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# Identifying Critical Issues Relating to Environmental Audit of Solid Waste Management in Large Educational Institutions; A case study of Ravenshaw University, Cuttack, Odisha

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**Abstract** – Of the entire problems related to environmental audit that have come into focus, institutional solid waste management has been the slowest to develop either in direction or regulatory mechanisms. In the absence of any specific regulatory directive, the institutions and especially the Universities have left waste management to the lower staff. There is no environmental management programme in any of the Universities in Odisha, India unlike most of the Universities abroad. This study examines the critical gaps in management through an audit of the solid waste of Ravenshaw University, Odisha. Results show that there is no framework in place for compliance of environmental laws. The top management of the University is not actively involved in directing the efforts. Even though the University generates 100.5 tons of waste per month only 37.5% of it is collected through regular municipality channels. Biodegradable waste constitute 82% of the total waste but is not used for energy recovery. There is no awareness among the students and faculty regarding sound practices. This paper attempts to provide a framework for policy and planning strategies relating to solid waste management in public and private educational institutions within the framework of Sustainable Integrated Solid Waste Management practices.

**Keywords** – *Environmental Audit, Ravenshaw University, Institutional Waste, Compliance Audit, Waste estimation.*

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## INTRODUCTION

Solid waste management includes all administrative, financial, legal, planning, and engineering functions (Ramachandra, 2006; Ramachandra and Varghese, 2003). The environmentally sound management of solid wastes issue had received the attention of international and national policy making bodies and citizens (Subramanian, 2005).

Auditing has become an increasingly popular tool to assess the environmental policies, quality of implementation, compliance with national law and regulation, etc. Environmental Auditing has also been widely used in India, especially in industries. The most popular audits that are carried out in India are energy audits (TERI, 2002) followed by environmental management systems audits of which a waste minimisation audit is an integral part (Mannan, 2002). Audits on MSWM in India are very rare. In western countries, however, audits on urban waste management have increasingly been carried out with respect to performance, compliance, risk, monitoring, existence of waste policy, quality of implementation, etc. Most of the

countries have established an auditing institution to carry out the above given assessments.

Waste audits are undertaken to ensure regulatory compliance, compare actual practices to best practice guidelines, develop baseline generation of data, identify waste minimisation opportunities and establish sustainable development indicators or bench marks (Ashwood et al., 1996).

While other aspects have received somewhat detailed study, base line data gathering is extremely scarce and especially with respect to institutions. (Samantsinghar and Dash 2008). In order to generate this data which forms the basis of all other interventions auditing solid waste is the preferred method. In general, there are three different approaches for conducting a solid waste audit, namely

- The back end approach, which measures the material generated by the entire facility, i.e., no attempt is made to assess the manner in which the wastes and recyclables are generated within the facility.

- The activities approach, which tracks the waste and recyclables as they are generated throughout the facility, by performing waste audits within each activity area, e.g., an office, warehouse, or cafeteria.
- The input/output approach, which tracks the material input and output associated with each activity area (CCME, 1996; Dowie et al., 1998).

In the present study we adopt the second approach while the first approach is used for estimation of collections.

A gazette notification regarding environmental audit was issued by the Ministry of Environment and Forests on 13 March, 1992 and later amended on 22 April, 1993. This applies to an industry, operation or process requiring consent to operate under Section 25 of the water (Prevention and Control of Pollution) Act, 1974 or under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981), or both, or authorisation under the Environmental Protection Act, 1986 (29 of 1986) (Srivastava, 2003). The notification requires that an Environmental Statement for the financial year ending on 31 March be submitted to the concerned State Pollution Control Board, on or before 30 September of the same year. However, institutions are not treated separately in this act as it places emphasis on the generators of waste.

As Simon and March identify, organizations are severely limited in their capacity to behave rationally due to inherent characteristics such as: complexity, limited capacities to calculate all parameters, the tendency towards "satisficing", fragmentation of problem and solution elements, limited organizational repertoires, shifting coalitions, shortages of time and attention, quasi resolutions to conflict and uncertainty avoidance (Weiss, 2001). All of these traits exist within universities. As a result of these rationality limiting characteristics of universities, environmental committees and staff are quickly forced to shift their focus from broad reaching systemic transformation to well-bounded projects with lower levels of participation, losing significant momentum and breadth in their organizational impact. Consequently, in a small percentage of universities across the world we now have many examples of how the different initiatives such as recycling, energy efficient lighting, water conserving fittings, composting toilets, passive solar design, green building design, carpooling programs, public transportation initiatives, environmental procurement programs etc. may work (Sharp 2002). Similar studies have not been undertaken in Odisha.

This paper presents a critical analysis of the issues involved in environmental audit of the solid waste generated in Ravenshaw University Cuttack, Odisha .

This would help in collecting base line data about solid waste in educational Institutions. This would explore the role of various stakeholders in Solid waste management, the current practices, the role of each entity, the shortcomings of the current practices and issues to be addressed to improve the condition.

## **MATERIALS AND METHOD**

The approach to the case study was mainly qualitative with emphasis on primary data collection and analysis. Information was gathered using a variety of methods to gain a better understanding of the situation, issues, perspectives and priorities. Environmental audit of solid waste mainly focuses on compliance with rules and law, gap in infrastructure and manpower for proper management, selection of appropriate treatment methods, recycling and energy recovery, sound disposal practices and the administrative machinery to implement all these (INTOSAI 2002). The case study focuses on all these aspects and tries to estimate the waste generated through a waste audit.

Data collection methods included on site sampling and actual weighing and sorting of waste generated for seven days over a period of three months. Standard waste auditing procedures as mentioned in the waste audit handbook prepared for "Canadian Council of Ministers for Environment" have been followed. A review of available literature and documents was made. Semi-structured interviews, checklists and physical observation were made in order to understand the issues pertinent to Institutions.

### **Sampling:**

A stratified random sampling approach was planned for collecting the primary data. The campus was divided into three segments, Arts departments and other Administrative Departments, Science Departments and Hostels and Households. The division was mainly based on the judgement about the nature of waste generated. In all the segments a sample size of 25% departments/waste producing units was selected based on simple random sampling with replacement (SRSWR). The waste was collected for seven days over a period of three month between November and January to eliminate bias. The segregated waste was tested for physical and chemical properties. Garden waste was sampled separately.

### **Estimation:**

Estimation was made by extrapolating the sampled data to all the departments. Since the departments have been divided into three strata we assumed that within the strata all departments have similar generating characteristics. Moreover, the waste generated is independent of the number of students studying in a

department since these are non residential and students spend most of their time outside the department. Hence the waste generated in 25% of the departments were extrapolated by straight line method to arrive at an estimate. These data were clubbed together and categorised as indicated in tables. The integrity of the estimation was tested based on Confidence Interval with a 95% confidence level. Raw tables are not represented in this paper.

For estimation of waste the backdoor method was used to certain extent but since there was no single collection point in the Ravenshaw Campus and the

CMC clears it only three times a week, this method was found not suitable for a reliable estimate. However, this data was used to find the percentage of collection and weight that is released to organised waste streams.

## RESULTS

### Waste Categorisation

Waste generated in the University was classified as follows. This was done keeping in view the Integrated Waste Management Framework.

Material	Category	Description
<b>Hostel/Household Waste</b>		
Compostable	Leftover food waste	
	Fruit and vegetable waste	
	yard waste	
Recyclables	Metal	Aluminium cans, soft drink cans, iron rods, scraps, nails, pipes etc.
	Glass	Beer and alcohol bottles, glass soft drink bottles, Broken glasses, window panes, water jugs and tumblers
	Recyclable Plastic	Water bottles, clear bags
	Recyclable Paper	Tissues, cardboard, printing paper, news paper, photocopier paper
Miscellaneous waste	Non-recyclable Plastic	Plastic bags, hard plastics
	Non-recyclable Paper	Damp napkins tissues, toilet papers
	Others	
<b>Department and Laboratories/Administrative units</b>		
Compostable	Food waste	From leftover food of faculty, staff and students
	Yard waste	Leaves, clippings of grass
Recyclables	Metal	Aluminium cans, soft drink cans, iron rods, scraps, nails, pipes etc. copper tubes, Broken iron furniture like tables and chairs, almirahs
	Glass	Laboratory glassware waste like broken test tubes and beakers, glass soft drink bottles, Broken glasses, window panes, water jugs and tumblers
	Recyclable Plastic	Water bottles, clear bags
	Recyclable Paper	Tissues, cardboard, printing paper, news paper, photocopier paper, used test papers, old files and records, old question papers etc.
Miscellaneous waste	Non-recyclable Plastic	Plastic bags, hard plastics
	Non-recyclable Paper	Damp napkins tissues, toilet paper
	Others	
Hazardous Waste	Chemicals/ radioactive materials	Laboratory chemicals, enzymes, reagents, genetic material, acids, alkalis, other hazardous material like syringes, sharp nails, cutters, biological material from

Material	Category	Description
		experiments
<b>Garden waste</b>		
Compostable	Leaves, twigs, branches	
	Grass clippings	
Miscellaneous	Inert material	Dust, sand, construction debris etc.

Table 1: Categorisation of waste in Ravenshaw University

### Study Area

The University is situated in an area of about 90 acres with a constructed area of 11, 84,041 Sq. Ft. (Parida, 2012). The University has 7000 students covering UG and PG departments. It has 22 departments and faculty strength of 109. Another 420 people work in

administrative office, post office, dispensary, hostels and other amenities. 75 staff quarters are also located in the campus comprising 300 people. There are 11 hostels out of which 9 are within the campus housing 1926 students.

### Waste generated as per waste audit plan for a week. (in KG)

Groups	category	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Average
<b>Departments and Labs, office etc.</b>									
	Compostable	1.67	2.00	1.98	2.1	2.81	1.32	1.00	1.84
	Recyclable	25.56	24.67	19.49	27.09	26.13	29.99	25.11	25.43
	Miscellaneous	18.53	21.67	18.64	14.79	10.87	10.91	16.9	16.06
	Total	45.76	48.34	40.11	43.98	39.81	42.22	43.01	43.32
<b>Hostels/ Households</b>									
	Compostable	200.00	210.73	200.30	250.00	220.90	208.1	213.70	214.82
	Recyclable	10.12	15.00	18.38	6.53	13.86	15.36	12.12	13.05
	Miscellaneous	50.00	39.97	11.42	31.97	25.94	22.14	14.18	27.95
	Total	260.12	265.70	230.10	288.5	260.7	245.6	240.00	255.82
<b>Gardens and Yard waste</b>									
<b>Excluding construction debris</b>	Compostable	25.98	30.12	35.89	38.53	28.5	30.0	33.18	31.74
	Recyclable	0	1.0	0.53	0	0.53	0	0	0.29
	Miscellaneous	4.78	4.46	3.88	3.22	1.07	3.79	5.62	3.83
	Total	30.76	35.58	40.30	41.75	30.10	33.79	38.80	35.87
					Avg. Grand Total Per day				335.01

Table 2 : Consolidated and extrapolated data on waste generated per day with averages

The above table does not include hazardous waste generated by the laboratories. This waste consists of broken glass lab equipment, hazardous chemicals, acids, alkalis, biological parts, enzymes etc. and are highly hazardous. It was estimated that on an average, 0.5 Kg of such waste is generated mainly in Physics, Biology

and Chemistry labs. This makes it 15 Kg a month and 180 Kg a year.

The confidence interval has been calculated with a confidence level of 95% with respect to the average waste generated in three broad categories.

Category	Avg.	SD	Variance	Confidence Interval
Departments and Laboratories/office	43.32	3.04193	9.25331	40.5 to 46.53
Hostels/households	255.82	19.25331	370.69006	238.023 to 273.62
Gardens and Yard	35.87	4.59347	21.09995	31.62 to 40.11

Table 3 : Averages, Standard Deviations and Confidence Interval

It is seen that almost all the observations fall within a 95% confidence level rendering the data highly reliable.

#### Average waste percentage by category of waste:

Category	Departments and Laboratories/office etc.	Hostels/households	Gardens and Yard Excluding construction waste	Total	Percentage (%)
Compostable	1.84	214.82	31.74	248.40	74.15
Recyclable	25.43	13.05	0.29	38.77	11.57
Miscellaneous	16.06	27.95	3.83	47.84	14.28
Total	43.32	255.82	35.87	335.01	100.00

Table 4 : Percentage of waste as per waste category

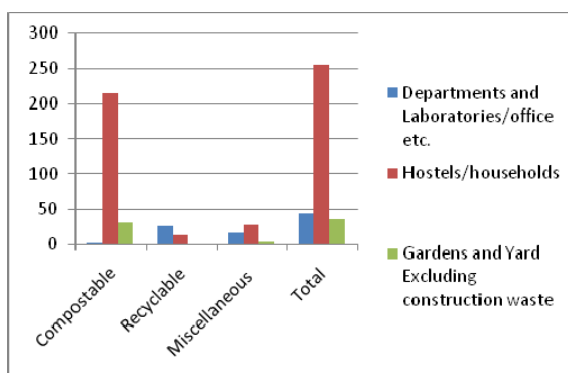


Fig: 1: Percentage of waste generated by major generating groups waste category-wise

#### Waste Estimation

Total waste generated in Ravenshaw Campus was estimated taking the total average figures.

	Per day	Per week	Per Month	Per year
In Tons	3.35	23.45	100.5	1206

Table 5 : Estimates of waste generated

It will not be useful to calculate the per capita waste generated in the campus since not all of the students actually reside in the campus and hence have a very high number of floating population.

Municipality collects waste from specified and unspecified dump sites three times a week. An enumeration of weight of waste collected shows that the weekly collection of mixed waste is 8.75 tons. This brings the collection to a mere 37.31% of generation. It is estimated that 5% of the waste generated in the households are recycled by the unorganised rag pickers and kawadiwallas.

#### Physical and chemical analysis of waste

It was found food that waste is approximately 35% dry solids, which are 95% decomposable. Following were the physical and chemical properties of waste.

Material	Food waste	Department/Yard waste(Miscellaneous)
Carbon, %	51.3	50.2
Nitrogen, %	5.7	1.1
Sulfur, %	0.4	0.1
C:N	10:1	50:1
Moisture, %	70.9	52.8
Bulk Density(wet) Kg/m <sup>3</sup>	760	358

Table 6 : Physical and chemical properties

#### Collection and transfer

In Ravenshaw the present system of waste collection is the dumping of waste by the department sweepers in open unspecified dumps periodically through emptying the garbage bins. The residents similarly dump their waste at various (not pre-designated) places around the campus thus creating an unhealthy atmosphere. No door to door collection method was adopted. A private agency "Paritosh" has been contracted out to do the sweeping of the roads, gardens, arts block and cleaning of the common area. The agency has engaged 8 sweepers and a supervisor for the cleaning work. Other than that 16 departmental sweepers (both permanent and temporary) clean the departments and library etc. It is estimated that around 37.5% wastes are collected and the rest is left at various dumps near the departments. Hostel waste, mostly biodegradable and highly putrescible are dumped behind the hostels on open ground.

**Present collection model**

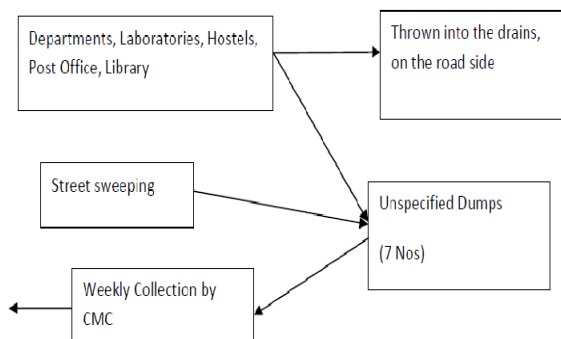


Fig. 2: Existing collection model

**Existing Compliance structure**

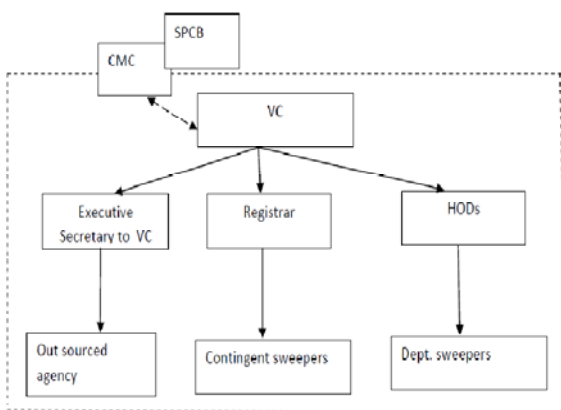


Fig. 3 : Existing Compliance Structure

**Solid Waste Management Framework for the University**

Type of Waste	Responsibility of Management	Enforcement of Rules and Compliance Monitoring
Solid Wastes, (MSW), Plastics	Generator (University), CMC	SPCB
Bio-Medical Wastes (BMW)	Generator, Operator of Facility	SPCB
Construction and Demolition Wastes (C&D Wastes)	Reflected in MSW, should be displaced separately	SPCB
Hazardous Wastes, Batteries	Generator, Operator of Facility	SPCB
Electronic Wastes(E-Wastes)		SPCB

Table 7: Solid Waste management framework

**Compliance Gap Analysis**

Sl No	Requirement	Responsibility	Present situation	remark
1	To avoid littering of wastes	University (Generator)	Littering of waste occurs extensively throughout the campus	Poor level of awareness, lack of garbage bins
2	To ensure delivery of wastes in accordance with collection and segregation system	University (Generator)	While delivery of waste to the collection system is only 36% , there is no segregation of waste.	Lack of awareness on segregation requirements as well as on the benefits of such practices, no facility for segregation
3	Organising house to house, department to department collection	University Cuttack Municipal Corporation	No door to door collection	No awareness about rules, about the benefit

Sl No	Requirement	Responsibility	Present situation	remark
4	Construction & Demolition waste and horticulture waste to be collected separately and disposed	University	Presently horticulture waste is mixed with regular waste. Construction debris is left on the site.	Clear disposal mechanism and rules for C&D Waste needs to be devised. Avenues for recycling of C&D waste need to be looked into.
5	Organise public awareness	University CMC	No awareness campaign organised	Need to do it in collaboration with CMC
6	To establish and maintain Storage facilities by considering the quantity of waste generation and spread of the locality	University CMC	Inadequate storage bins, damaged bins, no covered storage	Storage may be combined with decentralized treatment units for generation of compost/bio-gas for the food waste in hostels and households
7	The bins or containers to be cleared before they start to overflow	Municipal Authority	Cleared only thrice a week. Bins overflowing all the time.	Needs to be cleared on a daily basis
8	Setting up of waste processing and disposal facilities	University CMC	Yet to be implemented	Needs immediate attention for Biomethanation /composting
9	Monitoring the implementation	Orissa Pollution control board	Not monitored at all	Needs a compliance audit

Ref: *Municipal Solid Waste (Management and Handling) Rules 2000*

Table 8 : Compliance gap analysis

## DISCUSSION

The generation of waste of 3.35 tons per day and around 100 tons per month is largely because of the highly biodegradable waste of the hostels and 75 households that reside inside the campus. 72% of the waste is biodegradable. Since 2.4 tons of this waste is available per day and is highly putrescible, there is a need for a small scale biomethanation plant in the vicinity of the hostels for generation of gas for cooking and lighting. The C N ratio of 10:1 is very conducive for gas generation. This will be sufficient to generate 300 KWh of energy.

The waste management programme of the University operates within the overall waste management framework of the CMC and SPCB as it does not have any separate statute or regulation for

waste management. No compliance report either prepared or submitted to CMC or State pollution control board or to any other body or authority. It was noticed that CMC or the regulators have never issued notices regarding violation. This however should not mean that there have been no violations. It means that the rules

have been interpreted rather loosely and no cognizance has been taken about violations.

Collection is only 37.5% which needs to be improved by providing adequate (the study estimated 30 covered bins as per segregation rules) bins throughout the campus and asking the CMC to clear it once a day instead of three times a week.



### Proposed collection model

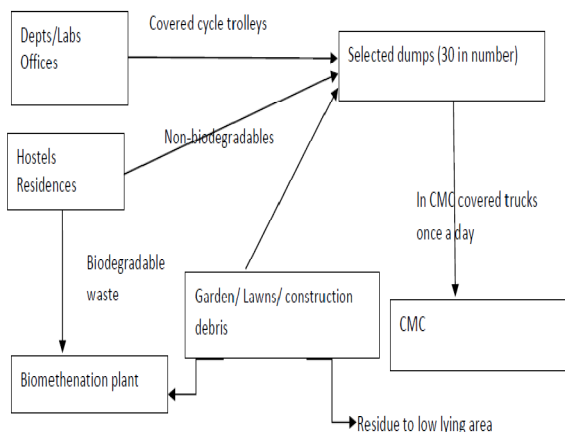


Fig. 4 : Proposed collection model

### BIOMEDICAL AND HAZARDOUS WASTE

#### Lab Waste

Ravenshaw generates various hazardous wastes from its Laboratories like acids, alkalis, various chemicals, sharp needles, Glass shards, syringes, biological waste like dead animals etc. These are now being thrown away along with other waste. Though the quantity generated is small this practice is dangerous and against the Waste handling rules. These wastes should be kept in closed containers and periodically buried deep at a secluded spot in the campus. The material produced is not of sufficient quantity to suggest any other method.

#### Hospital waste

The Ravenshaw dispensary generates small amount of biomedical waste. Since these are hazardous, these should either be buried deep along with the lab waste or handed over to SCB medical college authorities for safe disposal.

#### Compliance structure

The compliance mechanism is highly disaggregated and works independent of each other. There is no synergy of efforts and no commonality of purpose. At present there is no separate waste handling or management cell. No single person or group of persons other than the 25 sweepers are responsible for compliance and sound management practices. The waste management administration is integrated with the general management of the University and constitutes an insignificant portion of the duty of the administrator. There is an urgent need for senior management intervention for creating a framework of management

and assigning and enforcing clearly defined duties and responsibilities.

#### Resources:

The University spends around Rs 18.70 lac on waste disposal services. It is found that the number of staff engaged is not sufficient to maintain the desired level of services. It is estimated that at least 30 staff should be employed on an outsourcing basis for the service delivery to be effective.

#### Awareness

University being a learning institute have all the stakeholders who are educated and literate. This high literacy rate should have created a situation of active participation in waste management. Contrary to this, the University has no system of organised waste disposal and no segregation. Recyclables are sold to the Kawadiwallas in batches by the households and the sweepers of the departments as and when they wish. It was found that the students are generally not aware of their responsibilities regarding waste handling. The faculty, though aware does not participate actively in these activities and it is left to the sweeper to do as he desires.

There is an urgent need for a compliance audit regarding solid waste management practices in the University.

### CONCLUSIONS

Ravenshaw University generates an estimated 100 tons of waste per month out of which 72% are biodegradable. There are serious compliance related issues and the provisions of Municipal waste handling rules 2000 have not been complied at all. The University does not practise segregation, door to door collection or safe storage practices as required by law. The top management has not specified policy interventions and the monitoring mechanism is absent. The University runs the risk of being penalised by the state Pollution Control Board is urgent action is not taken for sustainable waste management practices.

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