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Recycling at UCT: A brief history and situational report for 2021

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Recycling at UCT

Abstract

The University of Cape Town (UCT) is one of Africa's premier universities. It is located on the slopes of Table Mountain with its upper campus jutting into a nature reserve: the Table Mountain National Park. One might thus presume that the university has both the incentive and capacity to become a global leader on living sustainably with nature on the urban edge. Yet as of the end of 2021, after more than 30 years of plans and commitments to becoming a green campus, UCT recycled very little of its waste.

This paper begins by pointing to the history and managerial challenges that sit at the heart of the problem. Recycling is not simply a matter of awareness-raising and behaviour change as it is profoundly shaped by labour relations (including changes from contract cleaning to insourced staff in 2016), and managerial practices. There have been long standing and persisting problems pertaining to poor recycling awareness, supervision and management of cleaners, infrastructure limitations and poor recycling behaviour across the university community.

We show that there has been recent improvement in recycling infrastructure, but that much recycling ends up in bins destined for landfill. We report the results of an audit of 'basic correct recycling' – that is the percentage of recyclable bottles, tins and food containers placed in the correct bin conducted during 2021. As of June 2021, recycling behaviour at UCT was little better than random and workers were persisting in placing the incorrect bin liners in recycling bins, meaning that much recycling placed in the correct bin inadvertently ended up in the landfill.

We also report the results of an intervention conducted in September 2021 to improve basic recycling through improved signage on external bins. We conducted a before-and-after analysis of external bins that were provided with improved signage, and we compared outcomes to bins that were not provided with improved signage. The results were disappointing in that there was no statistically significant difference in basic recycling from improved signage. This suggested that more radical interventions and institutional changes were necessary.

1. Recycling at UCT: A brief history

In 1990, the then University of Cape Town (UCT) Vice Chancellor, Stuart Saunders, joined university leaders from around the world in signing the Talloires Declaration (Association of University Leaders for a Sustainable Future, 1990). This committed UCT to an ambitious '10-point action plan' including raising awareness, establishing a 'culture of environmental sustainability', and practicing 'institutional ecology' including recycling.

Nothing came of this apart from an ultimately unsuccessful recycling campaign in the mid-1990s (Rippon, 2008: 3). Offices were fitted with a two-bin system: one for recyclables (mostly paper) and the other for general waste. This, however, increased the burden on office cleaners (who then had to deal with two waste pipelines) without any additional compensation. It was thus unsurprising that people often complained about seeing workers empty both bins into the same rubbish bag. The system collapsed entirely after the university 'outsourced' its cleaning operations to lower-cost outside contractors in 1999. Multiple sources have confirmed that the contract cleaning company at the time had 'no interest' in recycling, and that UCT management was similarly uninterested in emphasizing the importance of recycling in the terms, incentives, and enforcement of the cleaning contracts. By 2003, all recycling effort had been suspended because of 'poor financial feasibility' (Rippon, 2008: 16). The imperative to keep costs low meant that recycling was effectively discarded as it was seen as a 'nice-to-have' but ultimately low priority item. The fact that outsourced workers felt abandoned and betrayed by the institution (Luckett & Mzobe, 2016) no doubt also contributed to the problem.

In 2001, then Vice Chancellor Njabula Ndebele recommitted UCT to the Talloires Declaration and an 'Environmental Management Working Group' was created to 'coordinate' its implementation (Rippon, 2008: 3). Yet despite such efforts – and a 2004 'Partnership for a Sustainable Environment' that sought to establish UCT as an international leader in environmental sustainability – progress was slow. An 'Environmental Management Working Group' sought to reduce UCT's carbon footprint, recycle water, reduce waste, and promote recycling and environmentally friendly grounds management. It developed a plan to do so (Rippon, 2008) but the university leadership continued to prioritize other issues and it was only adopted as official policy five years later. Even then, it appeared unconnected to real managerial changes and progress remained slow, uneven and in several respects non-existent (Rippon, 2011).

One of the more positive developments during this time pertained to recycling. In 2008, a new student organization – the 'Green Campus Initiative' partnered with the Director of Estates and Custodial Services within the mega Properties and

Services division at UCT, to implement a ‘four-bin’ system. Bins were colour-coded and had distinctive apertures: blue (horizontal oblong) for paper; yellow (triangle) for plastic; red (circle) for tin; and green (square) for ‘other’ (Warambwa et al., 2010). This, however, did not improve recycling behaviour (Warambwa et al, 2010) and the additional complexity of a four-stream system ran up against the old managerial challenge of requiring the co-operation of cleaners when there were no incentives to comply and where supervision was largely non-existent.

In consultation with the waste contractor (a private company that collects the waste and the recycling), the system was scrapped in favour of a simple two-bin system: green for recyclables, and yellow for non-recyclables (Rippon, 2011: 19-20). Old four-bin systems were repurposed (Figure 2 below shows old four bin boxes with different shaped apertures repainted to yellow and green).

The idea behind the two-bin system was that clear bin liners would be placed in green bins and that these clear bags would get stored separately and picked up by the waste contractor on specified days and taken to a recycling facility. The yellow bins were to have black plastic liners, the idea being that these bags would get picked up and taken on specific days to the land fill. This system continued in 2021 but was undermined by poor recycling behaviour and incorrect use of bin liners. An additional problem was that this system was not introduced at university residences, where waste was simply divided into ‘wet’ (food) and ‘dry’ waste. Recycling of dry waste occurred only sporadically and mostly through student initiatives.

With regard to wet waste (food) recycling, the student-led Green Campus Initiative put a great deal of energy behind the installation of a pilot anaerobic digester (a system that uses bacteria to breakdown food waste into cooking gas) at one of the university residences. This entailed substantial investment of time educating kitchen staff (and to alleviate concerns about health and safety), as well as the involvement of academics and administrative staff (Melamu et al., 2010). The pilot project started in early 2011 and was managed by researchers. They found that the digester needed careful monitoring (being fed too much bread, for example, was a problem) and buy-in from kitchen staff. The digester was handed over to the residence in 2012 where it apparently ran for a few years before falling into disuse. An exploratory investigation in 2020 revealed that the kitchen staff employed at the time did not even know where the digester was, and that ongoing concerns about health and safety on the part of kitchen staff was apparently a factor behind its falling into disuse (private correspondence). In the absence of the food digestor becoming an expected aspect of kitchen staff’s duties, it appears to have been ignored. Food waste from university residences was simply collected by the waste contractor and taken to a protein (fly) farm to be used as food stock.

In 2012, then Vice Chancellor Max Price signed another global effort to improve sustainability on university campuses: the 'Sustainable Campus Charter' of the Global University Leader's Forum of the International Sustainable Campus Network (ISCN/GULF, 2012). This committed universities to working towards environmental and social goals simultaneously, and to use universities as 'living laboratories', the idea being for students, academics, administrative staff and relevant members of industry and civil society to work together on concrete goals. Yet a funding vacuum remained for such activities, and the Environmental Management Working Group had few resources and no authority to effect managerial change.

In 2019 some further institutional effort was made in this regard. A new Director of Environmental Sustainability (Manfred Braune) was appointed and located in the Office of the Vice Chancellor. The old Environmental Management Working Group was restructured into a formal university committee (the Environmental Management Committee). A new university document, the 'Environmental Sustainability Strategy' was developed, this time based on the triple bottom line concept of financial, social and environmental sustainability (Braune, 2020). The key objectives were net zero by 2050 for carbon, water, and waste to landfill. For the first time, a university environmental sustainability document drew a connection between poor waste management, pest control and the impact on wildlife – indicating that research was being done on the issue (Braune, 2020: 10).

This most recent iteration of UCT's attempt to create a 'green campus' goes beyond the previous attempts in that real institutional resources are behind it. The Khusela Ikamva Sustainability Campus Project,[1] of which we are a part, was launched in 2021. It provided some seed funding to conduct research in collaboration with UCT's Grounds and Gardens staff, and to engage with internal and external stakeholders to improve recycling.

Our part of the project included a link to wildlife research and the management of pests, as UCT's poor waste management has implications for the wildlife in and around the university. A core concern was that poor waste management was encouraging the proliferation of pest rodents and insects and that this was resulting in the prophylactic use of pesticides and rodenticides – both of which have been implicated in the global collapse of insects, birds, and mammals (Bongaarts, 2019; Sánchez-Bayo, F. & Wyckhuys, 2019). Research in Cape Town has shown that rodenticides make their way into the bodies of a range of predators

[1] This project was launched in 2021 but only announced in 2022. For more details see: https://www.news.uct.ac.za/article/-2022-05-10-khusela-ikamva-sustainability-campus-project

such as otters, caracals, genets, and owls (Serieys et al., 2019). Fixing waste in order to eliminate the use of poison was thus a further environmental reason for fixing the recycling.

2. Contemporary recycling at UCT: 2015-2021

As of the mid 2010s, UCT had about 35,000 students and staff, producing about five tons of waste per day. Figure 1 provides data on recycling (excluding food waste from university residences) for March and May between 2015 and 2021. It shows very low rates of recycling. 2020 and 2021are, of course, anomalous in that UCT was 'locked down' for most of 2020 because of the Covid-19 epidemic, and access to the campus remained severely restricted in 2021. Yet despite the potential for reshaping campus waste management infrastructure and managerial strategy during the lockdown, the percentage of waste going to the landfill increased.

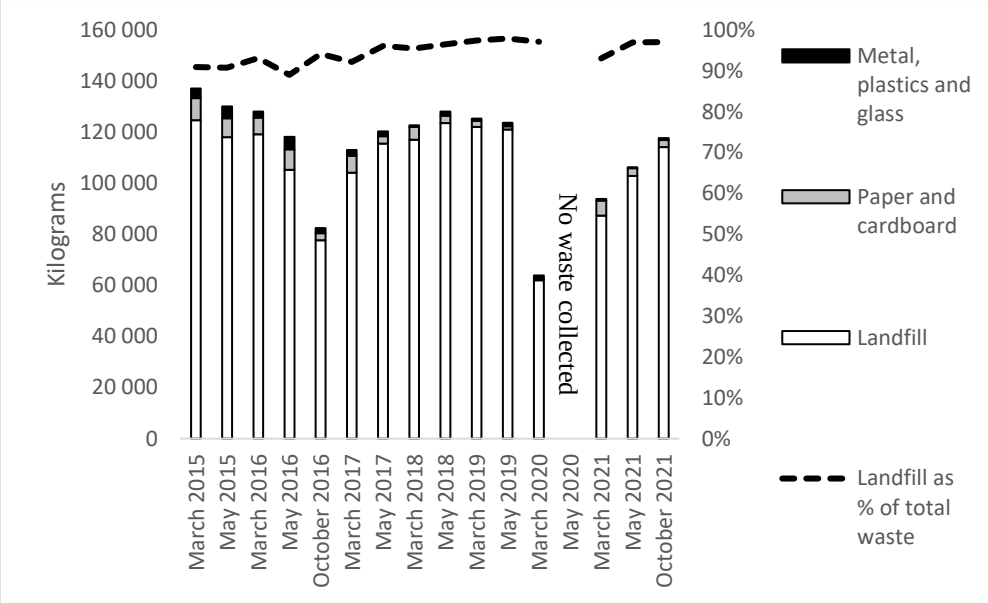

Figure 1: Recycling Trends at UCT: 2015 to 2021 (Data from Waste Control, excluding food waste)

In late 2014, UCT appointed a new waste contractor including a sub-contracted waste recycler '*Smart Waste*' At the same time, provision was made for large plastic wheelie bins to be located in office buildings in order to recycle paper. The contract with *Smart Waste* entailed a profit-sharing model in which the more UCT recycled, the more money both earned. *Smart Waste* produced detailed monthly statistics which we analyze in Figure 1. It shows that as of March 2015 UCT was recycling only about 10% of its (non-food) waste) and that its performance worsened over the following seven years. This was below the industry standard of between 50 and 75% recycling – and that achieved by other universities in the

area (Summers, 2020: 18). This was economically costly for the University as the contract with Smart Waste provided UCT with a two-thirds share of the revenues earned from recycling – a share which, in absolute terms, remained pitifully low. Continued calls from staff and students to fix the problem failed to gain any institutional traction, especially once the university became engulfed in student protests (over fees, accommodation and institutional culture) in 2015/6.

The student protests – especially in 2016 when they became violent and extremely disruptive on occasion – did much to degrade UCT's recycling infrastructure. Protestors used rubbish bins as battering rams and projectiles (Furlong & Hendricks, 2016; GroundUp Staff). Figure 2 shows two large recycling bin systems on the Cissy Gool Plaza being used as a battering ram in October 2016. Rubbish bins were often upended and burned during the protests (see, e.g., Bernado, 2016). The partial closure of the university and the destruction of bin infrastructure contributed to the drop in waste collection in October 2016 and to a further decline of UCT's already meagre recycling rate (see Figure 1). Between May and October that year, the percentage of non-food waste going to landfill rose from 89% to 94% and remained in the mid ninety percent region in subsequent years.

Figure 2: Protesters hurl a set of bins at private security guards protecting the main UCT library. Photo: Ashraf Hendricks (in GroundUp Staff, 2016).

One of the demands made by student protestors was that all those working for outside contractors be 'in-sourced', that is given permanent jobs at UCT, and at

much higher wages (roughly three time the industry standard) (Luckett & Mzobe, 2016). The university agreed. This created a whole new set of managerial challenges including training and specifying how their activities and supervision would change. Ongoing negotiations may well have been a distraction from operational matters like recycling, contributing to its apparent low prioritization by workers and managers alike.

Other managerial failures, such as the apparent persistent inability of supervisors to supply appropriate supplies for clear and black plastic bags to cleaning staff appear to have contributed further to the erosion of the recycling system. Those ordering the bin liners report that there have been difficulties in obtaining supplies of clear bin liners, especially during the COVID-19 lockdown, but some parts of the university were more proactive than others in addressing such problems. Whereas the cleaners who became part of Gardens and Grounds appear to have been routinely given the correct bin liners and were trained and supervised such that the correct bin liners were placed in the correct bins, cleaners inside buildings persistently placed black bin liners in all bins. When we asked cleaners about this, they told us that they had only been provided with black bin liners. As discussed below, this problem was evident also in our research.

The management of cleaners was complicated further by the university's managerial silos. Different managerial structures exist for workers inside and outside of academic buildings on campus, and in university residences. The areas where bagged waste from bins inside and outside of buildings is stored for collection by waste control trucks appears to have fallen into a managerial black hole with no one taking responsibility for it. Discussion with workers revealed that those working inside buildings considered the area to be the responsibility of workers outside the buildings, and the workers outside the buildings believed it was the job of the waste control company. The university eventually hired private contractors to clean these areas as an interim measure whilst it sought to tighten and clarify line management systems.

Budgetary considerations may also have complicated matters. Noelene le Cordier, UCT's senior horticulturalist (in Grounds and Gardens which falls under the Estates and Custodial Services division of UCT's mega Properties and Services division) has since 2015 made various submissions and representations to university committees, working groups and various line managers, and has written a comprehensive report on the failures of the refuse system (e.g., le Cordier, 2018). In 2019, legal experts were contracted to do an audit of UCT's waste management. They endorsed le Cordier's earlier critical analysis and found that UCT was in violation of the spirit, and in many cases the letter, of the Environmental Management: Waste Act (Summers, 2020). The report recommended, inter alia: improved infrastructure (bins and noticeboards);

‘banning the bin’ in individual offices (and introducing recycling at departmental level); campus-wide engagement to promote a culture of environmental awareness and recycling; requiring all food vendors to ensure that their products are recyclable; and requiring that managerial effort be deployed to ensure correct waste management by cleaning staff.

Unfortunately, these suggestions appear to have fallen on deaf ears. Academics, staff and students regularly draw attention to failures in recycling and waste management, but these have failed to gain institutional traction. It is hoped that by documenting the problems involved in waste management and researching the issue through the Khusela Ikamva Initiative that a bright light will be shone on the complex problem and that this will encourage real change.

3. New bin infrastructure

Figure 3: New bins for UCT. Photos: Noelene le Cordier, July 2020.

The new Director of Environmental Sustainability, together with concerned academics and supportive staff, was able to mobilize support and resources to revamp the bin infrastructure in 2020/21. Notably, the university ordered and installed new internal bins at the food courts (with improved signage) and similarly new and better signed bins at bus stops (Figure 3). As can be seen in Figure 3, ‘recyclables’ were identified through written labelling as well as visual designs. An obvious disadvantage of the new signage was that it referred to

‘recyclable packaging’ without explaining what this entailed. A further disadvantage was that it referred to ‘clean food trays’, which might have discouraged students from placing even lightly stained food containers (which the recycler informed us could be recycled), in the recycling bins. The clear advantage of the signage was that it clearly identified tins, cans, glass and plastic as recyclable.

Figure 4: Pebble dash bins with repaired lids (discarded broken lids are piled at the back – some of these date back to the old four-bin system). Photo N. Nattrass, December 2020.

The older external ‘pebble dash’ bins were repaired and not provided any additional labelling (Figure 4). These bins were placed in pairs (a green lidded bin with a clear plastic liner alongside a yellow lidded bin with a black plastic liner) at various points around the campus – their primary aim being to accommodate passing foot traffic and prevent litter.

4. Estimating ‘correct basic recycling’: the base-line study

As the history of recycling at UCT suggests, there are several factors contributing to UCT’s poor recycling record pertaining to institutional commitment, appropriate infrastructure, labour management and consumer (as in staff and students at UCT) awareness of recycling. Notably, poor recycling starts with incorrect bin liners being placed in the bins, and then continues when users (staff and students) do not place recyclable items in the recycling bins.

To explore these two dimensions to the problem, we conducted a small scoping study. The team, led by Noelene le Cordier, comprised Reggie Mayman from UCT Grounds and Gardens, along with Nicoli Nattrass and Refilwe Mofokeng (an academic and student in Economics respectively). This was very much an 'action research' project, or what development economist Jean Drèze calls 'research for action', that is, to pursue knowledge as a collective endeavor to achieve practical change (Drèze, 2017: 4-8). Rather than a spectator activity, where research is conducted 'on people', action research entails the 'participatory assessment' of problems and their solutions (McNiff, 2017). This approach adopts 'good-enough' measures, rather than 'best-practice', as this is more feasible and practical given constraints on time and resources.

Figure 5: The study team, 25 June 2021. Photo Noelene le Cordier

The team identified 22 pairs of bins inside and outside of buildings along UCT's main throughfare on upper campus. This included the two main food courts, a central plaza and bus-stop. We emptied the contents of each bin onto a plastic sheet, identified recycling items and collected totals for each bin (Figure 5). Of the 22 pairs, 12 were pebble-dash bins, six were old wooden bins of the type shown in Figure 2, two were new internal bins and two were new, external wooden bins (shown in Figure 3).

The objective was not to complete a full rubbish audit (in which every item, including food waste would ideally be identified and weighed), but rather to see if even the most 'basic recycling' was evident on the part of those using the bins – and if there were any statistically significant differences between recycling in different types of bins. In this regard, we followed the methodology adopted by Fritz et al. (2017) in their study of a university in Texas, and Felske (2020) who used a similar measure at a university in Missouri. Both studies counted items to estimate 'correct recycling' and did not do any weighing or further sorting of waste. In our study, basic recycling was operationalized as tin cans, plastic bottles and polystyrene and other recyclable food containers. We also recorded whether the correct bin liners were in use, as this was an important outcome for adaptive management.

Correct basic recycling was calculated as a percentage for each pair of bins. More specifically, correct basic recycling comprised the number of basic recyclables (as defined above) in the green (recycling) bins expressed as a percentage of the total number of recyclables in the pair of bins (the green and yellow bins combined). Our base-line study was conducted on 25 June 2021. This was during the teaching term, at a time when students were on campus. COVID-19 restrictions still applied, so UCT was operating on a low-density basis. Food courts, however, were operational and there was also a food truck operational at the main Sara Baartman Plaza.

Table 1 summarizes key results of the base-line study. We found wide variation across bins but disappointingly low mean rates of correct recycling of bottles (plastic and glass), tin and food containers. Green bins had a higher mean percentage of recyclables (than in their paired yellow bins) but this was not statistically significant. This implies that recycling in our study bins on 25 June was not reliably better than random. Table 1 shows that there were no statistically significant differences between correct recycling in internal or external bins, or between the pebble-dash external bins and all other bins.

As has long been the case at UCT, the study found frequent instances where black bin liners had been placed in green bins – the result being that the contents of those bins would go straight to landfill along with non-recyclable waste. Table 1 reports that only 50% of the bins internally had the correct bin liner compared to 83% of the external bins (and this was statistically significant at the 5% level). Internal and external bins are managed by different groups of workers, with different line mangers. The team notified the Director of Environmental Sustainability, who said he would take it up with the Executive Directors concerned. We hoped to see an improvement in the correct usage of bin liners.

Table 1: Results: 25 June 2021 for recycling of bottles, cans and food containers

% recyclables in all green bins	% recyclables in all yellow bins	t-test of mean difference
Mean = 0.572 Std deviation: 0.29 Variance: 0.08 Obs = 21	Mean = 0.428 Std deviation: 0.29 Variance: 0.08 Obs = 21	t=1.5952 Ha: diff!=0 Pr(|T|>|t|)=0.1185
% recyclables in internal green bins	% recyclables in external green bins	t-test of mean difference
Mean = 0.513 Std deviation: 0.27 Variance: 0.07 Obs = 8	Mean =0.608 Std deviation: 0.31 Variance: 0.09 Obs = 13	t=-0.7123 Ha: diff!=0 Pr(|T|>|t|)=0.4849
% recyclables in pebble-dash green bins	% recyclables in other green bins	t-test of mean difference
Mean = 0.608 Std deviation: 0.31 Variance: 0.09 Obs = 11	Mean =0.532 Std deviation: 0.28 Variance: 0.08 Obs = 10	t=0.5900 Ha: diff!=0 Pr(|T|>|t|)=0.5621
% external bins with the correct bin liner	% internal bins with the correct bin liner	t-test of mean difference
Mean = 0.826 Std deviation: 0.39 Variance: 0.15 Obs = 23	Mean =0.500 Std deviation: 0.52 Variance: 0.27 Obs = 16	t=2.2544* Ha: diff!=0 Pr(|T|>|t|)=0.0302

* Statistically significant at the 5% level

Table 2 repeats the analysis presented in Table 1, but this time for an even more pared down definition of recycling: bottles and glass. We wondered whether people might be confused as to whether the mostly polystyrene food containers were recyclable or not. As there is very clear messaging about bottles and tins being recyclable, we constructed a measure of recycling using only cans and bottles. Table 2 shows recycling by this measure also varied substantially between bins and that this time there was a large and statistically significant difference between the proportion of cans and bottles in the green bins (correct recycling) and the yellow bins (incorrect recycling) using this measure. This suggests that for these particular items, people were reliably more likely to place them in the recycling (green) bins than in the non-recycling (yellow) bins. As was the case for the results presented in Table 1, there were no statistically significant differences in results between the different types of bin.

Table 2: Descriptive statistics: 25 June 2021:recycling of bottles and cans

% recyclables in all green bins	% recyclables in all yellow bins	t-test of mean difference
Mean = 0.695 Std deviation: 0.30 Variance: 0.09 Obs = 21	Mean = 0.305 Std deviation: 0.30 Variance: 0.09 Obs = 21	t=4.1243 Ha: diff!=0 Pr(|T|>|t|)=0.000***
% recyclables in internal green bins	% recyclables in external green bins	t-test of mean difference
Mean = 0.637 Std deviation: 0.33 Variance: 0.11 Obs = 8	Mean =0.731 Std deviation: 0.30 Variance: 0.09 Obs = 13	t=-0.6755 Ha: diff!=0 Pr(|T|>|t|)=0.5075
% recyclables in pebble-dash green bins	% recyclables in other green bins	t-test of mean difference
Mean = 0.699 Std deviation: 0.31 Variance: 0.10 Obs = 11	Mean =0.691 Std deviation: 0.32 Variance: 0.10 Obs = 10	t=0.0621 Ha: diff!=0 Pr(|T|>|t|)=0.9512

*** Statistically significant at the 0.1% level.

Table 3: Correct bin liners in the internal and external bins

% external bins with the correct bin liner (25 June 2021)	% internal bins with the correct bin liner (25 June 2021)	t-test of mean difference (25 June 2021)
Mean = 0.826 Std deviation: 0.39 Variance: 0.15 Obs = 23	Mean =0.500 Std deviation: 0.52 Variance: 0.27 Obs = 16	t=2.2544* Ha: diff!=0 Pr(|T|>|t|)=0.0302
% external bins with the correct bin liner (17 August 2021)	% internal bins with the correct bin liner (17 August 2021)	t-test of mean difference (17 August 2021)
Mean = 0.927 Std deviation: 0.26 Variance: 0.07 Obs = 41	Mean =0.438 Std deviation: 0.51 Variance: 0.26 Obs = 16	t=4.27498*** Ha: diff!=0 Pr(|T|>|t|)=0.0000
% external bins with the correct bin liner (28 September 2021)	% internal bins with the correct bin liner (28 September 2021)	t-test of mean difference (28 September 2021)
Mean = 0.976 Std deviation: 0.15 Variance: 0.02 Obs = 42	Mean =0.50 Std deviation: 0.52 Variance: 0.27 Obs = 14	t=5.3594*** Ha: diff!=0 Pr(|T|>|t|)=0.0000

* Statistically significant at the 5% level; ** at the 1% level; *** at the 0.1% level.

On 17 August, we conducted a further round of basic recycling audits as we prepared to implement our intervention (discussed further below). We found that there had been no improvement in the correct use of bin liners in the internal bins. Less than half of the internal bins (43.8%) had the correct bin liners, compared to 92.7% of the external bins. Our management intervention to improve the correct use of bin liners had clearly failed. Table 3 shows that the difference in performance in the correct management of internal and external bins had grown larger and more statistically significant. A further round of audits of bin liners on 28 September revealed no change.

5. The intervention

On 17 August 2021, we piloted an intervention to see if additional signage on the external pebble-dash bins would have an impact on recycling behaviour. We attached large flexible plastic signs using cable ties onto the 24 external bins for which we already had data (as reported above). Figure 6 illustrates the design of the large signs and the stickers, and their positioning on the pebble dash bins. The photograph also shows the bin liners, which are, in this case, correct (clear plastic for recycling, black plastic for waste destined for the landfill).

The fast-food containers sold at UCT entail a confusing mix of unmarked products, products marked ‘biodegradable’ or ‘compostable’ or ‘recyclable’. People are likely to be confused as to whether, for example, the compostable or biodegradable containers should go into recycling or non-recycling. We consulted UCT’s recycling partner, and he informed us that his team would sort out the recycling (taking the compostable material along with the food waste to a protein farm and putting the recyclable polystyrene into the correct recycling channel). He advised us to encourage people to put all the food containers into the recycling bin. We thus devised a set of stickers for the lids to indicate to people to put bottles, tins and food containers in the recycling, and not in the non-recycling.

We hypothesized that our measure of basic recycling would improve in the bins with this additional signage. Our primary methodology was thus a before and after comparison of the pebble-dash bins. We also wondered whether this would be a bin-specific improvement, or whether the fact that some of the external bins on University Avenue and surrounds had improved signage might change behaviour more broadly and result in improved basic recycling in the other external bins too. We thus added a further set of nine pebble-dash bins that had not been provided with improved signage, in the vicinity. This allowed for a ‘treatment vs control’ analysis of the data collected from the pebbledash bins a month after improving the signage.

Figure 6: Labels, stickers and their positioning on the treatment bins.

Table 4 shows that recycling of bottles cans and food containers was higher in August than in June for the original 12 pairs of pebble-dash bins, but that this difference was not statistically significant. It also shows that recycling was slightly higher in these 12 pairs of bins destined to become treatment bins (with new signage) compared to the additional nine pairs of 'control' bins added to the study (i.e. additional pebble-dash bins on University Avenue which did not receive additional signage) but that this difference was not statistically significant.

Table 5 shows that the estimate of correct recycling was higher if we only include bottles and cans in our measure, but that the differences between treatment and control bins was not statistically significantly different.

Table 4: Recycling (cans and bottles and food containers) in pebble-dash bins prior to the intervention

The 12 pairs of pebble dash bins to become the 'treatment' bins (with new labels).		The control bins (bins without additional labelling)
25 June 2021	17 August 2021	17 August 2021
Mean: 0.608 Std deviation: 0.308 variance: 0.095 Obs: 11	Mean: 0.680 Std deviation: 0.164 variance: 0.027 Obs: 12	Mean: 0.629 Std deviation: 0.226 variance: 0.051 Obs: 9
t-test of the difference between 25 June and 17 August		=-0.7092 Ha: diff!=0 Pr(|T|>|t|)=0.4860
t-test of the difference between the bins selected to become treatment bins and the control bins		t=0.6031 Ha: diff!=0 Pr(|T|>|t|)=0.5536

Table 5: Recycling (cans and bottles only) in pebble-dash bins prior to the intervention

The 12 pairs of pebble dash bins to become the 'treatment' bins (with new labels).		The control bins (bins without additional labelling)
25 June 2021	17 August 2021	17 August 2021
Mean: 0.700 Std deviation: 0.314 variance: 0.099 Obs: 11	Mean: 0.737 Std deviation: 0.164 variance: 0.027 Obs: 12	Mean: 0.638 Std deviation: 0.191 variance: 0.036 Obs: 9
t-test of the difference between 25 June and 17 August		t=-0.3625 Ha: diff!=0 Pr(|T|>|t|)=0.7206
t-test of the difference between the bins selected to become treatment bins and the control bins		t=1.2814 Ha: diff!=0 Pr(|T|>|t|)=0.2155

We conducted two further rounds of rubbish audits for the pebble-dash bins: on 17 September and 28 September. Table 6 presents the results for the recycling of cans, bottles and food containers. The results were disappointing. The percentage of correct recycling declined in the treatment and control bins between 17 August

and 17 September (although not statistically significantly so). Recycling deteriorated faster in the control bins to the point that by the 28 of September, the difference between 66% correct recycling in the treatment bins and 44% in the control bins was statistically significant (p=0.0587).

Table 6: Measuring the effectiveness of the intervention on recycling of cans, bottles and food containers) in pebble-dash bins

Correct recycling in the treatment bins			Correct recycling in the control bins		
17 August	17 September	28 September	17 August	17 September	28 September
Mean: 0.689 Std dev: 0.164 var: 0.027 Obs: 12	Mean: 0.614 Std dev: 0.101 var: 0.010 Obs: 11	Mean: 0.664 Std dev: 0.246 var: 0.061 Obs: 12	Mean: 0.629 Std dev: 0.226 var: 0.051 Obs: 9	Mean: 0.577 Std dev: 0.204 var: 0.042 Obs: 9	Mean: 0.436 Std dev: 0.246 var: 0.075 Obs: 9
t-test of the difference between the treatment bins on 17 August and 17 September	t=1.1479 Ha: diff!=0 Pr(|T|>|t|)=0.2639				
t-test of the difference between the treatment bins on 17 August and 28 September	t=0.1826 Ha: diff!=0 Pr(|T|>|t|)=0.8568				
t-test of the difference between the control bins on 17 August and 17 September	t=0.5097 Ha: diff!=0 Pr(|T|>|t|)=0.6172				
t-test of the difference between the control bins on 17 August and 28 September	t=1.16334 Ha: diff!=0 Pr(|T|>|t|)=0.1219				
t-test of the difference between the treatment and control bins on 17 September	t=0.5301 Ha: diff!=0 Pr(|T|>|t|)=0.6025				
t-test of the difference between the treatment and control bins on 28 September	t=2.0115 Ha: diff!=0 Pr(|T|>|t|)=0.0587*				

* Statistically significant at the 5% level.

These results suggest that the improved signage may have helped improve recycling, but there is not much to celebrate given that the result was driven largely by deteriorating recycling in the control bins.

Table 7 repeats the analysis, this time for recycling of cans and bottles only. This shows that recycling was higher in the treatment than in the control bins, but never statistically significantly, and there was the same tendency for the percentage of correct recycling to deteriorate across the time period (though, again, not statistically significantly). According to this measure, there was no statistically significant difference between treatment and control bins as of 28 September.

Table 7: Measuring the effectiveness of the intervention on recycling of cans and bottles only, in pebble-dash bins

Correct recycling in the treatment bins			Correct recycling in the control bins		
17 August	17 September	28 September	17 August	17 September	28 September
Mean: 0.737 Std dev: 0.164 varr: 0.027 Obs: 12	Mean: 0.797 Std dev: 0.173 var: 0.030 Obs: 11	Mean: 0.678 Std dev: 0.282 var: 0.079 Obs: 12	Mean: 0.638 Std dev: 0.191 var: 0.036 Obs: 9	Mean: 0.627 Std dev: 0.279 var: 0.078 Obs: 8	Mean: 0.469 Std dev: 0.374 var: 0.140 Obs: 9
t-test of the difference between the treatment bins on 17 August and 17 September	t=-0.8504 Ha: diff!=0 Pr(|T|>|t|)=0.4047				
t-test of the difference between the treatment bins on 17 August and 28 September	t=0.6297 Ha: diff!=0 Pr(|T|>|t|)=0.5354				
t-test of the difference between the control bins on 17 August and 17 September	t=0.0901 Ha: diff!=0 Pr(|T|>|t|)=0.9294				
t-test of the difference between the control bins on 17 August and 28 September	t=1.2057 Ha: diff!=0 Pr(|T|>|t|)=0.2455				
t-test of the difference between the treatment and control bins on 17 September	t=1.6373 Ha: diff!=0 Pr(|T|>|t|)=0.1199				
t-test of the difference between the treatment and control bins on 28 September	t=1.4622 Ha: diff!=0 Pr(|T|>|t|)=0.1600				

Table 8 presents the results of a difference in difference estimations for both measures of recycling. The regressions (on the percentage of correct recycling) control for the date of the intervention and a dummy variable for the treatment bins and their interaction. The sign on the time dummy was negative, and it was positive on the treatment dummy. However, as expected, given our earlier reported results and the high level of variation in our relatively small sample, none of the coefficients was statistically significant. The F-tests on both regressions reveal that we cannot reject the null hypothesis that all the coefficients are equal to zero.

Table 8. Regressions (with robust standard errors reported in parentheses)

	Regression 1 (correct recycling of bottles, cans and food containers)	Regression 2 (correct recycling of cans and bottles only)
Dummy variable controlling for before and after the intervention (1=28 September, 0=17 August)	-0.19 (0.12) p=0.108	-0.17 (0.14) p=0.231
Dummy variable for treatment bins	0.05 (0.09) p=0.566	0.10 (0.08) p=0.216
Difference in difference estimator	0.177 (0.15) p=0.230	0.11 (0.17) p=0.518
Constant	0.63**** (0.07) p=0.000	0.64**** (0.06) p=0.000
N	42	42
R-squared	0.1583	0.1323
Prob>F	0.1330	0.2057
Mean VIF	2.56	2.56

* Statistically significant at the 5% level; ** at the 1% level; *** at the 0.1% level.

This implies that, despite an apparent trend towards worsening recycling performance and the possibility that the treatment bins might have arrested this somewhat, recycling performance at UCT is poor and the allocation of recyclables between bins is no better than random.

6. Conclusion

Recycling clearly remains a major challenge on UCT campus. People are more likely to recycle bottles and cans than food containers. Even when 'prompted' by improved signage and stickers, recycling behaviour did not improve significantly.

It is important to note that this study was limited by the relatively small number of bins in our study area (bins along University Avenue and surrounds). This, coupled with high variance across bins, made it harder to achieve statistically significantly changes. Yet even so, the results were disappointing. They suggest that more needs to be done to educate people about correct recycling and improve the supervision and management of labour, or perhaps that the university should attempt something more radical and do away with rubbish bins altogether. UCT's immediate neighbour, Kirstenbosch gardens, has since 2018 done away with rubbish bins altogether, requiring instead that people take their trash out with them. As can be seen in Figure 8, the motivation for doing so was primarily to deter rodents.

Figure 7: *Kirstenbosch Garden's no bins policy*

In the course of the research, we noticed two problems that might also help account for poor recycling performance. The first is that food containers are bulky

and can quickly fill up the green bins. Students presented with a full green bin are perhaps more likely to place their recyclables in the yellow member of the paired bins rather than find a green bin elsewhere to deposit the waste. The second is that recycling bins were often clogged by bags of waste that appeared to have come out of offices. These additional bags included recyclable items, but also items such as coffee grounds, other food waste and paper. It may well be that the lack of adequate servicing of offices under COVID-19 has encouraged people in offices to dump their accumulated waste in the pebble-dash bins meant only for passing foot traffic.

The problem posed by food containers suggests that more attention might also usefully be paid to finding ways to reduce waste directly, for example by banning the sale of plastic water bottles on campus (and providing metal water bottles to students on registration) and insisting that food vendors do not sell food in pre-packaged containers but serve it directly to customers and providing discounts to those who bring their own re-usable food containers. The Green Campus Initiative team in 2022 aimed to investigate this possibility and working on potential designs for re-usable cups and bottles.

Improving recycling on campus is not simply a matter of ensuring that people place recyclables in the green bins: It is also a matter of ensuring that the correct bin liners are used in the bins so that the recycler collects the correct bag, and to ensure that recyclables are not mistakenly sent to the landfill. It was most concerning to see that fewer than half the internal bins we surveyed in June and August had the correct bin liners and that, despite alerting the university to the problem, the problem got worse rather than better. The fact that there were statistically significant differences between the correct use of bin liners in the external bins compared to internal bins, suggests that management was the issue rather than the supply of correct bin liners in UCT.

Figure 8: UCT workers visit a recycling facility

In November 2021, cleaners and managers from Properties and Services, including teams working inside and outside of buildings, hosted a multi-day training program in recycling. The plan was to educate and motivate workers about the importance of recycling. It included a site visit to a recycling processing facility in Kraaifontein (Figure 8). No formal assessment was made of this intervention, but workers have independently reported that they found the process inspiring and empowering. Workers were asked to think about what could be done to improve recycling at UCT, and they made small group presentations. Line managers reported that workers felt more confident to confront people placing recyclables in the incorrect bins. 2021 thus ended on a positive note.

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