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CHARACTERIZATION OF ENVIRONMENTAL ASPECTS AND IMPACTS OF FIVE UNIVERSITY RESTAURANTS AT A PUBLIC HIGHER EDUCATION INSTITUTION IN BRAZIL

CARACTERIZAÇÃO DE ASPECTOS E IMPACTOS AMBIENTAIS EM 5 RESTAURANTES UNIVERSITÁRIOS EM UMA INSTITUIÇÃO DE ENSINO SUPERIOR PÚBLICA NO BRASIL

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ABSTRACT

University Restaurants (URs) of *Universidade Federal do Rio Grande do Sul* (UFRGS) are distributed across four campi at Porto Alegre, the capital of the state of Rio Grande do Sul. More than 1.5 million meals were served in 2012. This paper describes a characterization study of the environmental aspects and impacts of the activities involved in producing meals at the five URs. Two checklists were developed to conduct the survey of the environmental aspects and impacts, and they were applied at the URs. A typology of the waste produced at the URs was compiled, identifying organic waste originating from the employed foodstuffs and recyclable waste from the packaging of a wide range of items. It was observed that the URs' waste separation practices were inadequate. As to the use of natural resources, we identified: the water supply outlets, and the equipment that use electricity and liquefied petroleum gas. The identification and understanding of the environmental aspects and impacts of providing meals is the first step in the direction of improving sustainability.

Keywords: meals; environmental administration; solid waste.

RESUMO

Os Restaurantes Universitários (RUs) da Universidade Federal do Rio Grande do Sul (UFRGS) estão localizados em quatro campi na cidade de Porto Alegre, Rio Grande do Sul, e serviram em 2012 mais de 1,5 milhões de refeições. Esse trabalho tem como objetivo apresentar a caracterização dos aspectos e impactos ambientais referentes às atividades de produção de refeições nos RUs. Foram desenvolvidos dois formulários específicos para a caracterização dos aspectos e impactos ambientais que foram aplicados nos RUs. Quanto à tipologia de resíduos gerados nos processos identificaram-se os de natureza orgânica provenientes dos alimentos utilizados e os recicláveis das embalagens de diversos materiais. Constatou-se nos RUs a inadequação quanto à correta separação dos tipos de resíduos. Quanto ao uso de recursos naturais, foram quantificados: os pontos de água, e os equipamentos que utilizam energia elétrica e gás liquefeito de petróleo. A identificação e entendimento dos aspectos e impactos ambientais relacionados ao fornecimento de refeições é o primeiro passo no sentido de reforçar ações de sustentabilidade.

Palavras-chave: refeições; administração ambiental; resíduos sólidos.

INTRODUCTION

It is possible to determine the environmental aspects and impacts of any type of human production activity, whether the result is a product or a service. An environmental aspect is defined, in NBR ISO 14001 (ABNT, 2004), as an element of the activities, products or services of an organization that can interact with the environment, while an environmental impact is defined as any changes in the environment, whether adverse or beneficial, which is, entirely or partially, a result of the organization's environmental aspects (ABNT, 2004).

According to provision 4.3.1 of ISO 14001/2004, the identification of the environmental aspects of activities, products and services, and the determination of these aspects, so that they can be controlled or influenced, are the responsibility of the company or organization (ABNT, 2004).

Higher Education Institutions (HEI) can be compared to small urban centers. This is because, in addition to hosting teaching and research activities, they also have spaces in which activities relating to their operation take place, such as dining halls and communal spaces (TAUCHEN; BRANDLI, 2006; ALSHUWAIKHAT; ABUBAKAR, 2008).

Production, transformation, distribution and consumption of foodstuffs are essential activities for human health and prosperity (VAN DER WERF *et al.*, 2014). The production of meals in communal settings involves a series of processes ranging from the selection and storage of raw materials to the preparation of the finished product (ABREU; SPINELLI; ZANARDI, 2009). According to the American Dietetic Association (ADA), these processes are part of a group of sectors related to sustainability in food systems (HARMON; GERALD, 2007).

Processes involved in producing and providing meals that affect sustainability include: waste generation; inadequate disposal of products and packaging; use of non-biodegradable products; and wastage related to water and energy usage (VEIROS; PROENÇA, 2010; GRAU, 2014).

This study takes as its central question the environmental aspects and impacts of five University Restaurants (URs) at the Universidade Federal do Rio Grande do Sul (UFRGS). This question will be considered through the investigation of the following subjects:

- the structural dimensions of the URs' physical spaces;
- a typology of the waste generated by meal production;
- separation and storage of this waste; and
- the resource usage needed to produce meals.

MATERIALS AND METHODS

Study characteristics

This is an observational, cross-sectional, descriptive study, with a quantitative analysis of variables (PRODANOV; FREITAS, 2013).

The UFRGS is a higher education institution with campi in the cities of Porto Alegre, Eldorado do Sul and Imbé, plus installations in some other towns. There are four campuses in the state capital, Porto Alegre. The institution runs 89 undergraduate courses, 81 masters programs and 69 doctorate programs. In 2013, UFRGS had 29,212 undergraduate students, 20,397 masters and doctoral students and 2,612 professors, in addition to the institution's service personnel and service providers (UFRGS, 2015).

The UFRGS Environmental Management System comprises four programs: Survey of Environmental Aspects and Impacts, Environmental Licensing, Environmental Certification and Environmental Education. The programs include fifteen specific projects, which cover the environmental management of the student dining halls (UFRGS, 2012).

This study aims at the five UFRGS URs located in the four UFRGS campi in the city of Porto Alegre, Rio Grande do Sul, Brazil (Figure 1). The URs are one of the options for providing meals to the academic community of this HEI, and their mission is to provide good-quality balanced nutrition. The standard meal served at lunch and dinner in the URs consists of rice, beans, meat, garnish, salad and dessert (fruit). In 2012, the URs served more than 1.5 million meals (UFRGS, 2014).

Two specific checklists were developed to conduct the survey of environmental aspects and impacts. The items included on the checklists were selected after a review of the literature based on publications, reports, standards and scientific articles.

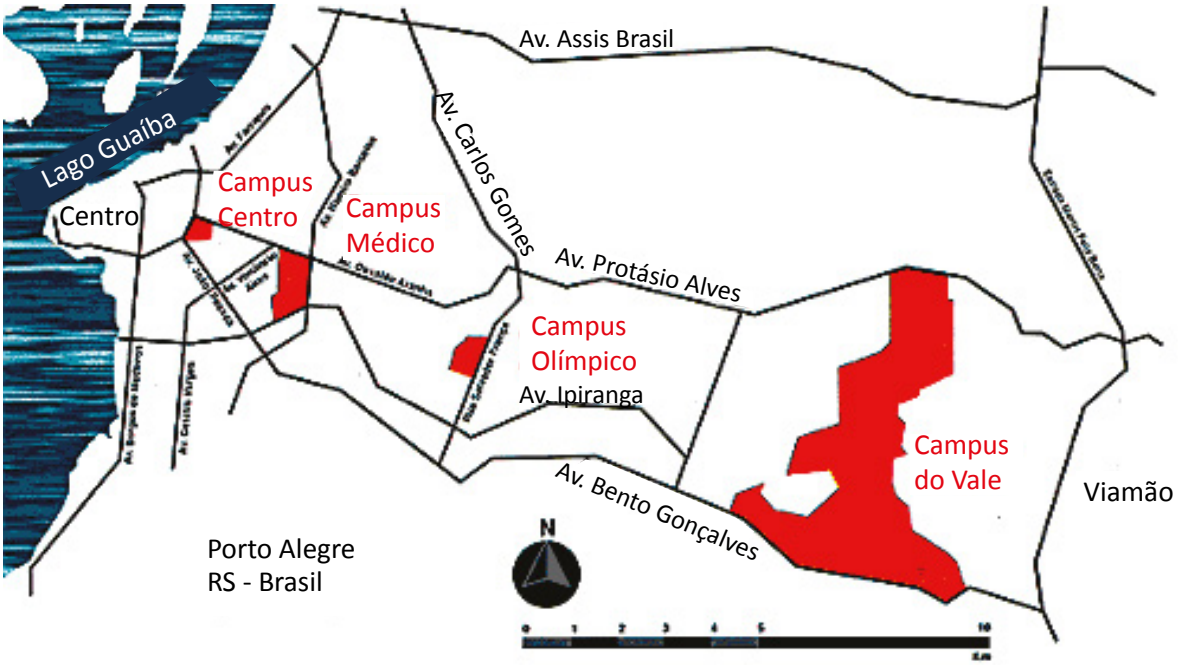

Figure 1 - Locations of UFRGS campuses.

Development of the data collection instrument

Checklist 1 was used to collect data related to all the different types of materials that contribute to the generation of solid waste during the production and distribution of meals, including reception of goods (perishable and nonperishable food items, products for hygiene and cleaning, and consumables) and processes involved in storage, preparation, distribution and cleaning. Additionally, checklist 1 also covers items related to energy use, atmospheric emissions, water consumption, consumption of (chemical) cleaning products and generation of effluents for each of the stages listed above.

The second checklist was used in order to conduct the survey with nominal description of the physical and functional structure of the URs, plus the equipment used and their energy sources. This checklist covered items such as:

- separation, storage, collection and disposal of waste;
- whether or not there are systems for recording waste and left-over foodstuffs and the use of those systems; and
- whether there are systems for controlling and recording water, electricity and liquefied petroleum gas (LPG) consumption and the use of those systems.

Administration of data collection instrument

The data needed to complete the checklists were collected during visits to all of the URs, conducted in August 2013. Later, repeat visits were conducted in October of the same year to confirm the data collected during the first visit. Data collection was conducted by two undergraduate scholarship students, with internships at the UFRGS foodservice department and environmental management office, who were monitored, supervised and instructed by the lead author.

Data analysis

All of the information collected was verified later on Microsoft Excel® spreadsheets. Results for quantitative variables are expressed as absolute frequencies, and descriptive statistics were produced from the results for qualitative variables.

RESULTS AND DISCUSSION

Characteristics of physical spaces

One of the checklists was used in order to identify the initial aspects related to spatial characteristics of the URs. All of the UFRGS URs have differing physical spaces, both those dedicated to production activities and those available for consumption of the meals.

The URs physical areas included in the survey were storages, kitchens, service areas, changing rooms, washrooms, laundries, administrative areas, internal circulation areas and the restaurant areas. Their dimensions were taken from the floor plans for the URs — obtained from the Foodservice Department —, and were: 993.02 m^2, 876.06 m^2, 964.46 m^2, 144.81 m^2 and 330.04 m^2 , respectively URs from 1 to 5, namely Central, Saúde, Vale, Agronomia and Escola Superior de Educação Física (ESEF).

In terms of seating capacity for customers, the URs have the following the number of places available: 464 (UR 1), 276 (UR 2), 1,060 (UR 3), 156 (UR 4) and 120 (UR 5). The numbers of employees also differ, with 50, 42, 71, 25 and 27 workers responsible for the daily tasks involved in the production and distribution of meals. Horng *et al*. (2013) discuss issues related to the physical aspects of the buildings used for URs, considering environmental pollution among other elements, and emphasizes the importance of efficient physical spaces and of working to achieve more sustainable buildings.

The core activity of a UR is to provide its customers with meals. Considering the mission of a restaurant — whether a commercial or an institutional one, and whether profitable or not —, should reveal the activities (aspects) that will impact the environment. This is because the activities of organizations that operate in the meal production industry revolve around two components: food production and service provision (LLACH *et al.*, 2013).

Characteristics of waste and waste management

Aspects directly related to food production occur during the stages of reception, storage, pre-preparation, preparation and division into portions. These are followed by distribution (for consumption by clients) and post-consumption (sanitation of utensils and cleaning of equipment and installations).

The results of application of the second checklist enabled the classification of the types of waste created by the different physical areas dedicated to specific activities. Chart 1 lists the major types of waste generated, along with the respective types of products that are directly or indirectly employed in providing meals.

With regard to the waste types listed in Chart 1, it is worth noting that each is discarded during a different set of processing stages, depending on the nature of the product groups to which they are related. For example, plastic and card/cardboard packagings, used for the different types of meat, are discarded when the ingredients are used in pre-preparation stages (defrost-

Chart 1 - Typology of waste, classified by groups of products used at UFRGS university restaurants (2013).

Product groups	Types of waste				
	Organic/ Foods	Paper /card	Plastics	Cans	Wood
Meat (beef, pork, poultry, seafood)	X	X	X	-	-
Chilled foods (dairy/cold cuts)	-	X	X	-	-
FVG (fruit, vegetables and greens)	X	X	X	-	X
Non-perishable (dry goods)	X	X	X	X	
HC (hygiene and cleaning)	-	X	X	-	-

ing or seasoning), while food remnants are discarded during pre-preparation, division into portions and when clearing up after consumption by clients.

The most common materials were plastic and card packaging. Steel cans were only used for nonperishable goods (soy oil, peas and sweet corn). All of these types of packaging could be separated into recycling streams, as long as they are not soiled with fat or blood. Wooden cartons used to deliver certain types of fruit, vegetables and greens (FVG) were collected by suppliers during reception, since these foods were stored in plastic boxes.

Other waste types identified were cloth (cotton and disposable), sponges, steel wool and dirty and wet paper. Cloths and sponges were used in the majority of washing and cleaning activities, while steel wool was only used for cleaning pans. Dirty and wet papers were discarded when workers washed their hands, which they are required to do with frequency during food preparation activities.

Many processes involved in the production of meals cause environmental impacts (HARMON; GERALD, 2007). Waste is created when packaging is discarded, after being used for storage of many types of food and chemical products, which are used directly and indirectly in food preparation — such as paper, card, plastics, glass, cans and tetrapack packaging, very often not adequately separated (WANG, 2012; GRAU, 2014).

A paper published by Collares and Figueiredo (2012) was performed in order to evaluate and characterize the different types of solid waste in an institutional restaurant, in which the authors identified: food (organic), plastic, paper/cardboard, tin, wood, cloth and rubber. The relationship of these materials corroborates the information published by Zein, Wazner and Meylan (2008).

Left-overs of prepared foods were dealt with in two different ways at all of the URs. Foods that had been prepared, but had not been put on the buffet tables for serving, were stored in cold storage rooms and could be used on a later occasion. Left-over foods that remained in the buffet table wells after a sitting were discarded. It was found that, out of the five URs studied, two of the them recorded the quantities of dish remnants in the food wells; one of them recorded the weight of food not eaten (buffet left-overs) on a dedicated spreadsheet and the other two did not have any control processes for these issues.

Wasting food also implies wasting the resources used to create food preparations, including water and energy (PIRANI; ARAFAT, 2014). Waste monitoring is an activity that should be included in programs for waste reduction. There are many possible monitoring methods, including simple tasks such as visual inspection and more sophisticated approaches by quantitative measurements of waste according to foods or food groups (STRASBURG; PASSOS, 2014; PIRANI; ARAFAT, 2014).

Collares and Figueiredo (2012) diagnosed in their study that food waste from pre-preparation waste, leftovers and debris accounted for 88.0% of the total generated in an institutional restaurant. The work of Peruchin *et al.* (2015) showed that food waste accounted for 49.0% of the total waste generated in hotel services during high season.

The survey also found that all sectors of the URs had waste collection facilities available. The number of waste containers per area varied from one to three, depending on the function. However, all inspections found evidence that some sectors were not correctly separating waste according to the UFRGS recycling collection process, rolled-out in 2008, and defines two waste streams (recyclable and non-recyclable). Recyclable waste is supposed to be collected in bins with blue plastic liners, whereas organic waste should be collected into bins with black plastic liners. Parts of ingredients that are not fit for consumption, removed during pre-preparation, and also food left by customers are put directly into 200 L plastic barrels. The same was observed with relation to disposal of used oil from fryers, also stored in duly labeled plastic barrels.

Pospischek, Spinelli and Matias (2014) reported in their study that 87.5% of 16 commercial restaurants in São Paulo held the selective collection of recyclable waste. However, within this percentage, only 18.8% use different colors containers for recyclables. The inadequacy for adequate separation of waste has been identified in the establishments inspected in the paper by Rossi, Bussolo and Proença (2010), which, however, measured the proper procedure for the collection and disposal of used cooking oil.

A thorough inventory of all waste created is the first step in implementing an integrated waste management system (DE VEGA; OJEDA-BENÍTEZ; BARRETO, 2008; SMYTH; FREDEEN; BOTH, 2010). De Vega, Ojeda-Benítez and Barreto (2008) conducted a waste study of a university campus in Mexico, finding that it produced 1 T of solid waste per day, and that 65% of it was potentially recyclable. Espinosa, Turpin and Polanco (2008) described the implementation with academic participation of an integrated solid waste management system, including recyclable waste separation in a Mexican HEI that was able to minimize waste creation. Iojă *et al.* (2012) identified — in their study in Romania — that 49% of 457 educational institutions do not perform the selective collection procedure, and the amount of waste generated was independent of the number of students. For Jibril *et al.* (2012), the use of a grounded waste management system in the 3Rs (reduce, reuse and recycle) for HEIs minimizes operating costs in the disposal and treatment of solid waste. At UFRGS, it is estimated that the organic material (remains of food and detritus from washrooms) accounts for 70% of the volume of waste (CAMPANI *et al.*, 2010). In the federal Brazilian institutions, there shall occur the correct separation of recyclable waste discarded, as stated in Presidential Decree No. 5940 of October 25, 2006.

The physical differences between the different UFRGS URs mean that the storage of waste is also conducted differently. Notwithstanding, all waste is allocated to external areas. The only university with a specific physical area, built specifically for this purpose, is at the Vale campus (UR 3). At the others URs, the plastic liners containing waste were stored in plastic barrels or containers with lids. At all sites, all materials are collected by Porto Alegre's Municipal Sanitation and Refuse Department (DMLU). The department has different teams to take waste to different destinations. Barrels containing remains of food are taken by one team to registered pig farms. The used oil from fryers is also collected by a third-party supplier, authorized to provide this service by the DMLU, and regular and recyclable waste is collected by the municipal teams and sent to sanitary landfills or registered recycling cooperatives. The frequency of collections varies according to the geographic location of each URs, ranging from every day to three times per week.

Spinelli and Cale (2009) observed that 87.8% of the total waste generated in the production of meals from a restaurant was sent to landfills and 12.2% was disposed for selective collection and recycling. As for the disposal of organic waste, the studies of Barthichoto *et al.* (2013) and Matias *et al.* (2013) described that the areas surveyed were sending them to landfills by the municipal collection service. Pospischek, Spinelli and Matias (2014) reported that the collection of waste in 16 commercial restaurants surveyed was held by the city (43.8%) or cooperatives (56.2%).

With regard to the regulatory aspects of waste management, the Brazilian National Sanitary Authority (ANVISA) has promulgated resolution RDC No. 216/2004, setting out best practices for food service (ANVISA, 2004) — including a specific provision covering waste management focused on the correct storage of waste. Additionally, article 7 of the Brazilian National Policy on Solid Waste covers prevention, reduction, reuse and recycling and the environmentally correct disposal of refuse (BRASIL, 2010). In a study of Feil, Strasburg and Naime (2015), the authors present a table with 17 Brazilian laws related to the environment in the period from 1967 to 2012. It should be noted that among the environmental legislation presented, Law 12305/2010 is the only specific one in relation to waste.

In the United States, the ADA has set out guidelines for professional nutritionists covering their professional responsibilities regarding aspects of waste management, including their responsibility to minimize wasted food, recycle cooking oil used for frying and provide for correct separation and recycling of materials such as glass, metal, plastics, card and cardboard, etc. (HARMON; GERALD, 2007).

Alshuwaikhat and Abubakar (2008) point out that HEIs have a double mission as environment is concerned. The first takes in reducing the environmental impact caused directly by their teaching, research and administrative activities and indirectly by activities related to the communal spaces for their academic community, as in the case of restaurants. The second mission is related to the responsibility that HEIs have to conduct research into sustainability and teach about it, resulting in the dissemination of this knowledge to society at large.

Use of resources

In order to provide meals, it is necessary to utilize natural resources in a wide range of different stages. As part of the survey, environmental aspects related to energy use, atmospheric emissions, water use, chemical cleaning products and generation of effluents were related to all of the activities that have been identified. Chart 2 lists the most important environmental impacts related to consumption of natural resources such as water, electricity and LPG.

It should be pointed out that the figure for number of water supply outlets at each UR relates to the entire physical structure. As such, in addition to the direct usage in processes conducted within kitchen and laundry facilities, water is also used in washrooms and changing rooms for employees and clients. Water is used to supply equipment such as the hot buffet tables, to run dishwashers and in water fountains used by customers. Water is used directly during food pre-preparation and preparation stages. Finally, water is also used for washing and cleaning, in conjunction with chemical products, and therefore leading to the creation of effluents.

Electricity is used in all processes related to the core activity. Electricity is indispensable for preserving foodstuffs stored in a cold chain (refrigeration and freezing) and also to run equipment used to prepare food and to keep it hot or cold. Some of the equipment is of standard dimensions in all of the URs, such as food processors, pass throughs and hot/cold buffet tables. The other items of equipment, listed in Chart 2, have varying dimensions and capacities, depending on the requirements and size of each installation. In addition to the items listed in Chart 2, smaller items, specific to the situation and needs of each UR, were also observed — including items such as vegetable peelers, liquidizers/blenders and food processors.

Chart 2 - Environmental impacts of UFRGS university restaurants (2013).

Environmental impacts	University testaurants				
Water usage	UR 1	UR 2	UR 3	UR 4	UR 5
Faucets (water supply outlets for entire structure)	33	23	29	11	18
Electricity usage	UR 1	UR 2	UR 3	UR 4	UR 5
Balances	1	1	2	1	1
Cold storage rooms	2	2	2	0	0
Refrigerators / Freezers	5	4	4	4	4
Fryers	2	1	1	1	1
Extractor hoods	2	1	1	1	1
Pass through	2	4	2	4	0
Hot and cold buffet tables (*)	6	4	13	2	2
Food processors	1	1	1	0	1
Water fountains (*)	2	1	3	1	1
Dishwashers (*)	1	1	1	1	1
LPG USAGE	UR 1	UR 2	UR 3	UR 4	UR 5
Cookers/ranges	4	2	3	2	2
Combined ovens (**)	1	3	2	1	1
Steam boilers	3	3	6	0	0

(*) hot buffet tables, water fountains and dishwashers are all supplied with water; (**) also uses electricity; UR: University restaurants; LPG: liquefied petroleum gas.

Another energy source used at the URs is LPG, which is the fuel used for thermal preparation of foods during cooking processes, on six or eight-ring ranges, and to generate the steam in the 300 L or 500 L sterilization boilers used in the URs. As a result of this energy use, it was also found that atmospheric emissions of smoke and steam are caused by food preparation and distribution stages. Steam is also released in the laundries when washing machines are used.

With regards to the usage of natural resources, it was found that the only item that could be measured was LPG purchases, since the URs do not have dedicated electricity and water meters, which are shared by all buildings on each one of them.

On the subject of electricity consumption, a study published by Horovitz, in 2008 (*apud* CHOU; CHEN; WANG, 2012), highlighted the results of research conducted by Pacific Gas & Electric's Food Service Technology Center, showing that restaurants are the greatest consumers of electricity in the retail sector, using as much is five times more of it per m^2 than other commercial Enterprises.

Barthichoto *et al.* (2013) conducted a study of commercial restaurants in the city of São Paulo, finding that just 37.5% of establishments (n=12) conducted electricity consumption measurement procedures. These authors showed that electricity consumption per meal varied from 0.2 to 1.3 kW/h (BARTHICHOTO *et al.*, 2013).Stys (2008) reported that restaurants in the United States consume large courts to offer disposable products, water and energy and have annual gas and electricity costs of an average of $161 per seat.

The ADA has published a series of recommendations related to meal production and aspects of energy and water usage. With regard to the issue of energy, guidelines exist on choosing more energy-efficient equipment, developing strategies to save energy and performing preventive maintenance on equipment. With regard to water usage, it is recommended that strategies for saving and re-utilizing water from the kitchen be implemented, that biodegradable cleaning products be employed and that the quantity of residues discharged in wastewater be minimized (HARMON; GERALD, 2007).

According to Blanco, Rey-Maquieira and Lozano (2009), reductions in resource consumption and waste generation are the first incentive for implementing environmental practices in service sectors. Companies tend to adopt these types of environmental practices in order to save on consumption costs, since they do not demand significant investments, but can lead to immediate financial benefits (ZENG *et al.*, 2010). Alonso-Almeida, Rodríguez-Antón and Rubio-Andrada (2012) argue that reducing water waste and energy consumption are situations in which the fields of quality management and environmental management meet.

FINAL COMMENTS

In this study it was shown an overview of the operating reality of five URs of the Brazilian public higher institution education. There were identified, at first, singularities as to the operating aspects of URs and structural differences related to size, service capacity and number of workers.

About the environmental impact identification, generation and disposal of waste, the ones from organic origin were diagnosed in stages that comprised the receipt and pre-preparation (parts not usable); and later on, the food prepared and distributed that was not fully consumed (leftovers of vats and the users' leftovers). Despite the existence of collectors in URs, it was found that the correct separation between the organic and recyclable source (paper, cardboard, plastics and cans) does not occur properly. On the other hand, all the URs have appropriate place for packaging waste to the collection and disposal carried out by the urban sanitation services in Porto Alegre city, Rio Grande do Sul.

The safety assurance of the food served depends on proper procedures in performing the tasks, as well as the availability and use of resources such as water, electricity and LPG. For this, the structural and description of the equipment used also identified the impacts of processes running in the URs.

The first step to reinforce the sustainability in URs of UFRGS is by identifying, characterizing and understanding the environmental aspects and impacts related to meal delivery processes. Similarly, studies of this nature should also have continuity in other models of costumer services of food for collectivities.

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