EFFECTS OF TRAINING AND PROVISION OF COLLECTION BIN ON SOURCE-SEPARATION OF SOLIDS WASTES AMONG WORKERS OF A TERTIARY INSTITUTION IN NIGERIA

*O.O. Elemile, G.R.E.E Ana, M.K.C Sridhar

Department of Civil Engineering, College of Science and Engineering
Landmark University, Omu-Aran, Nigeria

elemile.olugbenga@lmu.edu.ng

ABSTRACT

Source-separation is a solid waste management strategy which aids recycling. This concept is relatively new in Nigeria. The study therefore assessed the effects of a training intervention, education and awareness and provision of a refuse bin on workers' practice of -separation. A validated questionnaire with a 5-point knowledge scale was used to collect data at baseline from two groups made of the Experimental Group (EG) (180) and Control Group (CG) (168) workers respectively in the University of Ibadan on source-separation of solid wastes. A fabricated waste bin with three compartments was placed only at the EG and the workers there were trained on its utilization for source-separation of solid wastes. The CG was left to continue with the usual practice of waste collection without source-separation. At the end of the one-month intervention, a post-intervention data collection from the two groups was conducted with the same questionnaire used at baseline. Descriptive statistics and t-test were used to analyse data. Findings revealed that the training and provision of a collection bin was effective in facilitating the practice of source-separation among the Experimental Group. Therefore, advocacy, training and provision of refuse bins are needed to promote the adoption of source-separation in the institution.

Keywords: Source-separation, Waste sorting, Training intervention

INTRODUCTION

The day to day human activities generally draw inputs from the natural base in his environment. This may be by way of raw materials for industrial production or by direct utilization of the resources from the reserve in land. However, the use of these resources in turn results in the generation of various classes of unwanted, useless, damaged and discarded materials termed "waste" (Anurigwo, 2000). As urbanization continues to take place, the management of solid waste continues to raise major concerns for the environment and public health in urban areas of many developing countries. Such concerns are serious, particularly in the capital cities that, are often gateways to the countries of foreign diplomats, businessmen, and tourists. The poor aesthetics of these cities results in negative impacts on official and tourist visits and foreign investment (Ogawa, 2007).

Waste segregation refers to a solid waste management practice of separating and storing different materials found in

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Correspondence author

solid waste in order to promote recycling and re-use of resources and to reduce the volume of waste for collection and disposal (Bennagen *et-al.*, 2002). Waste segregation at the household level is not widely practiced and waste recycling is minimal. The reasons are not far-fetched, traditionally most people forget about their rubbish after leaving it out for collection, or after visiting 'the dump'. In recent years, however, the growing awareness of the environmental effects of indiscriminately disposing of waste either openly or into trenches has increased the community's expectations for enhanced environmental quality standards.

In Nigeria, the commonly practiced waste management option basically involves the collection of mixed waste materials and subsequent dumping at designated dumpsites. The solid wastes are seldom well disposed and it is gradually becoming an issue of environmental concern as solid wastes are dumped erratically into streams, drains and open dumps thus attracting vectors and pests. This can be attributed to poor waste management practices as it is not a practice to separate waste materials at source or any point during its management (Adekunle et al., 2011); therefore, the introduction of the practice of waste-separation and segregation would go a long way in reducing the problem.

Although waste bins had been used in advanced countries for the collection of source separated solid waste, the conventional system generally use a system of bins at the individual residential and business settings. These bins must be washed by the individual users on a regular basis because there is a significant amount of waste deposited in the bins or contained in torn plastic bags. Also, problems of conventional separation and collection systems include the high cost and the fact that they do not adequately address the disposal of compostable waste materials. Additionally, conventional curbside bins are difficult to collect after any episode of rainfalls, as a result, garbage is often left on curbs for several days.

There is therefore the need to look at the utilization of appropriate waste bins with different compartments in developing countries for sorting of waste at the collection stage at the community level and how this influences the practice of source separation among people in developing countries.

The concept of source-separation as a waste management strategy is relatively new especially in developing countries. Therefore, the purpose of our study was to assess the effects of adopting source-separation of waste coupled with training in the management of waste in the non-residential areas of the University of Ibadan.

MATERIALS AND METHODS

The Study Area

Ibadan. Ibadan is the capital of Oyo State in Nigeria and the largest city in West Africa in terms of geographical area and even population (Lagos is a State which comprises of cities and towns). It is an indigenous African town that lies between latitude $7^\circ 23'47^\circ$ N and $3^\circ 55^\circ$ 0' east of prime meridian (Wikipedia, 2014). Ibadan is located in south-western Nigeria

in the south-eastern part of Oyo State about 120 km east of the border with the republic of Benin in the forest zone close to the boundary between the forest and the Savana. The city ranges in elevation from 150m in the valley area, to 275m above sea level on the major north-south ridge which crosses the central part of the city. The city's total area is 1,190 square miles (3,080 km²) (Wikipedia, 2014). By the year 2000, it is estimated that Ibadan covered 4000 km²) (Onibokun and Faniran, 1995). Most of the people are engaged in petty trading and small-scale business, while others are civil/public servants. Ibadan is noted for several institutions and over 300 schools made up of both public and private nursery, primary and secondary schools.

The University of Ibadan. The study was carried out in selected areas in the University of Ibadan (UI). The University of Ibadan is made up of 13 Schools which offer both undergraduate and postgraduate programmes viz -Arts, The Social Sciences, Technology, Basic Medical Sciences, Pharmacy, Public Health, Law and others. The Schools are housed in 205 Academic Blocks; 9 students Hostels; Senior and Junior Staff quarters, commercial centres such as the Students' Union Building and the Black market. Other sections in U.I include: The Central Administration, the Kenneth Dike Library and the University Health Centre. Estate and Works Department, Waterworks, Workshops and Power house. Others are the University Press, Black Market, Sports Complex, Students' Union Building (SUB), Senior Staff Club, Abadina Community Centre, Trenchard Hall, Botanical Garden, Zoological Garden, shops, primary and secondary schools. (University Planning Unit, 2007 -2008 Statistics). The university has a total population of 33,481; out of which 29,021 are students with 35% post graduate and 65% undergraduate, 1,197 are academic staff and 3,263 are non-academic staff (Oyedele, 2013).

The study population comprised workers of the Students' Union Building (SUB) who are mostly business operators, and those of the Faculty of the Social Sciences and Works Department which consists of academic and non-academic staff and students of the University of Ibadan respectively.

Study Design

A quasi-experimental design was adopted with workers/traders of the Students' Union Building (SUB) serving as the Experimental Group (EG), while those at Works Department (WD) and Faculty of the Social Sciences (FSS) constituted the Control Group. The study involved field survey, design and fabrication of a three compartment wastes bin, as well as the training of workers on and the application of the designed and fabricated waste bin for source-separation of solid wastes at the Students' Union Building.

Questionnaire Administration

A 53-item, semi-structured, interviewer administered questionnaire was developed and used for data collection. The questionnaire was divided into five major sections for

ease of administration. The sections include demographic section, knowledge about source-separation and waste recycling on campus, attitude towards source- separation of solid waste on campus, practice of source separation and waste recycling on campus and problems of current waste management options on Campus. The questions on knowledge include: Which of these wastes do you generate/handle most often in your place of work/shop/office? What do you know about waste recycling? Have you heard of source-separation of solid wastes? If yes, what do you know? In what way can waste generated be converted into useful materials? Which of these wastes do you think can be converted into useful materials? In all 348 validated questionnaires were administered to elicit information at baseline from the study areas namely; the SUB, FSS and WD all in the University of Ibadan. Knowledge was assessed based on a 5-point knowledge scale. The same questionnaire used at baseline was then administered at all locations after the training and provision of the fabricated waste collection bin for the SUB following an intervention period of a month. This was done to assess the effects of training and provision of a fabricated waste collection bin on source-separation of solid wastes among workers in the University of Ibadan. Four trained Research Assistants conducted face-to-face interviews with respondents (business operators and workers) in the study areas. The interviews were conducted in English or Yoruba (the language widely spoken in the study area) to ensure good comprehension. The Structured questionnaire was administered to all the research participants except the cleaners at the Faculty of the Socials Sciences and Works Department.

Sampling Technique

Sampling Procedure for Study Locations. The non-residential areas of the University comprising the Students' Union Building (SUB), University of Ibadan Works Department (WD) and the Faculty of the Social Sciences (FSS) were purposively selected.

Sampling Frame. The sampling frame included 180 workers of the SUB as the experimental group and 72 workers of the FSS and 96 workers of the WD making 168 as the control group.

Training of Participants on Source Separation of Solid Waste

A major Training session was conducted for randomly selected 94 business operators domiciled in the SUB. The training was to enhance the knowledge, attitude and practice of the business operators on source-separation and recycling, introduce them to source-separation of solid waste with the use of a three-compartment solid waste bin to facilitate the adoption of source-separation as a waste management strategy among workers in the SUB. A pre- evaluation test was conducted before the training and the same test was conducted after the training session so as to appraise the effects of the training on the participants KAP.

Design and Fabrication of a Three Compartment Waste Bin

After the determination of weight and assessment of solid wastes generated across the three locations, a single unit three compartment waste collection bin was designed and fabricated. The appropriate waste bin was fabricated to accommodate the weight of 25 kg for each of the three types of waste that was highly generated at the University of Ibadan Students' Union Building. The wastes were; paper, nylon and plastics and food waste. The volume of the appropriate bin was obtained from the density obtained for each of the wastes at the Student Union Building. The bins for the paper and nylon and plastics were constructed from high gauge wire gauze with 25mm angle iron from the design dimensions while the frame was fabricated with 38mm angle iron. The bin for the food waste was fabricated from galvanized iron because of its malleability, lightness, availability, and antirust properties. The bins were painted accordingly viz: paper (Brown), plastics (Blue) and food waste (Green). The business operators at the SUB were trained on the proper use of the bin. Monitoring on the proper use and effectiveness of the bin was carried out for a month while the workers at the control group were left to continue their normal practices of waste management. Figure 1 illustrates the design of the bin using AutoCAD, while Plate 1 shows the fabricated three compartments waste bin.

Data Analysis and Management

Data was analyzed using SPSS computer software version 15. The results were presented in frequency tables, charts and figures at $P = 0.05$.

RESULTS AND DISCUSSION

Worker's Demographic Distribution

A total of 348 respondents comprising 168 from the Faculty of The Social Sciences (FSS) and Works Department (WD) who, and 180 from the Student Union Building (SUB) were interviewed. The characteristics as shown in Table 1 revealed that there were significant differences in the educational status, marital status, ethnic origin, sex and occupation of workers across the locations. Workers who had post-secondary education as their highest educational qualification were found mostly at the FSS and WD. Those with secondary education as their highest educational qualification were found mostly at the Students' Union Building. This may be due to the nature of occupation and the level of education required for such occupations.

More married workers were found at the FSS and WD. In contrast to this more un-married workers were found at the SUB. It is not surprising to find that the highest proportion of self-employed workers were found at the SUB because of the predominant commercial activity in place while the univer-
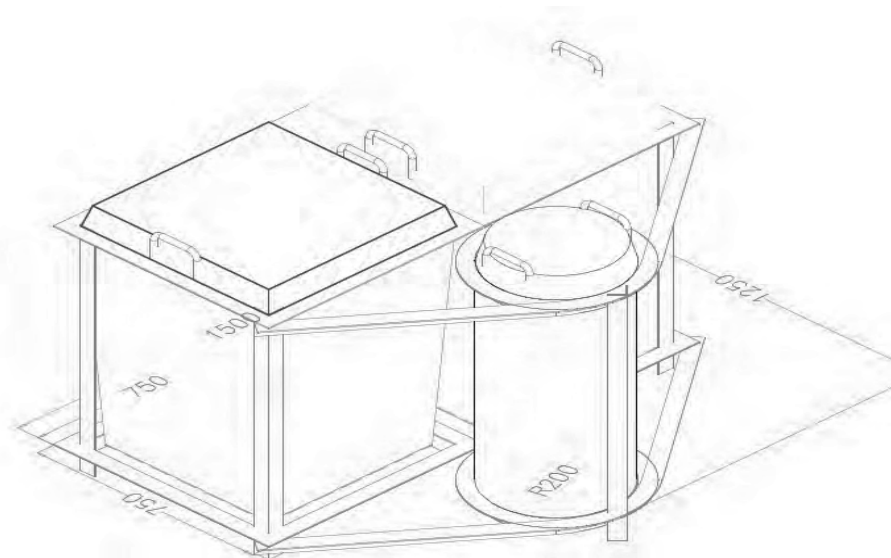
FIGURE 1
Design of a Three Compartment Waste Bin with the Aid of AutoCAD (dimensions are in mm)

PLATE 1
Fabricated Three Compartment Wastes Bin

sity employees were predominant at the WD and the FSS. Male workers were found mostly in all locations. Gender is a variable that has received consistent attention among researchers (Jones & Dunlap, 1992; Arcury & Christianson, 1993 and Petts, 1994). Raudsepp (2001) found that women were significantly more likely than men to be concerned with environmental problems. Females have been consistently shown to have higher environmentally conscious attitudes than men. The common reason advanced for gender differences is the different socialization patterns between boys and girls. More often than not, girls are made to carry out most of all the sweeping and cleaning activities; they are called upon more than their male counterparts to perform maintenance tasks at home or in schools. It would therefore take greater efforts for the concept of source separation to be accepted at the locations.

Knowledge of Participants on the Source Separation and Recycling of Solid Waste

Table 2 refers to the respondents' knowledge on waste recycling and source separation of solid waste. The

TABLE 1

Demographic Characteristics	FSS + WD N=168(%)	SUB N=180(%)
Age		
<20	5 (3.0)	18 (10)
20-29	36 (21.4)	115 (63.9)
30-39	82 (48.8)	31 (17.2)
40-49	36 (21.4)	14 (7.8)
50+	9 (5.4)	2 (1.1)
Sex		
Male	109 (64.9)	98 (54.4)
Female	59 (35.1)	82 (45.6)
Marital Status		
Single	34 (20.2)	124 (68.9)
Married	124 (73.8)	56 (31.1)
Religion		
Christianity	134(79.8)	145 (80.6)
Islam	34 (20.2)	35 (19.4)
Traditional	0 (0.0)	0 (0.0)
Ethnic Group		
Yoruba	131(78.0)	150 (83.3)
Igbo	33(19.6)	27 (15.0)
Others	4 (2.4)	3(1.7)
Educational Status		
Primary Education	18(10.7)	0 (0.0)
Secondary Education	62(36.9)	105 (58.3)
Tertiary Education	88(52.4)	75 (41.7)
Occupation		
Self employed	29(17.3)	180 (100)
University Staff	139 (82.7)	0 (0.0)
Number of Persons Per Office/Store		
1 to 5	91 (54.2)	146 (81.1)
6 to 10	57 (33.9)	16 (8.9)
11+	20 (11.9)	18 (10.0)

knowledge of respondents on waste recycling was low. Majority 67.2% at FSS and WD as against 72.6 % at SUB had no knowledge about recycling. FSS and WD (0.6%) in comparison with and SUB (1.2%) respondents reported the reprocessing of waste into useful items. At the FSS and WD 32.2% reported the conversion of waste into other products as against the 4.2% at SUB while 0.0% at the FSS and WD reported the dumping of waste properly in comparison with 21.4% at SUB. The knowledge of participants on source separation was low. Majority 72.8% had no knowledge of waste separation at source at the FSS and WD in comparison with 78.0% at the SUB. About 25.5% (FSS and WD) reported that source-separation indicates separating different waste components using different bins before disposal in comparison

with 14.9% at the SUB while 1.7% (FSS and WD) in comparison with 3.5% SUB) revealed that it means separation of papers and nylon from others.

Table 3 shows the proportion of respondents with good knowledge about source-separation of solid waste and recycling which was determined by the use of SPSS version 15.0 which categorized respondents who were able to have at least 3.75 which was the 75th percentile of the total scores of 5.00 as those with good knowledge of source-separation. It could be seen from the survey that the proportion of respondents (16.1%) at the FSS and WD had good knowledge than 8.2% at the SUB, although the knowledge of respondents was generally low. This could be associated to the fact that the respondents at the FSS and WD have a higher level of educa-

TABLE 2
Knowledge of Respondents on Recycling and Source Separation of Solid Waste at Baseline

Variable	Options	FSS + WD N = 168(%)	SUB N = 180 (%)
Knowledge on Waste Recycling	No Knowledge	121(67.2)	122(72.6)
	Reprocessing of Waste into Useful Ones	1(0.6)	2(1.2)
	Conversion of Waste into other Products	58(32.2)	7(4.2)
	Reuse of Waste	0(0.0)	1(0.6)
	Dumping of Waste Properly	0(0.0)	36(21.4)
Knowledge about Source Separation of Solid Wastes	No Knowledge	122(72.8)	131(78.0)
	Separation of wastes with different bins before disposal	43(25.5)	25(14.9)
	Separation of waste according to type	0 (0.0)	5(3.0)
	Separation of Paper and Nylon from Others	3(1.7)	6(3.5)
	Separation of Waste into useful and useless products	0(0.0)	1(0.6)

TABLE 3
Determination of Proportion of Respondents with Good Knowledge of Source-Separation of Solid Waste Using Percentiles

Percentile	Score	SUB N= 180%	FSS + WD N=168%
100th	5.00	0(0.00)	0(0.00)
75th	3.75	15(8.2)	27(16.1)
50th	2.50	48(26.7)	76(45.2)
25th	1.25	59(32.8)	34(20.2)
0th	0.00	58(32.2)	31(18.5)

tion. According to (Nixon and Saphores, 2009); (Oskamp et al., 1991) that the level of education of people will influence the knowledge on the environment and waste management. This is because they are more likely to access information from friends, newspaper, television and books. Chanda (1999) also reported that environmental concerns vary according to education and income levels. The low knowledge of respondents in general agrees with the findings of Grodzinska- Jurczak et-al (2003) that the level of knowledge among people regarding municipal waste and waste management is low and incomplete.

Effect of Training Session on Knowledge of Source Separation

A mean score of 4.98 was obtained from the pre-training evaluation test which was conducted for 96 workers at the SUB and after the training, the same questions used during pre-evaluation were used for post evaluation revealed a mean score of 5.60 making an increase of 12.5%. This confirmed and indicated an increase in participant's knowledge.

Table 4 shows the statistical analysis of the mean knowledge scores of the workers. It revealed no significant difference were observed at the baseline between the Mean knowledge scores of Experimental group (EG) and Control group (CG) respectively. Significant difference was observed between The Mean baseline knowledge score of EG and that of its post-intervention mean score. The mean baseline knowledge score of CG and the post-intervention score showed no significant difference. The difference between the two groups' post-intervention mean scores was significant ($p<0.05$). This

TABLE 4
Evaluation of the Changes in the Mean Knowledge of the Experimental and Control Groups Before and after Intervention

Parameter	Options	Experimental Group SUB (N=180)	Control Group FSS + WD (N = 168)	P- Value
Knowledge	Pre-Intervention Mean Score	2.2 ± 1.5	1.6 ± 1.1	> 0.05
	Post-Intervention Mean Score	3.0 ± 1.3	1.9 ± 0.6	< 0.05
	P-Value	< 0.05	> 0.05	

revealed that at baseline, the proportion of workers with adequate knowledge of source-separation and recycling of solid waste among the workers was low and inadequate. This is in agreement with the findings of Grodzinska- Jurczak *et-al.*, (2003) who stated that the level of knowledge among people regarding municipal waste and waste management is generally low and incomplete. After the training and provision of the bin, there was significant increase in knowledge among the experimental group while at the control group where there was no intervention there was no increase in knowledge. It was therefore ascertained that the training and provision of a collection bin was effective in facilitating the practice of source-separation among the Experimental Group. This corroborates the findings of Grodzinska- Jurczak et-al (2003) which reported that environmental education had a positive and significant impact on environmental knowledge.

Effect of Environmental Training and Provision of Wastes Bin on Attitude

The results of the survey as shown on Table 5 revealed the attitude of workers towards waste recycling and source-separation at baseline and after intervention respectively. Among the EG, 5.6% and 52.0%, agreed that waste recycling was necessary in the University of Ibadan Community at baseline and post intervention respectively. Another 12.8% at baseline and 54.4% after intervention agreed that individual sorting of waste was necessary for proper source segregation of waste. 2.8% and 52.8% agreed that solid waste has monetary value while 9.5% and 56.7% agreed that a single unit bin with three compartment would enhance source-separation of waste at baseline and post intervention respectively. This Among the CG, 47.0% and 51.2% at baseline and after intervention respectively agreed that waste recycling was necessary in the University of Ibadan Community. Another 70.2% at baseline and 72.6% after intervention agreed that individual separation of waste is necessary for proper separation of waste. 66.7% and 69.0% agreed that solid waste has monetary value while 64.9% and 67.2% agreed that a single unit bin with three compartments would enhance source-separation of waste at baseline and post intervention respec-

tively. This revealed that there was a significant difference in the attitude of the workers at baseline and after intervention at the Students' Union Building while no such difference was found in the attitude of workers at baseline and after intervention at Faculty of the Social Sciences and Works Department. This finding was in agreement with Barr and Gilg (2007) who reported that situational variable of physical infrastructure such as the provision of the waste bins and provision of environmental training could improve the attitude of people. The change in attitude at the experimental group also corroborated the finding of Kallegren and Wood (1986) who reported that knowledge may also be seen as a key variable affecting levels of environmental action including attitude. Also, the personal experience of receiving training is also a factor that may influence attitudes and behaviours according to Kallegren and Wood (1986); Oskamp et al., (1991) and Daneshvary et al., (1998).

Office/Shop Solid Waste Management Practices in The Study Locations

The results (Table 6) showed the source-separation' practice of workers at baseline; the practice of source separation before disposal at all locations was very poor; Majority 91.7% at the FSS and WD as against and 97.8% at the SUB do not separate their waste. 7.7% of the respondents at FSS and WD as against 0.0 % at the SUB reuse their waste. It was also only at the SUB that 2.2% of respondents that sell their wastes.

Effect of Environmental Training and Collection Bin on Practice

Table 7 illustrated the effect of the intervention on the practice of source-separation of solid waste. This revealed that the effect of the training on the practice of source-separation of solid waste was significant among the experimental group of the Students' Union Building. At baseline, 2.2% of the workers were involved in source separation and recycling, while at post-intervention 30% of the workers were

TABLE 5
Effect of Environmental Training and Collection Bin on Worker's Attitude towards Source-Separation and Recycling of Solid Waste before and after Intervention

Statements	Options	Experimental Group (SUB) N=180(%)			Control Group (FSS + WD) N = 168(%)		
		Pre-Intervention	Post- Intervention	P- Value	Pre – Intervention	Post- Intervention	P-Value
Waste recycling is necessary in the University of Ibadan community.	Agree	10 (5.6)	92 (52.0)	< 0.05	79 (47.0)	86 (51.2)	> 0.05
	Disagree	170 (94.4)	88(48.0)	< 0.05	89 (53.0)	82 (48.8)	> 0.05
Individual separation of waste at the shop/office is necessary for proper management of waste.	Agree	23 (12.8)	98 (54.4)	< 0.05	118 (70.2)	122 (72.6)	> 0.05
	Disagree	157 (87.2)	82 (45.6)	< 0.05	50 (29.8)	46 (31.9)	> 0.05
Solid waste has monetary value.	Agree	5 (2.8)	95 (52.8)	< 0.05	112 (66.7)	116 (69.0)	> 0.05
	Disagree	175 (97.2)	85 (47.2)	< 0.05	56 (33.3)	52 (31.0)	> 0.05
A single waste disposal bin with separate compartments for different component of waste would enhance source-separation of solid waste.	Agree	17 (9.5%)	102 (56.7)	< 0.05	109 (64.9%)	113 (67.2)	> 0.05
	Disagree	163 (90.5)	78 (43.3)	< 0.05	59 (35.1)	55 (32.8)	> 0.05

TABLE 6
Practices of source-separation at office/shop before disposal by Respondents

Responses	FSS+ WD N = 168 (%)	SUB N = 180 (%)
Sell	0(0.0%)	4(2.2%)
Reuse	13(7.7%)	0(0.0%)
Process	1(0.6%)	0(0.0%)
No	154(91.7%)	176(97.8%)

involved. This shows that the proportions were increased significantly among the experimental group. While at the control group, at baseline, 12.9% of the workers were involved in source separation and recycling, while at post-intervention 17.3% of the workers were involved thus revealing that there was no significant difference in the increase at the control group. This contradicts what other previous investigators observed that environmental education does not necessarily lead to improved practice (Tikka et al., 2000); Amini and Ramazini (2001); Mesgarof et al., (2001). In the same vein, another study showed that better integration was required between recycling programs and existing informal waste collection systems (Hernandez et al., 1999). Plate 2 illustrates the application of the three compartments wastes bin

CONCLUSIONS AND RECOMMENDATIONS

The study was carried out in the non-residential area of the University of Ibadan. The effect of Environmental training and provision of a locally fabricated and an adaptive three compartment solid wastes bin on source-separation of solid waste among workers was also assessed.

TABLE 7
Effect of Environmental Training and Collection Bin on Worker's Practice of Source-Separation of Solid Waste

Variable	Group	Pre-Intervention *(Yes)*	Post-Intervention *(Yes)*	P- Value
Do you Separate your waste before disposal	Experimental (SUB) N= 180 (%)	4 (2.2)	54(30.0)	<0.05
	Control (FSS + WD) N=168(%)	12(12.9)	16(17.3)	>0.05

PLATE 2
The Fabricated Three Compartments Waste Bin in use at the SUB

It was observed that not much work had been done on the source-separation of solid waste and the recycling potential of wastes generated in non-residential areas of institutions of higher learning. At the end of the study, it was concluded that the knowledge, attitude and practice of the workers towards source-separation of solid waste was very low at baseline, there was compliance in the utilization of the fabricated multi-compartment bin. The co-intervention was effective as it enhanced the knowledge, affected the attitude and changed the behaviour of the workers towards the source-separation of solid waste. Nevertheless, a better integration was required between recycling programs of source-separation and existing informal waste collection systems.

It is therefore recommended that to promote effective waste management on campus; there should be a separate office of solid waste management and recycling for the University. This office would be saddled with the responsibility of engaging on advocacy, environmental training and education. There should also be mass production of the multi-compartment wastes bin to encourage the adoption of source separation of waste as a waste management strategy, there should be more regular training sessions especially for generators of high volume of waste in other non-residential areas of the University.

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