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Hazardous Waste Generation and Collection At Malaysia TVET Institution

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Abstract: Improper Hazardous Waste (HW) disposal can be harmful to human health and environment. However, it can become a business opportunity with high returns if properly managed. The objective of the research was to determine the HW generation and collection by a TVET Institution namely ITI KL. The samples were collected from 12 sites for 5 years. The results indicated that the quantity of E-Waste (SW110) generation rate rw = 437.37unit/year/division. Whilst, for others of HW code (SW1, SW2, SW3, SW4, SW5) solid waste generated at 2,454.36kg/year/division and volume of liquid substances generated was 5,386.15ml/year/division. The generation trend lines found to be positive relationship with yearly training, students enrollment and extra skills events. The research recommended to implementing HW minimization plan through "cradle to cradle" processes and practice. In addition, to help decrease future threats to human health and environment of safer working and learning conditions for institute, students and staffs.

Keywords: Environmental Quality, E-Waste, Scheduled Wastes, Waste Management.

INTRODUCTION

In Malaysia, the hazardous waste (HW) problems were very much noticeable between the 1970s and 1980s, this is connected to the boom in the manufacturing sector between 1966 and 1988. Any product that has a warning, caution, poisonous, toxic, flammable, corrosive, reactive or explosive warning is considered hazardous (O'Leary & Walsh, 1995)[3]. Environmentally hazardous substances (EHS), under the Malaysian Environmental Quality Act (EQA) 1974, is defined as "any natural or artificial substances including any raw material, whether in a solid, semi-solid, or liquid form, or in the form of gas or vapor, or in a mixture of at least two of these substances, or any living organism intended for any environmental protection, conservation, and control activity, which can cause pollution" [4,8].

There are currently 3839 items in the EHS reference list [7] and in a situation where a potentially hazardous material is not on the list, such substances are classified using the globally harmonized system (GHS) classification scheme and assigned a hazard category as implemented by the Department of Occupational Safety and Health (DOSH), Malaysia [4]. According to Department of Environment (DOE), the volume of HW generated from the Malaysia industrial sector in 1998 was about 600,000 tons, yet there was no instituitional mechanism for managing the wastes [2]. In 2011, the HW generated was 7,304,902.74 metric tons, while in 2014, it grew to 41,622,031.52 metric tons [5]. The company namely, KualitiAlamSekitar Pte. Ltd. was given the responsibilities for waste collection, transportation, treatment and final disposal of 3 types of waste : hazardous, clinical and radioactive wastes.

Current HW management facilities used in Malaysia are scheduled waste, off-site waste storage, E-waste transport, secure landfill, clinical waste, physio-chemical waste, land treatment, resource recovery and waste water/ seawage treatment [6].

OBJECTIVE

Commercial or household generated HW may threaten human and environment when improperly disposed even though the amount of HW generated by the public is only a fraction of the generated by the industries [8]. Collectively, such HW pose a potential hazard to living creatures because they are toxic or lethal, non-degradable or persistant in nature and may cause detrimental cumulative effects. Due to the

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danger and risk, the objective of this research was to determine the HW generation and collection as well as to observe the practices of HW management by public.

METHODOLOGY

Study Location : Area selected for the study is a public vocational institute, namely IndustrialTraining Institute, Kuala Lumpur (ITI KL). It is a Technical and Vocational Education and Training (TVET) Institution fully operated by government under Ministry of Human Resources Malaysia (MOHR). ITI KL was established in 1964 in a 13.7 acre land located at coordinate: 3°05'33.1"N, 101°41'13.5"E as shown in Figure 1. It has over 30 blocks of building that can accommodate capacity of 204 employees and 1100 students [9].

Figure 1: Front view of ITI KL, Kuchai Lama

Sampling and Characterization : The research has been carried out within ITI KL compound. The total population of staff is 179 and 546 students in year 2017. They offer 12 courses which are Electrical, Automotive, Arc & Gas Welding, Production, CNC Machining, Quality Assurance, Refrigeration & Air Conditioning, Industrial Mechanic, Computer, Graphic, Printing and Industrial Electronics. Besides, interview and documentation from Unit of Asset Management and Maintenance, the HW sampling were taken from training workshops and laboratories HW collection area. The sample data were collected from 5 years (2013-2017), N=5 and 12 sites, n=12. Figure 2 depicts the location layout plan of ITI KL.

1. Electrical
2. Automotive
3. Arc & Gas Welding
4. Production
5. CNC Machining
6. Quality Assurance
7. Refrigeration & Air Conditioning
8. Industrial Mechanic
9. Computer
10. Graphic
11. Printing
12. Industrial Electronics

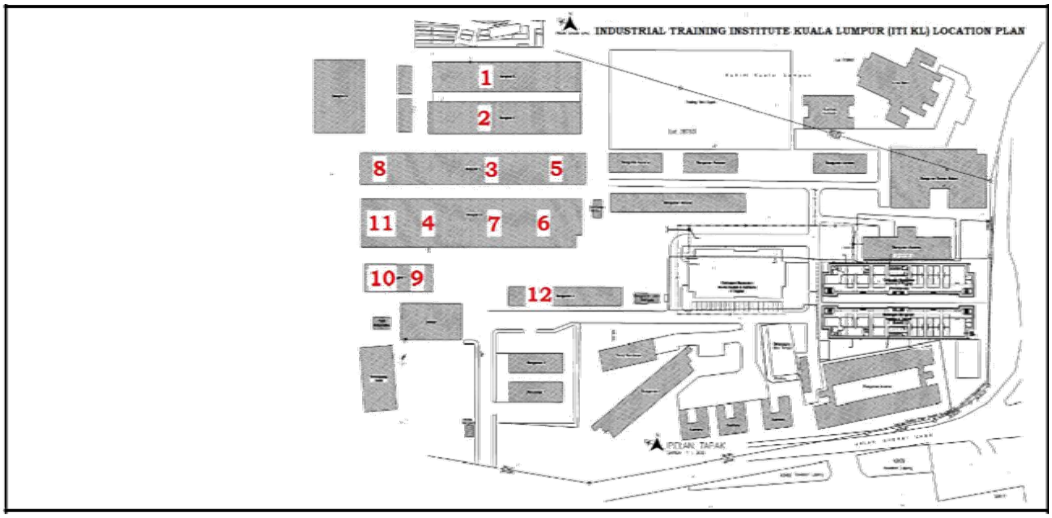


Figure 2: ITI KL Location Plan

Characterization of SW110 Electronic waste (E-waste) were according to the European Union (EU) Directive 2012/19/EU [1], consists of 10 categories as listed in Table 1. The composition were measured by quantity of generated HW. Others waste codes SW1, SW2, SW3, SW4 and SW5 were measured by weight, kg (solid) and volume, ml (liquid).

Table 1: E-waste categories according to the EU Directive 2012/19/EU

Number	Category	Label
1	Large household appliances	Large HA
2	Small household appliances	Small HA
3	IT and telecommunication equipment	ICT
4	Consumer equipment	CE
5	Lighting equipment	Lighting
6	Electrical and electronic tools	E&E tools
7	Toys, leisure and sports equipment	Sports
8	Medical devices	Medical
9	Monitoring and control instruments	M and C
10	Automatic dispensers	Dispensers

RESULTS AND DISCUSSION

The quantitative data were analyzed by the software IBM SPSS® (Statistical Package for Social Sciences) for Windows version 19.0. The statistical key features analysis applied for this research were including descriptive statistics, frequency, bar graph, pie chart, mean, and standard deviation (SD) with N=5 (Year 2013-2017) and n=12 (12 sites). Following are the mean and standard deviation formula.

Mean: $M = (\ (\ ))/$ *. . . equation 1*

Where,

Σ = Sum of

X = Individual data points

N = Sample size (number of data points)

Standard deviation : ^2 = (∑ 〖(−)〗 ^2)/(− 1) *... equation 2*

Where,

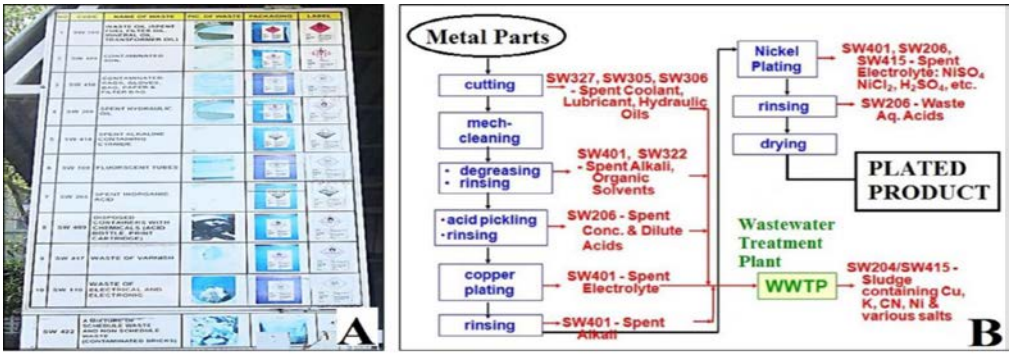
Σ = Sum of

X = Individual score

M = Mean of all scores

n = Sample size

HW samples data were generated from the disposal collection of substances identified by the 12 divisions, Electrical, Automotive, Arc & Gas Welding, Production, CNC Machining, Quality Assurance, Refrigeration & Air Conditioning, Industrial Mechanic, Computer, Graphic, Printing and Industrial Electronics. Figure 3 summarized the metal electroplating process flow implemented by the CNC Machining Workshop.



(A)Scheduled Waste signboard (B)Process flow of metal electroplating

Figure 3: CNC Machining Workshop Hazardous Waste

The rate of waste generation (rw) obtained by using equation 3, T(HW) total quantity/weight(kg)/volume(ml) divided by number of years (5) and divisions (12) to get the rate per year per division (kg/year/division).

$$rw = \frac{(\quad)}{(\quad)} = \quad / \quad / \qquad \text{..... equation 3}$$

Where,

T(HW) = Total HW generated

rw = rate of waste generation

y = number of years

d = number of divisions

Results of E-waste SW110 by quantity generation rate was rw = 437.37 unit/year/division as recorded in Table 2 with total quantity for 5 years=26242 unit, mean=5248.40unit/year and SD=2588.53 (year 2013-2017). The E-waste consist of electronic equipments of computers, workshops, offices, laboratories, kitchen, monitors, circuit boards, CRTs, VCRs, DVD players, TV tubes, primary cells, printer cartridges, treadmill, glucose meter, flashlights, lamps, radios, microscopes, printers, scanners, cables, mouses, keyboards, fluorescent tubes, handphones, oven, blender, training machines and others electronic appliances.

Table 2: Quantity of E-waste generated by ITI KL

No.	Year	T(HW)	Large HA	Small HA	ICT	CE	Lighting	E&E tools	Sports	Medical	M & C	Dispenser
1	2013	3572	382	1602	1987	684	76	122	3	0	42	7
2	2014	3890	389	1708	2130	715	87	130	5	0	61	9
3	2015	2704	369	1490	1763	508	72	107	1	0	38	4
4	2016	7805	407	1720	2351	811	95	145	7	0	72	11
5	2017	8271	421	1851	2581	903	116	152	10	1	75	22
Sum		26242	1968	8371	10812	3621	446	656	26	1	288	53
Mean		5248.40	393.60	1674.20	2162.40	724.20	89.20	131.20	5.20	0.20	57.60	10.60
SD		2588.53	20.56	135.68	317.07	148.28	17.51	17.99	3.49	0.45	16.95	6.88
Percentage%		-	7.5	31.9	41.3	13.8	1.7	2.5	0.1	0.0	1.0	0.2

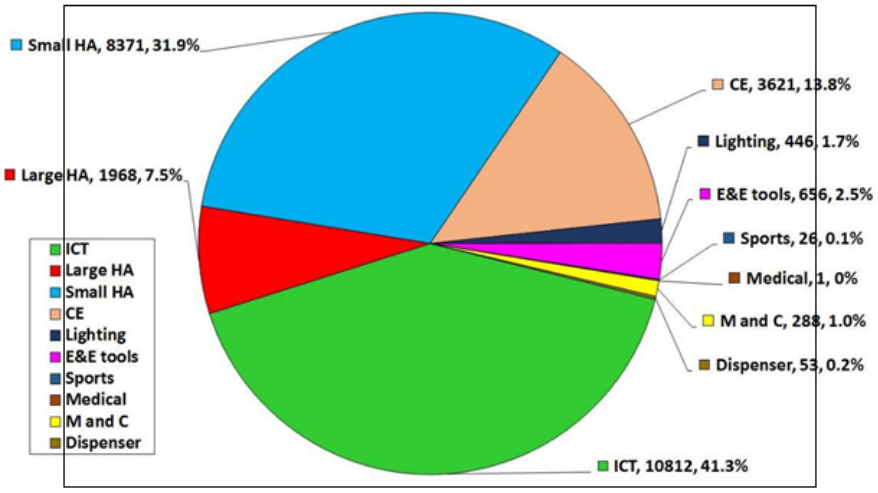


Figure 4: Composition of E-waste for ITI KL

Figure 4 presents the pie chart of E-waste composition in percentage (%) generated by ITI KL for 5 years 2013-2017. Results show that the highest generated was ICT 41.3% (10812) followed by Small HA 31.9% (8371), CE 13.8% (3621), Large HA 7.5% (1968), E&E tools 2.5% (656), Lighting 1.7% (446), M and C 1.0% (288), Dispenser 0.2% (53), Sports 0.1% (26) and the lowest was Medical at 0.003 ≈ 0.0%(1).

Table 3: Solid and Liquid Hazardous Waste generated by ITI KL

NO.	YEAR	HAZARDOUS WASTE GENERATION	
		Solid HW (Weight - kg)	Liquid HW (Volume - ml)
1	2013	76,143.91	38,062.81
2	2014	157,422.03	102,808.53
3	2015	143,036.56	41,246.65
4	2016	208,319.39	107,122.05
5	2017	162,339.77	33,928.70
Sum		747,261.66	323,168.74
Mean		149,452.33	64,633.75
SD		47,723.73	36,940.29
Rate (rw)		12,454.36 kg/year/division	5,386.15 ml/year/division

Results of solid and liquid HW (SW1, SW2, SW3, SW4, SW5), were reported in Table 3 and Figure 5. The total weight of solid HW generation for 5 years was 747,261.66kg with rw = 2,454.36kg/year/division, mean=149,452.33kg/year and SD=47,723.73. Meanwhile, total volume of liquid HW was 323,928.70ml with generation rate rw = 5,386.15ml/year/division, mean=64,633.75ml/year, SD=36,940.29.

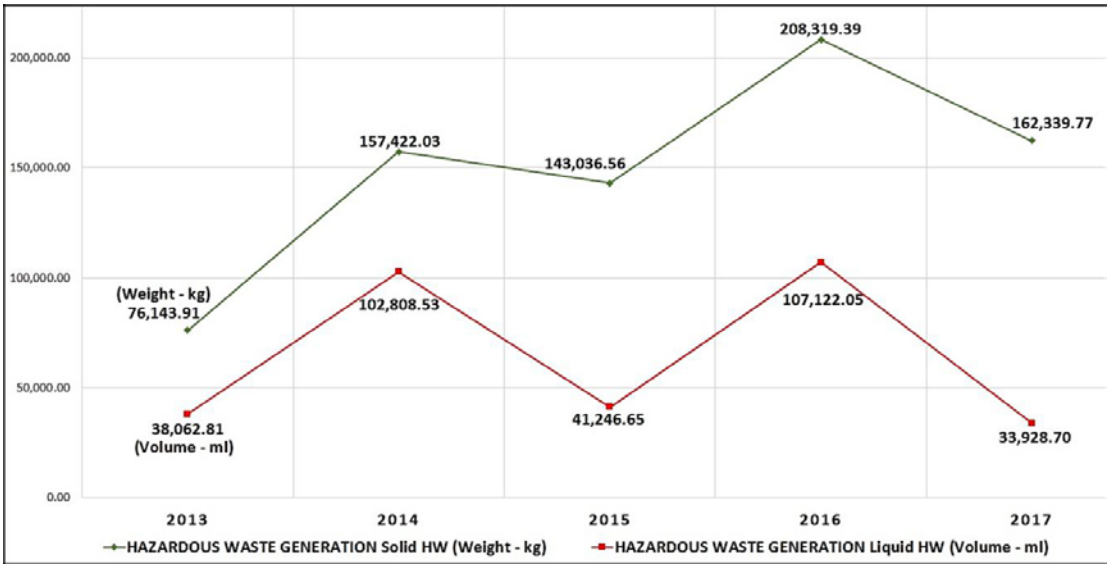


Figure 5: Weight (Solid) and Volume (Liquid) of HW Generation in Years

Referring to Line Chart amount versus year in Figure 5, in terms of solid HW, the highest generation was in year 2016 (208,319.39kg) and the lowest was year 2013 (76,143.91kg). Likewise, the highest generation of liquid HW was in year 2016 (107,122.05ml) and the lowest was year 2013 (38,062.81ml). The highest generation for both HW solid and liquid happened in year 2016 due to there were events of Malaysia Skills Competition held at ITI KL. The HW generated collection substances throughout the 5 years include wastes of SW103 (batteries), SW104, SW204 (metal, tin, nickel, copper, zinc, lead, cadmium), SW206, SW302 (acid), SW207 (fluoride), SW305, SW306 SW312 (oil), SW322, SW323 (alkali degreaser), SW327 (thermal fluids), SW401, SW402 (corrosive alkali), SW410 (stained rags), SW415, SW417, SW418 (ink, paint, varnish), SW427 (mineral sludges) and SW430 (obsolete laboratory chemicals). However, there was no substances under code SW5, any residues from treatment or recovery of scheduled wastes.

CONCLUSION

This research revealed that TVET ITI KL has adopted authorities regulations on HW management under Act 1974 and permitting only licensed by DOE to perform the disposal. The samples were generated data collection for 5 years (N=5) from 12 divisions (n=12). The outcomes indicated that the quantity of E-waste (SW110) generation rate was rw = 437.37unit/year/division. Whilst, for others of HW code (SW1, SW2, SW3, SW4, SW5) solid waste generated at 2,454.36kg/year/division and volume of liquid substances generated was 5,386.15ml/year/division. The generation trend lines found to be positive relationship with yearly training, students enrollment and extra skills events. The research recommended to implementing HW minimization plan with the goal of reducing the amount and toxicity waste generated through ITI KL activities. Committed to understanding HW minimization in order to reduce waste streams with the ultimate goal of a net zero waste through implementing “cradle to cradle” processes and practice by encouraging more sustainable purchasing and greater recycling. In addition, to help decrease future threats to human health and environment including cost savings opportunities in the form of avoided disposal costs and the creation of safer working and learning conditions for institute, students and staffs.

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