Abstract


The Solid Waste Management Plan at PUC-Rio, on the Gávea Campus, draws up a diagnosis of the managerial, functional and physical situation of solid waste at the University. The objective is to determine the data which will help in the preparation of the Waste Management Plan, in which actions are laid out for environmental, social and financial improvements of the institution.

Once the definitions of physical and operational aspects of the Solid Waste Management Plan are laid out on the Gávea Campus, at PUC-Rio, the implementation of Selective Waste Collection Project will start in two places. Considering that a Solid Waste Management Plan goes through the stages of diagnosis, implementation, verification and revision of the management process at the end of the project, aiming at the continuous improvement, a relative diagnosis of the functional and operational characteristics of the project will be presented, generating, thus, suggestions for improvements of the Management Plan.

After the diagnosis, it was possible to get a more comprehensive view of the origin, composition and system of the Solid Waste Management produced on the Gávea Campus at PUC-Rio. The management of the solid waste is done by the administrative department of the Campus, at PUC-Rio, having its operational part done by a third-party. That is, the collection, sweeping and storage of the waste proceeding from the educational, administrative and operational areas are the responsibility of the Sodexho Company, which in 2008 had 209 employees, and in the year of 2010, 220 employees, distributed in three shifts (mornings, afternoons and evenings).

The analysis of the data contained in the invoice of the Koleta Ambiental Company, contracted by the administrative department of PUC-Rio, showed some variations of the waste mass generated and the relative oscillations in the cost of storage and final disposal. As a result, the administrative department of the Campus increased the volume capacity of the compactors and of the open
containers, optimizing the use of the equipment for storage and reducing the costs in half to transport the solid waste to the landfill. Even so, the cost of the transport to the landfill increased, since the waste was no longer being taken to the Gramacho landfill but instead the “CTR” landfill of Nova Iguaçu city, further away from the Gávea Campus and which is more expensive.

After the historical analysis of the data for the production, storage and final disposal of the waste, it was possible to identify the months in which there were peaks in waste production and the overall reduction of 207 tons of waste between the years 2008 and 2010. The months which most produced waste were May and August; however, there are events only in August on Campus, for example Mostra PUC, that can explain the great mass of solid waste produced in the period. The lowest waste mass was seen in December and January in all the years researched, since it is holiday time and, as a result, there are fewer visitors and events on Campus.

An interview carried out with the employees of Sodexho in 2008, showed that PUC-Rio had 21,820 visitors and used 890 one hundred liter garbage bags per day, which adding to the food establishments discarding it, turned out to be 5,376.61Kg/day. The "official" information, taken from the invoice that describes the final destination done by Koleta Ambiental Company, shows the production of 3,512.32Kg/day.

The difference between the values collected through interviews and the “official” ones is due to insecurity of some employees when answering the questions, which were quite different due to a number of reasons: the employees had never paid attention to the amount of garbage bags used per day, the fear of being scrutinized and/or dismissed, or even being compared with other colleagues who might have used more garbage bags compared to them.

Even with a 4.5% drop of visitors on the Gávea Campus in 2010, there was an increase in the number of garbage bags collected by Sodexho, reaching the amount of 1,151. Therefore, even with the increase of 29% of bags collected daily, there was an apparent fall of 1,448.37Kg/day if compared to the waste production of the previous year.

The majority of Sodexho employees work in the morning shift and 49% of the total garbage mass of the Campus is collected during the same shift daily.
Therefore, even though the number of garbage bags increased, its volume decreased, showing that the type of consumption has not changed. So, there was an increase in the cost of the disposal material, and a reduction of the generated waste mass.

In 2010, the waste produced was of 2,491.58Kg/day, plus the discarding of 876.38Kg/day from the food establishments. So, the daily mass produced at PUC-Rio in 2010, according to the research done with the interviews, was of 3,367.96Kg/day. The information from the administrative department of the Campus indicates the production of 2,942.19Kg/day. With the evolution of the methodology, there was a visible reduction of the difference between the collected values during the interviews and the invoices of 2010. That is because, some of the employees, who were already known by the researcher and having been interviewed previously, started to pay more attention to the discarded material and to collaborate with more precise data on the research. Moreover, there was an improvement in the way Sodexho employees were approached for the interview, and also a better perception of the answers considered valid or questionable.

The Campus encompasses a physical area above 100,000m² and, therefore, needs a three-shift operational work schedule with a significant number of hired employees. The monthly cost of Sodexho Company services represents more than 90% of the total monthly expenditure of the administrative department of the Campus for solid waste. It is believed that the optimization of the logistics for waste collection, proposed by the Management Plan, can reduce the costs of third-party labour.

The collection, separation, storage and sale of the recyclable paper had been happening for 05 years by the administrative department of the Campus, at PUC-Rio; which meant that an average of 3,405.25Kg/month of paper was not taken to the landfill. It the “Paper Collecting Campaign”, according to data about the first months of 2011, supplied by “NIMA”, it was possible to verify an increase of up to 29% in the paper segregation. These data were seen in the gravimetrical characterization done in 2010, where the paper mass presented a reduction of 8% in relation to the research done in 2008.

In 2010, the disposal of organic matter by the visitors of the Campus increased by 14% compared to the total waste discarded. That is because of the
A great volume of this type of waste produced daily by the food establishments and by the sweeping done on the Gávea Campus.

In both years studied, 2008 and 2010, a great amount of tissue paper (toilet paper and paper towels) was noticed, which stands as a warning for the correct control of the use, collection, treatment and final disposal of materials inside the Campus. At PUC-Rio, a cart collector could be provided for the collection of the garbage from the restrooms and the exchange of the garbage bags of smaller collectors when needed, meaning that it could be done once a day on average, reducing, thus, the use of garbage bags.

Plastic packaging (rigid plastic) represented 6% of the overall composition of the solid waste found in the Institution, a 2% reduction of this type of material as compared to the research carried out in 2008. In conclusion, the decrease of the use of packaging for food storage and also of the waste of disposable plastic cups is an increasing action inside the University.

On the other hand, the thin plastic - plastic bags - achieved a significant reduction, going from 7%, in 2008, to 3% of the overall discarded garbage, in 2010. The reduction of this material brings important benefits to the environment and to the economy, minimizing the waste mass taken to the landfills, and extending, thus, its lifetime.

Aluminum represented 1% of all residue analyzed in the institution, since it is a material of great value in the recycling market. This material is not usually found in the discarded sum because it is collected by the employees of the food establishments and the cleaning staff.

The sample shows deficiencies in the waste management system on the Gávea Campus regarding the discarding of dangerous materials, like fluorescent light bulbs, and material that could be reused and/or recycled, such as computers.

According to the analysis based on the data supplied by (CEMPRE/IPT, 2000), the discarded material can be 100% recycled, which can become an important guideline for the treatment and final disposal of the solid waste of the Campus, directing, thus, to the preparation and implementation of the Project of Selective Waste Collection.

However, 50% of the discarded material of the University is considered putrescent, which can lead, in the future, to the implementation of actions that transform this waste to compost.
The final disposal of dangerous waste is done by “SESMT”, which chooses only registered transporting companies and also avoids a fixed contract, since the waste volume of this type is irregular and not significant. Moreover, there is an intention to register all the existing laboratories in the Gávea Campus and, thus, to create a hazardous waste exchange, which will promote negotiations of residues inside the University, in the view of extending to other universities through a virtual system. That way, the lab material and residues that would be discarded, could be seen by everyone, and have another use, and so, avoiding the discarding.

In cases when computers at the “RDC” become unusable and/or obsolete, the laboratory tends to fix them before taking them to other areas of the Campus, to the IT Secretariat, or to public schools as donations. Therefore, the sale of the electronic material is practically null, happening only when the computer cannot be fixed, which in this case, is sold to a recycling company, giving the institution a symbolic gain from the sale.

During the study exchange done at the Technische Universität Braunschweig, through the Program EXCEED, it was determined that the segmentation of the Campus should be divided in 04 study areas and that the general guidelines for the Solid Waste Management Plan at PUC-Rio should be prepared, with the objective of addressing the data about the production, handling, storage, final disposal and operation of the residues.

With regards to the solid waste, the Management Plan predicted the visitors' awareness in an effort to reduce discarded elements, to reuse materials and to correctly discard the waste, directing it to recycling.

As for the recyclable materials, they will have to be discarded, being separated in the place of origin, as recommended by the guidelines of the CONAMA RESOLUTION nº 275/01, of April 25th, 2001. This guideline points out a method of prevention so that residues of different types do not mix with each other, facilitating the management and reducing the costs, as well as minimizing the contamination of the environment, the worker and the community.

During the definition of guidelines for the implementation of the Management Plan, it was determined that 6 colors collectors be installed - separating metal, paper, organic matter, plastic material, dangerous material and
the remaining portion - at the main entrances of the buildings and public spaces inside the Campus. It was decided that the 04 color collectors (metal, paper, plastic and remaining portion) be placed at the side of the elevators and stairs, that is, the main flow of people, in all the buildings at the University.

As for restaurants and snack bars, the new contracts with these companies will have to require that they are part of the system of waste management and plan the acquisition and the installation of the discarding equipment (collectors).

The collection of the waste, at PUC-Rio, will have to be done with the help of a small cart collector - a 100L collector - for each type of waste previously discarded in its specific garbage bin, improving, thus, the logistics of transport of the residues inside the Campus and the quality of the work done. However, the importance of an awareness and training program for students, PUC employees and the third-party cleaning company workers was emphasized.

All collected material will have to be taken to a local warehouse, which will be equipped with bigger containers, before it is taken to the general warehouse three times a day. From the general warehouse, the non-recyclable material may be taken to the landfill or it may be sold to a Recycling Cooperative.

The 2010 study about solid waste on Campus showed that 60% of the residues are recyclable, that is, 11,474.40Kg/month could be collected and separated to be taken to recycling. With the separation of 70% of the organic matter - mostly discarded by the food establishments -, the institution will be able to transform the waste amount of about 35,217.90Kg/month into organic composition through the composting process.

The most appropriate solution for the Solid Waste Management of the Campus will be, initially, the implementation of the selective waste collection system without selecting or compacting, which will cost R$139,622.82, that is, the cost of the infrastructure, without the operational system. That way, the guideline presented in the Environment Agenda of the Campus, that consists of “making the reuse and the recycling of materials a daily practice at the University” will be put into practice, which has a fast implementation and financial return of about 1 year and 10 months of selling the collected recyclable material.
The Campus will have an initial cost of R$183,018.97 to implement the Solid Waste Management Plan, including the separation and the compacting process of the waste. Doing so, both the implementation of the infrastructure of the system and the Unit of Selection would pay for itself - with the sale of the discarded recyclable material - in 29 months, meaning 2 years and 5 months.

Certainly, the market value for the separated and compacted material is superior in the market, and, as a result, the profit of the sold material would be higher compared to what was presented in this document. Moreover, the installation of a Shed for Waste Segregation would bring incentives for the University and its surroundings, leading to people's awareness and the propagation of ideas and actions about environmental education, in both University and the city of Rio de Janeiro.

The storage and final disposal of non-segregated waste (without composting) foresees the reduction of 11,474.54Kg/month, which means that the waste volume of 88,265.70Kg/month in 2010 could be reduced to 76,791.16Kg/month through the separation of the recyclable material on Campus. The average cost for solid waste disposal, in 2010, was R$16,970.66/month, but after the Plan is implemented, the cost went to R$16,446.00 monthly. It was believed that, with the minimization of the waste mass and the use of less equipment, considering the optimization of transport for the final destination, the cost should have been lower. The oscillation of the market values presented after the comparison between 2010 and the research done for the Plan is typical of the normal annual readjustment to the service values. However, this emphasizes the real need for negotiation that the University will have to make with the company in charge of the final destination of the garbage, so that the costs of the non-segregated solid waste disposal are minimized.

The plan of final disposal of non-segregated waste (with composting) anticipates a reduction of 52.90% - 46,692.56Kg/month - of the solid waste that would be taken to the landfill. Therefore, an average cost of R$11,318.00 monthly for the correct disposal of this material was calculated, that is, reduction of R$5,652.66/month or R$67,831.92 per year compared to the cost presented in the year 2010.
All in all, considering the non-segregated material, the correct discarding of the organic mass of the University is of extreme importance, as well as regarding in the future, the Management Plan with the composting system included. Since the waste is easily segregated by the food establishments, this action would reduce of costs with storage and final disposal, also leading to environmental and social benefits.

The operation of the Plan must have its activities all accompanied and monitored, for the measurement of the economic and environmental gains and, thus, promoting remedial actions and the continuous improvement of the system performance.

After a Plan model was outlined for some of the buildings in Area IV, a consultancy was given to “NIMA”, leading to the preparation of the Management Plan and the implementation of the Selective Collection Project in Area II, with the objective of accomplishing some of the goals defined by the Environmental Agenda of the Campus.

With the interviews done at the University, it was possible to draw up a diagnosis of the operation, which analyses the stages determined by the Management Plan. The photos and the mapping in the diagnosis showed, initially, a relative lack of organisation of the places where the selective collectors were installed, which was outlined in the plan of separating recyclable material. The premises for the implementation of a separating discarding plan are to make use of collectors in sets, using a specific collector for each type of material to be separated. Moreover, it was decided that they would be placed in areas of high flow of people, that is, next to stairs and elevators, and that there would have a standardization of the positioning of the bins, so that they were always placed in the same order, thus facilitating the understanding and serving as a reminder for the way people should discard waste.

Some imperfections of installation, such as the wrong number of selective collectors that should be in sets of 04 (paper, plastic, metal and remaining portion); the wrong order of colors of the collectors; the positioning of the collectors, far from a high flow of people; the installation of the collectors in places of difficult access, such as, under notice boards; the installation of the collectors in forbidden places, such as near fire safety systems or in front of fire
hoses; all caused the facilities to be underused and caused mistakes in the
discarding of the recyclable material, making it harder to recycle most of the
residue. In this way, the awareness of the correct discarding and the amount of
recyclable material collected become insufficient and/or incomplete.

The way the Selective Collection Project was established is resulting in the
discarding of the residues without the necessary awareness and attention of the
visitors, reducing the potential of the segregated and recyclable material collected.
On top of that, the contribution to the minimization of the solid waste discarded
by the University to the landfill will not be reached. It is important to spread
information about the recyclable and non recyclable material, as well as its correct
disposal since the culture of how the material should be discarded is still being
implemented.

The improper waste discarding brings to mind the necessity of
environmental education programs, such as lectures of awareness and training for
the employees of the University and third-parties, as well as the need of general
information about the discarding of the materials consumed inside the Campus.

The logistics of the collection suggested in the Solid Waste Management
Plan was not implemented as yet, since the collection is done by an employee of
the Sodexho Company, who collects all the residues, each time in its respective
collector of 240L, and labelled in accordance with each material (paper, plastic,
metal and/or remaining portion). Sodexho Company, which is responsible for the
cleaning-up of the University, believes that it is possible to optimize the collection
by training a reduced number of employees, since the great rotation of employees
may cause the discontinuity of the activities of collection, garbage recycling and
waste reduction. Therefore, the company, together with “NIMA”, proposes to
train 4 employees for the waste collection of each building, with each person
being responsible for the collection of each recyclable material.

Since the local warehouse has not been implemented in this phase of the
project, the waste collected on the floors of the buildings is carried by a specific
employee to the general warehouse, extending the time interval between
collections, and reducing the optimization of time collection and the separation of
the material.
The general warehouse, located in Area III of the Campus, was not completely remodeled, since the Project of Selective Collection was only implemented in some constructions of the Campus. However, some of the equipment that was not included in the Management Plan was acquired to give support to the project, namely: Big Bags, the rent of 01 container, 03 containers of 1,200L for plastic, paper and metal, and 01 container of 700L for other types of material - requested by the administrative department of the Campus. Even though the 03 containers have been completely filled with plastic since the beginning of the project, this material has never been put up for sale; apart from that, the Big Bags and containers, which should have been used to store and control the separating residues, were never used.

According to information provided by “NIMA”, the sale of the recyclable material is being made impractical due to imperfections in the moment of the discarding, for instance, mixed and dirty material and, also, the lack of an employee responsible for the control of the material in the general warehouse. For this reason, all the collected material, except for the paper, is not being taken to the recycling market, but only to the landfill.

Even though the objective of the Selective Collection Project is directed to the re-education of the academic community, it is clear that the financial return, that will guarantee its sustainability, will be one of the consequences. That is, there will be a return from the sale of the separated recyclable material; savings from the less need of cleaning the internal and external areas of the Campus, since people will be more educated and littering less; and the money the administrative department will save when reducing the waste volume to be taken to the landfill. Moreover, the maintenance of the quality of the surroundings and the quality of life is achieved, which can hardly be expressed in quantitative values.

The system operation remains with the professionals of the administrative department of the Campus, in partnership with Sodexho Company and “NIMA”, without a team solely directed to the operation and maintenance of the Solid Waste Management Plan of the Campus being implanted.

With the involvement of the visitors (pupils, professors, employees) in the process of transformation and implementation of the project, they would stop
being static and would share responsibilities and feel they are part of the environment and the events derived from the sustainable project.

The implementation of the physical infrastructure in the Campus, integrating reduction in the discarding, efficiency in the collection and the correct storage and transport of the discarded residues is of great importance. However, the key to the solid waste management inside the University is the awareness of the academic community, the need for discussion on the subject and everyone's cooperation in the functioning of the system, leading, thus, to a more knowledgeable society.

Considering that the University is a living organism and that the frequency of people is sufficiently renewable, the update and the deeper research of the data for the production, storage and final disposal of the solid waste of PUC-Rio constitute an essential tool for the definition of strategies directed to the development, correction and improvement of the management system.

**Keywords**

Solid waste; Diagnosis, Management, Recycling, University.