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# POTENTIAL FOR INSTITUTIONAL SOLID WASTE REUSE AND RESOURCE RECOVERY: A CASE STUDY OF ALLAMA IQBAL CAMPUS UNIVERSITY OF THE PUNJAB, LAHORE

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**Abstract**
Sustainable development has forced developing countries to focus on their waste management system, including the institutional solid waste. Proper solid waste management is necessary and a fundamental key for achieving a sustainable environment. Solid waste management is a major challenge faced by many countries worldwide. If not properly managed, it can lead to severe hazards which are dangerous for the human health as well as the environment. Uncontrolled population growth and industrialization have resulted in more solid waste along with environmental problems.
This paper reports on institutional solid waste management and its potential for waste reuse and resource recovery. It is a case study on the Allama Iqbal Campus of the University of the Punjab. The advantages for the management of solid waste is being noted at institutional level because every institution have its unique characteristics which has a great influence on their needs regarding waste management.
This paper outlines the findings from a four month period at the 5 departments which include the following: Department of Pharmacy, Arts and humanities, Oriental learning, Department of commerce, Department of computing and information technology. Surveys were done along with field investigations. The on-site waste measurement including the collection, segregation, the estimation of waste generation rate and the characterization of the solid waste generated were done. The questionnaire surveys were also included to collect the information.

**Keywords:** Solid waste management, characterization, developing countries, institutional solid waste, resource recovery, waste generation rate.

## 1.1 Introduction:

Educational institutions for instance universities have significant impact on the urban areas which surround them (Armijo de Vega et al, 2003; Taghizadeh et al, 2012). Solid waste management in educational institutions is important for training the students for approaching a good solid waste management practice and taking this measure back to their homes. This will help the surrounding communities to adopt a successful approach and practices (Armijo de Vega et al, 2008).
In educational institutions, the solid waste management is gaining more attention in detailing and for the evaluation of resources recovery and the possibilities of recycling (Smyth et al, 2010). It has become an obvious need to develop recycling programs at institutional level. In educational institution, a reference framework for solid waste management is needed (Armijo de Vega et al, 2008).

The universities can show commitment to environmentally sound practices by one of the profound measures that is recycling (Armijo de Vega et al 2008). Therefore to build knowledge and estimate capacity for developing satisfactory plans and systems, this plan needs comprehensive data on present and anticipated situation of waste generation (UNEP, 2009). Many parameters cause variations on the composition and characteristics of solid waste (Tchobanoglous et al, 1996). Season and culture are some parameters that results in major differences in characteristics between one location to the other location. Good knowledge of the waste generated and the temporal variations requires full understanding of the solid waste management (Felder et al, 2001;Taghizadeh et al, 2012; Sebola et al 2014).

Because of the large sized of the institutions, there is an advantage to look at the solid waste management partly at institutional level and mostly because to a great extent, the institutions manage their waste by themselves. It is easy for institutions to fashion out their own mini-solid waste management systems due to integrated nature of their activities within the framework of the large municipal solid waste management system. Resource recovery and waste recycling can be incorporated more easily and effectively with such systems in place in institutions and it helps in the reduction of the pressure on solid waste disposal sites.

### 1.2 Case Description:

The institution discussed in this study is located in Lahore, which has a total area of 1, 772 $km^2$ and population of about 11. 13 million (2017). It has 4 districts named as Kasur, Lahore, Nankana sahib and Sheikhupura.

The geography of Lahore says that it lies 217 meters above the sea-level. It is located between 31 ºnorth latitude and 74º east longitude.

The maximum temperature here is seen in mid-March and is about 90º F. And the peak low temperature is 41ºF. The humidity is below 20 % in evening. The wind blow here at 15 – 200 miles per hour normally.

### 1.3 Allama Iqbal Campus PU

University of the Punjab Allama Iqbal Campus was named after Allama Iqbal the great south Asian thinker and a famous mystic poet. It has Islamic architectural design and is located in middle of Lahore. It is largest and oldest universities of Pakistan established in 1882. It has following 5 departments:

- Department of Pharmacy
- Arts and humanities
- Oriental learning
- Department of commerce
- Department of computing and information technology

Detail of some departments in given below:

#### 1.3.1 Arts and Humanities:

The faculty of art and humanities consist of approximately 353 students. It consists of 13 teachers. It has about 10 offices. It has 3 computer labs and 2 libraries. It consists of 1 cafe. The arts and design building consists of 1 grand hall, 1 lecture hall, 2 paintings hall and 1 graphic hall. The architecture building consists of 2 halls and 14 classrooms. It includes the department of architecture, fine arts, graphic arts, graphic design, performing arts and musicology, sculpture, textile design and postgraduate research centre of creative arts.

#### 1.3.2 Department of Computing & Information Technology:

It consists of approximately 180-200 students. The faculty members are about 30. It consists of almost 40 offices. It has 16 classes. It has 2 halls. The labs include 1 big and 3 other labs. It has 2 cafes. It has the departments which includes department of computer science, department of data science,

department of information technology, department of software engineering and Punjab University College of information technology.

### 1.3.3 College of Pharmacy:

It consists of 7 classes. There are 5 main offices and 23 teacher offices. There are about 30-35 labs in the pharmacy department. It consists of 1 cafe. The office staff consists of about 28 people. The library staff consists of about 5 people. There are about 352 students in the morning session and about 270 students in the evening session.

### 1.3.4 Oriental Learning:

The faculty of oriental learning consists of the following departments:

- Centre for Iqbal Studies
- Department of Hindi
- Department of Kashmiriat
- Department of Persian
- Institute of Punjabi and Cultural Studies
- Institute of Urdu Language & Literature
- University Oriental College
- Urdu Development and Translation Centre

### 1.4 Location of Study Area

University of the Punjab Allama Iqbal campus is situated in the middle of the busy city center. Allama Iqbal campus is also known as old campus. It has buildings of great architectural significance. It is located on Katchery road, near Anarkali bazar, Lahore, 54000.


**Fig 1.1 Location of Punjab University Allama Iqbal Campus**

## Materials and Methods

### 2.1 Materials:

Following materials were used for measurement of waste:

- ❖ Weighing balance of capacity of 100 kg
- ❖ Shoppers with empty weight of 7 kg and each has capacity of about 20 l : for collection and weighing the wastes from source
- ❖ Shovels and forks : used for loading and sorting the waste
- ❖ Gloves, gum boots and facemasks: used for personal defence.

### 2.2 Methods:

#### 2.2.1 Sampling Techniques:

Stratified random sampling was conducted to select the sources for waste generation. Before the process of sample collection preliminary site visits were carried out to access the restrained quality of study areas. It is also done for the establishment of basis for the evaluation of all these processes. Samples for this study were obtained from the ISW from each department of the campus small dumping site. Sampling was carried out during January and February. The recommended sampling technique was used.

#### 2.2.2 Measurement sites

The selection of source sites was done on the basis that the source must be major and typical should have variety of components. The sites of waste selected for measurement of waste were Classrooms. Cafeterias/ Canteens, Yards, Labs, Offices / Banks and Health care facility. The brief description of each of the source site is given below:

- ❖ **Health care facility**

The PU health care facility has capacity of admitting up to 10 patients at a time and an average of about 47 inpatient admission and the outpatient attendance of 370 people weekly. The total strength of workers were 75. This facility is used by students and staff families only.

- ❖ **Classrooms**

For PU Allama Iqbal campus not all classrooms were covered. 25 % of classes from department of commerce were covered. 50 % classes of department of pharmacy were covered under this study. 45% classes of department of arts were covered. 55% of classes of department of PUCIT were covered.

- ❖ **Labs**

There are 36 labs in department of pharmacy out of which 17 labs were covered during the study. PUCIT has 4 labs and all these labs were covered.

- ❖ **Cafeterias/ canteens**

There are 5 departments in Allama Iqbal Campus PU and each has its own Cafeterias. All were covered.

- ❖ **Offices and banks**

There are 125 offices in PU Allama Iqbal campus out of which 65 offices were covered during the research.

- ❖ **Yard**

All the yard in PU Allama Iqbal campus was covered. Waste from yards were collected daily

### 2.2.3 Questionnaire surveys and interviews:

Data and information was obtained from staff officials, cleaners and students about the current solid waste management practices. It was conducted through interviews and questionnaire surveys. The data collected from these interviews and surveys are computed in the conclusion and recommendation chapter.

### 2.2.4 Visual inspection and field investigations

Optical examination and field inquiries were done to assess the restrained quality of the study and also used for the establishment of base for evaluation of study facts and figures. It also aids selection of source site and measurement techniques.

### 2.3 Onsite waste segregation and measurement

Measurements of solid waste samples were done using followings steps:

1. First empty shoppers ($W_b$) were weighed using the weighing balance
2. The waste from each source was filled in those shoppers the way that there was no space left.
3. After filling the shoppers ($W_T$) these shoppers were weighed using the weighing balance.
4. Then the volume ($V_W$) of the waste was also computed.
5. Number of people (p) and duration of interval ($t_s$) of process of collection was also determined.
6. Then the waste generation rate was calculated using the formula.
7. Then the bulk density of the wastes from each source was also calculated.
8. Then the waste from each source was segregated one by one and weights of individual components were calculated and percentage composition was computed using the formula.
9. For the moisture content 30 g of mixed weight was put in the oven and its moisture content was also calculated by using its formula.

### 2.4 Formulas used for measurement and segregation

The waste generation rate ($W_G$) were calculated using following formula Stephen E. Mbuligwe et al (2001).

$W_G = (W_T – W_b) / p * t_s$

It is calculated in units of kg $pe^{-1}$ $d^{-1}$

The bulk density is calculated by

Bulk density = $(W_T – W_b)/ V_W$

The moisture content I was calculated using formula given by Tchobanoglous et al (1993).

I (%) = Wi – Wf/ Wi * 100

Wi used for initial weight and Wf is used for final weight

### 2.5 Scope of the Study

The scope of study was to measure the generation rates of different sources of waste present in Allama Iqbal Campus PU. The study was also conducted for identifying the errors in current waste management practices so that it can be improved and made more efficient.

### 2.6 Final Disposal of Waste:

The waste dumping site of Punjab University is Saggiyan which is located near the Ravi River. After the collection of waste from all the departments, waste is loaded on truck and transferred to the Saggiyan dumping site.

### 2.7 Random Sampling:

The solid waste from the source was collected and then segregated. Shopping bags were provided to cleaners at each source. After a week shopping bags with waste were collected from the cleaners. These shoppers were than weighted.

This collected waste was classified into the following main categories by hand sorting:

1. Organic waste
2. Paper
3. Plastic
4. wood
5. Cardboard
6. Glass
7. Grass trimmings
8. Tins
9. Test tubes, syringes
10. Filter papers
11. Dead animals from the pharmacy labs
12. Disposable cutlery
13. Masks and gloves etc.

**Figure. 2.1 Random Sampling**

**2.8 Analysis:**

A comprehensive analysis of the data collected through interviews, surveys and field investigation was conducted. The solid waste generation rate from all sources was calculated.

The moisture content of organic waste and mask and gloves were calculated in the laboratory. The decrease in weight showed the moisture content of the samples. The bulk density was calculated after its determination from each source of waste in the campus.

**2.8.1 Primary Data:**

- The primary data was collected through field visits, group discussions and interviews.
- The sources of the solid waste were investigated of all the departments of the Allama Iqbal Campus.
- All the data was collected by field visits.
- Detail working of the solid waste management system was being discussed by the principle and the workers of the campuses through interviews.
- A vast group consultation was carried out.
- Solid waste collection and the sites of disposal were discussed with principles, sanitary workers and other office staff.

**2.8.2 Secondary Data:**

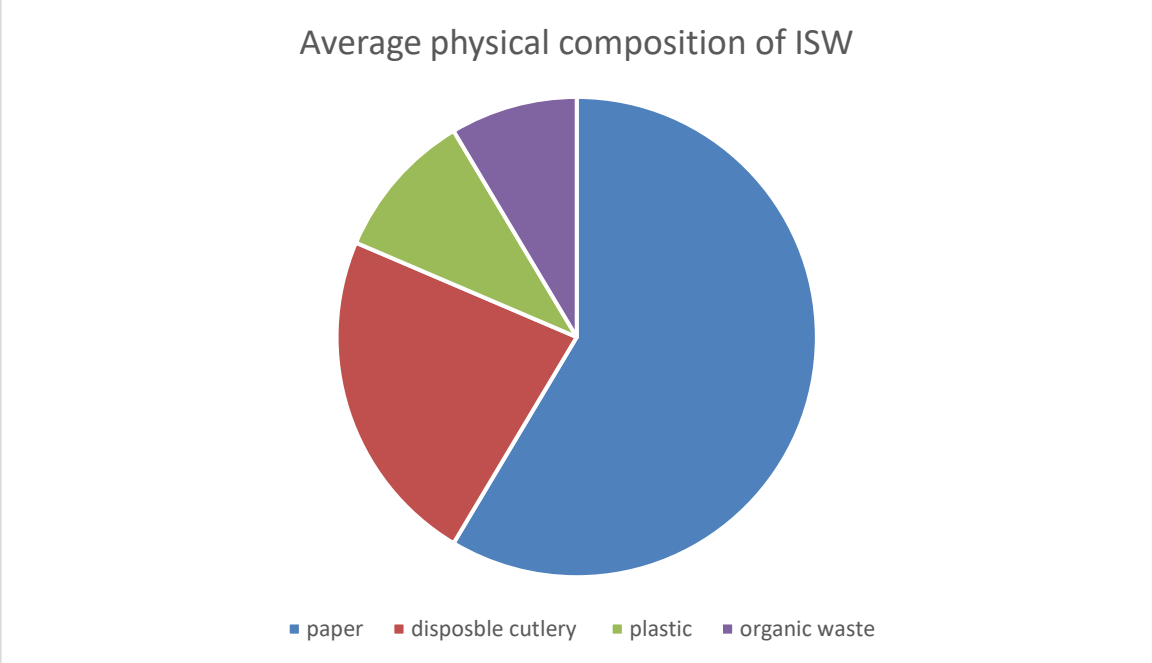
- Secondary data was collected from different published and unpublished reports.
- For the collection of waste, the data was collected from the respected authority.
- This data was used in the calculation of the total waste collected.
- A wide desk study was also done on the condition of the solid waste in the campus.

Moreover, the solid waste was collected from the campuses with the help of workers. The shoppers were provided to them to throw the waste in it so that it can be collected later for further segregation and analysis.

**2.8.3 Average physical composition of waste**

This data is collected from surveys that were processed to understand the problems related to SWM practices.

According to respondents, the average physical composition of waste is commonly as follows:




**Graph 3.1**

### 2.8.4 Importance of 3R Principle:

The three R's are defined as reduce, reuse and recycle. To make a good impact on our environment, these three are very useful and are said to be the best option. It is necessary to practice these in order to protect our environment as it is deteriorating quickly, the landfill is rapidly running out of space and there is a rapid increase of plastic pollution in our oceans.

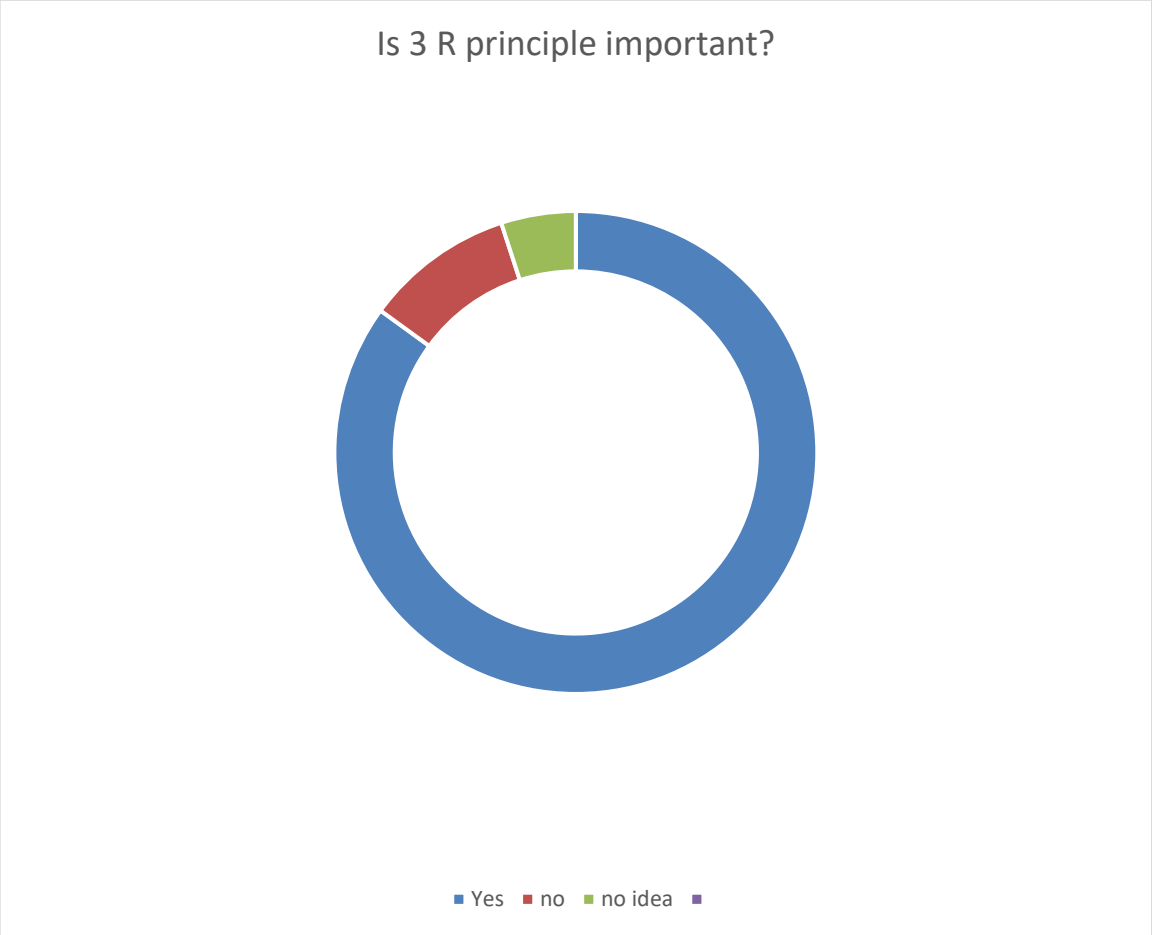
The 3R's are helpful in many ways:

→ These are helpful in cutting down on the quantity of waste that we throw away.

→ These are helpful in conserving energy, natural resources and landfill.

→ The three R's protect land and money communities must be used to discard the waste in landfills.

The graph below shows respodents thought about Importance of 3 R principle:




**Graph 3.2**

## CHAPTER 3
## RESULTS AND DISCUSSIONS

### 3.1 Solid Waste Management Practices

### 3.1.1 Current solid waste management practices:

Table 3.1 shows types of waste and sources from where it is generated inside Allama Iqbal Campus University of the Punjab. Onsite primary storage of waste is done in aluminium bins and various other types of containers.

**Table 3.1 Sources and types of waste from the institution**

| Sources | Types of waste |
|---|---|
| Classrooms | Plastics, cardboard, paper, tins, fine sand, wood, masks, paint cans, disposable cups and plates |
| Labs | Filter papers, broken glass, cotton, dead animals, masks, gloves, syringes, tissue. |
| Yard | Waste leaves, grasses, wood. trimmings of trees and many parts of plants |
| Health care facility | Syringes, cotton, bandage, pyodine bottle, drips, expired medicines, cannula, waste paper, food leftover, cardboard, sharps, test tubes, glass, packaging. |
| Cafeterias/canteens | Plastic, card board, glass, Bones, food leftovers, tins, vegetable waste, straws, disposable cutlery, tissues. |
| Offices/ banks | Plastic, cardboard, glass, paper, coffee cups |

The major sources of waste in this institution are cafeterias, yard and classrooms. Food leftover and waste from food preparation are used as animal feed mostly. Plastic storage containers were mostly used than other types of containers. The main reason of this preference is that these containers are easily adjusted inside the sources and are much more available than other types of storage containers. The system of daily final disposal of waste is appealing in PU also the classrooms and offices and cafeterias are cleaned twice a day.

Collection frequency of waste was daily for cafeterias, yard, offices and banks and twice a day for health care facility, labs and classrooms. Emptying of storage containers were done on daily basis. Due to shorter interval of storage it doesn't lead to filthy conditions or any health hazards.

### 3.1.2 Resource recovery and recycling of waste:

Food leftovers and wastes from food preparation in cafeterias mostly were reused as animal feed by cleaners. Plastic bags and paper was also collected by low cadre scavengers but this collection is limited to small extent. Tins and glass were also collected inside institution by re-cyclists.

For more efficient solid waste management it is obvious that separation of waste individual components at the source is really very important. As mixed waste is not suitable for any treatment even it is not suitable to recycle or to reuse it.

Its onsite separation will save the time of post generation segregation and this will save the wealth that is spend on the post waste segregation.

### 3.2 Solid Waste Generation Rates, Amounts and Bulk Density:

The solid waste generation rates of all sources were calculated as shown in material and methodology chapter. The consequences of the determination are shown in Table 3.2. Table 3.2 shows statistics for amounts of waste generated from all sources on the campus of the institution as shown above. The largest generators of waste are cafeterias, yard and classrooms. They are the highest ranked sources of waste in the campus followed by labs, health care facility and offices/ banks. The generation rate of waste from classrooms is 0.0253 kg pe $^{-1\ per}$ week. The table 3.2 shows variation in generation rates per sources. Table 3.2 also shows the total amount of waste from each source. Offices have the highest generation rates and labs have the lowest generation rates.

**Table 3.2 Quantities of waste from the sources**

| Waste sources | $W_G$ | $W_T$ | $W_{T(\%)}$ | Bulk density (kg $m^{-3}$) |
|---|---|---|---|---|
| Classrooms | 25.3 | 266.5 | 17.73 | 53.3 |
| Health care facility | 60 | 188.5 | 12.54 | 37.7 |
| Offices/ Banks | 67 | 189.3 | 12.6 | 37.86 |
| Labs | 11.08 | 133 | 8.85 | 26.6 |
| Yard | 23.8 | 357 | 23.7 | 71.4 |
| Cafeterias/ Canteens | 24.5 | 368 | 24.49 | 73.6 |
| Total | 624.68 | 1502.3 | 100 | 300.46 |

→ $W_G$ per capita waste generation rate (g $pe^{-1}$ per week) and $W_T$ total waste (kg- $week^{-1}$) and bulk density (kg $m^{-3}$).

→

Table 3.2 also lists bulk density results after its determination from each source of waste in the campus as described in the methodology. It can be found from the table below that maximum bulk density from the institution is the one which is found from the cafeterias. The high bulk density of waste from Cafeterias and yard are due to its high moisture content of its components like food leftovers, Leaves trimmings etc.as outlined in table 3.1. Labs and offices have mainly papers in their waste which are light so bulk density of wastes from offices and labs are lowest. The University of Punjab health care facility is a full- fledged centre of health that is performing many activities for example blood tests, ultrasounds, X-rays etc. These activities contribute to result in relatively high bulk density as shown in Table 3.2 also. On further analysis of data mentioned in Table 3.2 also, it was determined that the average bulk density for all sources of the campus is 50.08 $kgm^{-3}$. This figure doesn't compares with the bulk density that is given in the literature which is about 300 – 500kg $m^{-3}$ in the developing countries (Diaz et. al., 1996). This huge difference is because of smaller size of this campus and lesser population as compare to institutions mentioned in the literature. It can be noted from Table 3.2 also, that the waste generated from spruces such as cafeterias, yard need less compacting than waste from others sources because of their high densities. The waste from all these sources is not suitable for collection and transference in a compactor truck due to their high density.

### 3.3 Moisture Content:

The moisture content of the waste from Allama Iqbal Campus University of the Punjab was in-between 35 – 75 %, this range of moisture content of waste matches well with the range of moisture content reported by Chaggu et al. (1998) which is between 65- 75 % for the waste. On the basis of characterization and segregation of waste from each source as discussed above there is a major need of including the anaerobic digestion and composting in current solid waste management practices along with reuse as animal feed and recycling. All this aims of resource recovery is not easy to achieve as they get easily affected by number of factors like moisture content etc. It is preferred to segregate the waste as source to save energy and money required for post segregation processes.

### 3.4 Lessons from the Current Solid Waste Management Practices:

Major problems of current solid waste management practices of the institution are the careless behavior of the population, bad storing services and non- segregation of individual components of waste. As mentioned in this study above 9.4 % of the population of the institution doesn't use any storage container for disposal of waste. Segregation of waste will help better management of waste.
Data on potential for the waste reuse and resource recovery for Allama Iqbal Campus, University of the Punjab was collected from the solid waste management office.
It is noted from the table that overall resource recovery potential for waste is 49.1%. The organic waste can be recycled as feed material in biogas and compost production.
Providing distinct waste containers for different kinds of waste will save the energy and wealth that is required for post segregation processes. The resource recovery potential can be improved through

waste segregation at the source of production. This will result in betterment of the waste management practices of the institution.

Solid waste management practices can be improved by reducing the amount waste generated at the sources inside the Allama Iqbal Campus University of the Punjab. As reduced amounts of waste is easy to dispose and managed. It is more practicable than large amount of wastes.

It is the point of notice that solid waste management is not involved in hierarchy of management significant actions. There is no proper funding for the solid waste management performs in the institution. There is need of technical advancement for the betterment of these practices like a comprehensive waste management plan, expertize and proper equipment and facilities.

The potential for development in solid waste management of the institution lies in the opportunity of formulating and implementing a program of better waste supervision practices. Behavior changes are the need of the hour.

The careless behavior of student causes littering and there is lack of awareness of solid waste management. Improving the solid waste management practices for making it more efficient is easy for an institution as it is controlled by single authority.

This will help to run the waste management practices more smoothly. As the institution is run by one authority it is easy for institution to set codes for disposal and management but these codes should be strictly enforced for the enhancement and improvement of solid waste management practices. To eliminate littering on floor we need to fit the baskets or bins at shorter distance.

International standards for the sustainable disposal of solid waste, especially three R principle (reduce, reuse and recycle) should be opted and strictly followed. The environmental protection agency (EPA) and allied departments should guarantee efficient collection and disposal of solid waste from institutions. Staff and students should learn about the ISWM. Modern machinery and equipment for safe and easy disposal of solid waste should be practice in the institution. The reuse and recycling potential could be improved by making a better set up that would deal with this.

### 3.5 Waste Composition:

Solid waste composition analysis was conducted out as it is described in methodology. The aim of this analysis is to know about individual components of waste from each source which will help in better management of waste.

Results of waste composition analysis for waste from health care facility are presented in Table 3.3. The Table 3.3 shows the individual amounts of components from waste of heath care facility along with their constituent percentage. It can be noted that the abundant component of waste is test tubes and urine bottles used for testing in the centre.

**Table 3.3 Composition of waste from health care facility**

| Waste constituent | Average weight(kg) | Constituent (%) |
|---|---|---|
| Syringes & cannula | 21 | 11.1 |
| cotton | 3 | 1.59 |
| Bandages | 3.5 | 1.85 |
| Bottles (including urine bottles) | 62 | 32.89 |
| Drips | 31 | 16.4 |
| Expired medicines | 4 | 2.12 |
| Test tubes | 44 | 23.34 |
| Packaging | 20 | 10.61 |

Results of waste composition analysis for waste from Cafeterias/ Canteens are shown in Table 3.4. The Table 3.4 shows the individual amounts of components from waste of Cafeterias/ Canteens along with their constituent percentage. It can be noted that the abundant component of waste is disposable cutlery and plastic.

**Table 3.4 Composition of waste from Cafeterias/ Canteens**

| Waste constituent | Average weight(kg) | Constituent (%) |
|---|---|---|
| Plastic | 62 | 16.84 |
| Cardboard | 70 | 19.02 |
| Disposable cutlery | 88 | 23.91 |
| Organic waste | 45 | 12.22 |
| Glass | 53 | 14.4 |
| Tins | 50 | 13.58 |

Results of waste composition analysis for waste from classrooms are presented in Table 3.5. The Table 3.5 shows the individual amounts of components from waste of classrooms along with their constituent percentage. It can be noted that the abundant component of waste is cardboard and plastic.

**Table 3.5 Composition of waste from Classrooms**

| Waste constituent | Average weight (kg) | Constituent (%) |
|---|---|---|
| Plastic | 57.3 | 21.5 |
| Cardboard | 82 | 30.76 |
| Disposable cutlery | 26.5 | 10.01 |
| Paper | 51 | 19.13 |
| Fine sand | 6.5 | 2.43 |
| wood | 19 | 7.12 |
| Paint cans | 24 | 9 |

Results of waste composition analysis for waste from Yard are presented in Table 3.6. The Table 3.6 shows the individual amounts of components from waste of Yard along with their constituent percentage. It can be noted that the abundant component of waste is wood.

**Table 3.6 Composition of waste from Yard**

| Waste constituent | Average weight(kg) | Constituent (%) |
|---|---|---|
| Leaves | 142 | 39.77 |
| wood | 158 | 44.25 |
| Grass trimmings | 57 | 15.96 |

Results of waste composition analysis for waste from Offices and banks are presented in Table 3.7. The Table 3.7 shows the individual amounts of components from waste of Offices and banks along with their constituent percentage. It can be noted that the abundant component is paper.

**Table 3.7 Composition of waste from Offices and banks**

| Waste constituent | Average weight (kg) | Constituent (%) |
|---|---|---|
| Plastic | 34.6 | 18.27 |
| Cardboard | 47 | 28.2 |
| Disposable cutlery | 24 | 12.67 |
| Paper | 58.7 | 21 |
| Glass | 25 | 13.2 |

Results of waste composition analysis for waste from Labs are presented in Table 3.8. The Table 3.8 shows the individual amounts of components from waste of Labs along with their constituent percentage. It can be noted that the abundant component is test tubes.

**Table 3.8 Composition of waste from Labs**

| Waste constituent | Average weight(kg) | Constituent (%) |
|---|---|---|
| Broken glass | 33 | 24.81 |
| Filter paper | 26 | 19.54 |
| Cotton wool | 11 | 8.27 |
| Masks and gloves | 11 | 8.27 |
| Dead animals | 18 | 13.53 |
| Test tubes | 34 | 25.56 |

## CONCLUSIONS

### 4.1 Conclusions:

The results from this study has exposed that institutional solid waste management practices is not much appealing in Allama Iqbal Campus of University of the Punjab so there is potential for improvement. As universities are single entities and single authority can better and easily manage SWM practices.

Poor disposal practices were observed during the study, some students were observed showing careless behaviour and were littering on the floors and grounds.

Storage practices were also poor as waste were stored in open storage containers which can lead to health hazards in staff and students. The potential for improvement has been identified earlier that institution should establish rules and regulations in this regards these rules and regulations are easy to manage as there is one authority to run this set up.

Recovery of resources is done through following ways

- Organic waste as animal feedstuff
- Composting
- Recycling of recyclables( paper, plastics )
- Using again of waste for arts

Per capita waste generation rate for source like classrooms is 0.0253 kg, for Health care facility is 0.06kg, for labs is 0.01, for offices is 0.067kg and for cafeterias is 0.024kg. The emphasis of ISWM systems should be on reducing the quantity of waste. As quantity of waste would decrease management will be easier. New strategies and guidelines on SWM is the need of the hour and their formulation is the most necessary need of Pakistan. Proper funds should be set up, and a team should be made that should honestly deal with this fund. There should be separate bins for different types of waste components with proper labelling this will save the future cost and time. Public Private Partnership (PPP) in solid waste management should be initiated so to improve the standards of current waste management practices.

## REFERENCES:

1. Achankeg, E. (2004). Sustainability in municipal solid waste management in Bamenda and Yaounde, Cameroon.Department of Geographical and Environmental Studies, Doctorof(December), 405.
2. Adeniran, A. E., Nubi, A. T., &Adelopo, A. O. (2017).Solid waste generation and characterization in the University of Lagos for a sustainable waste management.Waste Management, 67, 3–10
3. Adzawla, W., Tahidu, A., Mustapha, S., &Azumah, S. B. (2019). Do socioeconomic factors influence households' solid waste disposal systems? Evidence from Ghana.Waste Management and Research, 37(1_suppl), 51–57.
4. Alam, R., Chowdhury, M. A. I., Hasan, G. M. J., Karanjit, B., &Shrestha, L. R. (2008). Generation , storage , collection and transportation of municipal solid waste – A case study in the city of Kathmandu , capital of Nepal, 28, 1088–1097.
5. Awosan, et al. (2017). Knowledge , Risk Perception and Practices Regarding the Hazards of Unsanitary Solid Waste Disposal among Small-Scale Business Op Knowledge , Risk Perception

and Practices Regarding the Hazards of Unsanitary Solid Waste Disposal among Small-Scale Busi, (October).
6. Abdel-Shafy, H. I., & Mansour, M. S. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. Egyptian journal of petroleum, 27(4), 1275-1290.
7. Coffey, M., Coad, A. (2010). Collection of Municipal Solid Waste in Developing Countries. Creswell, J. W. (2012). Educational Research: planning, condcuting and evaluating quantitative and qualitative research (4th ed.). Boston: Pearson Education.
8. Dominic, M. A. (2017). FACTORS AFFECTING THE MANAGEMENT OF SOLID WASTE IN URBAN AREAS.
9. Faris, D., & Scott, S. (2007). Governing solid waste management in Mazatenango, Guatemala Problems and prospects Many, (September).
10. Fei-baffoe, B., Nyankson, E. A., &Gorkeh-miah, J. (2014). Municipal Solid Waste Management in Sekondi-Takoradi Metropolis , Ghana, 2014.
11. Hair et al. (2013). A primer on partial least squares structural equation modeling (PLS-SEM). Journal of Chemical Information and Modeling, 53(9), 1689–1699.
12. Hassan, A. I. · B. I. · M. N. (2004).Overview of waste disposal and landfills / dumps in Asian countries, 104–110.https://doi.org/10.1007/s10163-004-0117-y
13. Health, W. (2010).Environmental health situation analysis in Somalia 2010. Henry, R. K., Yongsheng, Z., & Jun, D. (2006). Municipal solid waste management challenges in developing countries – Kenyan case study, 26,92–100.
14. Hufane, M. A. (2015). Challenges Facing Solid Waste Management in Borama Town, Somaliland.
15. Hui, Y., Li'ao, W., Fenwei, S., & Gang, H. (2006). Urban solid waste management in Chongqing: Challenges and opportunities. Waste Management, 26(9), 1052–1062.
16. Imam, A., Mohammed, B., Wilson, D. C., &Cheeseman, C. R. (2008). Solid waste management in Abuja , Nigeria Solid waste management in Abuja , Nigeria, (November 2017), 1980–1984.
17. Isa, M. H., Asaari, F. A. H., Ramli, N. A., Ahmad, S., &Siew, T. S. (2005). Waste Management & Research.
18. Jan Hauke, T. K. (2011). COMPARISON OF VALUES OF PEARSON ' S AND SPEARMAN ' S CORRELATION COEFFICIENTS ... COMPARISON OF VALUES OF PEARSON ' S AND SPEARMAN ' S CORRELATION COEFFICIENTS ON THE SAME SETS OF DATA, 30(2).
19. Jerie, S., & Tevera, D. (2014). Solid waste management practices in the informal sector of Gweru, Zimbabwe. Journal of waste management, 2014.
20. Jin, J., Wang, Z., & Ran, S. (2006). Solid waste management in Macao : Practices and challenges, 26, 1045–1051.
21. Lohchab, R. K., & Nain, A. (2017). Municipal Solid Waste Stabilization by Leachate Recirculation, (January).
22. Longe, E. (2015). People ' s perception on household solid waste management in Ojo Local Government Area in Nigeria PEOPLE ' S PERCEPTION ON HOUSEHOLD SOLID WASTE MANAGEMENT IN OJO LOCAL GOVERNMENT AREA IN NIGERIA, (January 2009).
23. Maity, S. K. (2018). Importance of Municipal Solid Waste Management. International Journal of Advanced Engineering Research and Science, 5(5), 237504.
24. Mcallister, J. (2015). Factors Influencing Solid-Waste Management in the Developing World by. Moore, S. A. (2012). Garbage matters: Concepts in new geographies of waste. Progress in Human Geography, 36(6), 780–799.
25. Moqbel, S. (2018). Solid waste management in educational institutions: the case of the University of Jordan. Environmental Research, Engineering and Management, 74(2), 23-33.
26. MUCHE, G. Z. (2016). SCHOOL OF GRADUATE STUDIES SOLID WASTE MANAGEMENT PRACTICE AND FACTORS INFLUENCING ITS EFFECTIVENESS . 2016.

27. Nations, U., & Programme, E. (2005). Olid waste management. No Title. (2002), (June). Ogwueleka, T. C. (2009). Municipal Solid Waste Characteristics and Management in Nigeria. Iranian Journal of Environmental Health Science & Engineering, 6(3), 173–180.
28. Ojeda-ben, S., Vega, C. A., & Marquez-montenegro, M. Y. (2008). Resources , Conservation and Recycling Household solid waste characterization by family socioeconomic profile as unit of analysis, 52, 992–999.
29. Oso, W. Y. (2013). PRINCIPLES AND PRACTICE OF EDUCATIONAL RESEARCH. PRINCIPLES AND PRACTICE OF EDUCATIONAL RESEARCH Willis Yuko Oso Faculty of Education and School of Postgraduate Studies Amoud University – Somaliland Barkhadleh Printing, BORAMA - SOMALILAND. Pattnaik, S., & Reddy, M. V. (2010). Resources , Conservation and Recycling Assessment of Municipal Solid Waste management in Puducherry ( Pondicherry ), India. "Resources, Conservation & Recycling," 54(8), 512–520.\
30. Qing, D., Keat, S., &Gersberg, R. M. (2010). Municipal solid waste management in China : Status , problems and challenges. Journal of Environmental Management, 91(8), 1623– 1633.
31. RODE, S. (2011). PUBLIC PRIVATE PARTNERSHIP IN SOLID WASTE MANAGEMENT IN MUNICIPAL CORPORATIONS OF MUMBAI METROPOLITAN, 3(4), 23–38. Sankoh, fodaypinka, & Yan, X. (2014). Assessment of Solid Waste Management in Freetown, Sierra Leone towards Sustainable Development. Journal of Applied Science.
32. Schübeler. (1996). UNDP / UNCHS ( Habitat )/ World Bank / SDC Collaborative Programme on Municipal Solid Waste management in Low-Income Countries Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries Peter Schübeler, (9).
33. Sekaran, U. (2012). Research Methods for Business Research Methods for Business.Research methods for business (Fourth). USA: John Wiley & Sons, Inc.
34. Sujauddin, M. (2008). Household solid waste characteristics and management in Chittagong , Bangladesh, 28, 1688–1695.
35. Tınmaz, E., & Demir, I. (2006). Research on solid waste management system: to improve existing situation in Corlu Town of Turkey. Waste management, 26(3), 307-314.
36. Zurbrügg, C. (2003). How to Cope with the Garbage Crisis, (February), 1–13. Hair et al. (2013). A primer on partial least squares structural equation modeling (PLS-SEM). Journal of Chemical Information and Modeling,53(9),1689–1699.