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Comparative assessment of awareness on issues pertaining to sustainability in institutions of higher education

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Abstract: **Institutions of higher education provide role models for excellence in education. They also have an added responsibility of providing guidance to the community for social upliftment and environmental sustainability. It becomes imperative, therefore, to assess the extent to which sustainable practices have been adopted in these institutions and their adequacy. It is anticipated that a holistic assessment will indicate strengths and weaknesses in sustainability practices so that effective measures can be taken to initiate the creation of a more sustainable environment. To accomplish the foregoing objective two parameters have been analyzed namely, Energy and Waste. Information gathered from administrators and service providers of select residential institutes of higher education with respect to the quantities associated with each parameter and the criteria taken to create the environment sustainable. Case study approach was adopted to examine power consumption trends and waste management practices. An online survey conducted to gauge the sustainability perception and the importance of sustainability parameters. Increasing awareness of issues pertaining to sustainability in institutions of higher education is reflected by relevant practices adopted, however, it is expected that initial movement generated in this direction will lead to further adoption of sustainable practices consisting with the cultural geography and social economic scenario prevailing.**

Keywords: Sustainability perception; energy management; waste management; campus sustainability

I. INTRODUCTION:

Sustainability as applicable to Higher Educational Campuses is a process of developing and managing campuses, particularly through the efficient use of renewable and other resources along with green practices [1]. Many researchers have identified the importance of higher educational institutes and their contribution towards growth for the sustainable development. Over the years, academic institutions contributed a great deal in solving major socio-economic problems of the society. Sustainability practice differs from institutions to institutions. Depending upon the accessibility of resources, various approaches were taken. For example, initially, people think that they met the environmental challenges by signing the national and international declarations [2]. Few have limited them self by introducing master plans, environmental programs and environmental guidelines [3]. The study conducted for seven worldwide universities based on tri-dimensional Framework-Level-Actors (FLA) [4]. Life cycle analysis adopted to identify the environmental performance of the University of Maribor [5]. Consumption based carbon footprint study was conducted for the UK University [6] (In press). Few European universities adopted Environmental Management System (EMS) [7]. Sustainability perception also differs from institute to institute. For some; physical planning/land use structure of the educational campus is more significant to make the campus more sustainable [8]. Energy is an important parameter, which measurably contributes in making the campuses more sustainable. Several works reported in Japan on the verification of energy consumption through investigations of energy used up in the entire campus [9]. General practice shows that, the power is mainly distributed through the grid generated either through the thermal power plants or through large hydros. Educational campuses cover a vast area where they hold the highest potential of getting energy from diverse renewable energy resources like biomass, solar thermal, solar photovoltaic, geothermal and wind energy. Universities considered similar to small towns because of their large size, population, and the various complex activities taking place on campuses [10]. Stakeholders perform various activities results of which various waste like; food wastes, paper waste, chemical waste, E-waste produced. The functional elements of waste management are; storage, segregation, collection, transportation, treatment and disposal. Storage of waste takes place at hostels, quarters, departments, other utility spaces and at community level. Various bins made of different material like cement, plastic, masonry, cylindrical concrete bins; metallic and plastic bins generally used for the collection [11]. Segregation includes segregating waste into several categories like Dry waste, wet waste, recyclable, non-recyclables etc. Conventional method shows that partial segregation of newspaper, milk pouches and the rest mixed up during the waste storage [12] [13]. Waste is being collected, either from door to door or from the community bin, are the most

prevalent systems in India [13] [14] [15]. After storage, segregation and collection, the waste is transported either to dumping sites or to the processing sites. Vermin Composting, Bio-methanation also practiced along with the selling of recyclables to the recycling industries [16]. The present report is organized as: first, introduction to study area; second, research methodology based on power consumption structure analysis, waste management practices along with the sustainability initiatives; third discussion part, explores the relation between land use and power consumption; last part is conclusion.

II. INTRODUCTION TO STUDY AREA:

Campus Sustainability in India is in its very nascent stage, not been acknowledged even by many of the leading institutions at the internal stage. In this paper, a case study approach is adopted to identify the real energy consumption structure and waste management practices. Two of the Indian institutes, namely, Indian Institute of Technology Bombay (IITB), and Indian Institute of Technology Madras (IITM) selected due to their different geographical location (Fig.1).

Fig: 1. Geographical location of the selected campuses

Brief profile of the institutions was collected from the respective institutions as shown in a Table.1.Total population of student, faculty and staff was collected from the dean academics section of the respective institutions to calculate the per capita energy consumption and waste generation. The population trend over the five years (2007-2012) of student, faculty and staff is studied by considering 2007 as a baseline year as shown in Fig.2.2.

Table: 1 Brief profile of the institutions

Description	IITB	IITM
Type of Institution	Residential	Residential
Year of establishment	1959	1959
Total Area	184.40 Ha.	248 Ha
Student population (2012)	9875	6934
Faculty population (as of 2012)	517	554
Staff population (as of 2012)	1228	705
Total campus residents (as of 2012)	19130	11277
Student: faculty	1:13	1:19
Type of programs	PG, PhD, UG	UG, PG, PHD
Funding from central government	Fully funded	Fully funded

Source: Annual reports of the respective institutions

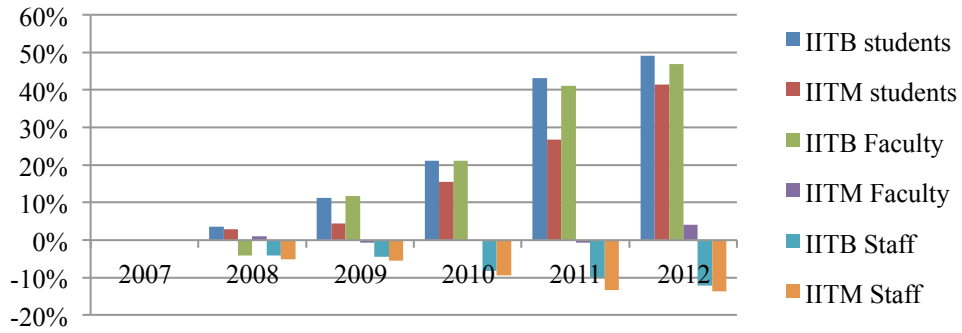

Fig.1: Population of student, faculty and staff trend over the five years in IITB and IITM.
Source: Annual reports of the institutions

III. METHODOLOGY:

The data were compiled from several departments of the select institutions by both online and offline. Focus was given on power consumption patterns of energy from the year 2007 to

2012 and waste management practices for the year 2012, Further; power consumption/student has been worked out to pull in the inferences. Emphasis made on various sustainability measures adopted to dilute the power expenditure and waste generation within the establishments. Comparative survey of growth trends of total students, power consumption units and power consumption/student for the year 2007-2012 analyzed to derive the conclusions. A physical survey conducted to examine the waste management practices. Data collected from the concerned departments and images taken were to support the quantitative and qualitative analysis.

IV. ENERGY:

Power supplied to the both institutes was from the respective State Electricity Boards. The electricity used for performing various activities like; lighting, air conditioning system (AC), all types of electric gadgets, heating and cooling and for performing various experiments in the laboratories. For the comparative analysis, monthly average power use of goods and services for the entire campus for the year-2007-2012 is considered.

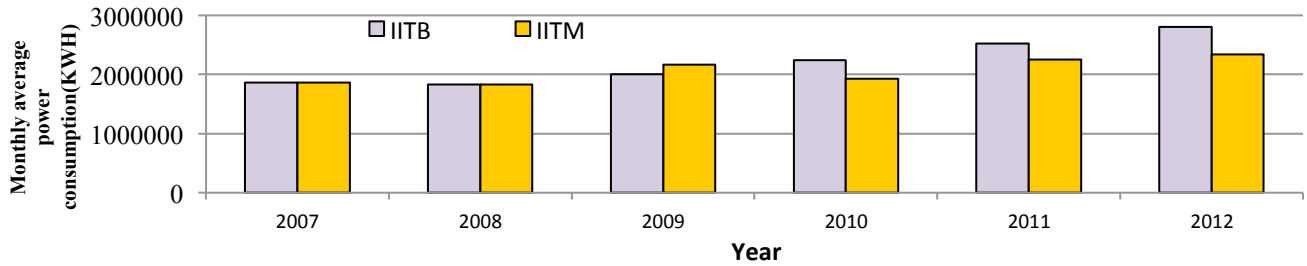

Fig: 2. An Average yearly energy consumption of IITB and IITM from 2007-2012.

A. DISCUSSION:

Power consumption trends were studied from 2007-2012 considering 2007 as a baseline year. Total power consumption and the total student population from 2007-2012 was considered for the study and year wise increase/reduction in total power units and student population were observed (Table.1). IITB shows a strong correlation between the student population and power consumption ($R^{2=}$0. 986) where as IITM shows a poor correlation ($R^{2=}$ 0.760). Year wise increase in the student's strength has considerably reduced total power consumption/ student. IITM's power consumption per student is consistently low as compared with the IITB. There was a slight increase in power consumption /student for the year 2011-2012 as compared with the previous years in both the campuses. The institutes comprise of two characters of power demands; constant power demand and fluctuating power demand. The constant power demands are due to lab equipments, heavy duty machines, kitchen equipments in hostels, lighting in common fields, library areas, water heaters, and so on Moreover, they consume the same amount of power when they operate irrespective of increase or decrease in the student population. The other power demand is of fluctuating type which depends on the number of users like; lighting and equipments used for the personal use, air conditioners, room heaters, personnel cabins, use of electrical equipments and so on As compared to the fluctuating power demand, constant power demands consume maximum electricity. In case of constant power demands, power consumption /student decreases with the increase in student population. In fluctuating power demands, power consumption/student increases with the growth in student population. Further, the use of energy efficient fixtures, LED's, energy star rated appliances, occupancy sensors for all the common areas has helped in reducing the overall power consumption in both the campuses. Nearly all the hostels were set up with the solar water heater and in IITM, few of the older hostels still operate the electric geysers for heating, but altogether the new hostels installed with solar water heater. In IITB, installation of solar photovoltaic cells on the rooftops of all the departments and administrative buildings was in progress. Policies were made by both campuses to make all the green buildings in the hereafter.

Table.1: Increase in Percentage of power consumption and student strength

	IITB		IITM	
	Total Power Consumption	Student Strength	Total Power Consumption	Student Strength
2007				
2008	-1%	4%	-1%	3%
2009	8%	11%	16%	4%
2010	21%	21%	4%	16%
2011	36%	43%	21%	27%
2012	51%	49%	26%	42%

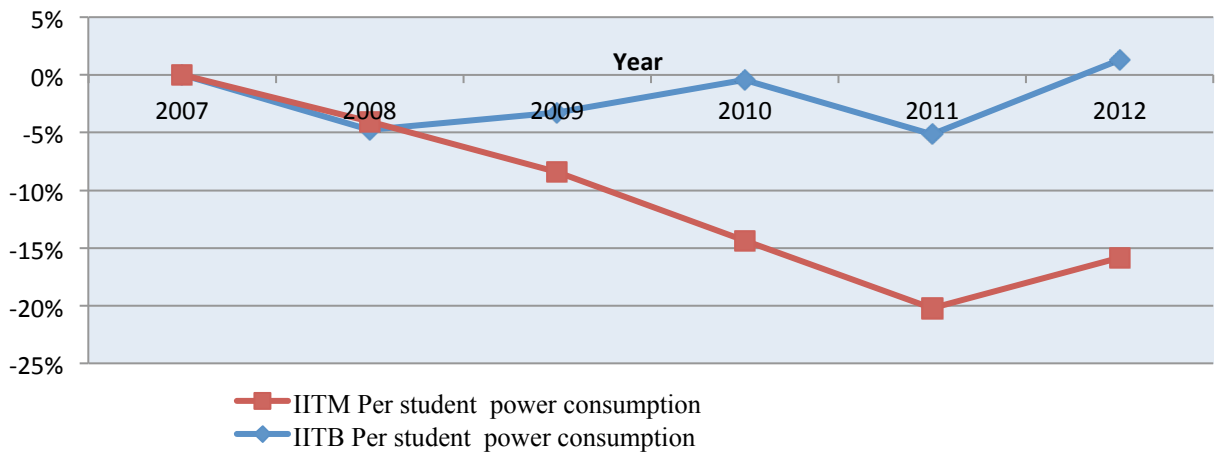

Fig.3: Power consumption per student from the base year 2007.

V. WASTE MANAGEMENT PRACTICES:

A. Waste Management practice in IITB:

Public Health Office (PHO) of IITB is looking after all the matter related to waste generation, collection, recycling, administration and so on Solid waste is collected in two types of bins namely; recyclable waste in the green colored, non-recyclable waste in a white color kept at various locations. Large sized bins kept at community level to collect recyclable and non-recyclable waste separately. Cleaning and Housekeeping were given to the local contractors. Waste thus, collected at various locations are being weighed and regular records are maintained. Food wastes from all the hostels collected four times a day and then it carried to the dumping site. Further, landfill gas generated from it. All the recyclable waste, collected from various locations finally dumped on the site located within the campus. Recyclable waste from the dumping site is separated and taken by local NGO namely 'Shrimurti Sanghatan' for recycling purpose. Separate dustbins kept to collect the E- waste from various locations, it was then sent to the material management department, which is then auctioned to vendors. The similar practice carried for furniture waste. Construction waste was collected by the local municipal authority and been dumped in the dumping yard located outside the campus. Non-recyclable waste dumped at the site near hillside, and then the local municipal authority collected it. Biomedical waste collected by the local contractor, which was collected in color-coded bags as per the regulations and regulation set by the local agency. The contract was given for one time in a year; the contract was either renewed or applied to another contractor. Collection and disposal were done twice in a week. The contractor was paid 54200/- for one year to collect the bio-medical waste from various labs like; Bioscience and Bioengineering, Chemical Engineering, CRNTS and MEMS. Biomedical waste collected for the month of June-2013 studied, which records an average of 1.6 kg daily. Fig. 4&5 shows a collection of dry waste (recyclable and non-recyclable) in a separate bin and compost plant provided at residential area.

Fig.4. Waste collection bins

Fig.5. Compost plant near the residential area

B. Waste Management practice in IITM:

Solid waste management in IITM, consisting of collecting and separating the waste into organic and non-organic wastes with the help of OWZONE, a Self Help Group. Recyclable portion of the non-organic waste sold to the local vendors. Segregated biodegradable waste carried to the vermin compost plant located inside the campus. Vermin compost thus generated was sold to the campus residents. The training program organized for a number of underprivileged groups of people from nearby villages. Presently there are five Self Help Groups (SHG) namely; Mahatma Gandhi SHG, Jhansi Rani SHG, Kannagi SHG, Peeliamman SHG and Sardar Vallabhai Patel SHG. The primary purpose of these groups is to collect,

segregate and sale of recyclable stuff. Revenue is thus generated, 20% were given to the IITM and rest is adjusted with the expenses occurred and the remaining amount was circulated amongst the members as an income. There are three sheds to segregate and storage purpose within the campus. With respect to the accumulation of waste, each resident had given one red and single green bin. Red bin for collecting non-recyclable waste and green bins for collecting recyclable waste. Workers collect both the waste separately recyclables are either carried to vermin compost bins or to the roadside bins, or it is being carted away by the solid waste collection contractor. Non-recyclable material taken to the sheds for separation later on all the assorted non-recyclable materials sold to the scrap dealers. IITM had a multi-storied centralized mess for all the boys' hostels. With regard to mess & canteen areas, organic and food wastes is collected and sent to a biogas plant (80 cum) located behind the mess. The gas such produced used for water heating. The M/s Multiclave collected biomedical waste every day for the incineration plant. The responsibility of the construction waste was given to the each contractor to dispose it through the Neel Metal Fanalca. E-waste was collected in each department is disposed through the authorized dealers and collectors. Fig. 6&7 shows waste segregation at the site and biogas plant, provided to generate energy from food waste/vegetable waste.

Fig.6. Waste Separation at site Fig.7. Bio- gas plant from food waste.

C. DISCUSSION:

The study shows that efforts were being taken by both the campuses to manage the waste produced within the campus. Efforts were taken to separate the waste either at source or at a site located within the campus. The very small amount of revenue was generated by selling out the recyclable and non-recyclable to the respective vendors. Food waste is one of the critical issues, which need to be address fully. Presently a fraction of the food waste produced sent to either biogas plant or to the land filling. The amount of biogas produced from the food waste is comparatively very low as compared to the total food produced. Awareness needs to be engendered amongst the student to reduce the all types of the waste inside the campus. Quantification of the waste was one of the good initiations taken by both the campus, which will further serve to distinguish the vital areas and frame the policies accordingly. Chemical waste produced within the campus needs to be addressed satisfactorily. Both the campus covers almost 65% of the total campus area under forest areas/unmanaged green spaces that produces a huge amount of leafy matter that needs to be utilized for producing the compost manure.

III. SUSTAINABILITY AWARENESS:

Youth "feels a relatively strong affinity to the environmental movement and consider environmental problems as important" [16]. Young people build up a social movement, which is known to operate outside the decision-making systems to both critique the status quo and to create their own answers. An online web questionnaire developed with the assistance of students of the parent institution. With the due permission of the Dean of Students Affairs (DOSA) from both the institutes, survey link floated on the E-notice during the spring 2012-2013 semesters that made accessible to all the students of several departments of both the institutions. Based on energy and waste seven questions were asked, three questions related to energy and four related to waste. The aim of the study was to gauge the students' perception about the importance of energy and waste related practices for the sustainable campus. Out of the total students, One forty eight to one sixty-nine students (***n=148-169***) from IITB and three fifty nine to four forty three students (***n=359-443***) from IITM were responded. The outcomes of the study are as indicated in the Table.1

The survey was voluntary in nature. The total student population of IITB and IITM for the year 2012-2013 was 9875 and 6934 respectively. Compared to the total student population responses from IITB and IITM were 1.71% and 6.35%, respectively. Survey results shows a similar view with respect to the importance of various activities related campus sustainability (R2=0. **972**).

Table.1: Survey Results

Questions	Extremely Important		Important		Somewhat important		Not at all important		Can't Say		*n*	
	IITB	IITM	IITB	IITM	IITB	IITM	IITB	IITM	IITB	IITM	IITB	IITM
ENERGY												
Adopting energy efficient Appliances	56%	52%	30%	36%	10%	9%	1%	2%	4%	1%	169	443
Use of renewable energy resources like solar, wind	40%	41%	45%	43%	9%	12%	1%	2%	5%	2%	164	424
Adaptive reuse instead of demolition of old structures	16%	24%	21%	34%	37%	27%	15%	7%	12%	8%	165	417
WASTE												
Waste generation from the offices, domestic waste and Leafy matter etc.	34%	37%	41%	41%	22%	19%	1%	1%	3%	3%	148	359
Recycling of the above mentioned waste within the campus	24%	31%	39%	38%	28%	23%	5%	4%	4%	3%	148	359
Reduction of electronic waste	41%	39%	34%	35%	19%	22%	3%	2%	3%	2%	148	359
Management for hazardous Waste	61%	56%	20%	27%	10%	11%	2%	1%	7%	5%	169	443

VII. CONCLUSION:

The study provides various adoptive practices under the two parameters; energy and waste. Data collected from the residence of different institutions (online and offline) with regard to their perception related to importance of both parameters. Data collected from administrators and service providers with regard to the quantities associated with each parameter to understand the sustainability measures adopted. Both the institutions took considerable efforts. Survey results reveal that the students are more aware of the importance of energy and waste parameters and they were willing be a part of the system. Use of energy efficient appliances has resulted in reducing the overall consumption of power units. Besides the efficient waste management, practices have maintained a clean environment within the campus. Still, there is a scope for further improving existing sustainable practices in both energy and waste management. Creating awareness amongst the stakeholders and implementing strategies that are more passive will help to reduce the energy consumption. There is still further scope of producing more energy within the campus by implementing small scale and large scale innovative projects.

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