



Integrated Solid Waste Management Systems for Environmental Sustainability at Institutional Level – Case Study.

Manju Minhas^{a}, Kavita Tandon^a*

^aAssistant Professor, Department of Civil Engineering, JSS Academy of Technical Education, Noida, India

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ABSTRACT

Solid waste menace is a serious, complex and challenging concern all over the World especially in developing countries where environmental protection has often been neglected in the haste to achieve economic development resulting in pollution, sanitation problems, intensified urban congestion and resource depletion. Conversely, solid waste if managed properly can be a resource to create energy, to local small scale industries which are involved in recycling as well as to poor people of the community like rag pickers etc. Therefore we have to identify a strategic way of addressing this problem and social concerns attached to it. Concepts such as appropriate technology, cleaner practices, life cycle assessment, effective environmental management systems as well as creating community awareness and enforcement of the guidelines can be useful for improving how solid waste management is approached. Since the magnitude of issues related to solid waste varies with location and time, area specific studies need to be carried out to derive management plans adequate to the region.

In the present study, an attempt has been made to do the qualitative and quantitative analysis of the Solid Waste Management (SWM) of JSS Academy of Technical Education (Jagadguru Sri Shivarathreshwara Academy of Technical Education), an apex educational institute situated in Noida, Uttar Pradesh, India. It was found that not only 70% reduction in the waste to be transported and disposed by land filling can be achieved but also revenue can be generated out of recycling which can compensate for the cost of segregation of waste. Nutrient rich compost obtained from the bio-degradable compost can be utilized in college lawns making the whole process self - sustainable. During the study a survey was also conducted among the college community to evaluate their awareness regarding environmental issues which showed that majority of people are ready to embrace and support environmental friendly ways to make the institute environmentally sustainable. If these practices are adopted as institute culture in form of Integrated Solid Waste Management System (ISWMS).

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1. Introduction

To develop an Integrated solid waste management system for any given environment, the following five steps are involved:

- Problem Definition and Statement of Objectives
- Inventory and Data Collection
- Development of Alternatives
- System Selection

• Implementation Methodology

The first step involves making a statement of the current problem and corresponding objectives from decision makers.

The second step involves making an inventory and collecting data pertaining to the existing system as well as that required for the new system. This would involve data relating to waste generation, waste

* Corresponding author. Tel.: +91-9582930609.

E-mail address: manjuminhas@jssaten.ac.in

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characteristics, transportation routes, collection systems, disposal sites, recycled materials markets etc.

In the third step, the data is evaluated and the feasibility of different technologies examined. Because a problem can have more than one solution, different alternatives are developed.

Next step is review of the alternatives the planners and decision-makers and a final set of technologies/programs are selected. These set of technologies and programs constitute the final management system.

The final step is the development of an implementation methodology for conversion of the existing system to the new system. This involves the setting up of schedules as well as monitoring mechanisms for implementation by the administrative organizations.

At the macro-level, the end result of an integrated waste management system is the development of materials flow chart, which shows how the waste is sorted, processed and transformed prior to disposal in a land fill.

2. Case Study

Case Study on SWM of JSS Academy of Technical Education, Noida: JSS Academy of Technical Education is an educational institute situated in Noida, Uttar Pradesh (28.613097oN 77.359473oE) affiliated to Uttar Pradesh Technical University, Gautam Buddha Nagar. The institute was founded by JSS Mahavidyapeeth of Sri Suttur Veerashimhasana Math, Suttur and inaugurated by former president of India Dr. A.P.J. Abdul Kalam in 1998. The college is approved by “All India Council for Technical Education”. The institute campus spread across an area of 28 acres(0.11km²) houses 4 academic blocks, workshops, food-court, garages, hostels for girls and boys, temple, staff quarters, multipurpose hall and two big playgrounds and 4 small lawns/gardens in front of blocks. Main programs run by college are B. Tech., M.Tech, MCA and MBA and various departments are Civil, Electrical, Electronics and Communication, Mechanical, Computers Science, Management as well as Mathematics, Science and Humanities. JSS campus also houses a Science and Technology Entrepreneur Park which has approx.250 personals of 25 start-up companies (mostly IT based). This case study was initiated to encourage students to do small research work which would improve their technological knowledge and when applied to some turnkey projects can give benefits which can be realized in terms of environment sustainability and resource utilization in case these project findings become permanent part of the campus waste management plan.

Waste Generation:

Keeping in consideration a total strength of 4292 including staff and students, the waste produced in institute is 54.75gm/capita/day. Out of this recyclables -paper, wood, metal and glass are total 34% and biodegradables, mainly food and vegetable waste, garden waste are total 60%.

The volume of waste generated by the campus population and JSSATE’s daily operations is increasing as the number of staff members and students are increased with increase in intake which makes waste management an on-going priority. The consumption of plastic packaging products such as plastic bottles and plastic bags has also increased steadily in recent years. The increasing quantity and changing composition of waste creates the need to find better waste management solutions. As in many developing countries, the local government is unable to cope with the increasing amounts of waste. Fortunately, the waste produced in college premises is well suited to recycling, recovery, composting and scientific disposal as most of it is clean (non-hazardous) and can be easily segregated. The details of the college are given below (Source- Maintenance Department, JSS):

- Campus is Urban, 28 acres (0.113 km²)
- Blocks- AB-1,2,3,4, Hostels, Temple, Food Court, Playground, Library
- No. of Students- 3983
- No. of Faculty- 249
- No. of Hostels- 1000 (Boys- 480, Girls- 520)
- Housekeeping Staff- 60
- STEP employees-250
- Frequency of Waste Disposal- Daily (Around 9.30am)
- Method of Collection- By rickshaws
- Method of Disposal- Dumping on Land all waste other than paper waste
- Average Waste Generated- 230-250kg/day(Total)

Collection and transportation of solid waste:

The dust bins are provided at various places in the campus, academic blocks and at food court for providing facility to students and faculty to throw the solid waste. The daily collection of solid waste at JSS is found to be approximately 230-250 kg/day. The labors come with trolley rickshaw with covered container and empty the dust bins in it and transport by pulling the trolley to the dump yard outside the Campus. The solid waste is collected, transported and dumped at around 10-11am once in a day.

Dumping of the solid waste:

The solid waste is dumped in open ground situated near the college campus in sector 62 from where the municipal vehicle collects and transports the waste to secondary disposal / landfill site near Okhla.

Existing Environmental friendly practices in Campus:

At JSS campus many initiatives have been taken in past to make it eco-friendly including rain water harvesting and underground air cooling through ducts.

3. Materials and Methods

Qualitative and Quantitative analysis of Solid waste in JSS:

The first step to decide about the solid waste management plan is to know the qualitative and quantitative details about the solid waste generated. To do that it is important to have a good sampling methodology.

Sampling of solid waste generated in Academy:

Solid waste was collected from various blocks in the campus premises including Academic Blocks, Hostels, Food Court and Temple inside the Campus. It contained mainly vegetable waste, food waste, plastic, glass, cardboards, wood, garden waste, papers and small quantities of cloth, metal, construction material waste and e-waste.

Information was gathered using a variety of methods to gain a better understanding of the situation, issues, perspectives and priorities. Data collection methods included document/literature review, semi-structured interviews, questionnaires and observation.

The maintenance authority responsible for waste collection in the campus provided sufficient help in Data Collection.

Preparation of Sample:

About 80 kg of solid waste sample was picked randomly (using grab sampling method) and after mixing thoroughly was reduced to 25kg (using quartering method) and the segregation of sample was done to find out the physical compositions in solid waste. We found that out of total 235-250 kg the quantity of 80kg of recyclable (waste paper, glass, recycle plastics, metals) and 150 kg Biodegradable waste (fruit and vegetable waste, temple and garden waste) as average of five sample analyzed on different days.

Physical composition of solid waste:

The physical compositions of the solid waste generated at JSS Academy, Noida is present in Table.

Waste Type	Quantity (kg/Day)	Quantity (kg/Capita/Day)
Paper	63.74	Total Waste- 235 kg/day Total College Strength- 4292 Waste Quantity- 0.05475 kg/Capita/day =54.75gm/capita /day
Plastic	5	
Glass	4.25	
Metal	0.95	
Wood	2	
Old Books /newspaper	5.11	
e-waste	0.50	
Bolts/Apparatus	0.10	
Concrete	0.52	
Food &vegetable waste	150	
Garden/Temple Waste	3.50	
Chemical Waste	0.25	

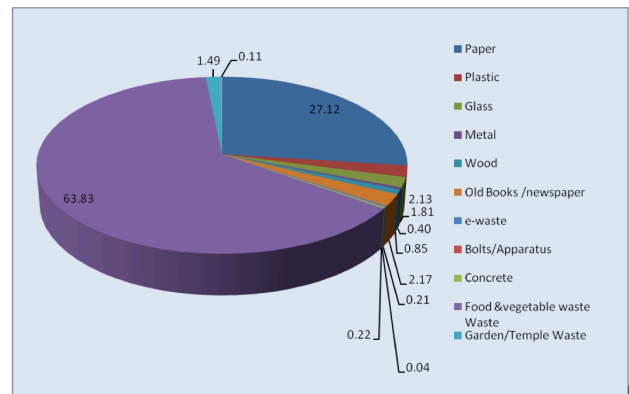


Figure: Pie Chart Representing Quantitative Composition of Waste Generated

Gist of Present Status Of Solid Waste Management As Seen At JSSATE:

- Proper storage of waste at source is satisfactory but improvements can be done.
- Segregation of recyclable waste done partially in blocks and partially by concerned maintenance department.
- Segregation of bio-degradable and inert waste is not carried out.
- Location and numbers of dustbins and waste storage points are inappropriate, resulting in littering of garbage at certain points. Moreover separate dustbins are not kept to collect dry and wet waste separately which can facilitate segregation of waste, which is most important step to recycle, reuse or recover resources from waste.
- Final disposal is generally done through crude dumping.
- Rag pickers collect recyclable material from dumpsites and litter the waste causing insanitary conditions.
- Safety gear is generally not used by most of sanitary workers as required by laid down norms.
- A large number of students were seen littering the drains/grounds without any concern about hygiene or cleanliness.
- Awareness programs /campaigns about hygiene and sanitation are rare on campus.

4. Survey on Environmental Awareness

A Questionnaire Survey was conducted on campus among 50 people including both Faculty and Students. Here are the questions of the survey:

- Q1. Are you aware JSS Academy is doing Rain Water Harvesting and its location?
- Q2. Do you use Dustbins provided in college?
- Q3. Do you think the number and location of dustbins provided is appropriate?
- Q4. Do you know the difference between Bio-Degradable and Non-Biodegradable Waste?
- Q5. Do you recycle anything you use?
- Q6. If we make JSS a Plastic-free zone will you co-operate?

Q7. Do you think littering at public places should be a punishable offence?

Responses of sample group represented below graphically.

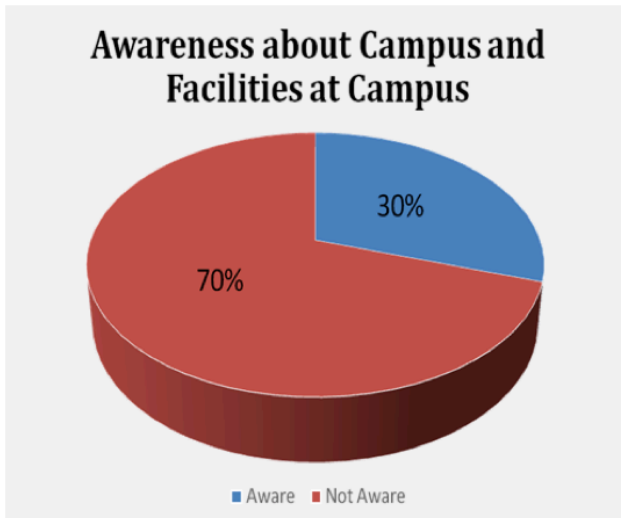


Figure: Sample group response to Q1.

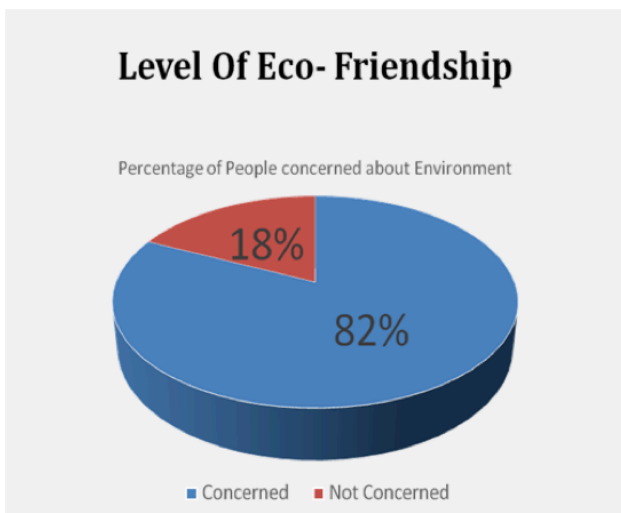


Figure: Sample group response to Q2.

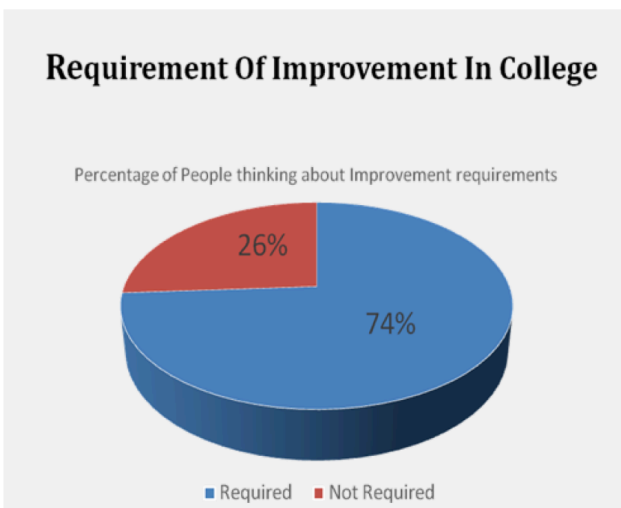


Figure: Sample group response to Q3.

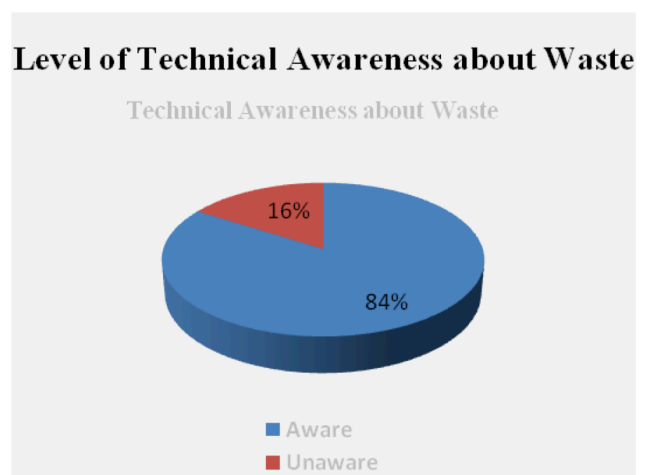


Figure 4: Sample group response to Q4.



Figure 5: Sample group response to Q5.



Figure 6: Sample group response to Q6.

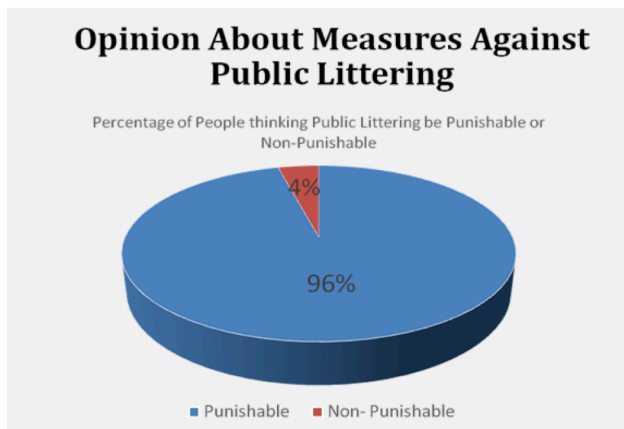


Figure 7: Sample group response to Q7.

5. Challenges and Limitations

Non-Segregation of Solid Waste:

As per the Municipal Solid Wastes (Management and Handling) Rules, 2000, solid waste generated should be segregated into biodegradable and non-biodegradable by providing separate bins for garbage collection. With increasing use of various kinds of packaging material for food items including plastic, segregation becomes all more important. Thus, it is necessary that the terms and conditions of the catering contracts bind the contractors to adhere to these laws failing which penalty would need to be levied.

All kinds of garbage recyclable and non-recyclable are collected in the same bins whereas the implementation of the process of waste management includes collection of all the generated waste in dustbins and vats, after due segregation into biodegradable and non-biodegradable waste and disposal at regular intervals adhering to the laid down rules and procedures.

Measures for Improvement:

Based on the case study and literature review, the following ten areas for improvement have been identified:

- Better Source Separation
- Better Data Management
- Training and Education involving morale and environment awareness
- Health and Safety Program
- Involvement of Employees and the community
- Proper Planning and management

Recommendations regarding disposal of waste:

- As observed in physical characterization of waste more than 35% of waste is recyclable therefore NGO's be invited to train and employ poor local people for not only segregation and collection of recyclables but also in addition setting up and run recycling unit which can recycle glass, wood, paper and metal under one roof. The revenue and employment generated will boost local economy and also help in achieving better solid

waste management as waste to be transported for landfill site will also be reduced.

Table: Recycling potential of solid waste

No.	Recyclable material	Market value Rupees/kg
1.	Plastic bags and packaging material made out of virgin material	6 to 10/kg
2.	Cans, disposable cups, bottles, disposable plates etc.	2to 16/kg
3.	Mixed color, polythene bags,	-
4.	Paper bags	2 to 6/kg
5.	Waste food and organic waste	-

- As the waste produced per day is found to be around 250 kg/day. Out of this less than 20% is non-recyclable therefore it is not feasible to plan a separate treatment or transformation facility. Therefore rest of the waste including biodegradable and non-biodegradable will be send to Okhla site preferably in separate bags and will be disposed as under:
 - Biodegradables: This waste is found appropriate for composting. Therefore should be send to vermicomposting cottages setup up near landfill site. The anaerobic digestion aspect can also be tried however quantity is not sufficient for setting up of separate biogas facility.
 - Non-biodegradables: The small quantity of inerts as well as non-biodegradables needs to be disposed at landfill. Proper sanitary land filling techniques should be organized here instead of present random disposal happening at site, which is not only unhygienic but also creating dangerous condition for flying of planes because of bird menace. The mass flow diagram is shown in Figure.

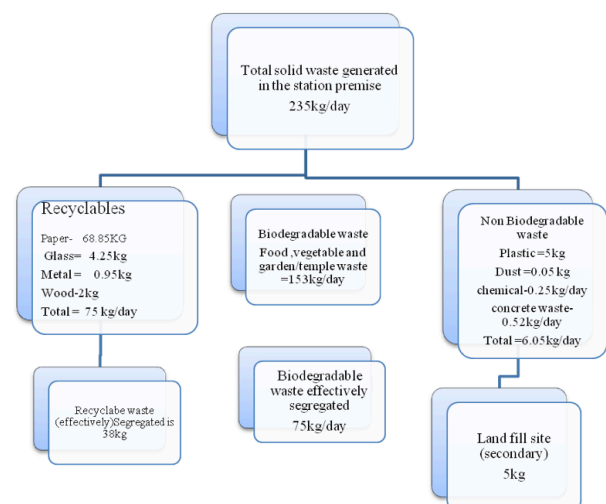


Figure: Mass Flow Diagram of Integrated Solid Waste Management System for JSS, Noida

6. Broad Action Plan

Solid waste created in different set ups have different quantities and composition so every type of organization needs to create its own tailor-made solid waste management plan based on guidelines, policies and latest technologies available in the market. This case study can give a broad action plan for a large number of colleges as well as schools which will generally have similar composition of waste. There is a need to integrate more vigorously minimization of waste generation and resource recovery component into the current practice of waste management as most of waste produced in institute is either biodegradable or paper based. Waste should be considered as resource and the waste management system should be focused on conversion of waste into resource rather than mere safe disposal.

Waste generation is first stage in the hierarchy of solid waste management and if given due thought the burden on all other components will directly reduce. Paper waste which is one of the major components in institutes like JSS can be reduced by simple steps like doing double side printing or by making all communications and documentation like feedback, records etc. on- line unless hardcopies are unavoidable. Also to encourage and motivate students and staff towards sustainable eco-friendly practices, management can think of setting a handmade paper making unit in college to recycle paper which can be run by students or by hiring one/two staff. The hand- made paper can be utilized to make file covers, paper bags for gifts or other such purposes.

In order to promote recycling there is a need to keep the waste segregated at source into biodegradable, recyclable and inert material as far as possible to avoid overflowing bin, inconvenience of segregation as well as excessive handling of waste. This can be achieved by adopting the buyback systems. Some change in market also needs to be created in the form of creating recycling conditions under which certain waste producing products can be made to carry 'label of guarantee of a prefixed refund on the left over of the product' it is important to note that this practice already exists as an informal sector all over India. It is necessary to have bins that can accommodate 20% more than the waste generated.

Transportation vehicles should have segregated waste while transporting and waste should be covered. Also, vehicles may have compacting mechanism especially for biodegradable waste if not composted on site itself.

So to avoid huge transportation costs, it is desirable to reuse, recover and recycle at source itself like having a small paper recycling unit as well as vermicomposting unit for biodegradable waste at campus itself. The effort should be to use latest technology to convert the maximum quantity of waste into compost and recycled resources.

Private organizations / cooperatives /NGOs/ student groups should be encouraged to participate in waste management.

Comprehensive training program and massive campaigns for raising awareness among the sanitary workers, students, staff and administration

should be taken up to achieve best results in form of reduction of generation of waste, reuse, recycling and conversion into useful products as well as safe disposal of the leftover waste which is expected to be not more than 30% if all these prior actions are taken sincerely.

At policy making level the recycling products should be having a display label announcing the same and should get some kind of tax subsidy from government.

7. Conclusion

“We humans have an amazing potential to convert everything useful into waste and anything waste into useful resources, if willing”

Anonymous

This review of case study undertaken against the background of the above mentioned policy decisions revealed that although maintenance department responsible for environment in campus premises is able to create a hygienic and clean condition in campus there is a need for planning and design of an integrated solid waste management system based on the standards and policies discussed in prior pages.

The case study provides a model for learning about the conditions pertaining to solid waste management in educational institutes especially in developing countries... It is worth noticing that segregation of waste, storage, transport, disposal as well as public awareness and training is now must and need to be given a much serious thought than earlier days. In fact the solid waste generated can be very easily converted into an attractive source of income with proper policies and govt. support. This case study of the SWM program helps to clarify the problem situation by providing a description of the various stakeholders, elements and issue involved with program implementation, and discussion of the conceptual and theoretical understanding relevant to the program. The methodological contribution of this study is the sharing of experiences and challenges during the conduct of study about SWM in developing countries that will be useful to other researchers in the field.

There is an urgent need of proper management of solid waste to minimize the health hazards. The solid waste from the campus should be cleaned periodically throughout the day. The dust bins (separate for recyclables and other wastes) should be insufficient quantities and strategically located so that the maximum solid waste get collected directly into these bins. As the solid waste generated at JSSATE is about 250 kg/day the provision of separate treatment facility is expensive and not practically possible. The major portion of waste is either biodegradable waste or paper waste so recycling capacity of waste is very high.

Hence, there is an urgent need of collection of these fractions periodically throughout the day to reduce the environment impacts and characteristics of solid waste shows that the waste is fit for composting. Hence it is suggested that after segregation of waste the biodegradable waste should be converted into compost.

A full-fledged awareness program should be planned and started for workers as well as for students and faculty to understand and help in better practices for hygienic, sanitation and segregation of waste using serrated bins for non-biodegradable and biodegradable waste. Personnel protecting clothes and equipment's should be provided to the solid waste workers to prevent the direct contact of solid waste further, the micro planning for the solid waste management at campus should be prepared, implemented and the record for same should be made.

REFERENCES

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- S. Raji and S. Aishwarya "Adopting Environment for Sustainability through an Institutional Culture –A case study.
 - Cary, S.S. (04 September 2008)."GM plans to dump use of landfills". USA today. Retrieved 23 September 2008.
 - Davoudi , S.Evans(2005)"The challenge of governance and Policy 23:493-517.
 - Young , C-Y, Ni,S.P. and Fan,KA(2010)."Working towards a zero waste environment in Taiwan".Waste Management and Research and Research 28:236-244
 - Barbalance ,Roberta Crowell (2003-08),"The History of waste"
 - Science Direct (2013)"Waste Management". Volume 33,Issue 1pp220-232.
 - New Energy Corporation (2014)"Waste Hierarchy"
 - USEPA(2014) "Energy Recovery from Waste"
 - Snow ,W. and Dickinson J.(2001). 'The end of waste: Zero waste by 2020"
 - Woodyard, Chris (19 feb.2008)."Zero waste :an aspiration or an oxymoron?" Waste management and Research2891):1-3
 - 'Solid Waste Management "2005 .United Nations Environment Programme.Chapter III :Waste Quantities and Characteristics,31-38.