main barriers to effective solid waste management. The local bodies should be provided support in terms of finance & involvement in decision making so that they can effectively decentralize their responsibilities and develop business atmosphere among private sector.

CONCLUSION

Measures mentioned in MSW rules and ISWM must be implemented. Time has come to encourage technology-based entrepreneurship to achieve effective solid waste management. NGOs should be involved in various components of waste management including public awareness. When we don't plan, we plan to fail hence we have to handle this issue on multiple fronts simultaneously. The involvement of all stakeholders will be crucial to SWM. Awareness should be created among citizens regarding their importance in contributing towards handling the menace of growing Waste. As they are the end user so their contribution holds the key here. Community level participation will have long-lasting implications not only in the present scenario but also for the future generation. Investment in scientific innovations to develop sustainable methods or enhance the efficacy of present available options should be increased. This step will boost the efficient waste management. The financial condition of ULBs in India needs drastic improvement. This improvement can be done through channelizing more resources towards ULBs as per the recommendation of the financial commission or generating fiscal avenues for the self-reliance of ULBs. State capacity has been limited over the period of time so involvement of the private sector will complement the efforts of the state.

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