Extended Abstract


In Brazil, much of what is extracted and leftovers from the productive processes are wasted in the form of "garbage", and disposed in landfills, controlled landfills and often also in open dumps. The implications of this waste start to appear as environmental problems due to the intense disposal of potentially recyclable or compostable material as garbage without any use, and without adequate treatment, which generates contamination of water, soil, and air, causing impacts of varying proportions not only for the environment but also for the quality of human life. Percolation of slurry and groundwater contamination, methane gas emissions, the presence of vectors, and the emergence of people who live from the garbage and use it for their livelihoods are some of the problems that arise due to poor waste management. Coupled with the waste and mismanagement of our tailings, there is the devaluation and the view that garbage is a material of no value, which makes it difficult to reinsert it in the productive chain. Brazil, following the promulgation of the National Solid Waste Policy (PNRS) by Federal Law 10,305 / 2010 (Brazil, 2010), has taken an important step towards the efficient management of its waste. In its Article 7, it defines as objectives the protection of public health and environmental quality, the non-generation, reduction, reuse, recycling and treatment of solid wastes, as well as environmentally appropriate final disposition of the wastes, which is the order of priority in waste management; besides encouraging the adoption of sustainable patterns of production and consumption of goods and services; the adoption, development and improvement of clean technologies as a way to minimize environmental impacts; reducing the volume and hazardousness of hazardous waste; the encouragement of the recycling industry, with a view to promoting the use of raw materials and inputs derived from recyclable and recycled materials and the integrated management of solid waste. Also, according to Law 12,305 (Brazil, 2010), establishments that exceed the expected volume limit (120 L per day) are considered to be large generators, and must prepare and apply a Solid
Waste Management Plan, seeking to reduce, not generate, reuse, recycle, treatment and final disposal of waste generated. According to the Municipal Law no. 3273/2001 (Rio de Janeiro, 2001), waste generated by establishments that exceed the limit of 120 L per day, is classified as RSE (Extraordinary Solid Waste), having each generator to guarantee a correct environmental destination for their waste, since they are excluded from the municipal collection system. The Pontifical University of Rio de Janeiro (PUC-Rio), with an area of over 100,000 m², and mixed-use buildings, such as educational, administrative, laboratory, restaurants and others, is a great generator, generating more than 120 L, in the definition of RSE, and it should be responsible for its removal. According to Law 12,305 (Brazil, 2010), the university, as a major generator, must prepare and apply a Solid Waste Management Plan. The objective of the PGRS is to perform a diagnosis of the solid waste generated or administered, containing the origin, volume and characterization of the waste, including the related environmental liabilities. In addition, the PGRS aims to establish operational procedures and responsibilities, so that a waste generating unit can adequately manage all waste generated within it, thus ensuring the protection of public health and the quality of the environment, and must follow the general principles of Reduction, reuse, recycling, treatment or use and disposal. The present research presents a diagnosis of the management and generation of waste from PUC-Rio between 2008 and 2015, taking into account Class I and Class II waste generated at the university, serving as the basis for the elaboration of a Management Plan of Solid Waste for the institution. The diagnosis raised aspects such as: origin of generated waste at the university (generating points), characterization (composition of university waste), volume, storage, collection and internal transportation and destination. Regarding the management of hazardous waste, it is fragmented. As the largest generator of this type of waste, the Department of Chemistry is currently responsible for the disposal of Class I waste at the university. Some laboratories that generate a smaller amount of hazardous waste, monthly or annually, use the management system of the Department of Chemistry for storage and disposal, and others request withdrawal through SESMT (Specialized Service in Safety Engineering and Occupational Medicine). As there is no waste management procedure to Class I waste, many laboratories have old residuals from past researchers who did not discard at the end of their research, leaving the next
researchers with the liability and the burden of paying for the disposal of the material. Therefore, it is clear the need for an administrative unit not tied to a specific department, responsible for managing all hazardous waste generated at the university, in order to ensure environmental safety as well as campus users. In order to obtain information on the origin, volume and characterization of Class I waste, on-site visits were carried out in all university laboratories, as well as other hazardous waste generating sectors, such as chemistry classrooms, and the department Medical service. In order to assist in the collection of such data, the Specialized Service in Safety Engineering and Occupational Medicine (SESMT) of the university and the Department of Quality Environment and Health Safety (QSMS) of the Chemistry department were contacted. According to information provided by SESMT, responsible for the monitoring and control of Class I waste disposal of laboratories and other sectors of the university, as well as the biological residues generated in the medical clinic, in 2013 11,124.03 kg of chemical waste were discarded, 6,087.6 kg in 2014 and 7,066.2 kg in 2015. In addition, according to information provided by campus prefecture, the university generates an average of 4,247 fluorescent bulbs per year. In 6 years, 25,483 lamps were generated, which were sent for decontamination and recycling. Activities related to Class II (not dangerous) waste management are the responsibility of the campus prefecture, which outsources management. From the diagnosis of waste management at the PUC-Rio University over two years, it was possible to perceive the lack of a management standard, or a unified and well-informed system for the entire PUC community, as well as an exclusively dedicated operational structure for waste management generated on campus. The current management presents flaws in both the selective packaging, the collection logistics, the storage in the plant and the disposal. The university does not currently have a Waste Management Plan in operation, as provided for in Law 12,305 (Brazil, 2010), which would ensure that management was performed correctly. Currently there are several trash cans around the campus with different collection patterns, causing difficulty for the correct disposal. It is possible to conclude that a reorganization of the existing collectors is necessary in the campus, as well as in the central of residues storage, being these, fundamental factors for the efficiency of the management, in order to allow the valorization of the residues, guaranteeing the possibility of reuse of materials by students,
teachers and employees, and the subsequent sending for recycling. For the initial stage of generation diagnosis of Class II waste, data was collected on the origin of the waste generated. To organize information on the origin of waste generation at the university, the campus was divided into 9 areas. Departments, administrative units, restaurants, and other waste generating points were listed in each area. In order to know the volume of waste generated daily in each area of the campus, a weighing of the waste collected at each generating point was done at the waste storage center. The weighing took place on Wednesdays, for 5 weeks in a row, in April and May 2016, using a digital scale, Marte LC100 model, with a maximum capacity of 100 kg. From this information, it was possible to verify the areas of greatest generation of waste at the university, as well as other information about the generation of the residues. In almost all areas, "recyclable" waste is collected mixed with "common waste" category, making potentially recyclable materials deposited in the waste compactor and discarded in a landfill. Restaurants are the largest waste generators on campus, accounting for 58 % of total daily generation on campus, being Bandejão the largest generator, averaging 540 kg per day. For the characterization of the "common waste", gravimetric analyzes were performed in order to obtain information on the composition of the types of materials present in the fraction of waste discarded as "common waste" and thus to evaluate how much of recyclable or compostable material could be diverted from landfill and reused. The methodology used for the gravimetric analysis of the "common waste" of the campus was the one of quartet, taken from the Manual of Integrated Management of Solid Waste, elaborated by the Special Secretariat of Urban Development of the Presidency of the Republic (SEDU), Brazilian Institute of Municipal Administration (IBAM), and Federal Government (IBAM, 2001). Noncompacted "common waste" samples were collected on a Friday during the afternoon in two 1,200 L. The amount of material deposited in these containers adds up to a total volume of 4 m³ of waste, guaranteeing at the end of the quartet a sample of 1 m³ for the determination of the gravimetric composition. The bags of waste were opened in a plastic canvas of 4 m² its mixed content with the aid of shovels. By the quartet method, the residue was separated into 4 equal parts, where a part of 1 m² was removed for gravimetric analysis. From this portion, the wastes were segregated according to their physical nature. The rest was discarded. 5 categories of waste were determined, these being; plastic; paper; sanitary waste;
metal and "organic". In the year 2015, 64% of the total waste disposed of as "common waste" was represented by organic material, 10% plastic, 23% paper/cardboard, 1% metal and 2% others (tetrpak, glass, styrofoam, electronic material). For the Class II waste generation data, an annual quantitative analysis was carried out. To collect information on waste generation from the years 2013, 2014 and 2015, the campus prefecture was asked to provide monthly waste disposal reports as well as waste manifests. The results show that total waste generation in 2013, both by category and in the general total, had indices lower than the previous 3 years. In 2013, total waste generation was 939.3 tonnes for the year, 176.4 tonnes less than 2010 (15% reduction), 192.4 tonnes less than 2009 (17%) and 380.3 tonnes less than 2008 (29%). In 2014, total waste generation was 1,134 tonnes, with an average of 94.54 tonnes per month. Compared with the year 2013, it can be noted that there was an increase of 195.2 tonnes in the total amount of waste generated, an increase of 20%. In the year 2015, the total generation of waste was in the order of 1095.8 with an average of 91.32 tons per month. Compared with 2014, there was a reduction of 3.4% or 38.7 tonnes in total waste generation during the year. From all the analyzed results it was possible to conclude that the outsourcing of the management, not accompanied by an internal manager responsible for monitoring all the internal operationalization related to waste management, leads to a management with several process failures. The need for a campus waste management operational unit, which stipulates internal operational procedures that define the logistics of internal waste collection and storage on campus as well as the responsibilities of those involved, is well-known. During the development of the research and search of internal data in the university as the visit to the laboratories, and based on the results of the operational diagnosis and the generation of residues and recycling indexes, it was clear that the PUC community as a whole is not aware of any internal procedure that regulates the management and defines rules of generation, packaging and disposal. Campus waste management presents flaws in the planning for selective packaging - separation of potentially recyclable materials from "common waste" - in the logistics of collection and internal transportation, which are carried out by two outsourced cleaning teams with operational weaknesses, in the storage of waste in the waste storage center, and does not have the necessary infrastructure for proper management. Above all, it is a failure to consider alternatives for both
the internal reuse of the waste generated and its disposal, with almost all waste generated annually, destined for Landfill. Besides the operational issue, it is clear the lack of internal communication in the university. In order to effectively manage the waste generated by the University, it is necessary to create a Waste Management Plan, with the establishment of operational procedures. Also, in order for the waste management plan and the procedures to be applied, it is necessary to create an administrative waste management unit, where there are employees able to perform the specific functions related to the sector, and so that management is centralized, ensuring a more efficiency. Communication of the system through internal communication vehicles is also extremely necessary, so that the population of PUC-Rio can collaborate with it. An environmental policy with the approval of the top management (Rectory) is essential for the success of maintaining the environmental commitment of all units and sectors of the academy (De Conto, 2010). However, even though PUC-Rio already has an environmental policy, it must be put into practice effectively. The efficient management of leftovers from our processes is necessary not only to eliminate environmental liabilities such as contamination of air, water and soil, but also because it is a fundamental factor for the recovery of waste, so as to ensure that it emanates from it a new economy, through research, technology development and, together with this, the generation of material and financial resources.

**Keywords**

Solid waste; waste management; diagnosis; management plan; higher education institution.