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Higher Education and Food Waste: assessing current Trends

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47 **Abstract**

48 *Purpose:* Food waste is a considerable sustainability challenge, and many universities around
49 the world are engaged in food waste prevention. University canteens offer opportunities for
50 prevention of food waste by steering the amounts of food served in meals at central locations.
51 Nevertheless, there is a paucity of international studies which look into this matter at a greater
52 depth.

53 *Research Question and Methods:* This paper discusses matters related to university policies
54 and strategies, best practices as well as deficiencies that are seen in preventing food waste.
55 An international study was conducted, including a sample of 52 higher education institutions,
56 in order to provide pieces of evidence of current trends. The study is explorative, and the
57 collected survey data was analyzed by descriptive statistics, complemented by a simplified
58 content analysis of open-ended questions.

59 *Findings:* The study reveals that even though food waste is as an essential issue in many
60 Higher Education Institutions, prevention efforts are not so widely spread as they should be.
61 The majority of universities represented in the sample implemented particular initiatives for
62 food waste reduction, focusing on collection for disposal and composting as well as for external
63 donation. Other examples for implemented efforts include training staff to serve adequate
64 portions, use of trayless dining, and provision of regular information for staff and students.
65 However, 60% of the sample does not have to follow a particular strategy or measure the
66 amount of food waste produced. About 15% of the universities in the sample reported no
67 engagement.

68 *Practical Implications:* In particular, there is a need for greater involvement of both students
69 and staff, in efforts towards preventing and better handling food waste. Food waste prevention
70 is also a cultural change that must be supported by the top management and administration of
71 higher education institutions. Finally, measurements and indicators should be considered for
72 helping and encouraging prevention measures, detecting inefficiencies, and in particular,
73 establishing targets for improvements.

74 *Research limitations/implications:* Further research could consider enlarging the sample of the
75 Higher Education Institutions involved, as well to explore (for instance, through in-depth semi-
76 structured interviews) some of the best practices highlighted by this research.

77

78 **Keywords:** food waste - sustainability - higher education – waste prevention

1. Introduction

Food waste refers to food that is actually of good quality, but which is discarded at the retail or consumption stages of the food supply chain (Lipinski et al. 2013; Halloran et al. 2014). There are several reasons for food being wasted along the food chain, i.e. overproduction, unnecessary inventory, defects in production or equipment, inappropriate processing or transportation, improper storage, losses in food preparation and when food is served, i.e. leftovers on the plates of consumers (Engström and Carlsson-Kanyama 2004; Gooch et al. 2010; Lipinski et al. 2013).

The amount of food waste produced is increasing, with almost 50% per capita increase in food waste produced since 1974 in the United States (Hall et al. 2009). The most considerable quantities of food are being wasted at the consumption level in particular in households (Evans et al. 2013), which is reported with ranges between 44 to 130 kg/person/year in EU 28 (Stenmarck et al. 2016; Lorenz et al. 2017a). Reasons for this are mainly related to individual behaviour and other personal factors such as attitudes and norms, for example, over-purchasing and underestimating the amount of food stored at home, as well as a preference of aesthetically pleasing fruits and vegetables, and an inadequate understanding of the best before-labels (Evans et al. 2013; Evans 2014). Notably, what is considered edible and suitable for consumption by most people varies based on cultural and religious factors as well as social norms (Papargyropoulou et al. 2014). The discourse around food waste varies. In developed countries, public discourse often focuses on individual attitudes and consumer responsibility while in developing countries, the discourse centres on fundamental reasons for accidental food losses (Gille 2012).

Nevertheless, also out-of-home food consumption, i.e. in restaurants, canteens, kiosks, schools or university cafeterias have been found to add a relevant share of total food waste (Silvennoinen et al. 2012; Beretta et al. 2013; Katajajuuri et al. 2014; Lorenz et al. 2017; Lorenz et al. 2017). In out-of-home settings, food waste in terms of leftovers is considered a potential indicator of consumer satisfaction. However, several other studies on food-related behaviour outside home indicate that technical and personal aspects may lead to left-overs.

Technical and service-related aspects are, for instance, menu offerings (Aschemann-Witzel et al. 2013; Ferreira et al. 2013), portion sizes and serving styles (Dinis et al. 2013; Lorenz et al. 2017b; Sanchez-Carracedo et al.). Personal factors compromise the expression of attitudes, subjective norms and intentions towards leftovers, avoidance of food disposal and behavioural control of eating everything up (Lorenz et al. 2017b).

Food waste prevention has become an essential topic for higher education institutions globally, in part due to its environmental and social impacts. Food waste prevention at canteens aims at reducing the loss and waste of food in particular during storage, processing or serving. It involves several steps, for instance, (A) auditing and planning, (B) implementation of effective measures and (C) awareness-raising campaigns, as depicted in Figure 1.

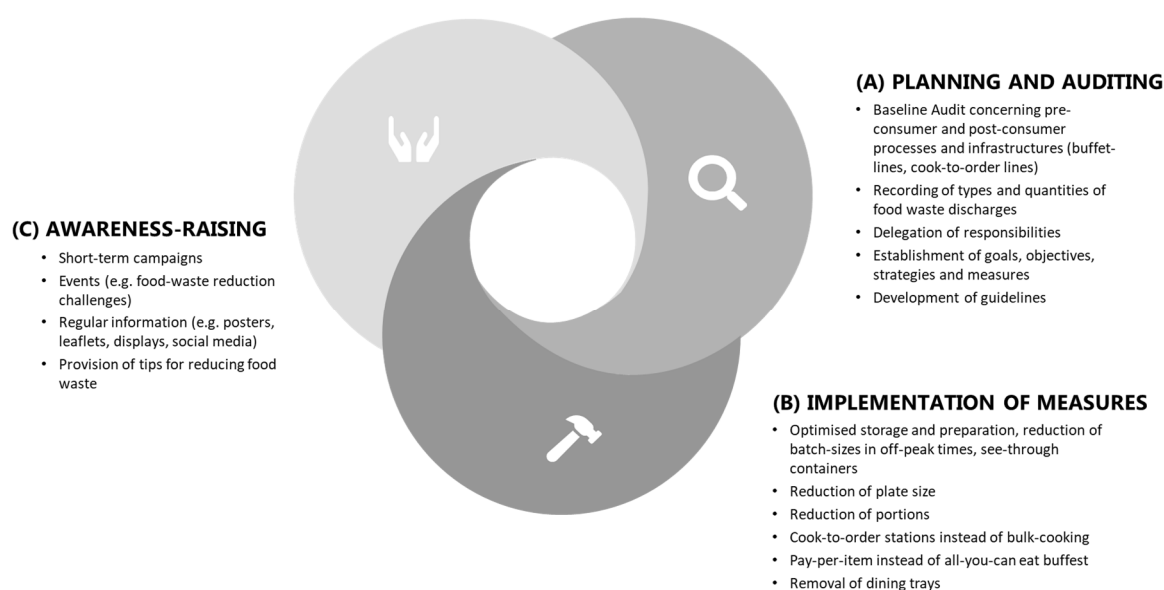


Figure 1-Food waste management framework

Research shows that reducing food waste can improve food security, reduce the amount of fresh water and fossil fuel used, and increase efficiency in resource use (Hall et al. 2009; Neff et al. 2015). University dining halls or restaurants provide an excellent opportunity for diverting food waste because lots of meals—and the waste from them—occurs at one location (Wilkie et al. 2015). Research estimates that around 540,000 million tons of food waste is generated each year at universities (Whitehair et al. 2013). Food waste is mostly disposed of in the municipal solid waste (MSW) stream of a campus, rather than being composted or

diverted for other uses. At the University of Northern British Columbia, for instance, nearly 700 kg of organic material was improperly disposed of per week. At the Asian Institute of Technology in Thailand, food waste comprised nearly 55% of the campus MSW (Smyth et al. 2010; Tangwanichagapong et al. 2017).

Within universities, serving waste (leftovers on serving dishes) is the most substantial part of food waste, mainly because:

- a) many university restaurants serve food in buffet-style
- b) staff at dining halls is unsure of how much food diners will consume and
- c) due to the difficulties in estimating portion sizes (Silvennoinen et al. 2012; Halloran et al. 2014; Papargyropoulou et al. 2014; Betz et al. 2015).

In Finland, researchers studying workplace and student canteens found that 25.3% of the total food waste was initially edible, with too larger portions being the primary cause (Silvennoinen et al. 2015). At Indiana University in the United States, there was 606 kg of solid waste when meals were served on trays and 435 kg during the trayless week (Thiagarajah and Getty 2013). At Rhodes University in South Africa, average food waste per meal was found to be 555 ± 107 grams per student per day. When extrapolated to all dining halls, this leads to estimates of 450 tonnes annually which is equivalent to 705,882 plates of food and has an economic value of US\$ 800,000 each year (Painter et al. 2016). A study found that canteen waste from University College Cork in Ireland was approximately 2500 kg per week during the academic year, or approximately 357 g per student served per day (Browne and Murphy 2013).

Globally, research on food waste at colleges and universities has focused primarily on determining the amount of leftovers and plate waste generated from meals. A 2010 study at a Portuguese university found an average of 80g of leftovers and 200g plate waste per individual (Ferreira et al. 2013). At a university in the Midwestern United States, researchers found an average of about 57 g, for individual plate waste (Whitehair et al. 2013). In a German university canteen, researchers found that 75% (258 participants) had hardly any plate waste while 8% (28 participants) had plate waste that was the equivalent of 0.5 servings of one meal

component (Lorenz et al. 2017). Many students are aware of the economic and environmental problems associated with food waste, as researchers found by surveying Italian students at Roma Tre University (Principato et al. 2015). Considered by meal, researchers found more waste at breakfast than lunch and dinner (Painter et al. 2016). Researchers have also found that females tend to have more plate waste than males (Lorenz et al. 2017a). Having fewer options, serving special dishes which are more palatable, having trayless dining facilities, and reducing portion size have all been shown to contribute to a reduction in plate waste (Freedman and Brochado 2010; Thiagarajah and Getty 2013; Miroso et al. 2016; Lorenz et al. 2017a; Lorenz et al. 2017b).

Prior studies have examined issues related to food waste in different sectors and cities (Eriksson et al. 2017; Moggi et al. 2018; Schmidt and Matthies 2018; Fami et al. 2019), the connection to behaviour (Russell et al. 2017; Stöckli et al. 2018) and importance of quantification (Eriksson et al. 2018). However, there have been relatively few studies connecting this issue to higher education institutions (Ellison et al. 2019). Therefore, this study fills in a research gap and aims at analyzing the issue of food waste at universities and exploring various approaches used by these institutions around the world to prevent and fight this problem.

The guiding proposition of the paper is: since many universities are concerned with sustainability issues, they should also be active in the prevention of food waste. The empirical part of the paper is concerned with this proposition. More specifically, the study also departs from the following set of research questions:

- a) To which extent is food waste produced and re-used on the campuses of higher education institutions? (RQ1)
- b) What are the deficiencies seen in preventing food waste today? (RQ2)
- c) Which concrete examples of good practice exist and which may be disseminated? (RQ3)

d) Which challenges need to be overcome in order to provide a basis for the long-term changes needed in the ways Higher Education Institutions can prevent food waste? (RQ4)

These research questions are discussed and processed in the next parts of this paper.

2. Methodology

An international study was performed in order to collect experiences from universities worldwide. The survey was based on previous literature on food waste and designed to address the research gap related to aspects of food waste in higher education institutions around the world.

The questionnaire was prepared and shared using the online application from Google Forms. Initially, the survey was pre-tested in the authors' universities to verify the understanding and relevance of the questions. After adjustments, the online survey was sent out to all higher education institutions members of the Inter-University Sustainable Development Research Programme (IUSDRP). There are currently over 120 members in this network¹ which is considered a designated sample of higher education institutions, already used in previous studies concerning sustainability and HEIs (Leal Filho et al. 2017; Avila et al. 2019). The respondents are members of administration staff in these institutions, possessing suitable know-how on-campus sustainability and university practices. The survey remained open for two months and contained closed-ended questions and one open-ended question (plus space for additional comments) where the respondents could express their opinion regarding better management options to handle food waste. A summary of the questionnaire is presented in Table 1.

¹ <https://www.haw-hamburg.de/en/ftz-nk/programmes/iusdrp.html>

Topic	Response options	
University description	University, City, Country	
	Year of Foundation, Number of Students	
	The canteen(s) is(are) operated by:	The university Catering service procured from external enterprise Other:
	The canteen(s) of your university is(are):	Buffet-style A la carte
	Are there special schemes/programmes/initiatives for food waste collection	Yes No
	If so, which one(s)?	Collection at canteens/cafeteria for disposal Collection for donation to outside organizations collection for composting Other:
Canteens' operation	Does the canteen measure the amount of food waste?	Yes No
	Is your university engaged in the implementation of food waste prevention measures?	Yes, very much so Yes, a little Yes, very little Not at all
	If so, please list them: (multiple answers possible)	By information in the restaurants/canteens By systematically informing staff By systematically informing students By donating food to prevent food waste By fostering recycling/composting on campus or outside it Other:
	Does your university procurement procedure/policy include specific requirements/criteria for preventing/reducing food waste?	Yes No
	Does your university have a policy on food waste?	Yes No
	Are there efforts to reduce or control portions to reduce food waste being made at your university?	Yes No
Engagement in the implementation of food waste prevention measures	If so, please identify these efforts: (multiple answers possible)	Trayless dining Having staff serve portions to diners Having diners pay by weight (or per item) rather than serving food buffet-style Other:
	Is your university administration supportive of efforts to use food resources more efficiently?	Yes, very much so Yes, a little Yes, very little Not at all
	If so, at which level? (multiple answers possible)	Rector/President Dean/Vice-Dean Head of Department Students or their Representatives Other:
	Which elements pose a challenge to your efforts to prevent food waste? (multiple answers possible)	Lack of funding for food waste prevention schemes Lack of interest from staff
Support from university administration and main challenges faced		

		Lack of motivation for Catering/Procurement staff to reduce food waste Lack of interest from students Other:
Better management options	What should be done on your opinion to better manage the food waste problem?	
Open space	Space for additional comments or highlights.	

209

210 The methodology and the results are divided into quantitative and qualitative analysis,
211 as follows:

212

213 *2.1 Quantitative analysis*

214 The survey contained a set of questions to examine the extent to which universities
215 have been considering food waste. The questions were related to three main issues:

216 a) Canteens' operation;

217 b) Engagement in the implementation of food waste prevention measures;

218 c) Support from university administration and primary challenges faced.

219

220 The data were analyzed using descriptive and correlation analyses, with support of the
221 software SPSS. First, descriptive analysis explored basic characteristics of the institutions,
222 regarding country, number of students and year of foundation. The same was done for each
223 section of collected material: details on canteens' operation, level of engagement in the
224 implementation of food waste prevention measures and support from university administration
225 and main challenges.

226 Secondly, a correlation analysis was conducted in order to examine any underlying
227 relationships among the topics previously discussed, namely operational aspects and
228 engagement in and support to food waste prevention measures. For that, at first, the data
229 normality was tested, using the Kolmogorov-Smirnov test which is recommended for a sample
230 size larger than 50 (Hair et al. 2013). Since the data distribution was not considered normal,
231 the correlation test of Spearman was applied (Hair et al. 2013) . The results range from -1

(strongly negative) to +1 (strongly positive): the closer to 1, the higher is the correlation between two variables.

The nature of the study was qualitative, i.e. descriptive. Consistent with its aim, descriptive statistics were applied mainly to state the frequency of responses. Other studies may choose to perform more sophisticated statistical analyses and dwell with other questions, but this was not the case for this paper.

2.2 Qualitative analysis

Data from the open-ended question were investigated through content analysis, with support from the software Nvivo, recommended for studies with qualitative nature (Mozzato and Grzybovski 2011). This technique involves reading and interpreting the material progressively and systematically, in order to categorize the information, which is considered useful for gathering essential insights from many different discourses. Also, this method was chosen for being recognized as a way to better analyze texts in the context of their uses (Krippendorff 2013) and for reducing the volume of text collected, grouping it into categories and seeking understanding out of it (Bengtsson 2016). The different categories of analysis were clustered according to similarities in the answers provided by the respondents and organized following the steps of food waste management, as presented in the literature review.

The additional space for comments at the end of the survey also provided interesting topics that were brought to the qualitative analysis.

3. Results and Discussion

As indicated in the methodology, the results are divided between quantitative and qualitative analysis. The quantitative part presents the results of the closed questions and the correlation analysis, and the qualitative part presents the main topics discussed in the open-ended question and develops some general discussions.

The authors have drawn their convenience sample from the total population of an international university network, i.e. the IUSDRP, which the first author coordinates. More than 40% of the members of the network took part in the survey. It can, therefore, be assumed that

the survey is representative of the IUSDRP population, but no generalizable statements about the entire population can be made. The survey received responses from 52 different universities located in 24 different countries, as shown in Figure 2.

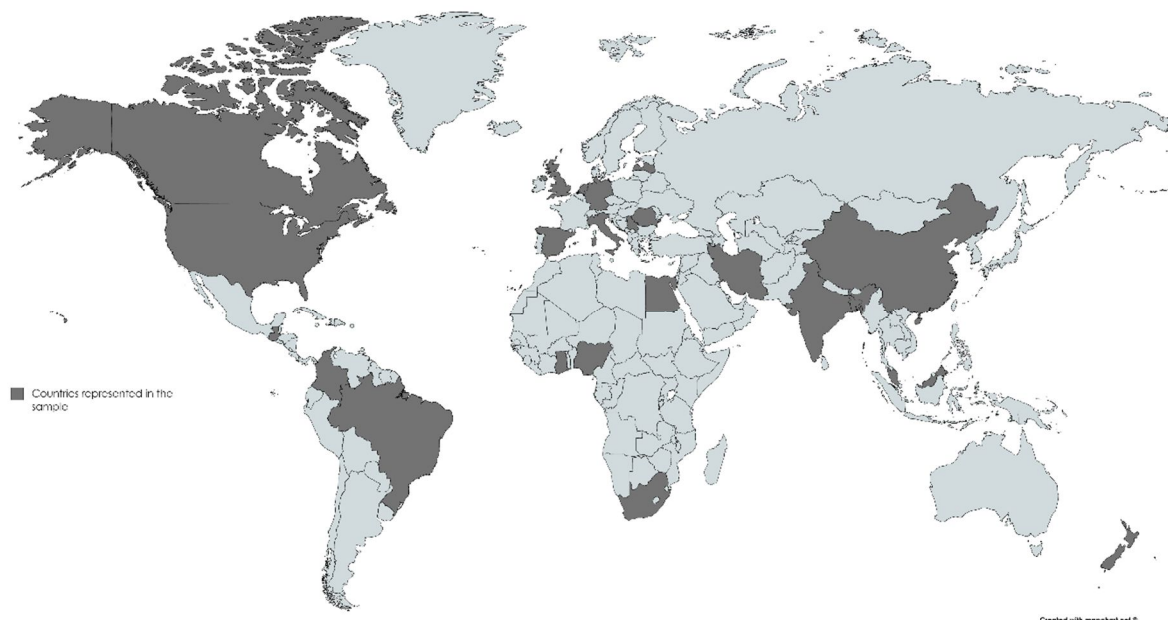


Figure 2- Schematic world map showing the surveyed countries

The respondents are distributed as follows: USA (n=11), United Kingdom (n=8), Malaysia (n=4), Nigeria (n=4), Brazil (n=3), Germany, India and Iran (n=2), and Bangladesh, Canada, China, Colombia, Egypt, Ghana, Guatemala, Hong Kong, Italy, Latvia, Netherlands, New Zealand, Romania, Serbia, South Africa, and Spain (n=1). It was received only one response per university.

3.1 Quantitative analysis

As shown in Figure 3, the study received balanced responses from developed and developing countries, most universities have more than 10,000 students and were founded rather recently (after 1951).

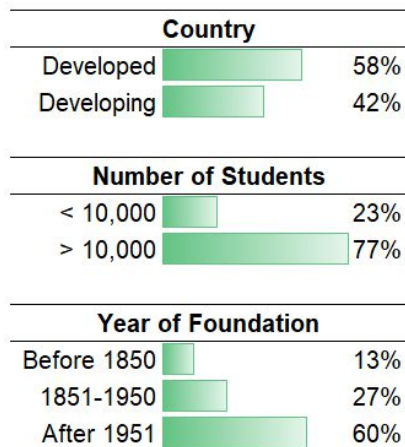


Figure 3. Distribution of universities according to their country, number of students, and year of foundation

Figure 4 shows the main results regarding the section on Canteens' operation. Most universities (60%) have canteens operated by external service instead of being managed by the university itself. In general, this situation can hinder the implementation of food waste prevention measures, since it depends not solely on universities' efforts but also on the hired company. The buffet is the most used canteen setting (54%), which can represent a problem for avoiding the generation of waste since the kitchen staff has the challenge of estimating how much food will be required.

More than half of the universities (60%) stated that their canteens do not measure the amount of food waste. Hence it is not possible to fully understand the extent to which food waste is being generated and its impacts in terms of waste and related costs. Real numbers or indicators help encourage prevention measures, detect inefficiencies, and especially establish targets for improvement. The main initiative for food waste collection is to send for disposal (48%), although a substantial amount of universities also reported sending to composting (37%). "Others" from the survey included initiatives such as using the food waste for fish and duck farming, feeding animals, sending to anaerobic digestion to generate biogas as well as electricity and heat.

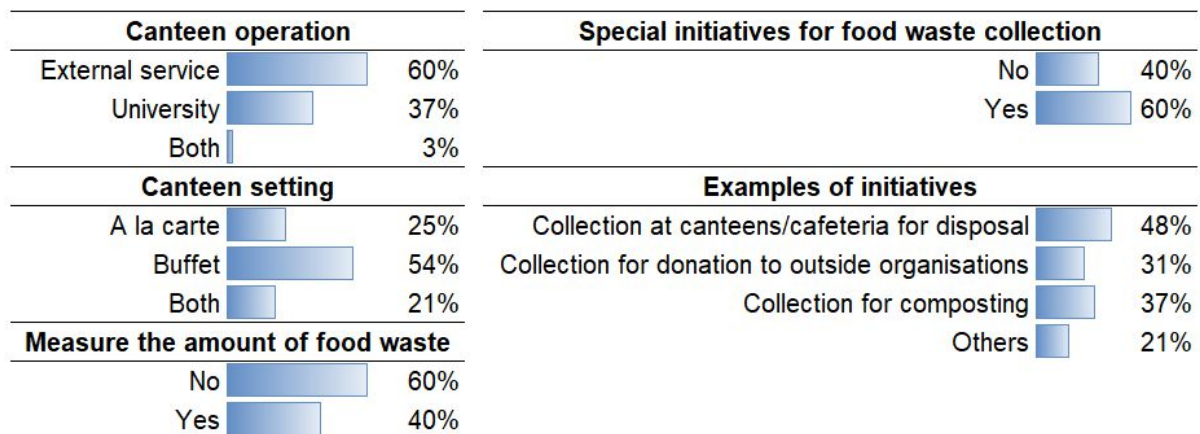


Figure 4. Results regarding Canteens' operation

Figure 5 presents the results of the second section of the survey concerning the engagement in implementing food waste prevention measures. Balanced results were observed when it comes to the inclusion (or not) of food waste reduction requirements in the university procurement (52% for positive answer). On the other hand, the result is unambiguous regarding the existence of a specific policy on food waste: most universities do not have one (65%).

In universities which do have efforts to reduce/control portions (60%) and consequently minimize food waste, the main effort is having the staff to serve these portions (46%). Trayless dining also had a considerable share of answers (27%), and other mentioned efforts include the use of campaigns, existence of special or reduced sizes of portions or plates, availability of take-home containers, development of food preparation techniques which minimize waste, and re-use for soups.

While 85% of the universities are somehow engaged in implementing food waste prevention measures at different levels, eight universities (15%) reported no engagement in this topic, which is a worrying situation. However, different types of engagement, which have been responded by the group of 85%, might assist others to find initiatives for improvement in this context. Fostering recycling and composting is the primary engagement action reported, followed by the availability of information in the canteens/restaurants. Providing information in a systematic way to staff and students is also another vital approach. Other mentioned

measures include: promotion of events where students are invited to bring their own "bowls" and take food which would be thrown away, therefore raising awareness on the topic of food waste; more food being offered in the buffet depending on demand; canteen offer to take out containers for students to take home the leftovers; universities' food shops reduce the price at the end of the day to avoid food waste; and students' participation in activities involving composting and use of fertilizers from food waste on campus. Most of these activities not only help reduce food waste but also contribute to creating a culture of sustainability on campus.

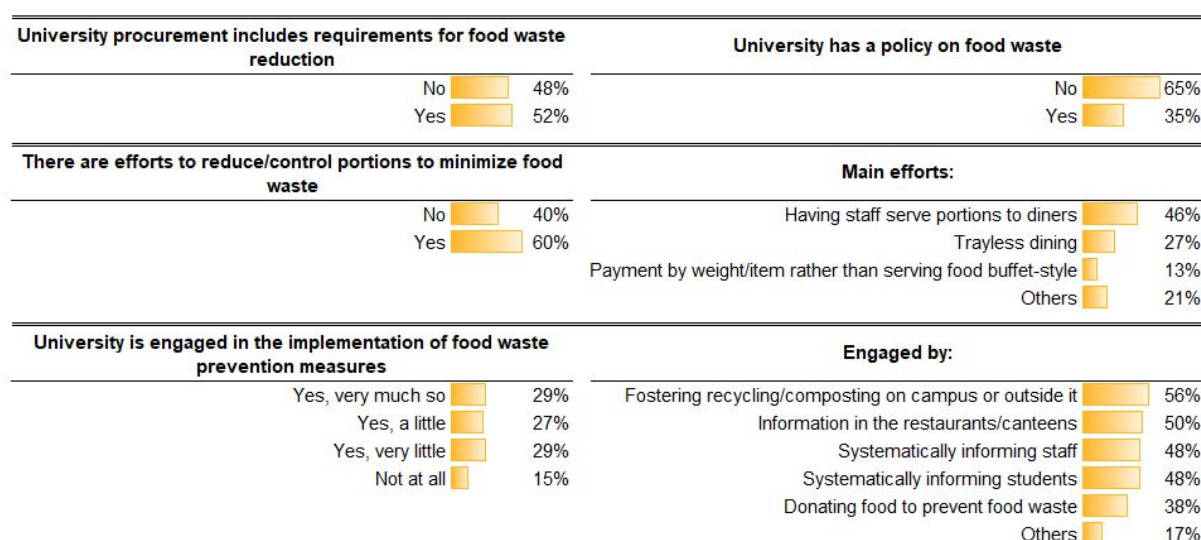


Figure 5. Results regarding university engagement in the implementation of food waste prevention measures

Finally, regarding support from university administration and main challenges, Figure 6 shows a summary of the results. Almost all universities (90%) reported having support from the administration but with different levels – the highest support was stated by 31% of the universities. The support is usually presented by students or their representatives (58%), followed by Heads of Departments. Dean/Vice-Dean and Rector/President had the least amount of informed support (25% and 13%, respectively). "Others" included mentions to the Canteen administration, Sustainability staff or "Green volunteers", and Faculty levels.

All challenges offered as an answer in the survey were similarly indicated, with higher percentages for lack of interest from staff and students. It is interesting to observe that different

from other examples of research (Elliott and Wright 2013), lack of funding was not the primary challenge indicated. People need to eat, and therefore food will always be purchased. Here, the term lack of funding is more connected with the resources needed to purchase infrastructure to process food which is not used. Other challenges include the support from the government, from the municipality, faculty and/or administration and work of green volunteers.

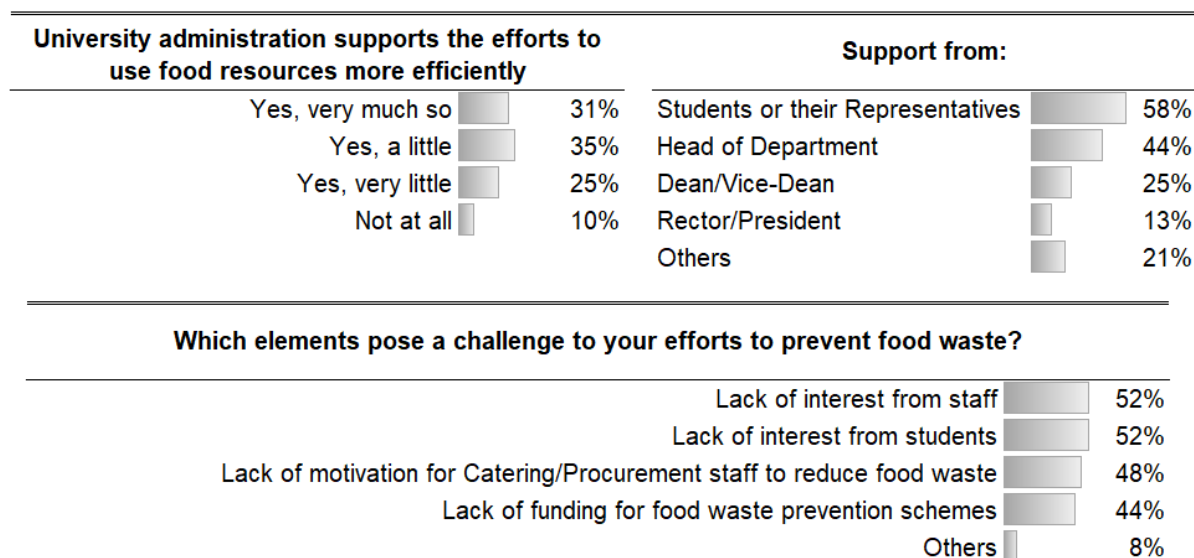


Figure 6. Results regarding support from university administration and main challenges

Table 2 presents the results of the correlation analysis performed in order to examine potential underlying relations between operational aspects and engagement in and support to food waste prevention measures.

	Canteen Operation	Food waste in the University Procurement	Canteen Setting	Engagement in prevention	Food Waste Policy	Schemes for collection	Efforts to control	Food Waste Measurement	Administration support
Canteen Operation	1.000								
Food waste in the University Procurement	.063 (.659)	1.000							
Canteen Setting	.309* (0.026)	-.017 (0.905)	1.000						
Engagement in prevention	-.152 (0.281)	.496** (0.000)	-.285* (0.040)	1.000					
Food waste policy	-.092 (0.501)	.457** (0.001)	-.170 (0.229)	.493** (0.000)	1.000				
Special schemes for collection	-.213 (0.130)	.385** (0.005)	.027 (0.847)	.549** (0.000)	.352* (0.011)	1.000			
Efforts to control	-.162 (0.250)	.306* (0.027)	-.156 (0.270)	.509** (0.000)	.352* (0.011)	.601** (0.000)	1.000		
Food waste Measurement	-.091 (0.521)	.557** (0.000)	-.056 (0.692)	.488** (0.000)	.307* (0.027)	.358** (0.009)	.438** (0.001)	1.000	
Administration support	-.043 (0.760)	.263 (0.060)	-.097 (0.493)	.559** (0.000)	.447** (0.001)	.456** (0.001)	.414** (0.002)	.332* (0.016)	1.000

Table 2. Bivariate correlations (i.e. presenting the correlation coefficient and the p-value, * correlation significant at 0.05 level, ** correlation significant at 0.01 level)

It is observed that there is a significant correlation (i.e. $p < 0.01$) between engagement in implementing food waste prevention measures and other aspects such as the inclusion of requirements to reduce food waste in the university procurement procedures, the existence of food waste policy, special schemes for collection, efforts to control, food waste measurement and administration support. Support by the universities administration is likely to have positive effects on the engagement on this topic. That is to say: engagement and administration support are among the crucial aspects within a university to guarantee the implementation of food waste prevention measures. Also, food waste measurement is related to the consideration in

procurement as well as to control. Both reveal potential starting points to monitor the effectiveness of schemes for collection and prevention campaigns.

3.2 Qualitative analysis

In the open-ended question, respondents were asked about what should be done, in their opinion, to manage the food waste problem better. After the content analysis, the comments could be grouped according to the main steps of food waste management, as presented in the literature review. Table 3 summarises the classification.

Step of food waste management	n	%
(A) auditing and planning	11	25
(B) implementation of effective measures	13	29
(C) awareness-raising campaigns	21	46
	45	100

Table 3. Classification of the main topics mentioned by the respondents in the open-ended question, according to the steps of food waste management

Regarding the auditing and planning (step A), approximately a quarter of the comments is concerned with food waste policy and administration measures. The respondents confirm the commitment from the top management as something fundamental for improvements in this area, as well as continuing efforts and a good strategy and policy. Referring to policy, some remarks occurred on developing a "good one", "sticking to it", and including matters related to "redistribution, recycling and banning food from residual waste".

For the implementation of effective measures (B), the responses are mainly associated with the topic of recycling (n=6) and operations (n=7). Recycling programmes are welcomed, in addition to the use of particular bins for food waste in order to encourage and ease the separation of food waste at source for later composting and anaerobic digestion. About this issue, some comments indicated composting, and anaerobic digestion as better ways manage the food waste problem (e.g. "Make compost bins available across campus", "Laws for food waste to be collected in separate bins and sent to anaerobic digestion", "Implement waste

composting through projects at the university or outsourcing this service"). Comments suggested several actions related to operations, for instance: offering smaller portions, which, according to the literature, may reduce food waste since kitchen staff is often unsure in estimating portion quantity (Halloran et al. 2014; Betz et al. 2015; Silvennoinen et al. 2015); catered accommodation packages for students who could pre-pay for meals; elimination of buffet options; payment by weight; and the need to manage food waste in all canteens, not only in some of them. This management, as suggested by one of the comments, could be the responsibility of the University Green or Sustainability Office, which is present at many universities (Leal et al. 2019).

The highest number of comments was related to the step of awareness-raising (C). Most of them express the urgency in building awareness on the food waste problem, highlighting that more information should be shared, especially with students (who should take more responsibility in this issue), contributing to a "cultural change and making people more conscious and responsible". Other comments expressed ideas for the development of education programmes which could focus specifically on informing students of the need for and reasons for reducing food waste, its implication in production and wastage. Some respondents highlighted the importance of educating staff on these issues as well. In general, the main idea is to enhance people's awareness of food waste, encouraging them to "cherish food and be responsible eaters", consequently contributing to the food waste problem.

Additional comments at the end of the survey show that some advances in the area of food waste could be observed recently, but there is still much to be done. The respondents tend to believe that this is a hot topic nowadays, and more universities must be investing in this issue in the coming years. The advances are related to the donation of food to people who cannot afford, encouragement of Zero Waste Events, collecting for biogas production and composting, and avoiding not only food waste but also disposable cutlery, plates, glasses and napkins (showing also the concern about plastic issues).

Some positive examples of initiatives on food waste presented by some respondents include the commitment to divert food waste from landfill, the availability of composting cans

in every building and no deskside trash pickup for staff, encouraging them to sort out their waste – and therefore raising more awareness on that topic. Another good practice mentioned relates to the periodic measurement of food waste in a sample of campus canteens, since the results might be used to estimate the amount of the whole campus and become useful in the promoting of awareness campaigns, reducing inefficiency, and for defining framework for action.

On the other hand, some canteens seem to prioritize the use of single-use food boxes still, and even though the students might be willing to pay the full price of a dish and receiving a smaller portion, staff would still serve the full one. Besides that, despite the higher generation of food waste, some universities still use catering for events, due to the actual convenience of this service.

Interestingly, despite the great diversity of countries and cultures presented in this study, the opinions regarding better ways to manage the food waste problem were quite similar. Respondents from both developed and developing countries mentioned all topics discussed above, from the importance of planning and implementation of practical actions to awareness-raising and more education campaigns. It is worth mentioning, though, that the positive examples and best cases came primarily from developed countries.

4. Conclusions and outlook

Food waste prevention is an important issue that directly affects many parts of a society and which increasingly attracted the attention of scholars from diverse fields of research. In particular, recent and more considerable attention has been steered toward universities due to their role in educating a future generation and their impact as a liveable organization producing waste. Research shows that about 540,000 million tons of food waste could be generated each year at campuses (Whitehair et al. 2013) and much of this waste is still disposed of in the municipal solid waste instead of being employed for other uses. Despite the significant impact that universities have on food waste generation and prevention, little is still

known on the extent to which food waste is handled on the campuses. Filling this gap, the present study proposed the analysis of practices and issues on food waste in a sample of 52 higher education institutions, looking for weaknesses that hamper actions against food waste and best practices that have developed measures toward prevention and re-use.

Various research questions were pursued with the study. Regarding the extent of food waste produced (RQ 1), it should be stated that most of the universities in the sample reported that there is no regular recording and measurement of food waste. Re-use of food waste and on-campus composting is, however taking place in some cases.

Going into the roots of the problem (RQ 2), it is seen that many universities employ external services for canteens and restaurants management, and their business model is mainly based on buffet service. This limits the possibility of further waste prevention during serving. The lack of measurements is also a crucial issue hampering the food waste reduction, because it is hard to understand the extent to which food waste is being generated and its impacts in terms of waste and related costs. Recycling programmes and zero waste events may be helpful, along with the provision of particular bins for separate waste collection, to improve the separation of food waste at source for later composting and anaerobic digestion.

Even though few universities have a specific policy on food waste, 60% of the analyzed sample declared they pursue efforts in this direction, focusing on separate collection and utilization for biogas or composting. Following previous studies, some of the measures deployed include staff serving reasonable portions during meals, trayless dining or the payment by weight for buffet service aiming at reducing plate waste (Thiagarajah and Getty 2013; Miroso et al. 2016; Lorenz et al. 2017a; Lorenz et al. 2017b). Just 30% of the universities declared to be really engaged. In these cases, awareness of food waste also is increased through informing students and staff on food waste issue, providing information at campus' canteens and restaurants. These reported experiences contributed to addressing RQ 3 by presenting some concrete examples of good practices.

An additional aspect, still largely neglected, is the importance of developing joint measures together with other organizations of the community such as supermarkets, farmers,

480 and farmer markets (Moggi et al. 2018) to create public awareness. By creating public
481 awareness, more interest around the issue of food waste could be raised, addressing one of
482 the challenges reported in this study (lack of interest from staff and students). Lack of
483 motivation and funding to invest in food waste prevention were also reported as important
484 challenges for universities to overcome (RQ4).

485 Since universities are in charge of educating a future generation and having a
486 significant impact on food waste production, they have a responsibility and may play a key role
487 in enhancing sustainable consumption and food security towards SDG 2 and SDG12 through
488 concrete actions. In this sense, the study identified some key factors that are pivotal for
489 enhancing food waste reduction and re-use. Firstly, higher engagement and information of
490 people who study and work at universities should be pursued, as tools to increase the
491 awareness on the subject and reduce food waste, leading to a reduction in waste generation.
492 Secondly, food waste prevention is a cultural change that must be supported by the top
493 management to guarantee the success of the implemented programmes. Finally,
494 measurements and indicators should be considered for helping and encouraging prevention
495 measures, detecting inefficiencies, and especially establishing targets for improvements.

496 Due to its exploratory nature, this study has some limitations. Firstly, the small size of
497 the sample of universities taking part in the survey makes it difficult to draw generalizable
498 conclusions. Secondly, whereas the survey was inclusive, some universities chose not to take
499 part in it, which means that some potentially useful information could not be gathered.

500 These limitations are partly compensated by the fact that 24 countries were involved in
501 the study. Hence it still allows building a profile of the situation and the identification of some
502 trends related to food waste, in both industrialized and developing countries.

503 Looking ahead, further research could consider enlarging the sample of the higher
504 education institutions involved, as well explore (for instance, through in-depth semi-structured
505 interviews) some of the best practices highlighted by this research. It is a paradox that many
506 people suffer from hunger, while food is being wasted at many universities, which should be
507 leading by example. Having a detailed knowledge of the processes and factors which influence

food waste is crucial in designing suitable initiatives to reduce the current wastage of food resources.

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