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1 **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

79 **1. Introduction**

80 Food waste refers to food that is actually of good quality, but which is discarded at the retail or
81 consumption stages of the food supply chain (Lipinski et al. 2013; Halloran et al. 2014). There
82 are several reasons for food being wasted along the food chain, i.e. overproduction,
83 unnecessary inventory, defects in production or equipment, inappropriate processing or
84 transportation, improper storage, losses in food preparation and when food is served, i.e.
85 leftovers on the plates of consumers (Engström and Carlsson-Kanyama 2004; Gooch et al.
86 2010; Lipinski et al. 2013).

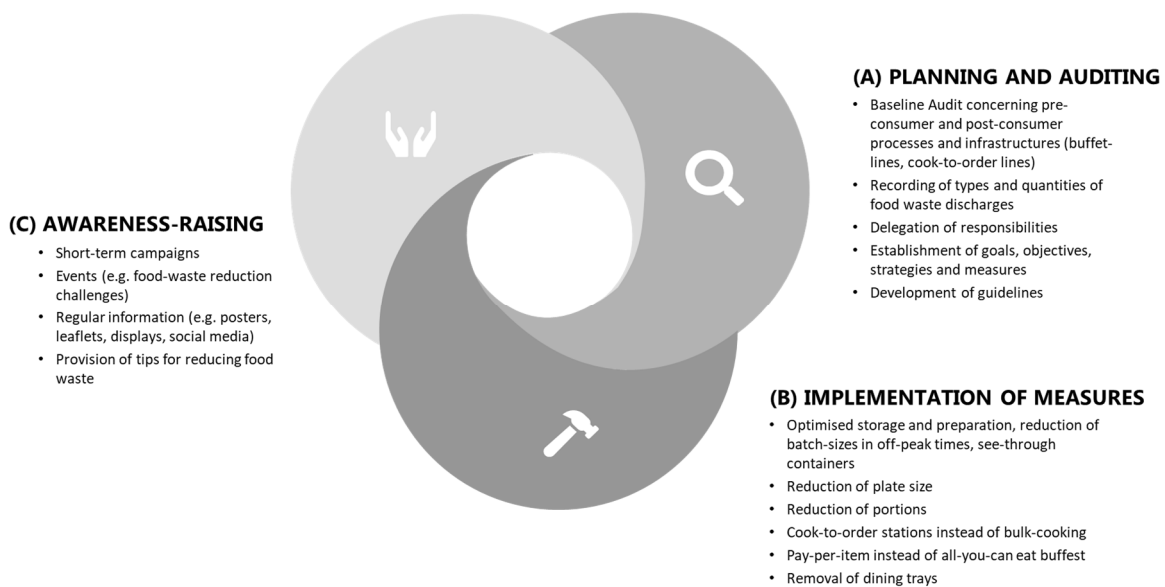
87 The amount of food waste produced is increasing, with almost 50% per capita increase
88 in food waste produced since 1974 in the United States (Hall et al. 2009). The most
89 considerable quantities of food are being wasted at the consumption level in particular in
90 households (Evans et al. 2013),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

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

107 Technical and service-related aspects are, for instance, menu offerings (Aschemann-Witzel et
108 al. 2013; Ferreira et al. 2013), portion sizes and serving styles (Dinis et al. 2013; Lorenz et al.
109 2017b; Sanchez-Carracedo et al.). Personal factors compromise the expression of attitudes,
110 subjective norms and intentions towards leftovers, avoidance of food disposal and behavioural
111 control of eating everything up (Lorenz et al. 2017b).

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

117



118

119 *Figure 1-Food waste management framework*

120

121 Research shows that reducing food waste can improve food security, reduce the
122 amount of fresh water and fossil fuel used, and increase efficiency in resource use (Hall et al.
123 2009; Neff et al. 2015). University dining halls or restaurants provide an excellent opportunity
124 for diverting food waste because lots of meals—and the waste from them—occurs at one
125 location (Wilkie et al. 2015). Research estimates that around 540,000 million tons of food waste
126 is generated each year at universities (Whitehair et al. 2013). Food waste is mostly disposed
127 of in the municipal solid waste (MSW) stream of a campus, rather than being composted or

128 diverted for other uses. At the University of Northern British Columbia, for instance, nearly 700
129 kg of organic material was improperly disposed of per week. At the Asian Institute of
130 Technology in Thailand, food waste comprised nearly 55% of the campus MSW (Smyth et al.
131 2010; Tangwanichagapong et al. 2017).

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

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

138

139 In Finland, researchers studying workplace and student canteens found that 25.3% of the total
140 food waste was initially edible, with too larger portions being the primary cause (Silvennoinen
141 et al. 2015). At Indiana University in the United States, there was 606 kg of solid waste when
142 meals were served on trays and 435 kg during the trayless week (Thiagarajah and Getty 2013).

143 At Rhodes University in South Africa, average food waste per meal was found to be 555 ± 107
144 grams per student per day. When extrapolated to all dining halls, this leads to estimates of 450
145 tonnes annually which is equivalent to 705,882 plates of food and has an economic value of
146 US\$ 800,000 each year (Painter et al. 2016). A study found that canteen waste from University
147 College Cork in Ireland was approximately 2500 kg per week during the academic year, or
148 approximately 357 g per student served per day (Browne and Murphy 2013).

149 Globally, research on food waste at colleges and universities has focused primarily on
150 determining the amount of leftovers and plate waste generated from meals. A 2010 study at a
151 Portuguese university found an average of 80g of leftovers and 200g plate waste per individual
152 (Ferreira et al. 2013). At a university in the Midwestern United States, researchers found an
153 average of about 57 g, for individual plate waste (Whitehair et al. 2013). In a German university
154 canteen, researchers found that 75% (258 participants) had hardly any plate waste while 8%
155 (28 participants) had plate waste that was the equivalent of 0.5 servings of one meal

156 component (Lorenz et al. 2017). Many students are aware of the economic and environmental
157 problems associated with food waste, as researchers found by surveying Italian students at
158 Roma Tre University (Principato et al. 2015). Considered by meal, researchers found more
159 waste at breakfast than lunch and dinner (Painter et al. 2016). Researchers have also found
160 that females tend to have more plate waste than males (Lorenz et al. 2017a). Having fewer
161 options, serving special dishes which are more palatable, having trayless dining facilities, and
162 reducing portion size have all been shown to contribute to a reduction in plate waste
163 (Freedman and Brochado 2010; Thiagarajah and Getty 2013; Miroso et al. 2016; Lorenz et al.
164 2017a; Lorenz et al. 2017b).

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

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

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

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

185

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

187

188 **2. Methodology**

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

193 The questionnaire was prepared and shared using the online application from Google
194 Forms. Initially, the survey was pre-tested in the authors' universities to verify the
195 understanding and relevance of the questions. After adjustments, the online survey was sent
196 out to all higher education institutions members of the Inter-University Sustainable
197 Development Research Programme (IUSDRP). There are currently over 120 members in this
198 network¹ which is considered a designated sample of higher education institutions, already
199 used in previous studies concerning sustainability and HEIs (Leal Filho et al. 2017; Avila et al.
200 2019). The respondents are members of administration staff in these institutions, possessing
201 suitable know-how on-campus sustainability and university practices. The survey remained
202 open for two months and contained closed-ended questions and one open-ended question
203 (plus space for additional comments) where the respondents could express their opinion
204 regarding better management options to handle food waste. A summary of the questionnaire
205 is presented in Table 1.

206

207

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	
Canteens' operation	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:
	Does the canteen measure the amount of food waste?	Yes No
Engagement in the implementation of food waste prevention measures	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
	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:
Support from university administration and main challenges faced	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

	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

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

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

238 *2.2 Qualitative analysis*

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

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

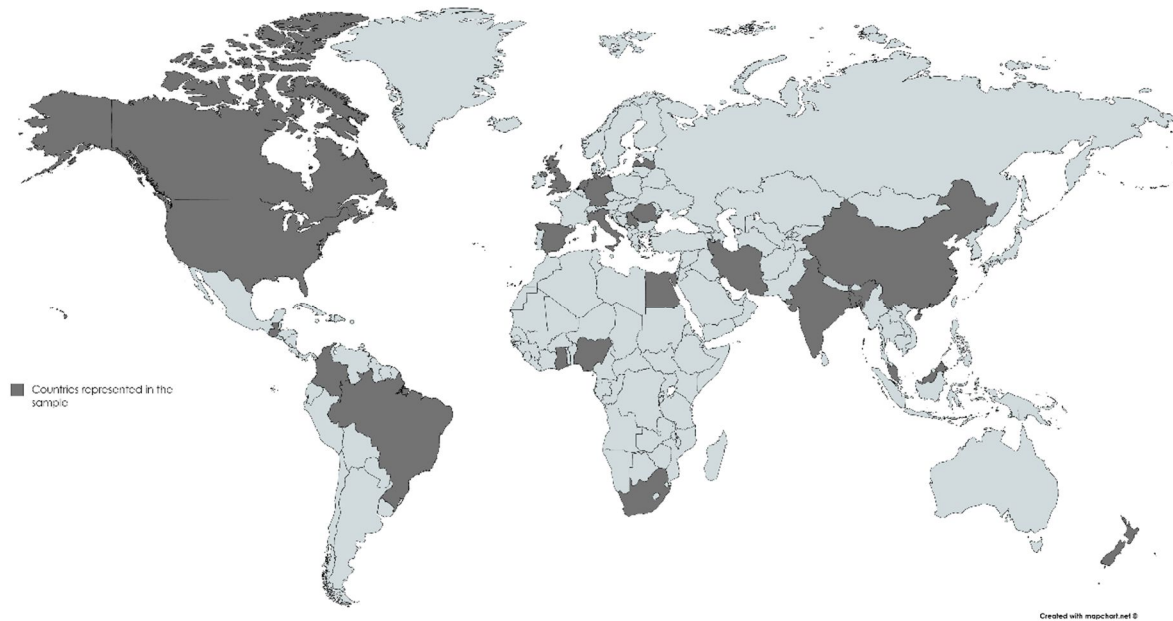
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252 **3. Results and Discussion**

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

257 The authors have drawn their convenience sample from the total population of an
258 international university network, i.e. the IUSDRP, which the first author coordinates. More than
259 40% of the members of the network took part in the survey. It can, therefore, be assumed that

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



263

264

265 Figure 2- Schematic world map showing the surveyed countries

266

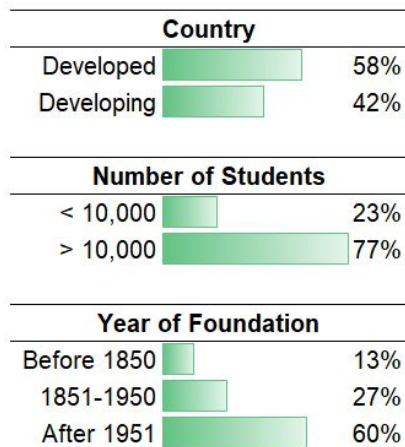
267 The respondents are distributed as follows: USA (n=11), United Kingdom (n=8), Malaysia
268 (n=4), Nigeria (n=4), Brazil (n=3), Germany, India and Iran (n=2), and Bangladesh, Canada,
269 China, Colombia, Egypt, Ghana, Guatemala, Hong Kong, Italy, Latvia, Netherlands, New
270 Zealand, Romania, Serbia,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

272

273 3.1 Quantitative analysis

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

277



278

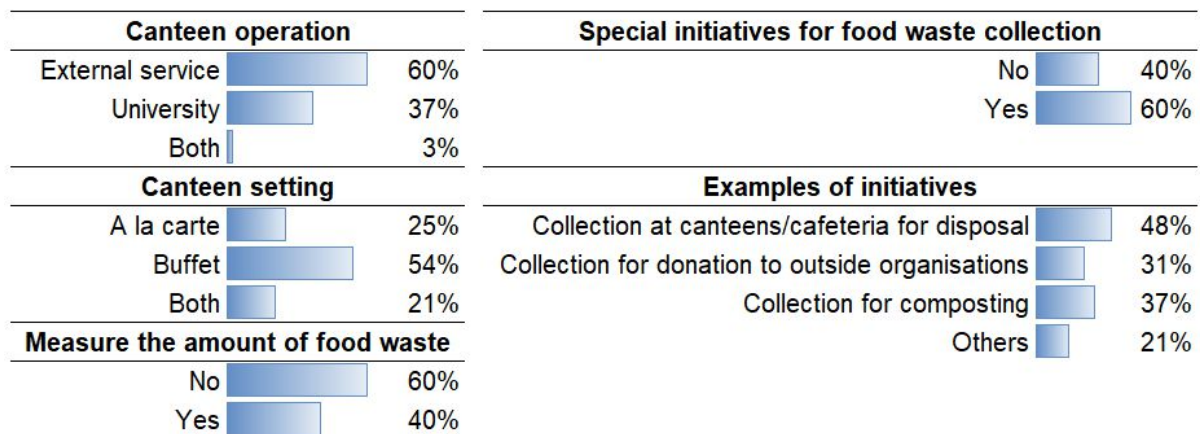
279 Figure 3. Distribution of universities according to their country, number of students, and year of
 280 foundation

281

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

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

298



299

300 Figure 4. Results regarding Canteens' operation

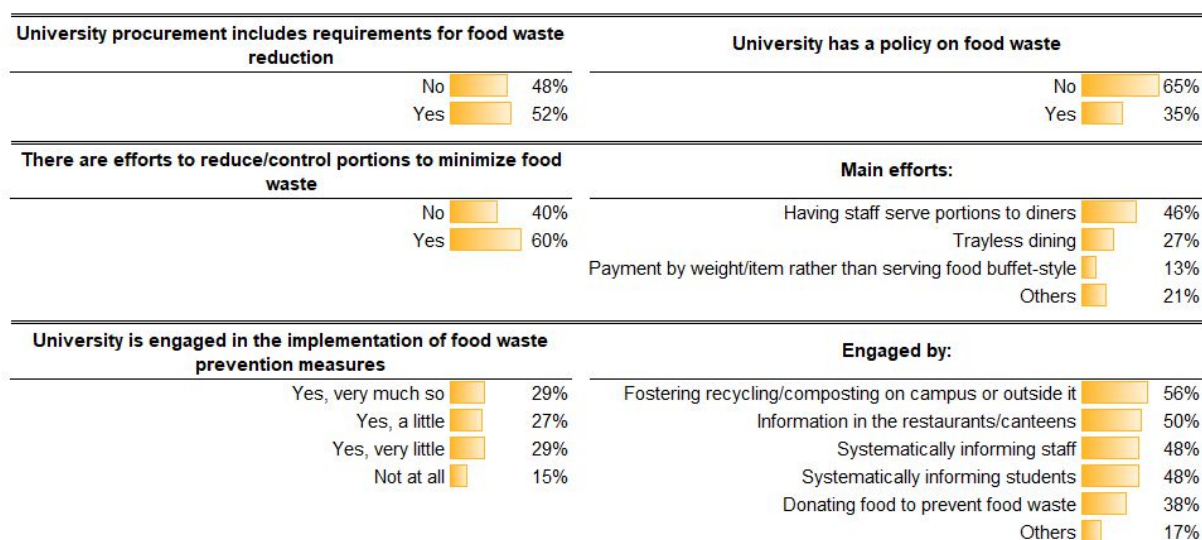
301

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

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

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

321 measures include: promotion of events where students are invited to bring their own "bowls"
 322 and take food which would be thrown away, therefore raising awareness on the topic of food
 323 waste; more food being offered in the buffet depending on demand; canteen offer to take out
 324 containers for students to take home the leftovers; universities' food shops reduce the price at
 325 the end of the day to avoid food waste; and students' participation in activities involving
 326 composting and use of fertilizers from food waste on campus. Most of these activities not only
 327 help reduce food waste but also contribute to creating a culture of sustainability on campus.
 328

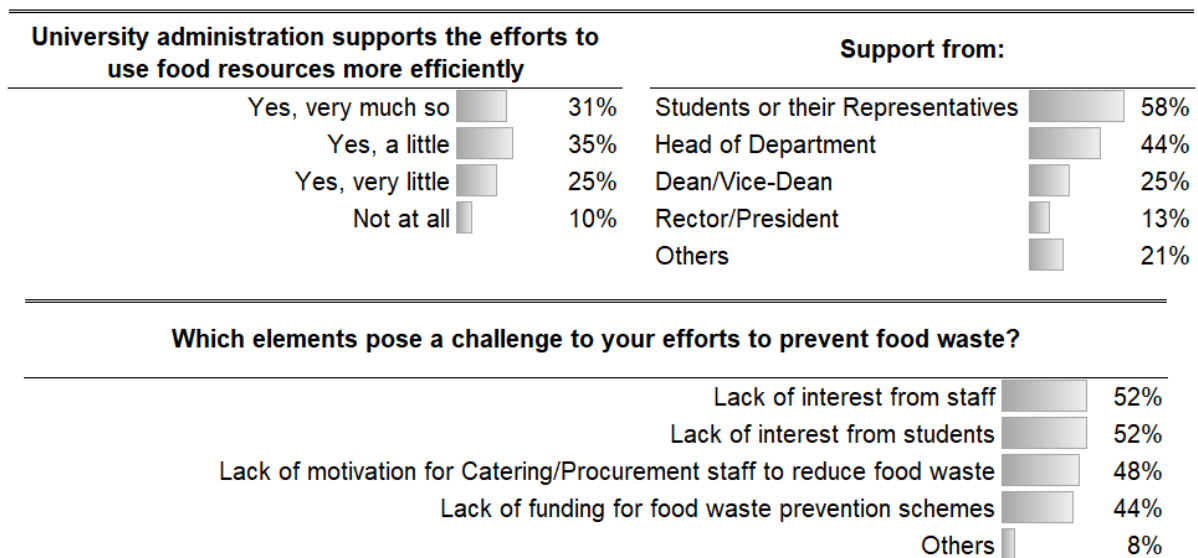


329
 330 Figure 5. Results regarding university engagement in the implementation of food waste prevention
 331 measures

332
 333 Finally, regarding support from university administration and main challenges, Figure 6
 334 shows a summary of the results. Almost all universities (90%) reported having support from
 335 the administration but with different levels – the highest support was stated by 31% of the
 336 universities. The support is usually presented by students or their representatives (58%),
 337 followed by Heads of Departments. Dean/Vice-Dean and Rector/President had the least
 338 amount of informed support (25% and 13%, respectively). "Others" included mentions to the
 339 Canteen administration, Sustainability staff or "Green volunteers", and Faculty levels.

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

342 from other examples of research (Elliott and Wright 2013), lack of funding was not the primary
 343 challenge indicated. People need to eat, and therefore food will always be purchased. Here,
 344 the term lack of funding is more connected with the resources needed to purchase
 345 infrastructure to process food which is not used. Other challenges include the support from the
 346 government, from the municipality, faculty and/or administration and work of green volunteers.
 347



348

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

350

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

354

355

356

357

358

359

	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

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

362

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

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

373

374 *3.2 Qualitative analysis*

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

379

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

380 Table 3. Classification of the main topics mentioned by the respondents in the open-ended question,
381 according to the steps of food waste management
382

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

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

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

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

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

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

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

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

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

441

442 **4. Conclusions and outlook**

443

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

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

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

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

468 Even though few universities have a specific policy on food waste, 60% of the analyzed
469 sample declared they pursue efforts in this direction, focusing on separate collection and
470 utilization for biogas or composting. Following previous studies, some of the measures
471 deployed include staff serving reasonable portions during meals, trayless dining or the
472 payment by weight for buffet service aiming at reducing plate waste (Thiagarajah and Getty
473 2013; Miroso et al. 2016; Lorenz et al. 2017a; Lorenz et al. 2017b). Just 30% of the universities
474 declared to be really engaged. In these cases, awareness of food waste also is increased
475 through informing students and staff on food waste issue, providing information at campus'
476 canteens and restaurants. These reported experiences contributed to addressing RQ 3 by
477 presenting some concrete examples of good practices.

478 An additional aspect, still largely neglected, is the importance of developing joint
479 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

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

510

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