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How University of Campinas is Coping with Continuous Improvement of Management of Hazardous Waste

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Abstract. This paper presents the approach that is being used to involve the community not only in handling the hazardous waste in accordance with the policy of the university but also in taking steps forward trying to improve the waste management practices and reduce the amount of waste generated by the campus operation. The approach involves the creation of a group of representatives of the Waste Management Group at each department who are responsible for disseminating the policy and best practices of waste management in their workspace. These representatives are trained to update or create the Local Waste Management Plans (LWMP) of the areas and as a result, currently, 52 areas of University of Campinas have their PGRL updated.

Keyword:

Hazardous Waste, Local Waste Management Plan

1. Introduction

According to Adeniran et al. [1], "the adoption of strategies for reducing waste generation, its hazardousness and extending the lifespan of products used in organizations are some of the goals in well-structured waste management planning. Among the environmental benefits, adequate waste management results in social and economic

positive impacts since it leads to human wellbeing and new opportunities related to the value recovery of materials to the industry, besides reducing the expenses of an organization."

The National Solid Waste Policy [2] of Brazil introduced an innovative instrument of management for urban waste when it demanded the elaboration of an Integrated Management Plan of Solid Waste for all the municipalities and according to Alshuwaukhat and Abubakar [3] the universities can be considered as small cities concerning solid waste management as it represents a major challenge since these institutions include a reasonable population that vary seasonally. The National Health Surveillance [4] has also a requirement for the existence of a Waste Management Plan for all health assistance areas. Taking all these requirements into consideration, the universities should also have a Waste Management Plan not only regarding the regulation but as an ethical responsibility towards the education of their students and the society [1,5].

Fagnani and Guimarães [5] have also pointed out that "managing residue not only means to establish a proper destination/treatment, but also involves rethinking production processes, minimizing waste generation, reusing and recycling." All these strategies should be considered when analysing the waste generated to propose improvements in the management and prevention of waste.

In 2003 University of Campinas started a pioneer work in Brazil when it started dealing with the management of hazardous waste stored and/or generated in its campuses. The approach used to reach all the departments of the university was to have two representatives indicated by the local administration. These representatives are trained by the Waste Management Group (GEARE) to work as a link between the central administration and their departments so that the procedures adopted for the management of hazardous waste could be replicated in all areas of the university.

Figure 1. Representation of the link between the Waste Management Group (GEARE) and areas through the representative of the area, called facilitador in Portuguese [6].

Being a big university with 6 campuses, 24 faculties and institutes, 4 hospitals and 2 technical High Schools and having 21,390 undergraduate students, 16,229 graduate students, 1,697 professors and 6,845 staff members [7], the training strategies for the representatives had to reach all the areas of the university.

In order to improve the management practices and prevent waste generation, since 2020 each area is updating or creating a Local Waste Management Plan (LWMP) through the enrollment of the representatives of each area in a course created by GEARE in cooperation with the Corporate School of UNICAMP (EDUCORP). This course presents all the procedures used by the university to deal with the different types of waste (biological, chemical, radioactive and domestic) and has the preparation or update of LWMP as a final task. The program of the course includes, (i) profile and Role of the local representative of the area, (ii) general Presentation of the activities conducted by GEARE, (iii) concepts and classification of waste, (iv) management of biological, chemical, radioactive and domestic

waste, (v) local Waste Management Plan (LWMP) Methodology, (vi) current environmental legislation, (vii) presentation of the Waste Management Programs of the University, and (viii) presentation of examples of LWMP.

It should be pointed out that the training for proper disposal of hazardous waste has been given previously in different occasions, since 2007, but the approach used now involved the elaboration of the LWMP with an action plan to improve the items that could be improved, resulting in a waste management plan based in the continuous improvement cycle model according to described by Fagnani and Guimarães [5]. In the new model of the course adopted from 2020 on, we also included the training of the areas which do not generate hazardous waste but have domestic waste that need to be reduced and handled properly.

Besides having the course to elaborate the Local Waste Management Plan, the training of the representatives also includes 3 or 4 annual meetings in which the advances in the waste management practices of the university are presented and different speakers talk about subjects that are relevant to sustainability. Additionally, the representatives have a platform in which they can get in touch with each other to solve their doubts or share their good practices. GEARE gives continuous technical support whenever the representative needs and regularly visits the areas in order to inspect the wastes that will be sent to treatment. Last but not least, a technical visit to the areas to audit the practices and the LWMP aiming continuous improvement is carried out in each area every two years.

The indication and training of the representatives started in 2003 and nowadays University of Campinas has 126 representatives working with waste management in 64 different areas. An internal workshop for them to present their work is being organized and the first edition of this workshop will happen in October 2024.

2. Points of Results and Discussions

The idea of having a PGRL written for each area originated from the necessity of having a Waste Management Plan for all health assistance areas, according to the Brazilian law RDC Nº 222/2018 that is edited by the National Health Surveillance [4]. According to this resolution the Waste Management Plan should present the quantity of waste generated in each category (biological, chemical, radioactive and domestic), the procedures related to each waste, describe the actions to be adopted in emergency situations and accidents related to waste management and present a comprobatory report with all the training of the team concerning waste management. Having these directions as a starting point, the Waste Management Group of University of Campinas developed a technical procedure to elaborate the Local Waste Management Plan (LWMP) to have a model which could be followed by all the areas.

The methodology to elaborate a LWMP is described in a technical procedure [8] and encompasses the following premises, (i) commitment of the administration of the area, (ii) indication of the representatives of waste management, (iii) appreciation of the pre-existing initiatives and (iv) compliance with the Waste Management Plan, Waste Prevention Plan and the technical procedures of the following programs: Biological Waste Management Program, Chemical Waste Management Program, Domestic Waste Management Program, Construction Waste Management Program and Radioactive Waste Management Program of the university [8].

The technical procedure [8] to elaborate the LWMP describes all the items that it

should involve. The items are (i) cover, (ii) summary, (iii) introduction, (iv) objectives, (v) working team, (vi) description of the area, (vii) diagnostic questionnaire, (viii) action plan, (ix) indicators for accompanying the effectiveness of the implantation of the LWMP, (x) references, and (xi) appendices.

The content of each item is described in the technical procedure [8] aiming for standardization of the LWMPs of all areas of the university. Some of the items of the LWMP will be explained below in more detail for clarification.

2.1. Objectives

The objectives of the LWMP must be clearly described, including the prevention of waste generated and the safe management of waste aiming to safeguard health, natural resources and the environment.

2.2. Description of the area

The description of the area must contain information about identification, description of operational capacity, physical space, organizational chart in accordance with the following script, (i) identification, (ii) name of the area, (iii) address, (iv) neighborhood, (v) municipality, (vi) state, (vii) ZIP code, (viii) telephones, (ix) website, (x) legal responsible, and (xi) description of operational capability

When describing the operational capacity of the area, the average quantity/month of processes, services, procedures, students, research, among others, must be included:

In the description of the physical space, at least the following data must be provided: total area of land, number of buildings, total built area.

The organizational chart of the area, if applicable, must be inserted.

Inform the number of professionals working in the area.

2.3. Diagnostic questionnaire

In this item, a critical review must be prepared based on the information collected through the questionnaires, tables, spreadsheets and charts contained in the appendix. The text must address issues related to management, classifying it as critical, semi-critical and non-critical. The definitions relating to the concepts of critical, semi-critical and non-critical are presented below, associated with the requirements of current legislation:

2.3.1. Critical - High Priority

Requirements that the area does not follow current legislation. For example, lack of adequate segregation, lack of waste shelter, containers without lids and pedals in the biological waste area.

2.3.2. Semi-Critical – Medium Priority

Requirements are available, but the area has not implemented it. For example, selective waste collection. At the moment it is not implemented in the health establishments but there is a cooperative in the city that could receive recyclable waste. This action can be implemented with medium priority.

2.3.3. Non-Critical – Low Priority

Requirements that need to be adapted but do not imply an environmental or health risk. For example, there is a need to exchange waste storage containers for the administrative area, but those existing on site could wait to be exchanged later.

2.4. Action plan

At this stage, the activities to be developed must be planned, based on the Diagnostic questionnaire, with a schedule, those responsible, costs and what actions must be carried out to achieve the proposed objectives. The suggested 5W2H action plan allows the consideration of all tasks to be performed or selected in a careful and objective way, ensuring their implementation in an organized manner.

2.5. Indicators

To monitor the effectiveness of the actions proposed in the Local Waste Management Plan, a measurement tool is needed to demonstrate the results. The use of indicators that demonstrate the effectiveness of the LWMP implementation is essential in this process. Weighing, as an indicator, is an important data for evaluating and monitoring the trend of growth or reduction in waste generation. The indicators allow monitoring the steps of segregation, correct packaging of waste generated and help to develop and monitor strategies for preventing waste generation in accordance with the goals and objectives defined by the area.

2.6. Appendices

A.1 - Internal Designation the Commission of Waste Management of the Area;
A.2 - Waste weighing worksheet;
A.3 - Monthly spreadsheet of the amount of waste collected by waste group (biological, chemical, radioactive, domestic);
A.4 - Table of quantity, description, capacity and symbols of the waste containers;
A.5 - Routine framework for internal waste collection and transportation;
A.6 - Framework of Treatment, External Collection and Final Disposal of waste;
A.7 - Standard Operating Procedures (SOP's) or Protocols for the treatment of the different types of waste;
A.8 - Diagnostic questionnaire;
A.9 - Waste Collection and Internal Transport Flow;
A.10 - External Waste Shelter Plan;
A.11 - Training framework for the employees of the area;
A.12 - Copies of Contracts and Licenses of the companies contracted for waste treatment or disposal.

Once the technical procedure to elaborate the LWMP was written [8] , the content of the course to be used to train the areas started to be considered. The presentation of the LWMP was included as a final task of the course. Besides presenting the theory related to waste management, we also presented the Waste Management Plan, Waste Prevention Plan and the technical procedures of the following programs: Biological Waste Management Program, Chemical Waste Management Program, Domestic Waste Management Program,

Construction Waste Management Program and Radioactive Waste Management Program of the university. We helped one of the areas to produce the first LWMP in order to check and improve the procedure and this area presented the LWMP as a model for the people enrolled in the course. After the procedure to elaborate the LWMP was written and tested, the content of the course was organized in 30 hours of course and technical support and we started the course.

The data related to the number of times the course of Local Waste Management Plan (LWMP) was carried out as well as the number of students and areas covered is presented in Table 1. It can be noticed that the course was offered six times and reached 68 different areas, 193 professionals and produced 52 updated LWMPs. It is important to mention that the total number of areas reached, as well as the number of LWMPs produced are not the sum of the respective columns at Table 1 because there were areas that sent representatives in more than one period of the course.

Concerning the meetings that are held regularly, the ones that took place in the period of 2020 and 2024 are presented at Table 2. As it can be observed at Table 2, there are four to five meetings with the representatives a year. The subjects of the meetings are chosen aiming for usefulness or to cover some of the representative's most regular demands as well as to cover the projects that are being carried out at the university. We have an average of 52 people attending the meetings and not all of them are representatives of the areas because sometimes we allow people that are interested in the subject to take part in the meetings. Besides that, some of the areas have a group of waste management and not only the 2 representatives and other people from the group may participate in the meetings. Unfortunately for some meetings the number of participants was not registered.

Table 3 presents the date of the visits to evaluate the LWMP of each area. It should be mentioned that after each visit, a report is prepared and sent to the area with the results of the evaluation and the points of compliance, partial compliance and noncompliance and some suggestions. The representatives of the area are asked to present an action plan for the improvements that should be done. However, we have observed that some of them do not do the action plan. Therefore, we are evaluating the possibility of establishing a period of 3 to 6 months for them to do the action plan and start demanding it when they do not deliver it in time.

Table 1. Data related to the course of Local Waste Management Plan (LWMP)

	PGRL of areas		
Period	Nº of Areas	Nº of students	Nº of PGRL delivered
Nov.2020 to March 2021	10	28	9
April to Aug. 2021	16	47	11
Nov.2021 to March 2022	13	32	9
Sept. to Dec. 2022	18	21	18
March. to June 2023	19	24	7
Aug. to Dec. 2023	15	41	13
Total	**68**	**193**	**52**

Analysing Table 3, it can be also noticed that from the 63 areas that have representatives, only 32 have received the technical visit so far but the other areas will still be visited because this is a continuous work. Moreover, some of these 63 areas have not presented their LWMP, as we have received the LWMP of 52 areas (Table 1). We are working with the areas that have not presented their LWMP in order to try to overcome their difficulties and present their plan. However, all the areas that produce hazardous chemical waste have their LWMP. There are some areas that have not nominated their representatives yet and we are working with them to do it as soon as possible so that we can start training them.

Figure 2: Some pictures of the representatives being trained

Table 2. Topics of the meetings of representatives that took place between 2020 and 2024

Date	Subject	Nº of Participants
May 28th, 2020	Zero Waste and Sustainable Purchase Projects	51
June 29th, 2020	UI GreenMetric World University Ranking	-
August 27th, 2020	Circular Economy at Universities: Examples of projects by NIPE/COCEN – UNICAMP	-
October 14th, 2020	Waste Management at Laboratories: case of study LABSAN-FEC- UNICAMP	-
December 10th, 2020	Talk given by a psychologist "We are always starting"	-
February 25th, 2021	SIGOR - MTR - Platform of the Environmental Agency to control the waste disposal	-
March 23rd, 2021	Projects being carried out by the Sustainability Group (GGUS) of Unicamp	-

Date	Subject	Nº of Participants
August 7th and 8th, 2021	Advances in Waste Management and Smart Cities	-
March 17th, 2022	Geoprocessing at Unicamp	43
April 28th, 2022	Generation of biological waste from the group A5 and emission of DMR	44
May 19th, 2022	Presentation of the Office of Controlled Products of UNICAMP	37
June 7th, 2022	National Solid Waste Policy: Legislation, Control and Inspection	-
August 18th, 2022	Geoprocessing: Advances and Possible Usage in Sustainability	35
October 11th, 2022	I Seminar of DEPI: Management of Controlled Chemicals and Waste	205
February 14th, 2023	Waste Management and Prevention of Construction Waste	49
May 16th2023	Sustainability Coordination of Unicamp (CSUS) - Current Projects and Perspectives	60
June 20th, 2023	How University of Campinas prioritizes its investments on constructions	-
August 15th, 2023	Hazardous Waste Management at Federal University of Santa Catarina	42
October 24th, 2023	Recycling and waste management of construction wastes	48
September 12th, 2023	II Seminar of DEPI: Management of Controlled Chemicals and Waste	390
March 18th, 2024	How Campinas city deals with the waste management by Department of Urban Waste of Campinas	53
April 17th, 2024	Recycling of blisters to produce PVC Wood for construction	110
August 21st, 2024	Management and Recycling of Civil Construction Waste in Brazil	76
September 2nd, 2024	III Seminar of DEPI: Management of Controlled Chemicals and Waste	148
October 8th, 2024	I Meeting of Waste Committees of UNICAMP	52

Table 3. Dates of visits to the areas

Number	Date of the Technical Visit	Area
1	May, 2022	CAISM
2	May, 2022	CBMEG
3	May, 2022 and July, 2024	HC
4	February, 2023	GASTROCENTRO
5	February, 2023	HEMOCENTRO
6	March, 2023	FCM
7	March, 2023	CEB
8	March, 2023	CECOM
9	April, 2023	FOP
10	April, 2023	SAR
11	April, 2023	FT
12	April, 2023	FCA
13	April, 2023	COTIL
14	July, 2023	IC
15	July, 2023	FEA
16	August, 2023	FEQ
17	August, 2023	FECFAU
18	September, 2023	IFGW
19	September, 2023	IG
20	October, 2023	LACTAD
21	October, 2023	CEMEQ
22	November, 2023	CCSNANO
23	February, 2024	FE
24	February, 2024	FEF
25	February, 2024	CEMIB
26	February, 2024	CPQBA
27	March, 2024	IQ
28	March, 2024	CEPETRO
29	April, 2024	IB
30	May, 2024	FEM
31	May,2024	FENF

Number	Date of the Technical Visit	Area
32	July, 2024	HC
33	August, 2024	CAISM
34	September, 2024	FEAGRI

3. Conclusion

According to the results we have had so far, the training has reached 193 representatives of 68 areas that have produced a standardized Local Waste Management Plan (LWMP) of 52 areas. From these 68 areas, 32 have already received a technical visit and are aware of the improvements they should do. However, some areas still need to nominate their representatives, some have to prepare their LWMP and others have to be visited. We have observed that this work has to be continuous because some representatives are occasionally substituted and even when they are not substituted, the waste management practices and the prevention of generation have to be improved and the preparation of the LWMP and the Technical Visit are good tools to improve them. According to what has been mentioned before, this is a continuous work that needs constant inputs and improvements. Furthermore, as it was proven at the I Meeting of Waste Committees of UNICAMP, the representatives are carrying out a wonderful job that needs to be shared so that they can contribute with the work of others.

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