



# **Zero Waste Campaign In University of Malaya**

## **2013 Annual Report**

Prepared by,



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## Table of Content

<b>Section 1: Introduction</b>	<b>4</b>
Sub-section 1.1: Goals and objectives of ZWC	6
<b>Section 2: Achievement in 2013</b>	<b>8</b>
Sub-section 2.1: Signing of MOU - UM and CHG Sdn Bhd (Cowtec AD)	8
Sub-section 2.2: Improvement of composting capacity	12
Sub-section 2.3: On-going research	21
Sub-section 2.4: Collaboration with external parties	26
Sub-section 2.5: Data collection and waste flow	33
Sub-section 2.6: Visitors and media publicity	35
<b>Section 3: Challenges and way forward</b>	<b>44</b>
Sub-section 3.1: Waste and recycling data collection	45
Sub-section 3.2: Roadmap of UM ZWC	45
Sub-section 3.3: Proposed projects in 2014	48
<b>Section 4: Summary and conclusion</b>	<b>52</b>
<b>Figures and tables</b>	
<i>Figure 1.0: Overview of UM composting center</i>	7
<i>Figure 2.0: Ceremony of MOU signing between UM and CHG</i>	9
<i>Figure 2.1: Ceremony of MOU signing between UM and CHG (2)</i>	10
<i>Figure 2.2: Ceremony of MOU signing between UM and CHG (3)</i>	11
<i>Figure 2.3: Organic waste treatment in year 2013</i>	12
<i>Figure 2.4: Organic waste treated since operation in September 2011</i>	13
<i>Figure 2.5: Tipping of kitchen waste for food waste recovery</i>	14
<i>Figure 2.6: Loading of food waste into composting piles</i>	15
<i>Figure 2.7: Other pictures</i>	16
<i>Figure 2.8: Compost out from composting piles for curing in water tanks</i>	17
<i>Figure 2.9: Grinding of compost</i>	18
<i>Figure 2.10: Grinded compost for packaging</i>	19
<i>Figure 2.11: Filtering of digestate from Cowtec AD</i>	20
<i>Figure 2.12: Composition of residual waste in UM (by weight)</i>	22

<i>Figure 2.13: Jaron represented UM Cares for the PPSPPA seminar</i>	22
<i>Figure 2.14: Research work for the study of carbon emission from composting</i>	23
<i>Figure 2.15: Waste characterization study</i>	24
<i>Figure 2.16: Sorting of waste for characterization</i>	25
<i>Figure 2.17: Bulky waste and scrap metals storage site run by JPPHB</i>	27
<i>Figure 2.18: Used cooking oil collection by Kris Biofuel</i>	28
<i>Figure 2.19: Recycling vendor and TPot Computer</i>	29
<i>Figure 2.20: Open top bins of Alam Flora sub-con</i>	30
<i>Figure 2.21: Open top bins of UM appointed contractor</i>	31
<i>Figure 2.22: Visit to food waste to animal feed site at UTM</i>	32
<i>Figure 2.23: Mapping of waste flow in UM</i>	34
<i>Figure 2.24: Percentage of waste streams by weight</i>	34
<i>Figure 2.25: Coverage on ZWC in TheStar, Feb. 2013</i>	35
<i>Figure 2.26: Jaron interviewed by Astro Awani at UM composting center</i>	36
<i>Figure 2.27: Interview (live) at Astro Awani on waste management issues</i>	36
<i>Figure 2.28: Interview by SinChew reporter</i>	37
<i>Figure 2.29: Visitors to UM composting center (1)</i>	38
<i>Figure 2.30: Visitors to UM composting center (2)</i>	39
<i>Figure 2.31: Visitors to UM composting center (3)</i>	40
<i>Figure 2.32: Visitors to UM composting center (4)</i>	41
<i>Figure 2.33: Visitors to UM composting center (5)</i>	42
<i>Figure 2.34: Explanation to visitors on the composting operation</i>	43
<i>Figure 3.0: Roadmap of UM ZWC</i>	46
<i>Figure 3.1: Strategy for organic waste treatment capacity increment</i>	47
<i>Figure 3.2: Strategic plan for the development of organic waste treatment</i>	47
<i>Figure 3.3: Construction waste bins hired by different PTj</i>	49
<i>Figure 3.4: Fluorescent lamps found in open top bin for renovation waste</i>	50
<i>Figure 3.5: Open top hired by PTj for green waste collection</i>	51
<i>Figure 4.0: Visit by UM Cares volunteers</i>	53
<i>Figure 4.1: Segregation of food waste in green bags</i>	54
<i>Figure 4.2: UM Cares environmental audit (1)</i>	55
<i>Figure 4.3: UM Cares environmental audit (2)</i>	56
<i>Figure 4.4: UM Cares environmental audit (3)</i>	57
<i>Figure 4.5: UM Cares environmental audit (4)</i>	58
 <i>Table 2.0: Organic waste treated by month in 2013</i>	 13
<i>Table 2.1: Estimated tonnage/day of different waste streams in UM</i>	33

**Appendix A:** Cowtec research report

**Appendix B:** Waste data UM – 2013

## **Section 1: Introduction**

January 2013 marked the MOU signing and official launching of the Cowtec anaerobic digester between the Deputy Vice Chancellor (Development) of UM and CEO of CH Green Sdn Bhd. The event was launched by Director-General of National Solid Waste Management Department (JPSPN) Dato' Nadzri Yahaya and attended by inventor of Cowtec AD, Mr. Dusit, president of MBT Co. Ltd. After the launching event, a three months experiment on the quantity and quality of biogas and digestate from various mixture of food waste was carried out. In April, the final report of the experiment was submitted to CH Green Sdn Bhd. Since then, food waste of "rice" of about 10-20 kg/day was regularly fed to the Cowtec AD. The biogas produced was mostly flared and used by the composting worker for cooking.

For the composting operation, after one year of using two workers, the food waste tonnage had never increased to more than 5 ton/month, and it had shown that the manpower is not a factor to increase composting capacity with that size of facility. Thus, since May 2013, the composting operation was handled by one worker only. In July and August 2013, there was no food waste as the period was semester break. In September 2013, the "dewan makan" of all residential colleges in the campus were closed, resulting in a significant drop of source segregated food waste in green bags. Food waste was sourced from kitchen waste (heavy black rubbish bags with high content of food waste). From October to December 2014, the food waste composting tonnage were increased to an average of 4-5 ton/month, which shown the improvement in overall efficiency and effectiveness of composting operation.

In year 2013, ZWC was fully funded by UM Cares. Besides organic waste diversion projects, ZWC embark into other projects/activities such as waste and recycling data collection and formed collaboration with various stakeholders inside and outside of campus such as JPPHB, UKKP (Unit of health,

environment and occupation), CITRA and externally PPSPPA, Kris Biofuel (Used cooking oil collector), Zie Enterprise (largest recycling vendor of UM) and T-Pot E&E (DOE licensed e-waste collector). For data collection, the types of wastes that ZWC managed to obtain data are domestic waste, green waste and bulky waste from residential colleges and faculties; e-waste, clinical waste, used cooking oil, recyclable materials, scrap metals and food waste composted. With these data, a comprehensive waste flow in the campus of UM was partially developed. ZWC is still in the process of gathering more quality information and data on waste arise in the campus. Construction, demolition and renovation waste is one of the major waste streams that have no data available and mostly disposed in illegal dumpsites, according to PPSPPA. This data collection practice is also contributing to UM LCCF (Low Carbon City Framework) project.

On the aspect of social and public relation, ZWC constantly received site visits and interviews by students and staffs in UM and external parties from higher learning institutes, government agencies and private entities throughout the year. The composting center also served as an experimental lab for several post-graduate students from ISB, Faculty of Science. ZWC was interviewed by TheStar with publication and Astro Awani in daily news. Besides, ZWC was invited to give talks and presentation on recycling and waste management by several residential colleges and faculties.

ZWC has drawn up a roadmap to achieve 15% landfill diversion by year 2020 (phase 1), 30% by year 2030 (phase 2) and 60% by year 2040 (phase 3). The next projects of ZWC under Phase 1 are green waste shredding and composting, campus level integrated formal recycling collection system, e-waste collection program and guidelines on collection of construction, demolition and renovation waste. For the existing projects, program like Green Bag Scheme has to be strengthened to increase source segregated food waste.

ZWC requires substantial support from UM top management for its sustainability. The sustainability of ZWC is important for UM's reputation locally and internationally. ZWC has successfully developed several key projects that serves as cornerstone to increase recycling rate in the campus. ZWC hopes all stakeholders (residential colleges and faculties) will collaborate to achieve the goal of sustainable waste management and ultimately zero waste in UM campus.

### **Sub-section 1.1: Goals and objectives of ZWC**

**Goal:** To achieve a campus with zero waste to landfill with the development of integrated and sustainable waste management model

**Objectives:**

1. To develop policy and innovation system to divert solid waste (non-hazardous) from disposal in landfill for resource and energy recovery.
2. To streamline recycling activities and strategize efforts to increase recycling rate.
3. To create awareness and inculcate best practice of waste separation at source among the campus communities.
4. To form strategic partnership with various stakeholders to develop integrated waste management system.

### **Significance of ZWC**

1. Serve as a long term campaign to achieve integrated waste management model and ultimately a zero waste campus
2. Initiate projects, research projects and schemes such as Green Bag Scheme, in-house composting center, anaerobic digestion project, recycling collection system, waste characterization, composting emission study, etc
3. A model of system innovation to shift toward sustainable waste management

Figure 1.0: Overview of UM composting center

	<p>View of UM composting center</p>
	<p>COWTEC ® 100kg/day anaerobic digestion unit</p>
	<p>Composting aerated static piles (in a simple windrow)</p>

## **Section 2: Achievement in 2013**

The various highlight of achievement of the OWD project were summarized:

1. Signing of MOU - UM and CHG Sdn Bhd (Cowtec AD)
2. Improvement of composting capacity
3. On-going research
4. Collaboration with external parties
5. Data collection for LCCF project
6. Visitors and media publicity

### **Sub-section 2.1: Signing of MOU - UM and CHG Sdn Bhd (Cowtec AD)**

The signing of MOU between UM and CHG Sdn Bhd marked the official partnership to carry research and operation of the 100kg/day Cowtec anaerobic digester in UM campus. Research on the quantity and quality of biogas and digestate based on different feedstock was carried out from January until April 2013. A final research findings report was submitted to CHG Sdn Bhd (as attached in Appendix A).




*Figure 2.0: Ceremony of MOU signing between UM and CHG*

	Gathering of VIPs
	In the MOU signing hall
	Signing of MOU

Figure 2.1: Ceremony of MOU signing between UM and CHG (2)

	<p>Press conference</p>
	<p>Site visit to the Cowtec AD</p>
	<p>Composting pile</p>

Figure 2.2: Ceremony of MOU signing between UM and CHG (3)

	Explanation of the operation of Cowtec AD
	Explanation of the operation of Cowtec AD
	UM composting site that houses the Cowtec AD

## Sub-section 2.2: Improvement of composting capacity

With the closure of all dewan makan in September 2014, the source segregated food waste in white bags had been reduced dramatically. The heavy black bags (kitchen waste) are segregated at the UM waste storage center for further manual pre-sorting to remove the impurities. Since September 2014, with the new composting worker, Samsul had managed to compost about 4-5 ton of food waste every month. The compost piles were enlarged to accommodate more food waste.

In year 2014, a total of 37,507 kg of organic waste was treated (Composting and anaerobic digestion). Out of this amount, 1,961kg was green waste that compost, 1,534kg of food waste digested anaerobically and 33,012kg of food waste was composted. In 2004, 1,978kg of compost was produced from 35,973kg of organic waste composted, which shows a 94.5% mass reduction of organic waste. However, the mass reduction may be lower as the compost piles were increased.

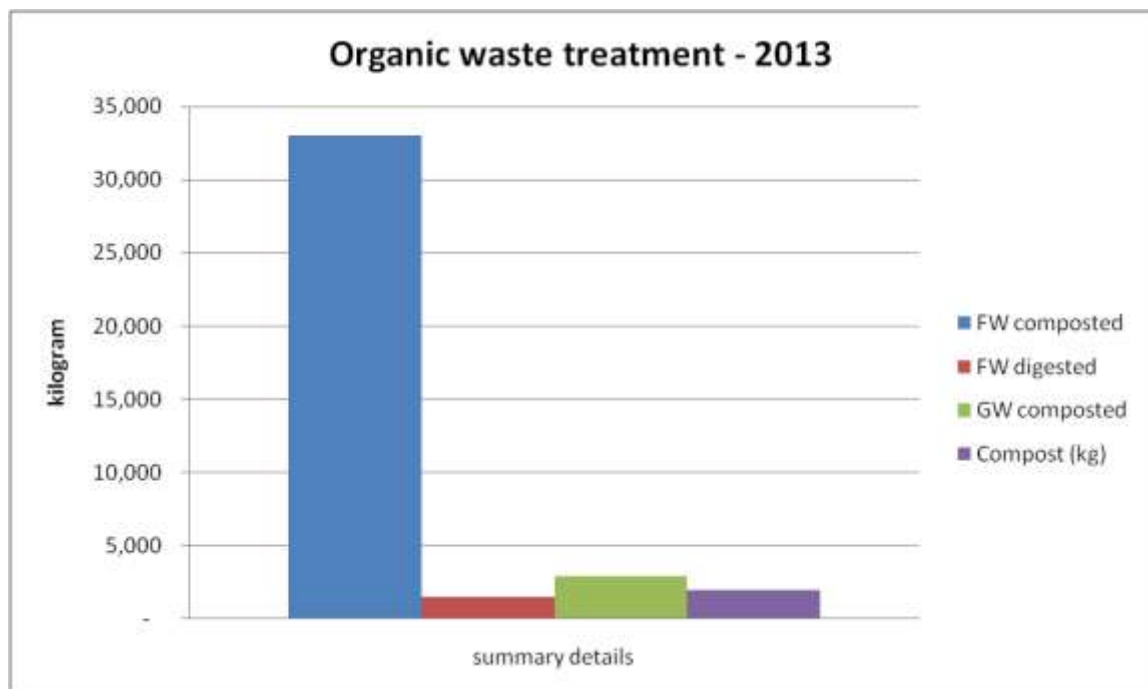


Figure 2.3: Organic waste treatment in year 2013

Table 2.0: Organic waste treated by month in 2013

Month	Recovered (kg)	Disposed (kg)	FW composted	FW digested	GW composted	Total treated	Compost (kg)
Jan-13	3,356	-	2,583	232	541	3,356	285
Feb-13	2,683	-	2,528	-	155	2,683	190
Mar-13	3,163	-	2,551	350	262	3,163	285
Apr-13	1,059	-	986	-	73	1,059	-
May-13	3,361	-	3,056	242	63	3,361	351
Jun-13	3,097	-	2,883	75	139	3,097	90
Jul-13	470	-	-	-	470	470	90
Aug-13	489	-	234	-	255	489	260
Sep-13	4,203	-	3,822	138	243	4,203	-
Oct-13	5,570	-	5,086	167	317	5,570	-
Nov-13	5,208	-	4,758	171	279	5,208	-
Dec-13	4,848	-	4,525	159	164	4,848	427
<b>Total</b>	<b>37,507</b>	<b>-</b>	<b>33,012</b>	<b>1,534</b>	<b>2,961</b>	<b>37,507</b>	<b>1,978</b>

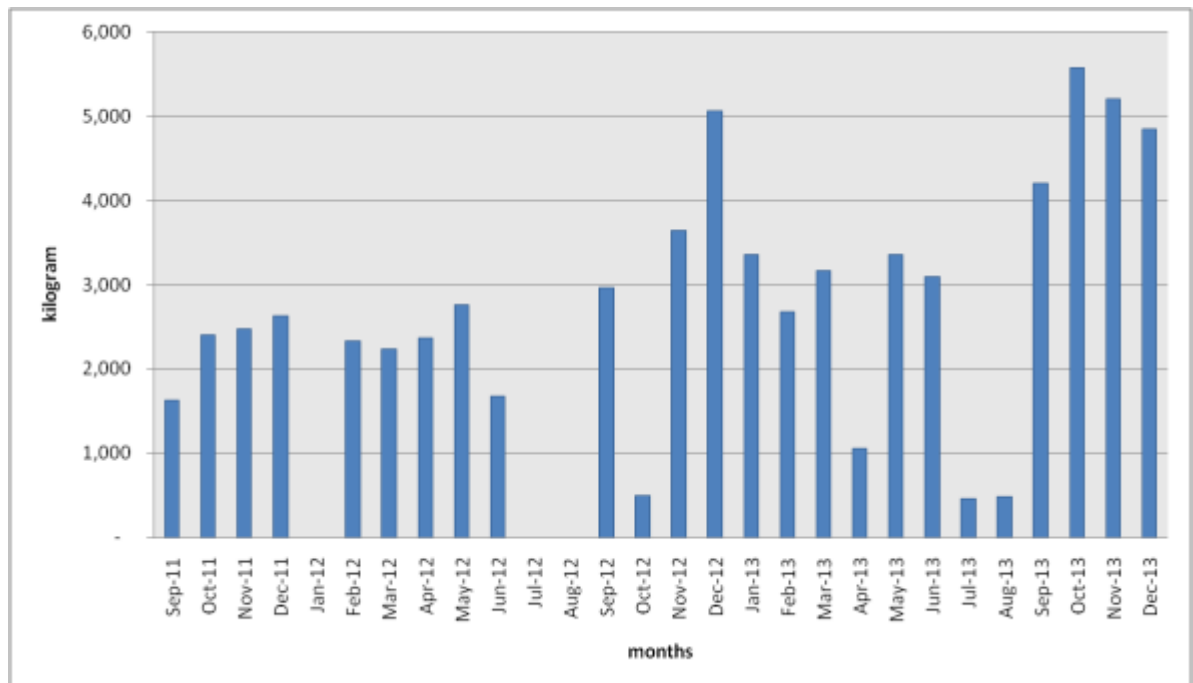



Figure 2.4: Organic waste treated since operation in September 2011



*Figure 2.5: Tipping of kitchen waste for food waste recovery*

	<p>Source segregated kitchen waste tipped by JPPHB for composting</p>
	<p>About 300kg of kitchen waste</p>
	<p>Food waste is recovered and put in two 240L wheelie bins for leaching of excessive liquid from the food waste</p>

*Figure 2.6: Loading of food waste into composting piles*

	<p>Loading of food waste</p>
	<p>Food waste in the composting pile</p>
	<p>Covering of composting pile with finished compost</p>

Figure 2.7: Other pictures



Sometime kitchen waste directly sent to be fed into the composting pile



Composting piles with green waste



Food waste (rice) that usually used for Cowtec<sup>®</sup> AD unit



*Figure 2.8: Compost out from composting piles for curing in water tanks*



Taking out of compost from composting pile



Unloading of compost to water tank for curing



Compost in water tank for curing or maturation for a period of 3-4 weeks before grinding

Figure 2.9: Grinding of compost



Grinder screen fabricated specially for the grinder



Conditioning of grinder screen



Grinding of finished compost

Figure 2.10: Grinded compost for packaging



Compost grinded



Compost packed in gunny sacks



Compost stored in gunny sacks



Figure 2.11: Filtering of digestate from Cowtec AD



Simple filtering system for digestate from Cowtec AD



Digestate filtered with textile



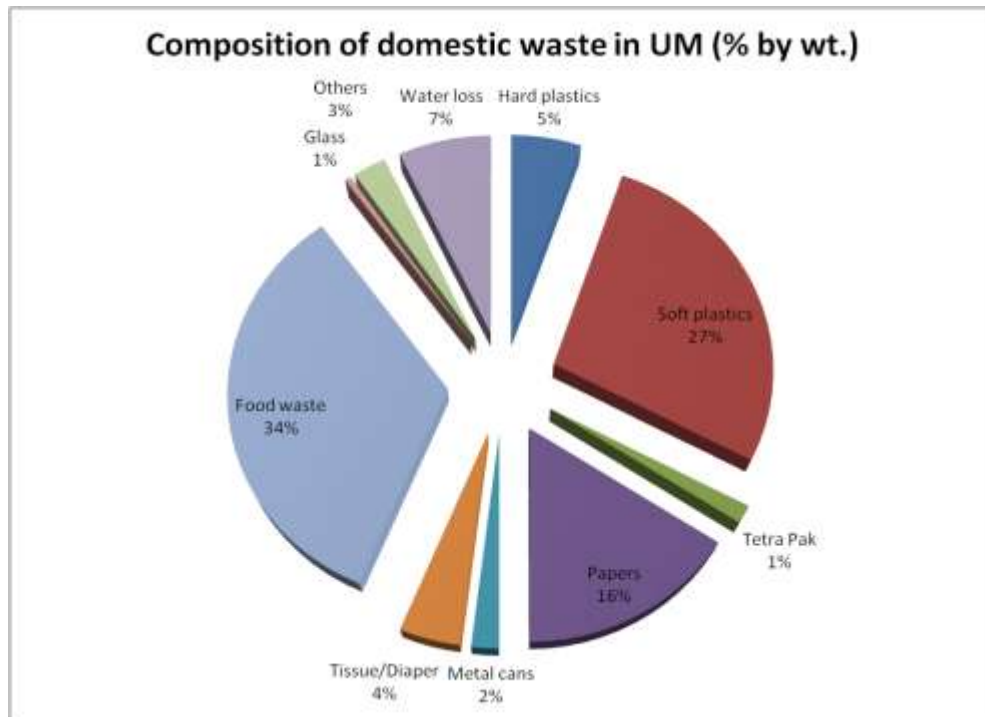
Drying of solid filtered under the sun

### Sub-section 2.3: On-going research

Some researches related to the existing projects of ZWC were carried out in 2013 and submitted to some ISI journals for publication:

- 1) Ng, C. G. and Yusoff, S. (2013). "Municipal solid waste characterization for a university campus: University of Malaya". *Paper sent to Sains Malaysiana in September 2013*. [Under review]
- 2) Ng, C. G. and Yusoff, S. (2013). "Assessment of GHG emission reduction potential from food and yard waste management Higher Educational Institution in Malaysia". *Paper sent to Sains Malaysiana in September 2013*. [Under review]
- 3) Ng, C.G. and Yusoff, S. (2013). "Substance balance and life cycle inventory of institutional centralized co-composting of food waste and yard waste in tropical country". *Paper sent to Sains Malaysiana in September 2013*. [Under review]
- 4) Ng, C. G., Yusoff, S., Morad, N. and Ang, C. T. (2013). "Modelling of Alternative Organic Municipal Solid Waste (OMSW) Management and Its Life Cycle Impact Assessment". *Paper sent to International Journal of Life Cycle Assessment in December 2013*. [Under review]

An ad-hoc waste composition study was carried out in March 2013 and it was found that food waste forms the major component of residual waste in UM with 34% by weight followed by soft plastics (27%) and papers (16%). The high percentage of soft plastics attributed to the high water content attached to the soft plastics as the main packaging material in Malaysia after papers. (Figure 2.5)



*Figure 2.12: Composition of residual waste in UM (by weight)*

Besides, ZWC was invited by PPSPPA (Solid Waste Management and Public Cleansing Corporation) to give a presentation for their annual seminar on waste management. Jaron Keng had given a presentation on recycling scenario in Malaysia: Issues and challenges.

*Figure 2.13: Jaron as the presenter represented UM Cares for the PPSPPA seminar*



*Figure 2.14: Research work for the study of carbon emission from composting*

	<p>3,000L water tank used for the capture of carbon emission of composting</p>
	<p>Compost under the water tank</p>
	<p>Closer view of the compost inside the water tank after study period</p>



Figure 2.15: Waste characterization study

	<p>Solid waste composition study using “quartering” method</p>
	<p>Sorting of solid waste</p>
	<p>Sorting of food waste for characterization</p>



Figure 2.16: Sorting of waste for characterization

 A close-up photograph showing several individuals wearing gloves and bright clothing, sorting through a large pile of waste on a red tarp. They are placing items into black plastic baskets. One basket in the foreground is filled with various pieces of plastic waste.	<p>Sorting of waste</p>
 A photograph showing two black plastic baskets filled with sorted waste. The waste is segregated into different types, including plastic bags, paper, and other debris. The baskets are placed on a red tarp.	<p>Different types of waste segregated in baskets</p>
 A wide-angle photograph showing the overall waste sorting activity. Several people are working on a red tarp spread on the ground, sorting through a large pile of waste. A large black plastic basket is in the foreground, and a concrete wall is visible in the background.	<p>View of the waste sorting activities</p>

#### **Sub-section 2.4: Collaboration with external parties**

ZWC had formed partnership with several internal PTj and external parties to improve the waste management and recycling efforts in the campus. The new internal PTj that collaborate with ZWC are UKKP (Health, safety and environment unit) and CITRA (Industrial relation center). ZWC is still working closely with TNC (Development), JPPHB and all residential colleges to improve the recycling and food waste segregation in the campus. The external parties are:

1. CH Green Sdn Bhd: Cowtec anaerobic digestion
2. Kris Biofuel: Used cooking oil collection
3. Zie Enterprise: Recycling collection from most PTj
4. T-Pot E&E Sdn Bhd: E-waste collection
5. Life Line Clothing: Used cloths collection
6. Isti Tulin Sdn Bdh and Pelangi Sutera Sdn Bhd: Waste data provision

ZWC also forms collaboration with other higher learning institute such as UTM in food waste conversion animal feed. In November 2013, ZWC paid a visit to UTM's food waste to animal feed processing center to learn more about the food waste landfill diversion initiative in UTM.

Figure 2.17: Bulky waste and scrap metals storage site run by JPPHB

	<p>Storage site for bulky waste and scrap metals</p>
	<p>Bulky waste with scrap metals</p>
	<p>View of the scrap metal storage site</p>

Figure 2.18: Used cooking oil collection by Kris Biofuel



Used cooking oil collection drum



Weighing of UCO drums



Kris Biofuel collection truck



Figure 2.19: Recycling vendor and TPot Computer

	<p>Recycling collection by Zie Enterprise</p>
	<p>TPot Computer</p>
	<p>Visit to Cowtec AD</p>

Figure 2.20: Open top bins of Alam Flora sub-con



12m<sup>3</sup> open top Ro-Ro bin



12m<sup>3</sup> open top Ro-Ro bin – Isti  
Tulin Sdn Bhd



Figure 2.21: Open top bins of UM appointed contractor

	<p>15m<sup>3</sup> open top bin for green waste and bulky waste</p>
	<p>15m<sup>3</sup> open top bin for domestic waste from faculties</p>
	<p>New “20ft” long open top Ro-Ro bin for green waste</p>



*Figure 2.22: Visit to food waste to animal feed site at UTM*

	<p>Mixing of food waste with coconut fiber</p>
	<p>Drying of animal feed</p>
	<p>Dr Sumiani and Jaron visited the site</p>



## Sub-section 2.5: Data collection and waste flow

Data is important as baseline for improvement. ZWC is in the process of acquiring accurate data of all wastes arise in UM campus. University of Malaya is selected as one of the pilot projects under LCCF (*Low Carbon City Framework*) waste data collection is essential to calculate the carbon emission profile from waste management in the campus. ZWC is in the process of acquiring accurate data of all wastes arise in UM campus and draw up the comprehensive waste flow for UM. Data of different waste streams were gathered from different parties. For instance, domestic waste data obtained from Alam Flora sub con, green waste and bulky waste from UM appointed contractor, recyclable materials from the largest recycling buyer in UM, e-waste from T-pot Computer, clinical waste from UKKP (Faber), scrap metals from JPPHB and food waste from ZWC. The tonnage/day of different waste streams, waste flow mapping and waste streams by weight are shown in the table and figures as follow.

Waste streams	Tonnage/day
Domestic waste	4.48
Green waste & bulky waste	2.10
Recyclables	0.50
E-waste	0.08
Clinical waste	0.09
Scrap metals	0.06
Food waste	0.07
Construction & demolition waste	NA

Table 2.1: Estimated tonnage/day of different waste streams in UM

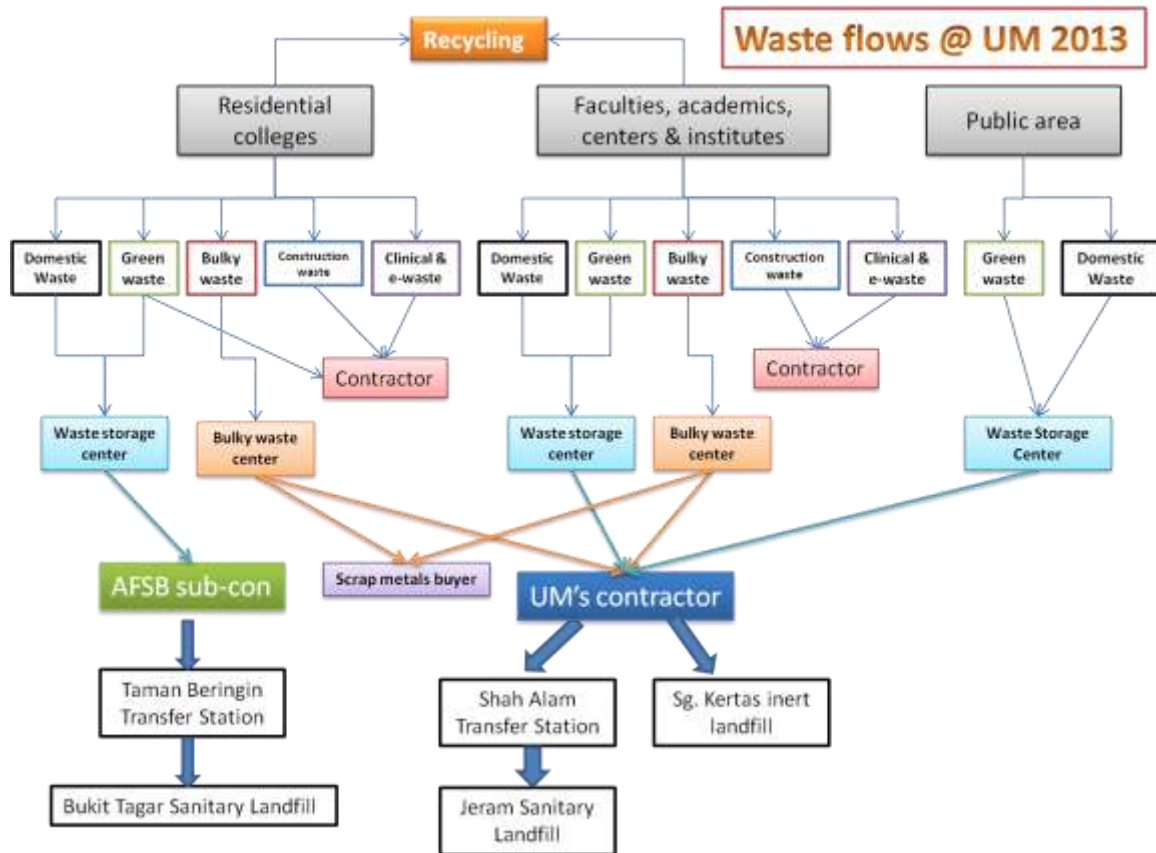


Figure 2.23: Mapping of waste flow in UM

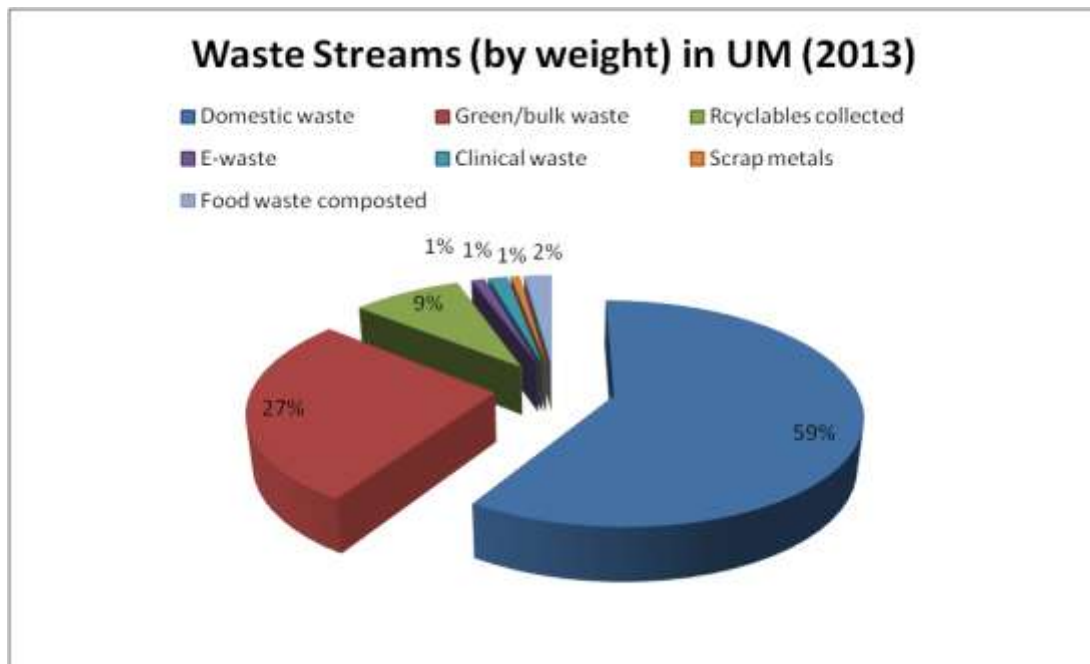


Figure 2.24: Percentage of waste streams by weight

## Sub-section 2.6: Visitors and media publicity

ZWC had received more than 30 visitors from UM communities and external parties in year 2013. The visitors comprised of students and staffs, lecturers, researchers, interested parties/individuals, reporters, higher learning institutes, etc. There were several media coverage by local newspapers and news coverage by Astro Awani. Most of the students visited the UM composting center for assignments, research and educational visit.

Figure 2.25: Coverage on ZWC in TheStar, Feb. 2013







Figure 2.26: Jaron interviewed by Astro Awani at UM composting center in October 2013



Figure 2.27: Interview (live) at Astro Awani on waste management issues in Malaysia

Figure 2.28: Interview by SinChew reporter



Visit to KK5 for interview



Penyelia of KK5 was showing the OR-bin with green bag



Reporters visited to UM composting site to interview Dr Sumiani

Figure 2.29: Visitors to UM composting center (1)



Visit by Prof. Kurunathan and Cowtec inventor – 18<sup>th</sup> January 2013 (Cowtec MOU signing)



Visit by SinChew reporters on 30<sup>th</sup> January 2013



Visit by AP Dr Fatimah and her students from faculty of economy on 27<sup>th</sup> May 2013



Figure 2.30: Visitors to UM composting center (2)

	Visit by professors and students from civil engineering department on 29 <sup>th</sup> June 2013
	Visit by UM Cares volunteers on 18 <sup>th</sup> May 2013
	Visit by Dato' Rohana, UM TNC (HEP) on 1 <sup>st</sup> July 2013

Figure 2.31: Visitors to UM composting center (3)



Visit by waste contractors from Australia on 12<sup>th</sup> of Sept.



Visit by Prof. Don Huisingh, chief of editor for Journal of Cleaner Production on 22<sup>nd</sup> Aug



Visit by 6<sup>th</sup> residential college on 25<sup>th</sup> Oct



Figure 2.32: Visitors to UM composting center (4)

 A group of four people standing in front of a white composting container. From left to right: a woman in a purple hijab and black shirt, a woman in a blue hijab and blue dress, a man in a white shirt and brown pants, and a woman in a pink hijab and patterned dress.	<p>Visit by students from faculty of science on 27<sup>th</sup> Nov.</p>
 Two men standing in front of a white composting container. The man on the left is wearing a light blue shirt and dark pants, and the man on the right is wearing a blue shirt and dark pants.	<p>Visit by researcher from UTM on 27<sup>th</sup> Nov.</p>
 Four people standing next to a silver car with its trunk open. From left to right: a woman in a pink hijab and patterned dress, a man in a dark shirt and dark pants, a man in a white shirt and dark pants, and a man in a white shirt and dark pants.	<p>Visit by staffs from JKA on 3<sup>rd</sup> of Sept</p>

Figure 2.33: Visitors to UM composting center (5)

	<p>Visit from Politeknik Nilai on 8<sup>th</sup> of Oct.</p>
	<p>Visit from 1<sup>st</sup> year environmental engineering students on 8<sup>th</sup> Oct.</p>
	<p>Visit by En. Azril from UKKP on 25<sup>th</sup> Oct.</p>

Figure 2.34: Explanation to visitors on the composting operation



Jaron explained the composting to students of UM



Jaron explained the composting to students of Politeknik Nilai



Jaron explained the composting to students of JKA

### **Section 3.0: Challenges and way forward**

ZWC will continue the journey of recycling, recovery, treatment for landfill diversion of solid waste to achieve an integrated and sustainable waste management model in the campus of UM. From various data collected in year 2013, ZWC estimated the present campus recycling rate by weight of 13-14%. To further increase the recycling rate, several important projects have to be carried out and these projects are outlined in the following sub-sections. These projects are:

- 1.) Introduction of formal separate recycling collection in UM to regulate the recycling activities in the campus and comprehensive data collection.
- 2.) Regulate the collection and disposal of inert waste especially construction, demolition and renovation (CDR) waste.
- 3.) Development composting system for green waste which represents more than a quarter of the total waste arises in UM.
- 4.) Comprehensive waste and recycling data collection and development of database for waste generation and waste/material flow in UM

To enable these projects, collaboration with various parties internally or externally is essential to form strategic partnership to realize common goal of landfill diversion.



### **Sub-section 3.1: Waste and recycling data collection**

Data collection is very important for the improvement of waste management system. Data availability enables targets setting for continual improvement such as to increase the recycling rate, composting tonnage, etc. Presently, there is an absent of waste data collection in UM. For instance, the tonnage of waste disposed to landfill is not reported to UM management. ZWC is working with UM Cares and UM top management to develop waste data collection mechanism to capture all the waste and recycling data as well as waste flow.

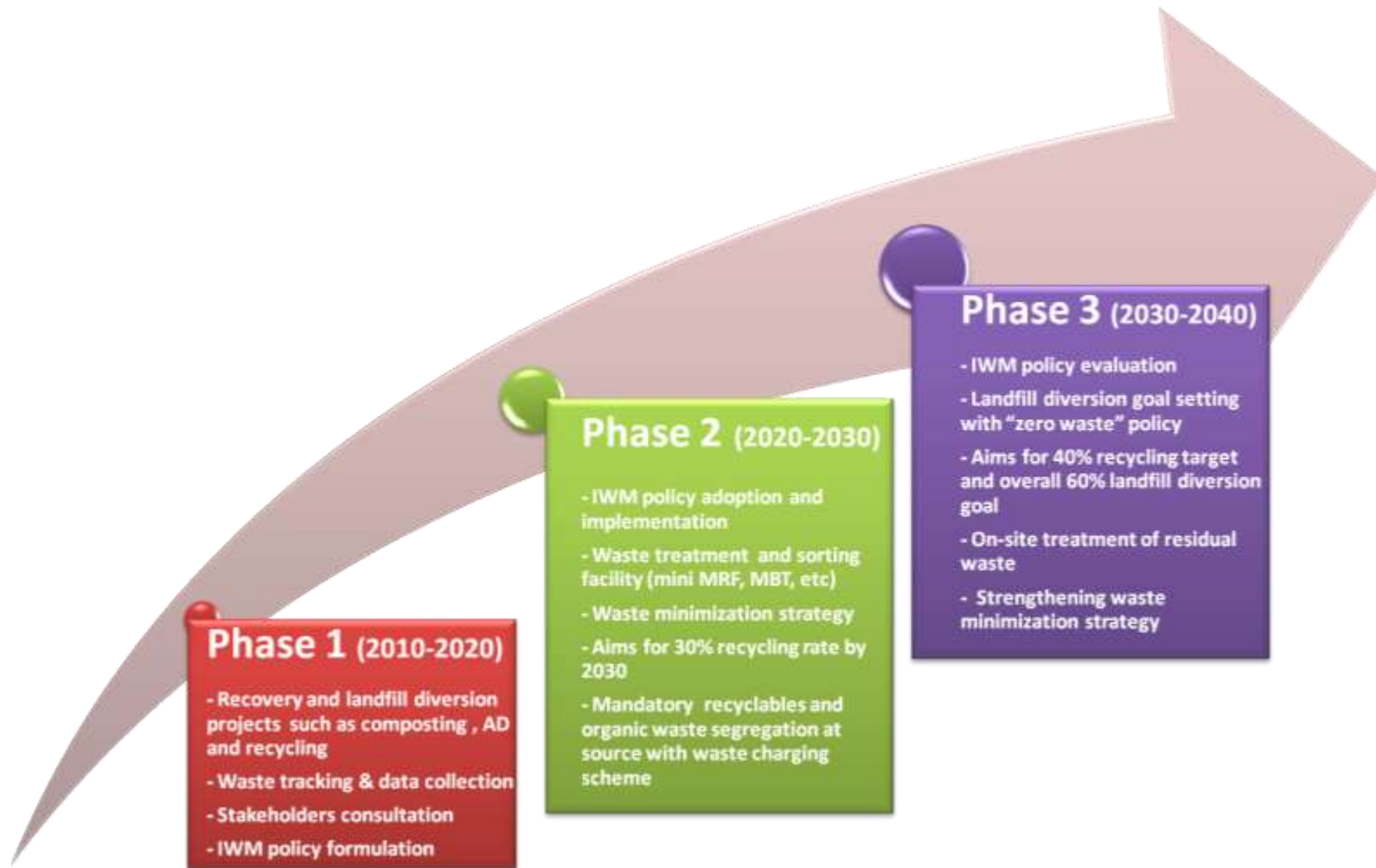
To capture the waste and recycling data in UM, formal recycling collection is important to control the flow of recyclable materials arise in the campus. Introduction of weighbridge at the UM waste storage center is imperative to obtain reliable waste and recycling data in the campus.

### **Sub-section 3.2: Roadmap of UM ZWC**

UM ZWC has developed a long term roadmap to achieve integrated waste management model in UM campus. The roadmap is a long term plan to achieve 60% landfill diversion in the period of about 30 years. Presently, ZWC is in the first phase of agenda setting and policy formulation, especially for organic waste and recycling. Three phases are proposed:

1. Phase 1 (2010-2020): Agenda setting and policy formulation
2. Phase 2 (2020-2030): Policy adoption and policy implementation
3. Phase 3 (2030-2040): Policy evaluation and continual improvement

Figure 3.0: Roadmap of UM ZWC



Institutionalization of separate organic waste collection and treatment system in UM is the key to achieve integrated waste management system. Green Bag Scheme is the first program to kick-start the food waste segregation practice in the campus. Organic waste made up almost half of total waste arise in UM campus and thus the recovery and treatment of organic waste is very important to increase recycling rate (landfill diversion rate). A strategic plan for organic waste treatment was prepared to achieve 100 tpa in phase 1 to 200 tpa in phase 3. The organic waste treatment was 27 ton in 2012 and 37 ton in 2013.



Figure 3.1: Strategy for food waste and green waste treatment capacity increment



Figure 3.2: Strategic plan for the development of organic waste treatment

### **Sub-section 3.3: Proposed projects in 2014**

Several projects are proposed to further increase the recycling rate in the campus especially organic waste and recyclable materials. Green waste size reduction and composting is the most desired project to further boost the organic waste treatment capacity while formal separate recycling collection is expected to improve the overall recycling collection in the campus from informal recycling buyers and ensure quality recycling data collection. A proper recycling collection system in the campus level will be developed with the project and intermediate recycling centers will be introduced in all PTj with a central recycling facility (MRF) at the present central waste storage area beside Damansara gate. It is expected as the first ever formal recycling collection in higher learning institute. Data collection system development for all wastes arise is another important project that is expected to capture more than 90% of the total waste data in the campus and eventually to 100%. This data collection is especially important for construction, demolition and renovations (CDR) wastes normally disposed to illegal dumpsites and usually contain hazardous waste such as fluorescent lamps and paint cans. Similarly applicable to open top bins hired by PTj to collect green waste and bulky waste.

The three proposed projects are:

1. Green waste size reduction and windrow composting
2. Formal separate recycling collection at campus level
3. Data collection system for all waste arise in campus



Figure 3.3: Construction waste bins hired by different PTj

	<p>Open top bin for renovation waste at KK12</p>
	<p>Pick-up of renovation waste in KK4</p>
	<p>One open top bin for renovation waste in faculty of engineering</p>

*Figure 3.4: Fluorescent lamps found in open top bin for renovation waste*



Fluorescent lamps normally can be spotted at open top bin



Open top bin for renovation waste



Fluorescent lamps spotted at open top bin

*Figure 3.5: Open top hired by PTj for green waste collection*

 A photograph of an open-top green waste collection bin at location KK3. The bin is a large, rectangular structure with a metal frame and a curved metal roof. It is situated outdoors on a paved area. In the foreground, there are some wooden pallets and a blue wheelbarrow. The background shows some greenery and a building.	<p>Open top bin for green waste at KK3</p>
 A photograph of an open-top green waste collection bin at location KK5. The bin is a large, rectangular structure with a metal frame and a flat metal roof. It is situated outdoors on a paved area. In the foreground, there are some wooden pallets and a blue wheelbarrow. The background shows some greenery and a building.	<p>Open top bin for green waste at KK5</p>
 A photograph of an open-top green waste collection bin at location KK12. The bin is a large, rectangular structure with a metal frame and a flat metal roof. It is situated outdoors on a paved area. In the foreground, there are some wooden pallets and a blue wheelbarrow. The background shows some greenery and a building.	<p>Open top bin for green waste at KK12</p>

#### **Section 4: Summary and conclusion**

ZWC requires substantial support from UM top management for its sustainability. The sustainability of ZWC is important for UM's reputation locally and internationally. ZWC has successfully developed several key projects that serves as cornerstone to increase recycling rate in the campus. ZWC hopes all stakeholders (residential colleges and faculties) will collaborate to achieve the goal of sustainable waste management and ultimately zero waste in UM campus.



Figure 4.0: Visit by UM Cares volunteers

 A group of UM Cares volunteers, some wearing yellow and black vests, are gathered around a large pile of organic waste. One volunteer in a green shirt and a wide-brimmed hat is using a green wheelbarrow to move material from the pile. The site is covered by a large, light-colored tarp.	<p>Visit by UM Cares volunteers on 18<sup>th</sup> May</p>
 A group of people, including volunteers and visitors, are gathered under a large tarp. A long, narrow pile of organic waste is being turned over by a person using a long-handled tool. The scene is outdoors, with trees visible in the background.	<p>Demo of composting piles turning for aeration</p>
 A group of people are gathered around a table outdoors. On the table, there is a white container and some equipment. A person in a green shirt is pointing at something on the table. The background shows a building and some trees.	<p>AD digestate filtering system</p>

Figure 4.1: Segregation of food waste in green bags

	Green bags segregation in KK1
	Green bags segregation in KK5
	Green bags segregation in cafeteria at faculty of science

Figure 4.2: UM Cares environmental audit (1)

	<p>PRO bin at KK1</p>
	<p>Recycling bins at KK6</p>
	<p>Recycling bins at KK6</p>

Figure 4.3: UM Cares environmental audit (2)

 A photograph of a pink wall in a hallway. A large vertical banner for the 'Green Bag Scheme' is posted on the wall. The banner features a green background with a large black silhouette of a person and text in Malay. To the right of the banner, a fire extinguisher is mounted on the wall. A mirror is visible on the wall to the right of the fire extinguisher.	<p>Green Bag Scheme bunting at KK7</p>
 A photograph of a recycling area. Three small, round, plastic recycling bins are lined up against a light-colored wall. The bins are green, blue, and green from left to right. Above the bins, three small informational posters are pinned to the wall. To the right of the bins is a large black trash bin.	<p>Recycling bin at KK3</p>
 A photograph of three large, wheeled recycling bins. The bins are orange, blue, and brown. They are lined up in a row on a tiled floor. The blue bin is in the center, flanked by the orange and brown bins.	<p>Recycling bin at KK9</p>



Figure 4.4: UM Cares environmental audit (3)

	Recycling bin at KK8
	PRO bin at KK8
	Recycling bin at KK10

Figure 4.5: UM Cares environmental audit (4)

	<p>Recycling bin at KK10</p>
	<p>OR-bin at KK11</p>
	<p>Recyclable materials collected by janitors at KK11</p>