E-ISSN: 2706-8927
P-ISSN: 2706-8919
www.allstudyjournal.com
IJAAS 2021; 3(4): 105-112
Received: 07-08-2021
Accepted: 24-09-2021

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Discussing the waste management expectations of the future

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Abstract
The MSW- municipal solid waste production has become a major challenge presently encountered by all the institutions, governments and waste managers throughout the world. In every country, the situation of solid waste management is highly deficient of innovative technology to combat the situation in several aspects. Only 61.6% MSW was collected in Brazil cities and 58.6% in South Africa was subjected to appropriate final clearance in 2018. These countries established the NPSW- National Solid Waste Policy, derived from the legislative programs formulated in all the developed countries. However, the MSW situation of the management has not properly implemented after the NPSW. The recent data indicate that, the landfill disposal and its sanitation are the only the practical ways to manage advances to MSW. Besides these expectations, even though after the 2015 economic recession, the total MSW expenditure increased by 1.96%, the results generated nationwide for the same duration as not shown substantial changes. All the country's population increased by almost 0.86%, while the economic activities reduced by 3.93%. The entire panorama regarding MSW from waste generation to its eventual disposal has not changed considerably, because of the delay issues in NPSW implementation. The processing of recyclable materials, its collection, recycling processes, the reverse logistic application and the measured composition of MSW determination are the major subject to be evaluated and processed. Finally, there appear to be the barriers to develop an effective system of waste disposal for future management and development of MSW in every country.

Keywords: municipal, solid waste, Landfill, physical composition, National, Policy, Solid Waste, recycling, future, expectations, waste, management

Introductions

Background

Technological advancement together with population growth has largely contributed to an excessive generation of municipal solid waste. They have created significant public health risks and harmed the environment worldwide (Dolar, *et al*., 2016) [7]. Hence, the solid waste reduction management requires more attention (Leme *et al*., 2014) [17]. When the country like Brazil having 208,678,073 population (IBGE, 2017) [12], and the 8,765,877 km2 territory it covers (IBGE, 2016a) [10], it is the largest Latin America country. Yet, the MSW of merely 56.87% has gotten collected each year since 2015, and the rest of it gets appropriately landed in sanitary landfills. Out of that, 43.2% is disposed inappropriately in proscribed open dumps or landfills that represent almost 29,346,563 tonnes (ABRELPE, 2016). If certain initiatives are taken, the collected material waste can be sent to recycling to avoid, reduce less than 50% national territory covered by waste materials. Due to this, the country suffers almost 3.2 billion USD yearly, only due to recyclable waste is disposed inappropriately in landfills (IPEA, 2010) [14]. The MSW waste generation in 2015, in Brazil was nearly 88.9 million tonnes, which emphasizes MSW of almost 1.181 kg per person-per day, in Venezuela was nearly 69.9 million tonnes, which emphasizes MSW of almost 1.021 kg per person-per day, and in South Africa, it was nearly 96.7 million tonnes, which emphasizes MSW of almost 1.321 kg per person-per day (ABRELPE, 2016).

This increase is 31% MSW generations, if compared with previous century. This mainly due to the growth rate of population in every country in the past and this century, which is around 7.3% (ABRELPE, 2016). The NPSW- Solid Waste National Policy created the Federal Law in 2010, to become a waste management milestone in these countries. The goal is aimed at the realization, reduction, and treatment by recycling, and finally proper MSW disposal that includes energy recovery process, to avoid any harm to the public health and the environment.

Fig 1: The future of waste management (Rubbish Begone, 2020) [25].

The law forbids MSW disposal in the open dump yard and the same is set for all cities and states. They were compelled to close their open dumping system (Presidência da República, 2010) [24]. Due to this specific condition, in these countries, related to MSW has changed a little, when NPSW was introduced. Yet, the waste materials lead to inappropriate final destinations (Maier & Oliveira, 2014) [22]

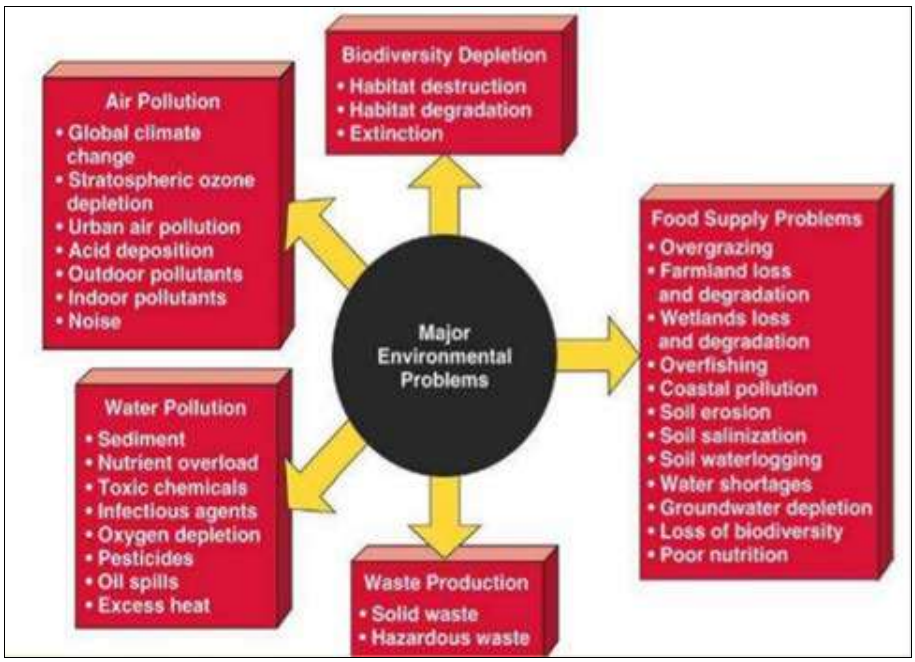

Fig 2: Environmental problems (Periyar Selvam, 2016) [23].

This situation Caan be revolutionized by controlling landfill programs, which was operated as open dumping space. Now, they arrive at the isolation process, in its place, gas drainage and Leachate systems are placed, where the waste materials are covered by adding layers (Argolo & Cerbato, 2012). The final MSW disposal of destination from 2010 onwards until 2018 were done on a weight basis), where, the 58 % were sanitary landfill; 24 % controlled landfill, and 1.5% were open dump (ABRELPE, 2016). Because of open dump system closure, other areas had received remedial notice, with controlled landfills in each country. From the point of view of social and environmental aspects, this is yet considered as the MSW disposal, unsuitable solution; nevertheless, it is preferred to open dumps. This is because of localized pollution generation (ABRELPE, 2016). A MSW management and its comprehensive review offered the aligned legal regulations of MSW management; the MSW physical composition, prevailing situation MSW management and system in every country, including final cost of collection, generation, disposal, region, collection, and resources used; there are also recyclable material collection, the recycling procedures, applicable reverse logistics; and, finally, challenges for the future regarding MSW management. The provides a clear impact on the international status and scenario, along with all the developing countries. Hence, the amount of MSW generated provides an indication of the effect of the global environmental and impacts on human health (SELUR, 2014) [27].

Fig 3: The non-hazardous collection of solid waste, transfer, process of recycling, disposal service for residential, municipal, and energy systems, in the USA and Puerto Rico (Tim Smith, 2019) [30]

Nexus of Water-Energy

Waste water can be used to produce energy

The wastewaters contain more than 10 times energy prevailing in most waters required to process energy. Hence, this helps the energy production using wastewater very effective and profitable system of making use of the waste as the prime energy source and this specific water with energy nexus has become a reality concept. All the advantages include: more energy, less pollution, clean water used for several applications (Rubbish Begone, 2020) [25].

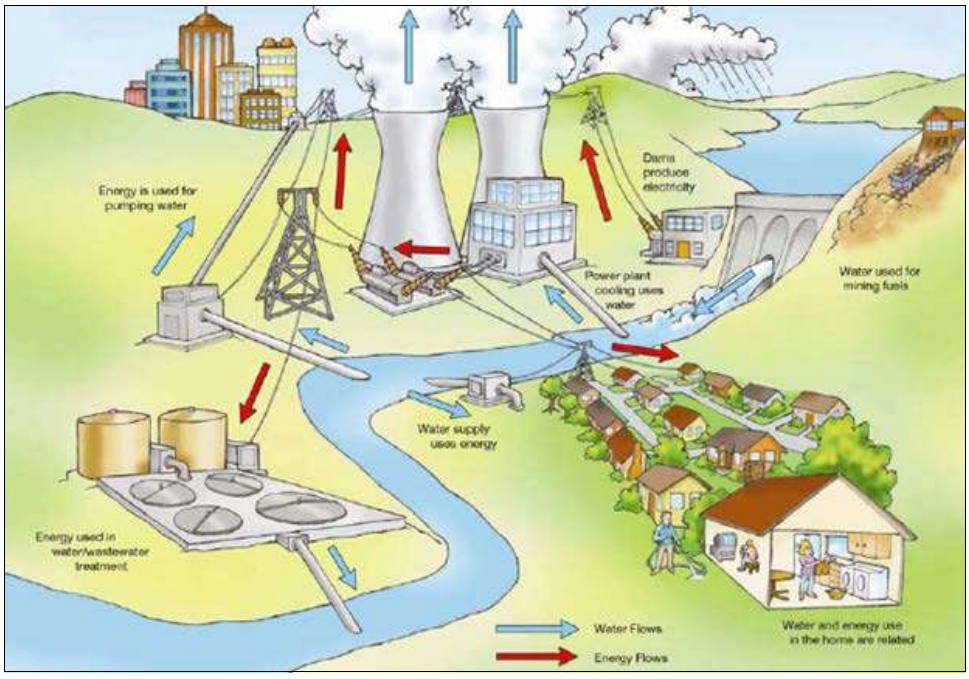

Fig 4: Waste Management Future (Rubbish Begone, 2020) [25].

Barcelona university scientists discovered various ways to involve organic matters in wastewater using helpful bacteria. The wastewater organic waste gets converted into hydrogen because of reaction process, which can further transform into pure energy. By this method, the wastewater treatment process becomes cheaper, and also, provides free energy, which can be utilized, sold or also stored for the future (Rubbish Begone, 2020) [25].

Key discovery

Exponentially, the plastic production has progressed, while it presently exceeds the 368 million tonne level. Out of this, almost 39% is mainly utilized for packaging purpose, which means, they are meant to be disposed immediately after the delivery of products. Around 65% of the entire plastic ever developed reaches the dump yard affecting the environment, and further, it continuously impacts our ecosystem, because

the plastic gets fragmented and degraded (Yang, *et al*., 2021) [32]. It remains in the debris form, as nano and micro plastics, and eventually these plastic materials reach the air, the ocean waters, and inside the soil. Some nano-plastic materials are deliberately included in several products and hence, they get added to water systems and supplies to finally enter the human body. Lack of knowledge and uncertainties produce the gaps undermining the complete understanding of the toxicological, ecological, and environmental problems and impacts the plastics can produce. Reduction in toxic exposure due to plastic waste, in its every form, requires an excessive innovations and solutions, both legislative and voluntary. In reality, the plastic production, its use and finally disposal should be properly implemented and managed at a strictly imposing method, on a global level, because, thee prevailing supply chains keep crossing and re-crossing borders, oceans and continents (Fadare & Okoffo, 2020) [8].

Fig 5: Persistent plastic problem, innovative collection, upcycling and recycling ventures (KGM, 2020) [15].

- Every day, 9 million plastic pieces reach the ocean waters;
- Annually, this indicates about 10 million tones of plastic reach our ocean waters;
- This is same as one garbage truck of plastic material abandoned in ocean waters every minute;
- From the entire plastics lands in landfills, 81% goes to ocean waters, around 12% gets recycled and remaining 7% is incinerated;
- Nearly 57 trillion micro and 27 trillion macro- littered plastics go to ocean waters;
- Out of them, 278,000 tonnes keep floating on the water surface;
- This amounts to 500 times total stars in the sky and 1345 time blue whales;
- Plastic is observed all over the world, including isolated and remote locations;
- In the next 5 years, plastic garbage can increase almost 10 times (KGM, 2020) [15].

	North[a] (%)	North-east[b] (%)	Mid-west[c] (%)	South-east[d] (%)	South[e] (%)	Brazil[f] (%)
Organic matter	54.68	57.00	54.02	52.00	57.27	51.4
Recyclables:	27.46	10.31	29.72	41.70	26.87	31.9
Metal	1.09	1.74	3.64	1.66	1.46	2.9
Paper and cardboard	10.87	3.7	7.48	15.39	11.62	13.1
Plastic	14.67	3.86	16.73	21.15	11.23	13.5
Glass	0.83	1.01	1.87	3.50	2.56	2.4
Others	17.86	32.69	16.26	6.30	15.86	16.7
Total	100	100	100	100	100	100

Chart 1: MSW physical composition of various places and regions in the country (Prefeitura Municipal de Araguaína, 2013).

Legal management framework for MSW

As mentioned previously, the open dumping deadline in the country like Brazil, was set in August 2014, by Federal Law, 12.305/2010. The entire MSW was supposed to be disposed of as stipulated by the environmentally friendly manner (Presidência da República, 2010) [24]. But, after two years of legally instituted deadline, the purpose for which the framework was made was not established (ABRELPE, 2015) [3]. Hence, they tried to extend its time limit to 2018 as the Provisional Measure, 685/2015, and that got approved by the Deputy Chamber of the Senate; it was further vetoed by the Republic Presidency (Chamber of Deputies, 2015a).

The Sanitation Policy of the Nation defined the basic sanitation concept as a service combination, operational facilities and infrastructure to provide a clean water supply, better sewage treatment facility, solid waste management, drainage systems, urban cleaning, and rainwater safety management (Presidência da República, 2007) [24]. The generation of solid waste has enhanced due to an extreme population growth and it has turned out to be the main challenge, specifically in urban regions (Souza *et al*., 2014), The NPSW gives objectives, principles, guidelines and instruments related to the solid management integration, that included hazardous waste, and also the responsibility guidelines of the public authorities, along with economic tools (Presidência da República, 2010) [24]. Their law did not consider radioactive waste materials, which is specified by a different legislation (Presidência da República, 2010) [24]. Certain NPSW principles are prevented with precautionary measures for sustainable development, and that considers reusable solid wastes, which can be recyclable to improve its social value and generate more jobs, better income to promote social inclusion.

MSW management Current situation

A recent ISWM concept, of integrated, sustainable management of waste materials is bifurcated into governance features and physical elements to provide better functioning system, of 'software and hardware' (UN Habitat, 2010) [31].

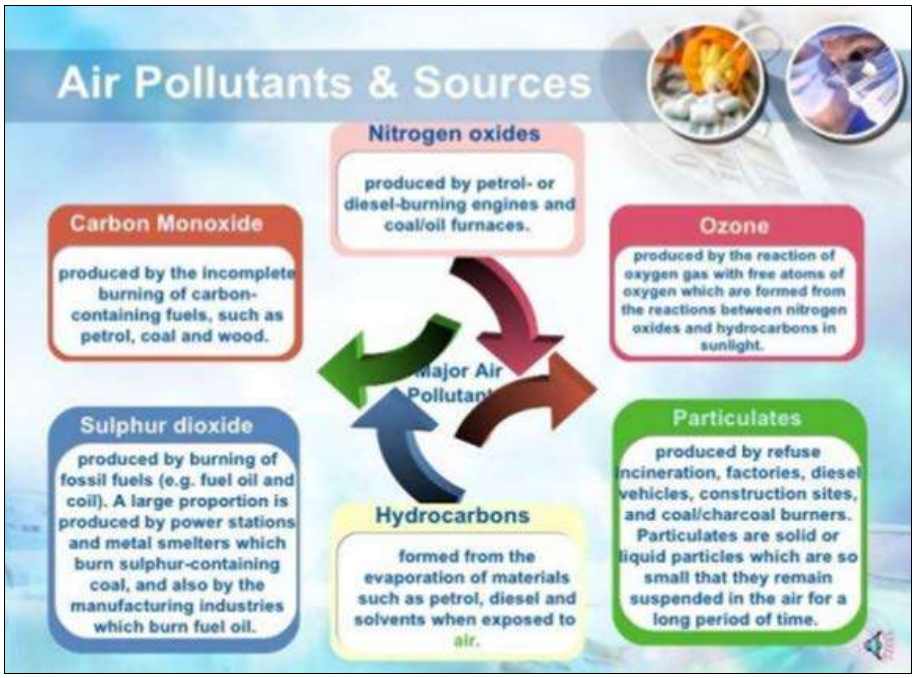

Fig 6: Environmental Monitoring (Periyar Selvam, 2016) [23]

The public health is related to 'hardware' a wide-ranging MSW Gathering service provided, environmental protection during the treatment and disposal and various resources like waste reduction, reuse, recycling, organics management and recovery (ABRELPE, 2013) [1]. Whereas, the concept of "software" involves three interconnected needs to deliver a "good and regressive waste authority and governance." There is also a necessity to remain inclusive, providing stakeholder spaces to be a part of the cause as users, pronunciation between various classes of business sectors, government authorities, intended for financial and technical cooperation, to become financially sustainable, affordable, and cost-effective, having proactive policies (UN Habitat, 2010) [31]. Therefore, the prevailing situation as regards to MSW management concept, to move towards the Zero wastage policies are adopted and properly implemented in various European countries as a prime strategy to support the society and the environment. The 'zero wastage Europe' approach, wherein the wastes have to be transformed into new resource methods (Zero Waste Europe, 2014). The plants for MSW treatment should contain proper facilities to sort out recyclable materials, and to operate the requisite recycling processes, have incineration and composting plants (Fudala-Ksiazek *et al*., 2016) [9]. In the meantime, Brazil has developed sanitary landfill disposal facility, which is practically the best technique implemented to manage the entire MSW (Luz *et al*., 2015) [18].

Future of SWM- Solid Waste Management

Greenhouse gasses developed from the waste materials are the key contributors to climate change. "SWM is the business and priority for everyone. By ensuring proper and effective solid waste management, the critical stage can be achieved for the Sustainable Development Goal," Environmentally sound, touch of waste management can achieve several critical development aspects. Considering the financing SWM systems and overwhelming costs involved, they provide a repeated significant challenge. The investment by the World Bank have stepped up to provide help to many countries to meet such demand. Without progress and advancement in this sector, foul gas emissions from the solid waste can increase to almost 2.86 billion tonnes of gas CO_2 equivalent by the year 2040. But the fact is, there are more than 18 million unofficial waste collectors and pickers all around the world, specifically children, women, the elderly, unemployed people, and migrants, who always remain mostly in unhealthy condition, due to lack of health insurance and social security, enduring social stigma. The financial support from the World Bank have always supported the development and construction of three major landfill sites, and they are serving over three million residents, helping them to get rid of open dump sites, to develop sustainable programs of livelihood for waste collectors and pickers, and linking them to better service, payment, and delivery system through results-oriented financing.

Integrating waste management planning and data collection

Many countries need financial support with planning, particularly the fast developing countries to implement the modern and quick WMS- waste management system. They are trying to decrease plastic waste formation and marine litter by a comprehensive waste reduction system using recycling strategies. Further, they wish to promote food waste reduction by organic management, education and all the coordinated and integrated waste food management programs.

Fig 7: Towards sustainable management of solid waste

Conclusions

Reducing the environmental harm is related to how the people around the world accept and follow the plastic control norms. Plastic product impacts are linked with its disposal process, generation planning and designs, and its final solid waste treatment and these entire aspects have become a global issue and problems. In many countries, the authorities to address these problems have recently started. Certain major challenges and findings are specified below.

1. It depends on legislation, programs implemented by the main countries with specific goals that specifies closure of open dumping places, the reduction in the dry recyclable waste materials, and solid waste wet urban disposed in landfills.

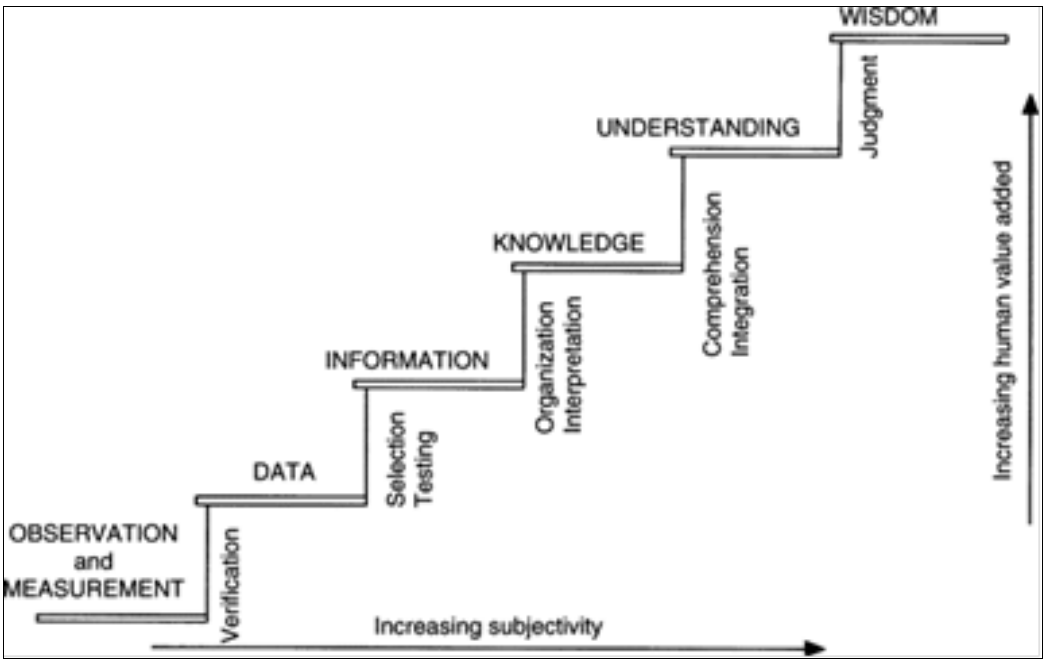

Fig 8: Improving Subjectivity of waste management by remote sensing (Comprehensive remote sensing, 2018).

2. The MSW physical composition generated in several countries indicate that in developing countries, the biodegradable materials constitute the largest proportion of 53.4%. The proper MSW treatments mainly depend on waste composition; sorting of materials, composting, and digesting organic waste materials.

3. The prevailing situation of MSW management indicates that: MSW generation per capita is 1.16 kg per day; coverage of waste collection is 91.3%; the cost of average resource allocated to collect nearly 3.4 million USD per year; while the collection cost is nearly 37.8 USD per metric tonne. Even after legally establishing the deadline for the closure of open dumping sites, the situation of the MSW working system has not changed much. Many countries, yet maintain very large number of sanitary landfill places without proper treatment, which shows almost 96% (Talalaj, & Biedka, 2015) [29].

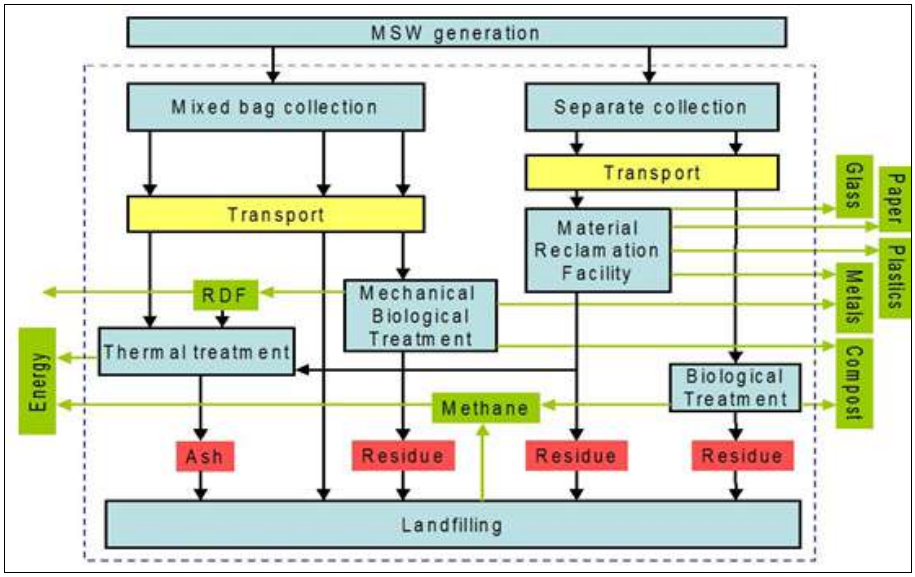

Fig 9: Life Cycle Assessment in MSWM (Konstadinos Abeliotis, 2011) [16].

4. When in 2015, the purchasing power of people reduced, still, the MSW generation increased. This is due to the consumption pattern not changed, while the people living and working in large urban regions is growing consistently.
5. Due to recyclable material collection initiatives are in place, they cover less than 50% of the national region. Hence, the waste materials of around 2.5 billion USD are generated annually only because of inappropriate ways of disposed of recyclable waste in the landfills (Talalaj, & Biedka, 2015) [29].
6. Certain countries invest 80% less for the MSW management. This becomes the major cause why the cities lack enough resources to control, organize and manage the waste appropriately.
7. The people should help the regions to change the population, culture and habits concerning conscious consumption of material and food, so as to control solid waste formation. These are the major waste management challenges: improvements in recyclable material programs; closure of open waste dumps; properly investing in improving technologies to deal with organic wastes (Talalaj, & Biedka, 2015) [29].

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