Abstract. Blooming of industrialization and urbanization are directly correlated with increased solid waste generation. Every year India faces a massive challenge as it deals with municipal solid waste equating to approximately 62 million tonnes including E-waste, plastic and medical waste. This has mounted and stands as a budding hazard to public and environmental health. Within India solid waste management predominantly adheres to sustainable development. The waste management rules are generally framed and handled through the Ministry of Environment and Forest (MoEF); however, compliance varies among states. In this article we are describing the present status, challenges and implementation followed in the waste reduction processes including segregation/collection, recycling, energy recovery (composting, bio methanation, and bioremediation), landfilling of household and industrial waste; its impact on the environment. This review concludes with some simple and effective international trends in waste management, with a vision of improving in current Indian systems.

Key words: Solid waste, Urbanization, Sustainable, Management, Environment

1. Introduction
For several urban local bodies (ULBs) within India, solid waste management (SWM) is viewed as a challenge and a serious problem. Urbanization and industrialization created an increase in municipal solid waste (MSW) produced by each individual person [1]. Despite India’s extensive progress illustrated through environmental, social and economic factors, unfortunately in comparison SWM systems of the country have remained underdeveloped. Currently, the percentage of residual urban waste dumped is around 90%, in contrast to being properly landfilled, therefore illustrating a major role played by the informal sector to extract value [2]. While, economic globalization, technology and culture have been linked to the recent emergence of megacities [3].

In the year 2000, the management and handling rules of MSW was issued by MoEF. This was to ensure appropriate waste management occurred within India, a further effort was initiated through a recent published update of draft rules [4]. The implementation of these rules has enabled municipal authorities to create an infrastructure that aids “collection, storage, segregation, transportation, processing and disposal”
of MSW. Notably strategic progression in the way SWM has been handled was initially noted in Chandigarh, particularly in comparison to other cities within India as it demonstrated upgraded waste management [5].

2. Urbanization of India
It has been predicted that the world will produce approximately 27 billion tonnes of waste by 2050. Asia will source a third of this; however, the maximum contributions will come from fast-developing countries like China and India [6]. It is believed that by 2025 each person will generate approximately 0.7 kg of solid waste within urban India which surmounts to a value which is four to six times higher than in 1999. As a result of population growth, challenges relating to waste increase, resulting in the need for decentralized waste management. This can be obtained through initiatives like; dedicated solid waste management NGOs or self-help groups [7]. Due to increase in population and shifting lifestyles, it is noted that urban India possesses approximately 170 000 tonnes of waste formation every day. This amalgamates to an annual figure of approximately 62 million tonnes, which is estimated to rise by 5% every year [8].

3. Portrayal of solid waste
The composition of waste varies dependent on local area economy, higher earners are deemed to use more packaged products thus this results in the accumulation of more materials like paper, plastic, glass and metals. Therefore, this can affect waste management practices through discrepancies in waste composition [9]. Hazardous waste like used medicines, pesticides, batteries and pesticides can also be incorporated in MSW. While organic food waste includes vegetables and fruit. Medical waste is classed as biomedical waste and should not be assorted with MSW, in line with guidance from Biomedical Waste Management and Handling Rules 1998 and revised in 2003. Such materials comprise of sanitary products, blood-stained clothes and disposable syringes [10][11]. The typical MSW components formed by cities within Indian for organic is approximately 41 wt.%, inert is 40 wt.%, and materials that can be recycled is 19 wt%[12]. Maximum organic waste is produced from domestic usage, while construction, road sweeping and demolition produces inert waste. However, the MSW composition differs within cities and is illustrated through comparing solid waste collected from Delhi, Ahmadabad and Bangalore [13][14].

4. Adverse effect of solid waste
Public health and the environment have been affected by junkyards resulting in harmful impacts [15][12][16][17][18][19]. One such impact is the production of methane via the decomposition of biodegradable waste, as anaerobic conditions are created within open dumps. It is a dominant contributing factor to global warming and promotion of fires and explosions [9]. Odor associated challenges and leachates immersing into water reservoirs are proven issues [20]. This has been notable within India during the summer season, when the temperature average increases to 45°C [21] and uncontrollable burning of waste at dump sites without adequate controls, produce the formation of fine particles resulting in a dominant contribution of smog and respiratory diseases [20].The effect on public health resulting from deprived waste management has shown a rise in infections relating to the nose, throat, bacteria, inflammation, breathing difficulties, anemia, asthma, immunity reduction, allergies and other infections [22].

5. Infrastructure development for SWM
For India’s economy to become a global leader, developments in civil infrastructure are imperative. Thus, to achieve active economic growth, it is important to build a superior infrastructure that achieves the public requirements and safeguards the environment [23]. Natural resources have reduced, due to the growing population in India. For effective SWM, resource abstraction is important where valuable
resources are obtained from wastes through well-organized waste management which can provide an income for individuals through finding new energy, materials or nutrients [24]. However, this can only be achieved through investing in SWM capital which can drive market developments, recovery of recycled materials and other strategic activities [9].

6. Informal sector in waste management
The formal SWM systems needs to amalgamate with the Indian informal sector due to the critical roles they are both involved in [11][25]. However, the informal sector constitutes to a small component predominantly consisting of intensive labor with little technological work, limited services and lack of materials and is predominantly not regulated or registered (Wilson et al., 2006) yet it is effective. This is demonstrated through a study involving six cities in India, recovered approximately 20% of the waste by 80 000 waste collectors equating to approximately three million tonnes. Through this the ULB saved approximately INR 24 500 each year from every tonne of biodegradable material collected. Thus, evaded 721 kg of CO₂ emission per year [25]. To lessen the environmental impact, municipal solid waste management (MSWM) comprises of segregation, collection, processing and disposal [7].

7. Segregation
Currently in India, segregation of waste has no organized and systematically planned method, regardless of domestic or community related. Generally, it is accomplished through an unorganized sector and occasionally completed by waste producers. The conditions and efficiency that segregation and sorting processes occur are usually insecure, adverse and low. This is due to the search and extraction of valuable waste products only, that produce a financial gain when recycled [26].

8. Solid waste collection and transportation
Vital steps of every SWM system comprises of waste collection, storage and transport, however cities are challenged in this endeavor. Indian municipal corporations are duty bound to collect waste and are usually provided bins to separate biodegradable and inert waste materials [27][28][29]. Despite these initiatives they are frequently mixed, dumped and burnt openly. Developments relating to waste management collection processes and Indian transport structure will generate more job opportunities, progress public health and increase tourism [30].

9. Reuse/recycle
Recycling involves collecting materials from waste, appearing to produce profit and are used for producing new goods. Simultaneously, nonsegregated waste is discarded in community bins, where recycling that waste is unlikely. However, materials like plastics, glass are extracted and separated by rag-pickers who trade recyclable materials, his is vastly demonstrated in Pondicherry [31].

10. Disposal and treatment
UNEP (2004) reported that composting is comparatively one of the appropriate treatments followed in developing countries of Asia, such as incinerator [32]. In India, composting is practiced approximately 10-12%, while countries like Bangladesh, Nepal, Sri Lanka and Pakistan follow the process less than 10%. Among the developing Southeast Asian countries, the last phases of SWM were usually open dumping and landfills. Open dumping constituted to over 50%, while 10- 30% was landfill; composting less than 15% and incineration 2 -5%.

11. Landfill
SWM dumping has reached a critical stage requiring improvement in India. Thus, services need to be developed allowing treatment and disposal of increasing volumes of MSW [33]. UN Environmental Program has defined the term landfill as “controlled disposal of MSW on land”. With the reduced connection maintained between the environment and waste, disposal needs a designated distinct area. Therefore, a good landfill allows the MSW to be disposed safely on land and should protect surface water from pollution, odor, litter blown in the wind, surface water, evading air emissions, reduction of greenhouse gas (GHG) emissions, fires, animals and wildlife with a reduction in instability issues [4]. Dumps in India should be replaced by appropriately managed engineered landfills which would notably decrease the impact of waste on the environment [34].

12. Aerobic composting
Composting occurs in a humid warm environment, when the organic matter present in MSW is biologically converted. The final product of composting is humus (compost) containing a significant nutrient value. The method of composting varies from laborious or mechanical, in small sized town labor intensive composting is practiced. However, larger cities in India are fitted with composting units that drive power [35]. For example, Mumbai, Bengaluru, Delhi, Kanpur and Vadodara were all fitted with mechanical composting units delivering between 150 and 200 tons daily [33].

13. Anaerobic digestion
Biomethanation also known as anaerobic decomposition of waste is used in subtropical climates as a treatment option for the biodegradable component of MSW. It is a significant technique with a method that stabilizes the organic matter releasing biogas 55–60% methane, which can be converted into energy fuel for power production. The bio methanation technology is supported by the Indian government hence it is used in many municipal outlets, industry and agriculture. Schemes have been developed to use biomethanation to convert accumulated wastes produced by vegetable markets and yards in cities like Bangalore, Delhi and Lucknow [36].

14. Thermal treatment
Solid waste thermal treatment can be achieved via incineration, pyrolysis and plasma are gasification methods. An inappropriate MSW treatment method is incineration, due to its moisture content, increased organic constituents, 30% to 60% inert content and MSW 800–1,100 kcal/kg calorific value [37][38]. Incineration requires extra fuel when waste contains low calorific value or increased humidity, hence Indian hospital waste is burnt using small incinerators [39].

15. Steps to improve SWM in India
India requires a dedicated powerful, independent governance to take control and improve waste management. Clear rules and administration only can achieve development and innovation in SWM. Waste management companies would benefit from financial support and sponsorship for better infrastructure obtained from producers of the waste and applying waste tax charges. For example, 1 rupee collected from each individual daily would equate to approximately 50 000 crores annually and provide funds towards effective waste management around India. To aid crucial primary and secondary collection, there is a need for governmental investment in vehicles and equipment with plausible systems in place relating to collection, transport, disposal and management. This would include better organization of separating from waste recyclable materials like inorganic dry waste and biodegradable wet waste, noting materials of value chargeable to the waste producer. In India, all children in schools should be educated on the importance of waste management, their impacts upon the environmental and health, simultaneously promoting individual responsibilities to control waste management in educational systems. Literature is
being used within the modern world as a method of educating students [40] and should be utilized in an effective manner to provide lasting knowledge which constitutes to the development of responsible citizens. Through this, students will find prospective resources in waste. Segregation and recycling initiatives can create enhanced employment options in waste management. This will enable the poorer people in India to be self-sufficient and develop their lifestyles, thus viewed as a business opportunity [26]. Public awareness is paramount in order to create realization of the importance of source segregation at the source. This will ensure that biodegradables, inert and recyclable materials in waste are correctly managed from the outset. Through education the public will alter their views and recognize the significant service of rag-pickers. A communal initiative should be introduced to create manpower to carry out cleaning work and renamed Green brigade/crew or similar [41]. Many European countries ensure containers for paper, plastic, glass, food and general waste are kept separate from the outset. This approach eases the sorting process as individual citizens take responsibility in the segregation of waste. It reduces the labor as well as money input by the government. Those countries make laws that companies must produce their packaging material as reusable and it should be marked with green dot.

16. References

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