International Journal of Sustainable Development and Planning
Vol. 17, No. 4, July, 2022, pp. 1205-1213
Journal homepage: http://iieta.org/journals/ijsdp

Multi-Sectoral Partnership for Waste Management Evaluation and Awards Recognition in Higher Education

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https://doi.org/10.18280/ijsdp.170419

Received: 31 January 2022
Accepted: 1 June 2022

Keywords:
environmental awareness, environmental management, higher education, sustainability development goals, waste management

ABSTRACT

Waste management is an important part to achieve green and sustainable campus. This study aims to evaluate waste management implementation in higher education. The methodology used in this study is a cross sectional with a non-probabilistic sampling. Data were collected using a well-structured evaluation instrument through an online focus group discussion, document review and evidence of implementation. The evaluation instrument consists of 10 elements: waste management policy, resource availability, waste segregation, waste collection, temporary waste storage, handling of general and hazardous waste, personal protective equipment (PPE), waste segregation awareness educational program, and evaluation on waste management. There were 15 faculties/schools/program were participated. Data was analysed using univariate analysis, radar plot representation, Box and Whiskers plot analysis. The level of waste management implementation amongst faculties /schools/program was varied between 52% to 98%. Higher education needs to evaluate waste management implementation and established a systematic environmental awareness program to achieve sustainability development goals (SDGs). The mean score ranking from highest to lowest level: personal protective equipment (5.6) to evaluation of waste management implementation (3.2). Indeed, to ensure a comprehensive general waste management, it was suggested that higher education need to build a centralized waste collection facility, a chemical waste treatment and competence personnel for handling laboratory waste.

1. INTRODUCTION

Nowadays, the increasing number of community population, economic growth, and changing in public life style caused the increasing amount of waste volume [1]. Globally, there are more than 120-130 billion tones of natural resources been consumed and produced 3.4-4 billion of solid waste [2]. More than 2.5 billion wastes produced by 6.4 billion coastal areas people in the year 2010 [3]. Indonesia is one country of amongst 192 countries with the majority of people living in the coastal areas [3]. Countries population living in the coastal areas are accounted for 93% of global population [3]. The use of plastics in modern life style poses challenge on waste management. Plastics are used widespread in modern life style including for packaging (39.9%), building and construction (19.7%), automotive (10%), electrical and electronic (6.2%), agriculture (3.3%), household, leisure and sports (4.2%) and others (16.7%) [4]. However, the plastics industry gives direct employment to over 1.5 million people in Europe, and more than 60,000 companies are operated at which most of them are SME's [4]. Indeed, the European plastics industry had a turnover nearly to 350 billion Euros and close to 15 billion Euros had a trade balance of close 15 billion Euros in 2016 [4]. The balance between the economic growth generated from the plastics industries and the waste produced from the public activities need to be addressed with a comprehensive waste management. If not properly managed, the plastic waste can be accumulated on the ocean, and endanger the sea life and sea ecosystem. It was estimated around 275 million metric tons. There are several potential public health problems from the mismanagement of plastic waste including increasing load of waste at the final waste landfill, toxic emission to the environment, and contamination of the ocean [2]. Indeed, improper waste management could lead the waste to enter the water stream, surface water, river and ocean [3]. Waste management has been viewed as the most important part to achieve the sustainability of the organization [5]. Mismanagement of plastic wastes can increase environmental

pollution, land pollution, water pollution and air pollution [6]. Indeed, mismanagement of plastic wastes may cause other consequences such as environmental contamination, entanglement and death of marine animals, blockage in urban sewage system, decreasing in aquatic purification and normal land farming aerations and lead to decreased productivity [6]. Other consequences from the mismanagement of plastic wastes may cause aquatic animals such as fish, turtles, seabirds and mammals ingested or entrapped in or with plastic waste, causing movement difficulties, scratches or damages to their digestion and finally death [6].

There are several strategies to properly managed plastic waste including involvement of higher education, government regulation and extended producer responsibility over waste [7, 8]. Indeed, solving plastics waste management problems required a multisectoral partnership engagement, including local government, national level government, industry and higher education experts. Higher education is the place where future young generation is educated, and this young generation will build future sustainability of the nation's [8]. One of the biggest higher educations in Indonesia, has the initiatives to build an awareness of public and campus society through an awards competition for the waste management implementation. Awards competition and recognition has been known can improve the performance on waste management implementation [9]. The awards are part of the evaluation of the waste management implementation in higher education conducted by a multisectoral partnership through engaging experts from the university, local government environmental services, and Ministry of Environmental and Forestry. The multisectoral partnership on the evaluation process for awards recognition is expected to have a wider impact in waste management, as well as creating a role model for sustainability and green campus initiatives. The objective of this study is to evaluate the implementation of waste management in higher education. The evaluation process is part of awards recognition for the best performance on waste management in higher education. It is expected that through the awards for the best performance on waste management implementation can trigger improvement for campus sustainability efforts.

2. METHODOLOGY

2.1 Research design

The study used a cross-sectional method approach that it was carried out in all faculties at one university at one time in January 2021. The data were carried out by conducting Focus Group Discussion (FGD) and collecting supporting evidence online between researchers and the faculty representatives at one meeting.

The study used a descriptive research design. Evaluation instrument was developed (Figure 1) through several multisectoral meetings between higher education experts, industry representative, local government representative and national government representative. The basic concept of the evaluation instrument development was to adopt environmental management system concept is Plan, Do, Check, Act (PDCA). The context and scope of the evaluation was within the faculty, school or program level.

2.2 Evaluation instrument and scoring system

There were 10 (ten) elements were finally established to evaluate the waste management in higher education including waste management policy, resource availability, waste segregation, waste storage, waste collection, waste temporary storage, handling of general and hazardous waste, personal protective equipment (PPE), waste segregation awareness educational program and evaluation of waste management as presented in Table 1. [For more detail on evaluation aspects, criteria and scoring system see additional File 1. Evaluation Criteria of Waste Management Implementation].

Table 1. Evaluation aspects for waste management implementation

SECTION	ASSESSMENT ASPECT	SCORE
A. PLANNING	1. Waste Management Policy	
B. IMPLEMENTATION	2. Resource Availability	
	3. Waste Segregation	
	4. Waste Storage	
	5. Waste Collection	
	6. Waste Temporary Storage	
	7. Handling of General and Hazardous Waste	LEVEL 1-6
	8. Personal Protective Equipment (PPE)	
	9. Waste Segregation awareness educational Program	
	10. Evaluation of Waste Management implementation	
C. IMPLEMENTATION		

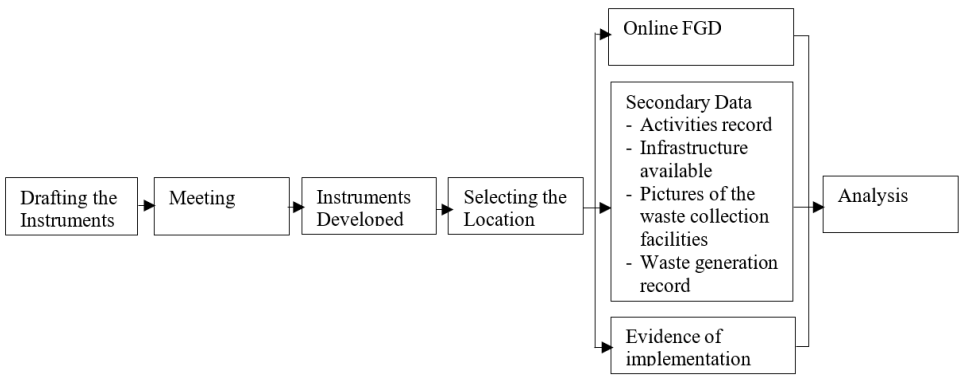

Figure 1. Research flow

The evaluation instrument made based on the development of the results of monitoring and evaluation of waste sorting at Campus X; Law Number 18 of 2008 concerning Waste Management, particularly regarding the process of waste sorting, collection, transportation, and final disclosure; and Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The basic concept of the evaluation instrument development was to adopt environmental management system concept is Plan, Do, Check, Act (PDCA). The context and scope of the evaluation was within the faculty, school or program level. In addition to several related parties mentioned earlier, this research was also supported by one of the chemical companies in Indonesia.

$$\%\ of\ Total\ Score = \frac{\sum score\ of\ 10\ elements}{60}\ x\ 100\% \quad (1)$$

The scoring system are at 6 levels of implementation: Level 6 (the most comprehensive levels), level 5 (good level), level 4 (medium level of implementation), level 3 (lower than medium level of implementation), level 2 (average level of implementation) and level 1 as the lowest level of implementation. Score from each aspect would be summed and converted into percentages (Eq. (1)). Therefore, the maximum total score is 60 (100%).

2.3 Data collection

Data were collected from 15 (fifteen) faculties, schools and programs listed on Table 2.

Table 2. Faculties/Schools/Program participated in the evaluation of waste management

No	FACULTIES / SCHOOL / PROGRAM
1	Faculty of Dentistry
2	Faculty of Mathematics and Natural Sciences
3	Faculty of Psychology
4	Faculty of Computer Science
5	Faculty of Humanities
6	Faculty of Nursing Science
7	Faculty of Economic and Business
8	Faculty of Public Health
9	Faculty of Pharmacy
10	Faculty of Administrative Science
11	Faculty of Medicine
12	Faculty of Engineering
13	Faculty of Law
14	Faculty of Social and Political Science
15	Vocational Education Program

The university for this study has been selected based on the initiative to be a role model for the evaluation process of waste management implementation, it was located in West Java, Indonesia. This study used a population sample that consist of 15 (fifteen) faculties, schools, and programs that produce waste have participated during the evaluation process (Table 2). The data were collected through an online focus group discussion to selected key informants, secondary data collection and evidence of implementation. Key informants included in this study were deans, vice deans, general affairs manager, and relevant staff related to waste management at faculty or school or program level. Secondary data was collected including activities record, infrastructures available, pictures of the waste collection facilities, record on amount of waste generated every month, and other relevant evidence.

2.4 Data analysis

Data generated from evaluation score results were then tabulated on Microsoft excel and univariate analysis was implemented. Faculties or Schools or Education program names were then coded for the purpose of this publication and maintaining data confidentiality. Data generated from evaluation score results was then averaged (Table 4) and further analysed using radar plot (spiderweb) as presented in Figure 2. The radar plot (spiderweb) graphical presentation was presented to determine the variety level of waste management implementation (score 1-6; from the lowest to the highest), and using this radar plot (spiderweb) presentation, it shows variation score level on each element and which element has the highest level and the lowest level.

Data generated from evaluation score results was also presented in Box and Whiskers plot. Box and Whiskers plot were used to determine the symmetrical distribution of the scores. Score distribution was used to indicate the variability outside the upper quartile (highest score – 6) or lower quartile (lowest score – 1). The box-and-whisker plot shows the minimum value, maximum value, median value, lower quartile and upper quartile [9]. Box and whisker plot methods helps to understand the variations in score data. It also shows which way the data sways, including the size of the box, the position of the median in the box, the length of the whiskers displays the overall picture of the skews in the data [10].

Score results from Table 4 were then ranked from the highest to the lowest score of waste management implementation at the faculty or schools or education program in order to determine the awards category (Table 6). Data was also presented in bar-chart (Figure 4).

2.5 Awards category

Awards are categorized into 3 (three) levels of awards category: Platinum, Gold, and Silver. The award category is presented in Table 3.

Each category represents the level of achievement for waste management implementation in faculties or schools or education program level. Platinum category represent the "Excellence" category performance level, Gold category is "Good" performance level and Silver category "Average" level of waste management implementation. This categorization is based on project team and funding provider consent. Moreover, with this categorization, it will facilitate the judging process. Awards category, performance level and criteria are presented in Table 3.

Table 3. Awards category

Awards Category	Performance Level	Criteria
Platinum	Excellence	Innovation, Strong Commitment, Strong leadership, consistent implementation of waste management and best performance
Gold	Good	Strong Commitment, Strong leadership, consistent implementation of waste management and good performance
Silver	Average	Good Commitment, good leadership, medium implementation of waste management and average level of performance

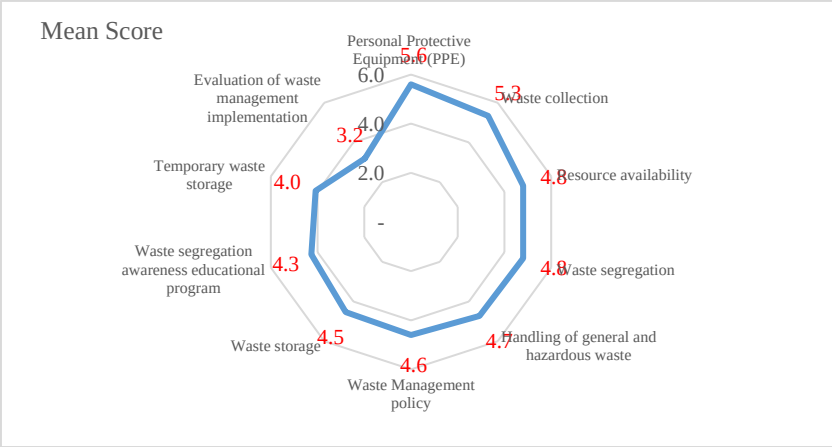

Figure 2. Radar plot on evaluation score of waste management implementation

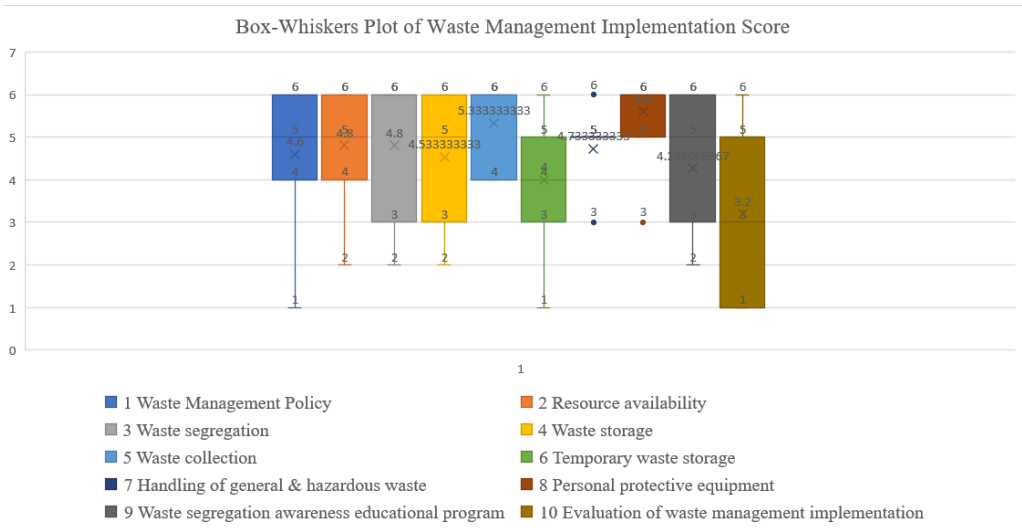

Figure 3. Box and Whiskers plot for evaluation of waste management implementation scoring

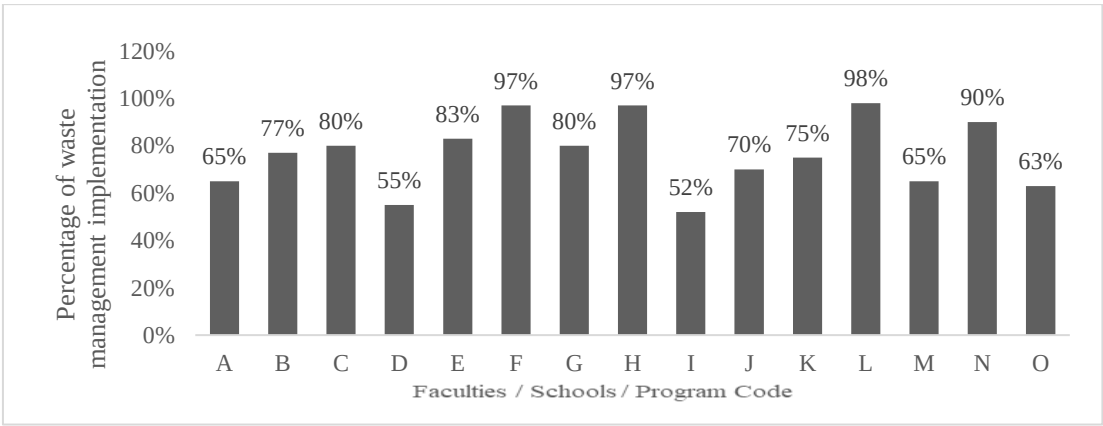

Figure 4. Evaluation results of waste management implementation in Faculties / Schools / Education Program

3. RESULTS

Results of evaluation on waste management implementation in higher education presented in Table 4. Faculties or schools or program were coded for the purpose of this publication and ensure data confidentiality. During the announcement of the awards category, the names of the faculties or schools or program were announced based on awards category. The total score and percentage of achievement on waste management implementation is displayed in Table 4.

Based on the descriptive analysis in Table 2 show that the faculty that has the highest total score is Faculty L (97%), followed by faculty F and H which have the same score (96%), N (90%), and G (81%). The Faculty that has the lowest score is Faculty I (47%).

In the Table 2 shows that in the element of waste management policy, the faculties that have a score of 6 (highest) in sequence are A, F, H, K, and L faculties.

Meanwhile, the faculties that have a score of 1 (lowest) are I. In the resource availability element, the faculties that have a score of 6 (highest) in sequence are A, E, F, H, L, and O. Meanwhile, the faculties that have a score of 2 are faculty I.

In the waste segregation element, faculties that have a score of 6 (highest) in sequence are faculties B, E, F, G, H, J, L, and N. Meanwhile, faculties that have a score of 2 sequentially are K and O faculties. In the waste storage element, the faculties that have a score of 6 (highest) in a row are C, F, H, L, and N faculties. Meanwhile, the faculties that have a score of 2 consecutively are M and O faculties.

In the waste collection element, the faculties that have a score of 6 (highest) in sequence are faculties B, E, F, G, H, I, L, M, and N. In the waste temporary storage the faculties that have a score of 6 (highest) in sequence are faculties L and N. Meanwhile, the faculties that have a score of 1 consecutively are D and I.

In the handling of general and hazardous waste element, the faculties that have a score of 6 (highest) in sequence are faculties A and E. In the PPE element, the faculties that have a score of 6 (highest) in sequence are faculties B, C, E, F, G, H, I, J, K, L, and M. In the waste segregation awareness educational program element, the faculties that have a score of 6 (highest) in sequence are faculties C, F, H, L, and N. In the evaluation of waste management implementation element, the faculties that have a score of 6 (highest) in sequence are faculties F, H, and L. Meanwhile, the faculties that have a score of 1 consecutively are A, D, G, I, and K.

The variation on the total score results were between 31 to 59 and the percentage of achievement were between 52% (lowest) to 98% (the highest). The distribution based on evaluation score result on the graphical representation was presented in Table 5.

Results suggested that the ranking order from the highest level of implementation to the lowest level as shown in Table 5 were the personal protective equipment (5.6), waste collection (5.3), resource availability (4.8), waste segregation (4.8), handling of general and hazardous waste (4.7), waste management policy (4.6), waste storage (4.5), waste segregation awareness educational program (4.3), temporary waste storage (4.0) and evaluation of waste management implementation (3.2), respectively. Based on radar plot presentation, the strongest four elements were the use of personal protective equipment, waste collection, resource availability and waste segregation. The weakest element was the evaluation process on the waste management implementation at the faculty or schools or education program level and waste temporary storage.

Result suggested from Box and Whiskers plot analysis shows that the distribution of score was varied. As presented in Figure 3, there were 3 (three) elements that have similar distribution including waste management policy (median 4.6), resource availability (median 4.8), waste collection (median 5.3). These 3 (three) elements have a uniform distribution at the upper line towards higher score between 4-6. There were 2 (two) elements which have lower tendencies that was segregation process and waste management evaluation. These variations show the tendencies amongst faculties or schools or programs toward the highest score achievement of waste management evaluation.

The first category of the award is “Platinum” which its level of waste management implementation is ranging from 80%-98% with faculty or school or program L successfully scored the highest point (Table 6). The second and third category of the award is “Gold” and “Silver” with the implementation of its waste management are ranging from 70%-83% and 52%-65% respectively.

Table 4. Evaluation results of waste management implementation in Faculties/Schools/Education program

No	Elements	Score results of waste management implementation in Faculties/Schools/Education program*															Total Score
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	Waste Management policy	6	4	5	4	5	6	4	6	1	3	6	6	5	4	4	**69**
2	Resource availability	6	4	4	4	6	6	5	6	2	3	5	6	4	5	6	**72**
3	Waste segregation	3	6	4	5	6	6	6	6	3	6	2	6	5	6	2	**72**
4	Waste storage	3	5	6	5	3	6	5	6	4	4	5	6	2	6	2	**68**
5	Waste collection	4	6	4	4	6	6	6	6	6	5	5	6	6	6	4	**80**
6	Waste temporary storage	3	5	4	1	4	5	5	5	1	4	5	6	3	6	3	**60**
7	Handling of general & hazardous waste	6	5	5	3	6	5	5	5	5	3	5	5	3	5	5	**71**
8	Personal Protective Equipment (PPE)	5	6	6	3	6	6	6	6	6	6	6	6	6	5	5	**84**
9	Waste segregation awareness educational program	2	3	6	3	4	6	5	6	2	5	5	6	2	6	3	**64**
10	Evaluation of waste management implementation	1	2	4	1	4	6	1	6	1	3	1	6	3	5	4	**48**
	TOTAL SCORE	**39**	**46**	**48**	**33**	**50**	**58**	**48**	**58**	**31**	**42**	**45**	**59**	**39**	**54**	**38**	
	PERCENTAGE (%)	**65**	**77**	**80**	**55**	**83**	**97**	**80**	**97**	**52**	**70**	**75**	**98**	**65**	**90**	**63**	

*Note: Score 6: The highest level of waste management implementation; score 1: the lowest level of waste management implementation.

Table 5. The distribution on the evaluation of waste management implementation for each element

Rank	Elements	Mean Score	Median	Std Deviation	Min - Max
1	Personal Protective Equipment (PPE)	5.6	6	0.8	3 - 6
2	Waste collection	5.3	6	0.9	4 - 6
3	Resource availability	4.8	6	1.3	2 - 6
4	Waste segregation	4.8	5	1.6	2 - 6
5	Handling of general and hazardous waste	4.7	5	1.0	3 - 6
6	Waste Management policy	4.6	5	1.4	1 - 6
7	Waste storage	4.5	5	1.4	2 - 6
8	Waste segregation awareness educational program	4.3	5	1.6	2 - 6
9	Waste Temporary storage	4.0	4	1.6	1 - 6
10	Evaluation of waste management implementation	3.2	3	2.0	1 - 6

Table 6. The distribution on the evaluation of waste management implementation for each element

Faculty Code	Score	%	Ranking	Awards Category
L	59	98%	1	Platinum
F	58	97%	2	
H	58	97%	3	
N	54	90%	4	
G	48	80%	5	
E	50	83%	6	Gold
C	48	80%	7	
B	46	77%	8	
K	45	75%	9	
J	42	70%	10	
M	39	65%	11	Silver
A	39	65%	12	
O	38	63%	13	
D	33	55%	14	
I	31	52%	15	

4. DISCUSSION

Waste management implementation in higher education is quite challenging, since the wide diversity of waste types, including general waste such as papers, organic wastes, plastics waste, in-organic waste, and hazardous waste from laboratories. Waste management as part of environmental management system have been shown one of the major lacks within higher education settings [11]. These challenges have been overcome by introducing the environmental policy in the selected university such as green campus, reduce paper policy and zero plastics policies [12, 13]. Faculties or schools or program have been urged to implement these policies such as waste segregation, reduce plastics waste, reduce papers, measures the amount of waste generated, energy management, climate change initiatives and collective waste collection and disposal [12, 13]. There are several management strategies for plastic wastes including recycling, incineration, landfills, pyrolysis and bioremediation [14]. Plastic waste disposal needs a good plastic waste management including waste segregation at which the plastic waste is segregate based on their functions and types such as plastic waste bottle, plastic wraps, plastic box and other type of plastic materials. University has implemented the waste segregation method by segregating plastic wastes based on this classification and conducted by students, university staff and campus facilities. A special box has been placed in several areas of the campus at which students and university staff can placed their waste according to types and function. The plastic waste was then collected by the university facilities, central waste weighing and sale to the third party.

The importance of campus as a role model for waste management implementation has been well known [15]. Results from this research suggested that the implementation of waste management within one campus are variety, ranging from the highest level of 98% to the lowest level of 52% (Table 4). This result suggested that even though the environmental policy and commitment towards green campus has become a priority in this selected higher education, the implementation of comprehensive waste management needs to be more endorsed. It is clearly found that faculties with strong commitment and leadership will have a strong waste management implementation.

The highest averaged scores (5.6) were the use of PPE (Table 5), indicated the strong commitment within the university on the implementation of occupational safety, health and environmental (OSHE). Previous research suggested that the implementation of OSHE management system enhance the implementation of environmental management system [16, 17]. Other strong elements were related to waste management cycle including waste collection, waste segregation, resource availability, waste management policy, waste storage, handling general and hazardous waste, and waste segregation awareness educational program with the average scores ranging between 4.5-5.5.

One of the most challenging elements is handling of laboratories waste as there are diverse types of hazardous waste generated from the laboratories and usually small amount [16, 17]. Result from Table 5 suggested from this research that handling of general and hazardous waste averaged scores was at 4.7, this is indicated that the university have implementing waste segregation according to the waste types (organic waste, in-organic waste, residual waste and selected hazardous disposed by the third party). Organic waste has been treated using a composting method in the university's central waste composting facility and have a beneficial impact to the university by the use of composted products for natural fertilizer and providing circular economy. The university provides a centralized waste collection, hence ensuring that the waste management implementation align with University's environmental policy. Indeed, university have implemented a strong OSHE management system in laboratory to enforce the implementation of safety, health and environmental management system including laboratory waste management [16, 17]. Previous research found that the waste generated from the laboratories has been segregated, labelled, and stored based on the waste type and then followed by a third-party disposal to prevent environmental pollution in higher education [16, 17].

In relation to environmental educational awareness, the mean score was 4.3 whilst the score range was between 2 to 6. Even though the distributions were towards higher score, the environmental educational awareness need to be improved (mean score 4.3). Since the higher education is the leading sector for education including environmental education, the mean score for this element was expected to be higher. It was found from other research that a comprehensive and integrated between basic requirements of waste management facilities, operation, education, and higher education societies participation will ensure better environmental perception, changing people behavior and attitude towards environmental and sustainability campus [9].

The lowest averaged scores elements in waste management implementation were the evaluation of the waste management implementation (3.2) and waste temporary storage (4.0) (Table 5). For the element of waste temporary storage, these results align with the situation that since the university already provide a daily routine and centralized waste collection, so the faculties or schools or programs does not have to be worried that the waste will pile up. Waste was collected every day and the university facilities management ensures that there is no waste deposited in the faculties or schools or program. In regards to the evaluation of the waste management implementation element, this is the area need to be improved, because this is the lowest averaged scores as indicated on radar plot representation (Figure 2). Similar previous research also indicated that higher education institution is often focusing mainly on the implementation part for safety, health and environmental management, while sometimes lack on the evaluation process [15, 16]. Higher education needs to put more attention on the evaluation process since it is also a valuable process for providing feedback and monitoring on how the implementation of environmental management system has achieving its objectives. Universities need to measure the amount of waste generated within a periodical time based on each waste types (paper waste, plastic wastes, organic wastes, in-organic wastes, and hazardous wastes), in order to see how is the waste amount has been reduced.

Result suggested from Box and Whiskers plot analysis (Figure 3) shows that the distribution of score was varied. These variations show the tendencies amongst faculties or schools or programs toward the achievement of waste management evaluation. It is suggested that there are several areas for improvement such as the waste segregation process to improve the segregation process in the temporary waste area and to include waste evaluation as part of the complete cycle in waste management. The selected university have implementing environmental management system with different and comprehensive approach including UI Green Metric initiative [12, 13], UI Zero plastics policy [18] and Safety, Health and Environmental management system [16, 17]. Indeed, result from this research suggested that to encourage the implementation of waste management needs a strategy to achieve its environmental management system objectives, including the awards recognition program [9, 19]. Multisectoral partnership is clearly eminent will have a wider and deep impact, as well as maintaining sustainability of waste management implementation [20]. Evaluation instrument that developed from this research engage multisectoral partnership, and expected to have a wider impact, increase a strong environmental awareness, encourage industry's responsibility and finally building an environmental consciousness for young future generations through the involvement of higher education [11, 13, 14, 16, 20, 21]. It was found during the evaluation process that through the awards recognition program, faculties or schools or programs were more open in discussion, discuss the problems, provide feedback, deliver ideas on how to improve the waste management implementation, and improve institutional performance. Other studies have mention that providing awards for environmental management evaluation will create competitiveness in achieving environmental objectives and performance [2, 7, 11, 15, 18, 19, 22, 23]. Indeed, participation of industry and government during the development of waste management evaluation process, increase the understanding, mutual benefit and better waste management implementation.

As regards to the general and laboratory waste management, based on Box and Whiskers analysis, the score distributions seem to be skewed to the lower score. It was indicated that this element needs to be improved, particularly management of laboratory wastes. Laboratory waste management at the current situations has been segregated, labelled, treated with a simple waste treatment method and the waste that cannot be treated inside the campus was handled by third party. Other research suggested that the most difficult waste in the higher education to managed was the laboratory waste, since there are a wide variety of waste types, small amount, dynamic change of waste, and the variety of hazardous waste characteristics [23]. It was suggested that higher education need to build a centralized waste collection facility, a chemical waste treatment and competence personnel for handling laboratory waste [23].

Evaluation score from the awardees of "Platinum" category (80%-98%) which have an excellent waste management implementation shows the highest level of score 5 to score 6 on several elements including waste segregation (all scores 6), waste collection (all scores 6), waste storage (score 5-6), waste segregation process (score 5-6), cleanliness of disposal sites (score 5-6), personal protective equipment (PPE) (score 5-6), resource availability (score 5-6), waste segregation awareness educational program (score 5-6), and handling of general and hazardous waste (all scores 5) – Table 4. This result shows that within these faculties or schools or program (L, F, H, N, G), the waste management implementation elements has been at the highest level. The second category of the award is "Gold" have the good level of waste management implementation ranging between 70%-83% were the faculties or schools or program (E, C, B, K, J) have a variety on the scores achievement, with the highest strongest element is the use of personal protective equipment (PPE) at scores 6 in all these faculties. Other research suggested that the implementation of waste management have several barriers including financial constraints, lack of environmental education, cultural barriers and lack of space [15]. However, it was suggested that to overcome the barriers for creating green campus is to raise the environmental awareness within campus societies [15]. Our research suggested that faculties or schools or program which have a good environmental awareness educational program will have a good waste management implementation, especially the "Platinum" awardees category (Table 6).

In order to achieve "sustainable campuses" goals, higher institutions need to build a commitment from the top management, directives from leaders, strong leadership towards sustainability, build collaborations and assignment of role and responsibilities across the organizations [21]. Based on our research, results suggested that faculties or schools or programs which already have waste management policies,

strong leadership commitment, full collaboration and clear role and responsibilities trough out the responsible persons will have a good waste management implementation. It is aligned with other study which indicated that environmental policies, full collaboration and clear role and responsibilities will ensure the implementation of waste management implementation [21].

Regarding the centralized waste collection, the university have a structured and systematic ways for daily, routine of waste collection and waste segregation. Waste segregation divided into of 5 (five) different categories: 1) organic waste from food waste; 2) organic waste derived from tree pruning and grass cutting; 3) plastic waste; 4) in-organic waste consists of e-waste or electronic waste; 5) laboratories waste. Organic waste from food waste, tree pruning and grass cutting was collected into university's centralized composting facilities. Plastic waste and in-organic waste were collected into the university's earth bank, and laboratories waste were handled by third party. This process requires full collaboration of all relevant stakeholders including waste segregation by students, staff, lecturer, guests, visitors, contractors, and canteen providers. The university have included an environmental awareness induction integrated with HSE communication program, HSE promotional program such as HSE induction videos for students, staff, lecturer, guest, visitors, contractors and canteen providers and part of new students orientation program. The importance to maintain of good communication and relationship to relevant stakeholders for the waste management implementation have been found in another research [24].

5. CONCLUSIONS

In conclusion, results from this research suggested that the waste management implementation on the selected higher education was varied amongst faculties or schools or program. The variation on the total score results were between 31 to 59 and the percentage of achievement were between 52% to 98%. Results suggested that the ranking order from the highest level of implementation to the lowest level were the personal protective equipment (5.6), waste collection (5.3), resource availability (4.8), waste segregation (4.8), handling of general and hazardous waste (4.7), waste management policy (4.6), waste storage (4.5), waste segregation awareness educational program (4.3), waste temporary storage (4.0) and evaluation of waste management implementation (3.2), respectively. Results suggested from radar plot presentation that the strongest four elements were the use of personal protective equipment, waste collection, resource availability and waste segregation. Indeed, it is clearly shown that the weakest element on waste management implementation was the evaluation process on the waste management implementation at the faculty or schools or education program level and waste temporary storage. Based on Box and Whiskers plot analysis shows that the distribution of score was varied. There were 3 (three) elements that have similar distribution including waste management policy (median 4.6), resource availability (median 4.8), and waste collection (median 5.3). These 3 (three) elements have a uniform and upper towards higher score between 4-6. There were 2 (two) elements which have lower tendencies that was segregation process and waste management evaluation. These variations show the tendencies amongst faculties or schools or programs toward the achievement of waste management evaluation. Based on the research result, it was suggested that there are several areas for improvement including ensuring the evaluation process on the waste management implementation, so the complete cycle of management or PDCA will established. Indeed, in order to ensure a comprehensive general and laboratory waste management, it was suggested that higher education need to build a centralized waste collection facility, a chemical waste treatment and competence personnel for handling laboratory waste. Finally, higher education was expected to become a role model for the society, a systematic and structured environmental educational awareness program to build better environmental perception, changing people behavior and attitude towards environmental and sustainability campus need to be implemented integrated with higher education program.

ACKNOWLEDGMENT

This research was funded by multisectoral partnership grant between Dow Indonesia and Universitas Indonesia particularly for evaluation of waste management and awards recognition. The authors would like to thank to Dow Indonesia for significant contribution for the evaluation of waste management implementation and awards recognition. The authors would like to also expand its gratitude to all the evaluators including Dr. Haruki Agustina from Ministry of Environment and Forestry Indonesia, Universitas Indonesia's team and representative from local Environmental services, Depok, West Java Indonesia. In addition, authors would like to thank you to all key informant involved, including Prof. Dr. Ir. Dedi Priadi, DEA as Universitas Indonesia's Vice Rector for Human Resources and Asset; University Facilities Director and staff; Universitas Indonesia's Director of Partnership; Deans of faculties; Director of Schools and Programs, Faculty's or Schools or Program's facility managers, and all staff.

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NOMENCLATURE

Greek symbols

Σ	summation