A Novel GSCM Model Approach to Sustainable MSWM Aiming to make Chennai a Green City

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***Abstract* — Rapid population growth and unemployment coupled with lack of resources and civic asininities in villages causes the migration of large population to urban areas resulting increased rate of unplanned urbanization in many cities in developing countries including India resulting to tremendous increase in generation of Municipal Solid Wastes (MSW) in urban areas. Moreover the mismanagement of MSW leads to public health risks, adverse environmental impacts and other socio-economic problems. Many researchers worked on issues related to Municipal Solid Waste Management (MSWM) so as to help the Urban Local Bodies (ULB) and the issues are yet to be deciphered. Though the Green Supply Chain Management (GSCM) received world wide growing attention in B2B and B2C to surpass the environmental disquiet, the GSCM model approach to MSWM has ever been focused by the waste managers. GSCM has become an essential component of every corporate management strategy but not in MSWM. The GSCM principles to up stream supply (flow of goods from suppliers) and down stream supply (flow of goods to consumers) with minimal impact to the environment can be very well applied to the MSWM too. The intensive review of literature also reveals that so far no researcher had ever been made an attempt to develop such a model. This motivated the authors to develop a novel GSCM model approach to MSWM for Chennai Metropolitan Area (CMA) to fill up the gap and to make Chennai a Green City. The present practice of MSWM by Corporation of Chennai (CoC), the major stake holder of CMA has been analyzed with the support of basic data collected through a case study. The authors also make use of the information and secondary data acquire from CoC's official website. Since the MSWM is a burning issue for every ULB, the proposed model can be implemented in any typical Indian Metropolitan cities with little or no changes.**

Key words* — *Municipal Solid Waste Management; Urban Local Bodies; Green Supply Chain Management; Chennai Metropolitan Area; Corporation of Chennai;

I INTRODUCTION

The Municipal Solid Waste Management (MSWM) is one of the imperative challenges being faced by every Urban Local Bodies (ULB) in India like any other country having social, environmental, public health and livelihood insinuations. Chennai (formerly Madras) is the fourth largest metropolitan city in India facing typical MSWM issues. This is the reason for the authors to choose the Chennai Metropolitan Area (CMA) for the current research study. Every action taken by the waste planners has the potential to generate negative social or ecological impacts. Addressing of environmental issues represents that segregation of MSW very much from the point of generation, collection, transporting to the Transfer Stations (TSN) centers and final journey to the Landfill Disposal Sites (LDS) in an Effective, Economic and Environmental (3E) friendly demeanor. A sustainable MSWM means it must be socially passable, environmentally sustainable and economically feasible. It is quite difficult to minimize the environmental impacts and the cost simultaneously in any business operations and is also true for MSWM. Besides MSWM is not a commercial operation rather it is an essential, non profit and obligatory service that has been entrusted to every ULBs. But trade off between operational cost and overall environmental impacts is indispensable, since it is the precious taxpayer's money with no returns. However the ever increasing rate of pollution, deteriorating environment, distressing level of global warming, ensuing natural catastrophe concoct the United Nations to enact the "United Nations Environment Programme (UNEP)" [1] and directed every national governments to mandatorily to enact their own Environmental Protection Acts (EPA) aligned with UNEP and subsequent rules [2]. The ever increasing environmental degradation particularly in urban areas advocated the academics, researchers and waste managers to focus on green initiatives in MSWM. The EPA discriminate what is and what is not a MSW, since the commercial and hazardous industrial wastes are also been mixed up with the MSW and disposed together. Off late the interest groups mounting pressure on ULBS to accomplish green initiatives for MSWM by employing Reduce, Reuse, Recycle (3R) strategies to reduce the ecological impacts. The novel GSCM model approach MSWM proposed by the authors will spotlight the problems from "cradle to grave" approach in an economically, environmentally and socially sustainable demeanor. The proposed model helps the CoC to convert the MSW as a source of business opportunity to extract valuable resources contained within it for future developmental purposes and also pave the way for a Clean, Green Gorgeous Chennai City beside preserving natural resources.

II LITERATURE SURVEY

India generates about 1,33,760 Metric Tones Per Day (TPD) of MSW (MoEF Report). The increase of population, urbanization, change in life style and consumption pattern in CMA caused the increase of MSW generation from 600 to 4500 TPD during the last 20 years[3]. An economically, environmentally and socially sustainable SWM is effective if and only if it follows an integrated approach beginning from its generation to its disposal. So far the Supply Chain Management (SCM) principles were applied to design the

business operations in B2B or B2C environment to oversee the flow of goods and information in up stream, mid stream and down stream supply chains. The article demonstrates an unique model of SCM and apply as a tool to systematize the collection and disposal of organic wastes in Pune Municipal Corporation[4]. The environmental, social, and economic implications of disposing of e-waste through 3R strategy has been analyzed with global perspective[5]. The paper emphasizes the need of micro-treatment options for components of organic fraction of MSW collected from the residential areas to recover/conserve energy[6]. The study on MSWM show that local governments in India spend nearly 35-40% of their annual budget on SWM of which 60–70% is spent on waste collection and transportation alone. Despite this expenditure, many local governments do not satisfy their citizens' expectations is the prime reasons for ULBs in India adopting the PPP strategy for MSWM[7]. The article explore a modern approach for environmental and economic value assessment of commercial waste discarding procedures applied by the traditional markets in Indonesia[8]. The articles give the detailed procedure for theoretical accomplishment of GSCM to the stake holders for applying the state-of-the-art communication, coordination and encapsulation frame work in their business activities and their barriers[9,10]. Espousing the reverse logistics strategy for MSWM particularly in developing countries will optimize the transportation costs[11]. It is nerveless to say that waste managers and planners need to consider the financial aspects of collection, segregation, transportation, processing, storing and disposal of wastes for developing effective MSWM system[12].

III SCOPE AND LIMITATIONS

Chennai (formerly Madras) is the fourth largest metropolitan in India and capital city of Tamil Nadu State located on the eastern coast (Latitude 13º 07' N and Longitude 80º 16' E). The total area of Chennai city is 174 square kilometer. Presently the Chennai Metropolitan Area (CMA) covers the Corporation of Chennai (CoC) and 16 other adjourning local bodies of Municipalities, Town Panchayats and Panchayat Unions. The present population of Chennai City is 6.5 millions and it has been estimated that each individual is generating 700 grams of solid wastes per day. It has been estimated that 4500 TPD of solid waste generated in 15 zones of CMA and in addition CoC also handles about and 700 TPD of building debris [13]. The responsibility of conservancy activities are entrusted to CoC's Zonal Officers. The current research work is limited to study of the CMA covering 15 zones of CoC and 16 adjourning local bodies and two LDS viz. Kodungaiyur and Perungudi.

IV RESEARCH METHODOLOGY

This research articles has been concocted from the strenuous study of facts provide by the Department of Solid Waste Management, Corporation of Chennai and data collected through field survey of 11 TSN and 2 LDS. The authors also held discourse with the city based NGO, "Citizen consumer and civic Action Group (CAG)" working for the welfare of the unorganized rag pickers of Chennai City[14]. The insights gained from the pragmatic data collected in the course of case study through a Waste Diagnostic Toolkit (WDT) also been applied for the current research work. The secondary and perceptional data has been adopted in the form of qualitative techniques for the study[15]. This article has been alienated chronologically into eight sections.The section I gives the epigrammatic introduction and section II is dedicated to an assiduous literature review. Scope and limitations of this article has been defined in section III. The section V gives the conscientious analysis of data acquired during the case study. The proposed GSCM model MSWM has been demonstrated in section VI and section VII has been devoted to Results and Discussions. The section VIII apportion to the Concluding Remarks.

V DATA COLLECTION AND ANALYSIS

A. Magnitude of MSW collected by CMA

The extent of the Kodungaiyur LDS located at northern part of city is 200 hectares and about 2100 to 2300 TPD of solid waste collected from CMA is disposed here. Whereas the Perungudi LDS located at southern part of the city is 200 hectares and about 2200 to 2400 TPD of solid waste collected from CMA is disposed here. So as to handle such a colossal quantity of MSW, CoC devotes a sizable proportion of its revenue, resources, time and labor. The CoC applying the 3E principles through a two stage waste collection process namely Primary collection and Secondary collection.

1) *Primary Collection: (Small Transportation)*
   a. Primary collection is by manual sweeping, collection and storing.
   b. Direct door to door collection of garbage and segregation at source.
   c. Tricycles or Light Motor Vehicles are used for moving to TSNs.
2) *Secondary Collection: (Bulk Transportation)*
   a. Wastes collected at streets and sent to LDS.
   b. Compacted bulk wastes at TSN sent to LDS.

Gist on assorted types of MSW and their instigating points in CMA are exemplified in Table 1.

TABLE 1, TYPES AND INSTIGATING POINTS OF MSW

Sl. No.	Types of MSW	Instigating Points of MSW
1.	Domestic waste	Household kitchen waste, packing, bottles, crockery wares, furnishing materials, garden trimmings etc.,
2.	Commercial Waste	Waste from business premises, shops, offices, markets, (paper, packing material, spoiled, discarded goods)organic, inorganic, chemically reactive and hazardous waste
3.	Institutional Waste	Schools, Colleges, Hospitals, large hotels and restaurants, markets selling vegetables, fruits, fish etc., community halls, religious places, function sites etc.,
4.	Street Sweeping	Unconcerned throwing, littering made by pedestrian traffic, vehicular traffic, stray animals, roadside tree leaves, rubbish from drain cleaning, debris etc.,
5.	Industrial/ Trade Waste	Waste generated through manufacturing and material processing.
6.	Debris/Construction rejects	Comprises earth, bricks, stones, wooden logs etc.,
7.	Bio Medical Waste	Discharges from hospitals, animal houses and Microbiology/biotechnology laboratories, needles, syringes, scalpels, blades, glass etc.
8.	Hazardous Waste	Waste listed in Hazardous waste management rules 1989.(batteries, cleaning fluids, pesticides.
9.	Sewage Waste	Liquid wastes typically consists of washing water, faeces, urine, laundry waste and other material.

(Source: Ready Reckoner on MSWM for ULB-2008)

B. The composition of MSW from CMA

The composition of MSW collected from CMA has been depicted in Table 2 and pictorially shown as Pie-Chart in Fig.1.

TABLE 2, COMPOSITION OF TYPICAL HOUSEHOLD MSW

Sl..No.	Composition	Qty. per kg of MSW	Percentage
1.	Organic	0.738 Kg.	74%
2.	Inorganic	0.159 Kg.	16%
3.	Sanitary	0.103 Kg.	10%

(Source: Harsha Anantharaman-2015)

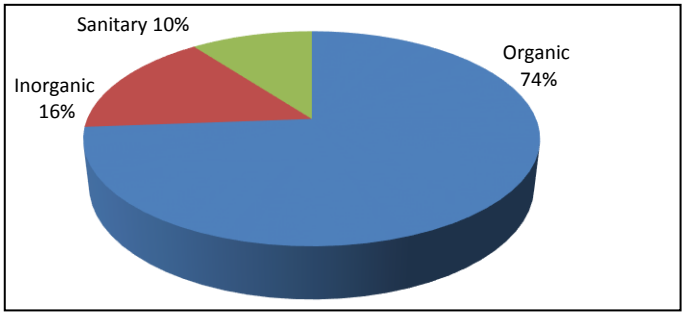


Fig 1. Composition of Typical Household MSW

C. Source Wise Break Up of MSW from CMA

The analysis of case study data from the show that 63% of the solid wastes are collected in CMA are from the Households units, 14% from Commercial Establishments, 11% from Hotels and Restaurants, 4% from Market areas and 3% from Hospitals and Health Care Units. The types of wastes and their percentage are given in the Table 3 and graphically shown as Bar Chart in Fig. 2.

TABLE 3, SOURCE WISE BREAK UP OF MSW FROM CMA

Sl. No.	Waste generating sources	Type of MSW	Percentage of contribution
1.	Household/Residence	Domestic	68%
2.	Commercial Establishments	Package	14%
3.	Hotels and Restaurants	Food	11%
4.	Markets	Vegetable	4%
5.	Hospitals and Health Care Units	Bio-Medical	3%

(Source: CoC)

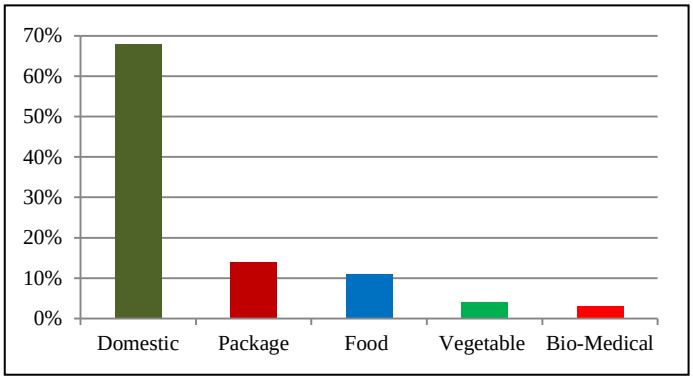


Fig. 2, Source Wise Break Up of MSW from CMA

D. Physical and Chemical Components present in MSW

The analysis of MSW collected from CMA indicates the existence of hodgepodge of components and have been classified into two distinctive groups as Physical component and Chemical component. There are 10 items falls into the physical group and 6 into the chemical group. The list of bits and pieces and their percentage of trace are depicted in Tables 4 and 5 and also graphically shown as Bar Charts in Fig. 3 and 4.

TABLE 4, LIST OF PHYSICAL COMPONENTS PRESENT

Sl.No.	List of Physical components	Percentage of trace
1.	Inerts	34.65%
2.	Green Waste	32.25%
3.	Food Waste	8.00%
4.	Timber (wood)	6.99%
5.	Paper Waste	6.45%
6.	Consumable Plastic Waste	5.86%
7.	Rags & Textiles Waste	3.14%
8.	Rubber & leather Waste	1.45%
9.	Industrial Plastic Waste	1.18%
10.	Steel and Material Waste	0.03%

(Source: CoC)

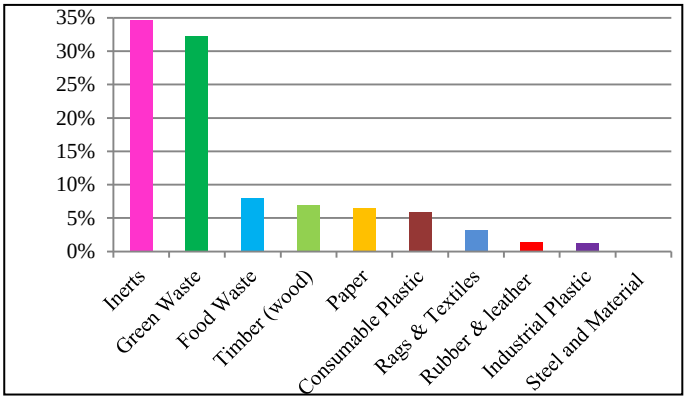


Fig. 3, Physical Components Present In MSW

TABLE 5, LIST OF CHEMICAL COMPONENTS PRESENT

Sl.No.	List of Chemical	Percentage of trace
1.	Organic content	39.06%
2.	Moisture content	27.60%
3.	Carbon content	21.53%
4.	Nitrogen content	0.73%
5.	Phosphorous as P2O5	0.63%
6.	Potassium as K2O	0.63%

(Source: CoC)

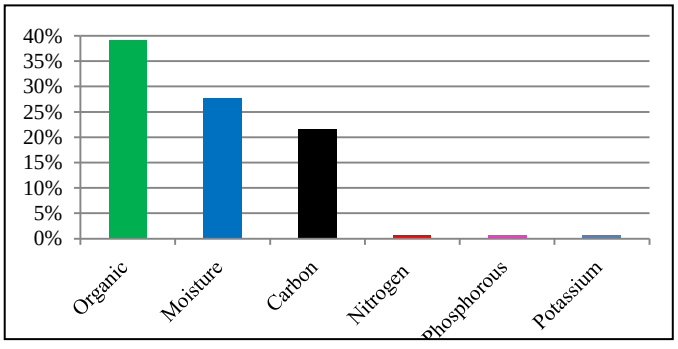


Fig. 4, Chemical Components Present in MSW

The analysis of physical and chemical Components show that the presence of high percentages of moisture, compostable matter (ie organic) and inert materials indicates its low potential to be used for Refuse Derived Fuel(RDF) or

energy recovery from waste (i.e. incineration) processing option, but it has the high potential for composting option[15].

E. Typical Service Standards of MSWM in CMA

The Service Standards of collection of MSW in CMA by CoC from the point of generation, frequency and service level options are depicted in Table 5.

TABLE 5, TYPICAL SERVICE STANDARDS

Type of Service	**Typical Frequency Measures**	**Typical Service Level Options**
Residential and Commercial Waste Collection	Daily, every other day, set days/week.	Door-to-door, building-to-building, waste pooling sites.
Industrial Waste Collection	Daily, every other day, set days/week.	On-site pickup, regional collection centres.
Bio-Medical Waste Collection	Daily, every other day.	Site pickup in containers by service provider or delivery by producer to waste treatment facility.
Street Sweeping and Cleaning	Daily, set days per week.	Mechanical, manual, all streets, primary and secondary streets, litter baskets.
Public Facility Solid Waste Collection	Weekly, monthly, bi-monthly.	On-site pickup, litter bins and public bins

(Source-Case Study)

F. MSWM concerned to CMA

In-spite of well established MSWM in CMA the CoC is not free from problems. The issues associated with the MSWM encountered by CoC are given below.

1) Abridged Health of Citizens

Inadequate segregation of organic waste resulting to biodegrades rapidly and releases pungent odors. The discharges from organic waste attract flies, rats and other pests. These vectors spread diseases such as typhoid and cholera, and also cause diarrhea, eye problems, skin diseases etc. Improper and poor disposal of MSW resulting to blocking of drains, contaminate the water bodies, rise of mosquito population and more diseases [17]. Eventually affects the health and reduce life expectancy resulting to higher Infant Mortality Rate (IMR).

2) Threats to Environmental Sustainability.

Mismanagement of MSW resulting to the water, air and physical environment have been affected. The contaminants with MSW and leachate oozing out from MSW pollute the water bodies. The illegal open burning of MSW causes air pollution and affects the public health.

3) Losing of prettiness of the surroundings

If MSW are not properly treated it will spoil the natural beauty of water bodies, forest area, mountains and beaches ultimately the urban area and country sides. Recklessly littering spoils the scenic beauty of the environment and finally aesthetic pollution.

VI NOVEL GSCM MODEL APPROACH TO MSWM

A. Sustainable MSWM

With ever increasing rate of generation of MSW, it is highly imperative for ULB to move towards adopting sustainable MSWM. Sustainable MSWM engross into three aspects viz.; Economic sustainability, Environmental sustainability, and Social sustainability.

a. Economic sustainability can be achieved by RDF or waste to energy processing.

b. Environmental sustainability can be realized through segregation of wastes-at-source; in situ organic waste processing and meticulously espousing the 3R strategy.

c. Social sustainability can be attained by effectively utilizing the underprivileged waste pickers.

1) Empowering of underprivileged waste-pickers and other destitute communities.

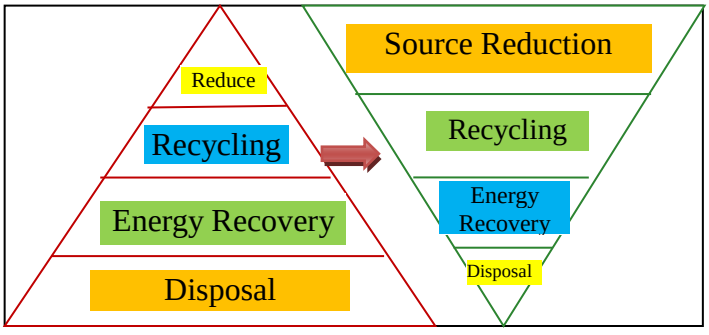
It cannot be refuted the significant role of unorganized underprivileged waste-pickers and other destitute communities for the MSWM in collection, segregation at source and recycling of selective materials. They are almost exclusively responsible for any recycling activity in most of the conurbation in India and Chennai is also not exempted. They form the vast majority of the informal unorganized waste sector and help to divert hundreds of tons of MSW from the CMA's overloaded landfills[14].

2) Polluter Pays Principle

The study on green SWM initiatives in the developed countries show the mechanisms of recover the cost from waste producers to change waste generation behaviors. The "Pay As You Throw" (PAYT) schemes adopted in the US and some European Countries based on the "Polluter Pays Principle" (PSP) is very effective, where the cost recovery resulting to alleviate the financial burden for ULBs.

B. Green SCM model approach to MSWM

In the first step, the proposed GSCM model MSWM focused to shift from a collection and disposal dominated waste hierarchy to a waste minimization and recycling dominated hierarchy as illustrated in Fig. 5.



(Source: SACN Programme 2014)

Fig 5. Shift from conventional to resource efficient hierarchy

1) *Green Initiatives in Primary Collection*

Accentuate the '3R' strategies "Reduce, Reuse and Recycle" in Primary waste Collection. Domestic members, who are the key waste generators, are to be encouraged to "Reduce" the generation of waste right at home. In addition, source segregation of bio-degradable and non bio-degradable are also to be encouraged. CoC has to make use of media to intensify its campaign to reduce the waste generation.

2) *Green Initiatives in Transits Locations*

Tricycles or Light Motor Vehicles are been used for collecting the Source Separated Waste (SSW) from the House holds for unloading in TSN. "Recycling and/or Reusing" the SSW at transit points itself to be explored before transporting them to the TSN.

3) *Green Initiatives in Ward Level*

The 100% implementation of Vermi-culturing of composting the organic fraction of MSW at ward level will shrink the cost of secondary collection drastically, since only the non recyclable fraction is transported to LDS. Zero Waste Energy (ZWE) by state-of-the-art dry anaerobic digestion technology to transform organic waste into bio-gas option also to be explored.

4) *Green Initiatives in Transfer Stations*

TSN are the pivotal points for the MSWM, since they are connecting the Primary Collections (Small collections) (ie up stream domain of GSCM) and Secondary Collection (Bulk Transportations) (ie down stream domain of GSCM) of wastes to LDS. All the 11 TSNs operated by CoC located in CMA are in close proximity to the human habitat. Since these TSN are in surface level, it liberates intense stench and flies and numerous other insects circulate the place. The TSNs should be constructed in under ground so as to prevent the aforementioned nuisance. As a part of GSCM, TSNs may use the green energy recovered from the organic fractions of the waste in centralized mechanical composting units. The TSN facility sites with optimum potential for technical, environmental and economic perspective are listed below:

- *Central location:* Locating the TSNs at decisive points will optimize waste collection efficiency.
- *Easy Access:* Direct and easy accessibility have to be ensured for the vehicles emptying and taking back the MSW to LDS.
- *Adequate area:* The working space for TSN has to be adequate with the volume of MSW required to process.
- *Traffic compatibility:* Due Consideration must be given to prevent surges of vehicles when they have finished their routes.
- *Prospects for future expansion:* The TSNs are to be designed with a prediction to handle subsequent increase in the daily tonnage of MSW in future.
- *Forestall the impacts:* To moderate the impact to the neighboring community, the TSNs should be away from the sensitive adjoining residential domiciles.
- *Appropriate sloping topography*: The landscape of the sites should be appropriately slopped for the convenient access to upper levels from the higher parts of the natural terrain and also easy access to the lower levels from lower parts.

5) *Green Initiatives in Secondary Collection*

The Secondary Collection falls into the down stream domain of GSCM and also the final transportation channel to LDS, where every MSW designated for final disposal will be subjected and need to be addressing the Green Logistics principles. Green logistics refers to minimizing the ecological impact by reducing energy usage of logistics activities and reducing usage of materials. Green logistics help to brought down transportation expenses and also reduce the pollution released into the ecosystems by the vehicles [18].

6) *Project success factors*

The present research study takes into account the following project success factors:

a) Impact on Resources: The implementation of the proposed model MSWM results in more sustainable use of natural resources for both up and downstream supply of MSW.

b) Impact on Pollution: The level of pollution resulting from the MSWM process will get reduced by the implementation of the new model GSCM.

c) Impact on Climate: The proposed model will reduces the impact on climate change by mitigating the release of Green House Gasses (GHGs) into the atmosphere.

d) Economic feasibility: The proposed model is economically feasible from the cost revenue perspective or, at a minimum, reduces the operational of cost of MSWM to CoC.

e) Creation of additional job: The proposed GSCM model MSWM will lead to the creation of additional jobs particularly for the socially weaker section.

7) *Challenges and Issues of Concern: I*t is inevitably required to address the following trepidation to surpass the challenges and issues in green MSWM.

a) Source reduction: Source attenuation is a basic solution to the MSWM. Less waste means less problem and vice versa. Change of consumption pattern and lifestyle, using the recyclable materials, encouraging segregation at source and switching over to bio-gradable materials for packing.

b) Optimize waste reuse: Waste converted into products, materials and feedstock for the original or other purposes (e.g. tyres as building material).

*c) Optimize waste recycling: R*ecycling bestows considerable benefits by reducing the waste drastically. Source separation and recycling of waste condense the volume of waste required to be disposed.

d) Encourage energy recovery: Waste to energy processes RDF ie 'landfill gas to energy projects,' (e.g. bio-digestion, gasification, pyrolysis and heat co-generation with incineration). Approximately 75% of MSW constitutes organic components and it can be used for bio-gasification or methanation for generating electricity.

e) Encourage to dispose waste safely: Though it is a healthier practice to dump the waste in open space, it should be ensured that only nonhazardous materials are subjected to land filling.

VII RESULTS AND DISCUSSION

The result of the study shows that the efficiency of the MSWM system can be improved systematically by adopting the GSCM techniques outlined below.

- The involvement and cooperation of stake holders ie individual and public is of high priority to achieve the green initiatives.
- GSCM will make the MSWM very effective, efficient and helps the CoC to function in tight cooperation, coordination and conversation with all stake holders.
- Clean and Green cities attract more tourists and investors ensuing to create more jobs in the locality. The inflow of investments brings economic prosperity and revenue to the ULBs.

VIII CONCLUSIONS

Implementing GSCM practices in MSWM may initially involve additional investments for ULBs. But in long run GSCM approach will improve the performance and also ensures sustainable environment to the future generation. The proposed GSCM model approach in MSWM for any city or town is as follows:

1. Bulk MSW to be handled everyday, sanitary landfill sites have to be set up to dispose off the rejects after composting and land filling.
2. Adequate under ground TSNs have be set up in all slum areas to ensure proper handling of wastes and also to reduce the transportation costs.
3. Comprehensive PPP with green initiatives for garbage collection, segregation, reuse, recycle, energy recovery and disposal to be implemented.
4. Improved storage containers for biodegradable wet wastes to be provided in all transit locations.
5. Primary collection of MSW to be carried out on daily basis through active public participation.
6. For Secondary collection apply green logistics principles, go for improved vehicle design, increased capacity and efficiency.

The paper concludes by suggesting that GSCM model approach to MSWM will ultimately be the most efficient approach in terms of economic, social and environmental benefits besides it will provide ample opportunity to make the cities a better place to live and do business in. The conclusions so drawn may be further modified to apply in real life situations also.

REFERNCES

[1] UNEP 2011, Towards a Green Economy.

[2] The Environmental (Protection) Act-1986; Municipal Solid Waste (Management and Handling) Rules-2013; Hazardous and Other Wastes (Management and Transboundary Movement) Rules; Bio-Medical Waste Management Rules; Plastic Waste Management Rules; e-Waste Management Rules- 2015.

[3] Sujatha. P. and Janardhanam. P.V.S., SWM in Chennai city, IJ of Education and Information Management, Vol. 1, No. 3, 2012.

[4] Gupte Deepak D. and Saptarshi Praveen G., Supply Chain Management as a Tool for Collection and Disposal of Organic Waste in Pune, Universal Journal of Environmental Research and Technology, Volume 2, Issue 3: 261-268, 2012

[5] E. Williams, R. Kahhat, B. Allenby, E. Kavazanjian, J. Kim, M. Xu, Environmental, social, and economic implications of global reuse and recycling of personal computers, Environmental Science & Technology 42 6446-6454, 2008.

6] Chanakya HN, Ramachandra TV, Guruprasad M and Vinutha Devi. Micro-treatment options for components of organic fraction of MSW in residential areas. IJ of Environmental Monitoring and Assessment 135: 129-139, 2007.

[7] Ankit Kumar Chatri Arslan Aziz, Public Private Partnerships in Municipal Solid Waste Management in India, Potential and Strategies, May 2012, Report of Public Policy Team, Athena Infonomics, 2012.

[8] L. Aye, E.R. Widjaya, Environmental and economic analyses of waste disposal options for traditional markets in Indonesia, Waste Management 26, 1180-1191, 2006.

[9] Torres, B., Nones, S., Morques, S., & Evgenio, R. (2004). A Theoretical Approach for Green Supply Chain Management. Federal University DO RIO GRANDE, Industrial Engineering Program, NATAL-BRAZIL, Janaury-2004.

[10] Mudgal, R.K., Shankar, R., Talib, P., & Raj, TModeling the barriers of green supply chain practices: an Indian perspective. IJ of Logistics Systems and Management, 7, 1, 81-107, 2010.

[11] Joel R. Kinobe, Girma Gebresenbet and Björn Vinnerås, Reverse Logistics Related to Waste Management with Emphasis on Developing Countries—A Review Paper, Journal of Environmental Science and Engineering B 1, pp 1104-1118, 2012

[12] Palmer, K., H. Sigman and M. Walls.. "The Cost of Reducing Municipal Solid Waste,"Journal of Environmental Economics and Management 33: 128-150, 1997.

[13] Esakku, S., Swaminathan, A., Karthikeyan, O.P., Kurian, J., and K. Palanivelu (2007). Municipal Solid Waste Management in Chennai City, India. Eleventh International Waste Management and Landfill Symposium, S. Margherita di Pula, Cagliari, Italy; 1 - 5 October 2007. CISA, Environmental Sanitary Engineering Centre, Italy, 2007.

[14] Harsha Anantharaman, Data-driven planning for Solid Waste Management in Chennai – Working Paper-, Citizen consumer and civic Action Group (CAG), 2015

[15] R. Alam, M.A.I. Chowdhury, G.M.J. Hasan, B. Karanjit, L.R. Shrestha, Generation, storage, collection and transportation of municipal solid waste—A case study in the city of Kathmandu, capital of Nepal, Waste Management 28, 1088-1097, 2008.

[16] Chanakya HN, Sharma I and Ramachandra TV.. Micro-scale anaerobic digestion of point source components of organic fraction of MSW, Waste Management 29: 1306-1312, 2009

[17] Solid Waste Collection and Transport, Service Delivery Training Module 1 of 4, Ministry of Local Government and Provincial Councils and the Sri Lanka Institute of Local Governance, 2008.

[18] Yu Lin, C., & Hui Ho, Y. An Empirical Study on Logistics services provider, intention to adopt Green Innovations. Journal of Technology, Management and Innovation, 3(1), 17-26, 2008.