3R'S CRITICAL SUCCESS FACTOR FOR INTEGRATED SOLID WASTE MANAGEMENT IN HIGHER EDUCATIONAL INSTITUTIONS

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Abstract: Higher Educational Institutions (HEI's) in Malaysia has been faced with a wide population increase in the past decades, with an estimated population of 35,000 students and staff in Universiti Teknologi Malaysia (UTM), these lead to force a shift which results the University to an increasing volume of municipal solid waste, attached to these increase, it is an economical social and environmental development which has raised the standard of living and changing the waste generator's habits within the HEI's environment, these gave birth to the higher volume of solid waste generation. This paper focus on a strategic implementation and practice of 3R's (Reduce, Reuse and Recycle) in integrated solid waste management, thus it becomes everyone's responsibility to minimize the waste generation. The shift brought about the need to get proper solutions for the sustainable leaving condition of public within the HEI's. Questionnaire survey, interviews and walkthrough were used to examine the level of attitudes and awareness base on 3R's practice amongst the waste generators in HEI's and propose a new Critical Success Factor for a sustainable solid waste management in HEI's. The findings indicated that, the success of Integrated Solid Waste Management in HEI's depends on the participation of students and academic staff using 3R's in Integrated Solid Waste Management Hierarchy, with emphasis on source reduction, intermediate treatment then final disposal and enlighten the waste generators on the importance of 3R's, these will serve as a substantial measure to reduce, reuse and recycle the generated solid waste there all days. Finally it was revealed that, proper 3R's practice amongst the waste generator in HEI's will help to reduce the environmental impact and running cost of solid waste management. It will also lead to developing environmental consciousness amongst graduate professionals and HEI's staff as a whole.

Keywords: 3R's awareness; Higher Educational Institution; Integrated Solid waste management; Malaysia; and Universiti Teknologi Malaysia.

INTRODUCTION

Managing solid wastes in society has been a challenge for as long as people have gathered together in sufficient numbers to impose a stress on local resources. In bygone centuries (and nowadays in poorer countries) waste from homes and industries could be dealt with simply by hauling it to crude dumps where it could be buried, eaten by animals and burned.

Most human activities create waste, and it is the way this waste is handled, stored, collected and disposed of, that can pose risks to the environment and to

public health, [35]. Wide population, rapid urbanization and other human activities in Higher Educational Institutions (HEI's) perhaps result the academic environment in over-stressing of urban infrastructure services including municipal solid waste Management services. HEI's are facing considerable difficulties in providing adequate services in municipal solid waste management (MSWM)

Sizes in terms of land mass, infrastructures and population, as well as various complex activities taking place on campuses makes universities to be similar to small towns, [2]. As such, they not only need to maintain an appropriate physical infrastructure, they require similar services to small towns, including accommodation, transport, retail, leisure and, of course, waste management. Higher Education Institutions (HEIs) are key sites of tertiary learning and research, major employers, economic actors and providers of cultural, recreational and infrastructure resources, [15] and they have substantial potential to catalyse and accelerate societal transitions towards sustainability, [23]. Integrated waste management systems in particular, are one of the greatest challenges for HEIs' sustainable development, [4]. HEIs generate thousands of tonnes of waste and waste generated from HEIs is classified as household waste in the United Kingdom (UK), although in many cases, it is collected by private contractors, [7]. Nevertheless, the dramatic expansion of UK Higher Education (HE) sector in scale and scope has put even bigger pressure to formally integrate sustainable development into policy and practice.

Most of Institutions are directed towards "large waste generators", i.e., those with a production of over 10 tons/yr. Most educational institutions belong to this category; therefore, they must develop the corresponding management plans, which must include an acquisition policy directed towards sustainable consumption, based on "green purchase" with the subsequent reduction of waste and the consumption of recycled and/or recyclable products. Sustainable consumption based on "green purchase" targeted at the input of the materials is just one of the control points in the management system, pursuing their transformation and finally the reduction of waste generation. It is expected that waste management plans of educational institutions involve the students as part of the educational process, [19].

Household waste and other waste streams needed to be removed from the human environment to avoid nuisance and public health problems, and the wider environment provided an ample sink for these negative effects of human life. Growth in population and in individual prosperity have since combined to put greater pressure on the environment, at the same time as permitting a growth in people's appreciation of that environment. Consequently waste management policy and practice in industrialized countries developed rapidly in the second half of the 20th century, to ensure that, while public and occupational health risks are minimized, environmental resources are protected. This paper describes the 3R's critical success factor for the management solid waste generated within HEI's, as well as to present the results obtained.

BACKGROUND

Waste management programs in higher education institutions in industrialized countries began more than 20 years ago and vary from voluntary and local efforts to institutionalized programs [3]. Some of the higher education initiatives focused on recycling and waste reduction have been very successful. It is important to note that in the USA it is mandatory that colleges and universities implement waste reduction and recycling strategies.

Solid waste management is one of the most critical issues faced by Malaysia due to the rapid development of the country in population and economic. The same goes to the Higher Educational Institutions. UTM is a hostel provided campus, the human traffic is big within the campus. Every day there are tons of solid wastes been produced by the residents of UTM. Most of the solid waste created by UTM residents are papers, household waste, glass, plastic and others. We could realize most of the above solid wastes are recyclable. However, the residents of UTM are not aware on sustainable and environmental issue; they are not playing the active role to take initiative to reduce the solid wastes and recycle the waste.

The main reason is due to lack of awareness in sustainable and environmental issue among the students. To be more accurate, the students do not see the relevant and responsibility to play a role in the awareness issues. Besides, lack of facilities and support from government also contribute to this problem in UTM. There are not enough recycling bins inside the campus; without any program to encourage and involve the students in UTM in solid waste recycling. University authority also does not putting enough effort to reduce the solid waste in campus as well. If we do not look serious into this problem, UTM campus will be contaminated and caused by certain significant environmental impact. The causes of this problem should be investigated,

thus the ways to minimize or solve solid waste management problem could be figured out, [24].

DEFINITION OF WASTE

Waste generated in households, commercial establishments, institutions, and businesses. MSW includes used paper, discarded cans and bottles, food scraps, yard trimmings, and other items, [10]. Basel convention in 1989 defined waste as any substance or object which is supposed to be disposed or intended to be disposed by the provisions of the law. Waste creation by mankind is inevitable as far as the manipulation of the chemical environment continues, [20].

Base on waste history, Environmentalists became worried about the heap quantity and toxic level that wastes produced. [22], is of the view that, the problem of waste has always been created by human since the prehistoric times. By the time immemorial waste has less negative effects on environment due to the less population rather than a benefit to help improve the soil, [22, 32].

The definition of MSW varies, but typically includes waste arising from private households to that collected by or on behalf of local authorities from any source. MSW therefore includes a proportion of commercial and non-hazardous industrial waste. Depending on the country, the definition can include some or all of: (a) household wastes (collected waste, waste collected for recycling and composting, and waste deposited by householders at household waste disposal sites) (b) household hazardous wastes (c) bulky wastes derived from households (d) street sweepings and litter (e) parks and garden wastes (f) wastes from institutions, commercial establishments and offices

In Britain, municipal waste is defined as waste collected by, or on behalf of, local authorities and includes all the waste types listed above, although the trade waste component tends to be limited. In most countries, municipal waste is taken to be a broader and more encompassing definition than simply household solid waste [12]. Solid wastes could be defined as non-liquid and nongaseous products of human activities, regarded as being useless. It could take the forms of refuse, garbage and sludge, [17].

SOLID WASTE GENERATION AND CHARACTERISTICS

Whenever human settled as leaving creatures, they will ignite themselves with activities thus waste will be generated from such activities. Reducing the waste there by management it accordingly, further more initiatives and understanding the waste in different categories would be a priority to help and enhance the waste management system as a whole.

Population in Malaysia has been increasing at a rate of 2.4% per annum or about 600,000 per annum since 1994. With this population growth, thus brought about the municipal solid waste (MSW) generation also increases rapidly, which makes Municipal Solid Waste (MSW) management crucial. During the year 2003, the average amount of MSW generated in Malaysia ranges 0.5–0.8 kg/person/day; it was then increased to 1.7 kg/person/day in some major cities, [14]. Despite the aggressive economic development in Malaysia, the solid waste management is relatively poor and haphazard, [11]. It was estimated by the year 2020; the quantity of MSW generated was estimated to have increased to 31,000 tons. Information on the quantity of solid waste generated is fundamental to almost all aspects of solid waste management, [26]. At most, previous studies on MSW generation used the load-account analysis, which is based on waste collected and disposed in the landfills. Changes in MSW generation rates are mostly caused by the demographic factors and facilities, which are provided by the respective departments, [24].

EFFECT OF SOLID WASTE MANAGEMENT IN HEI'S

Higher Educational Institutions (HEI's) has a major role to educate members of society, including future leaders, and then they must be at the forefront of the sustainability movement, working to increase public awareness concerning environmental issues and increasing the knowledge, the technology and the will to create a sustainable future, [21].

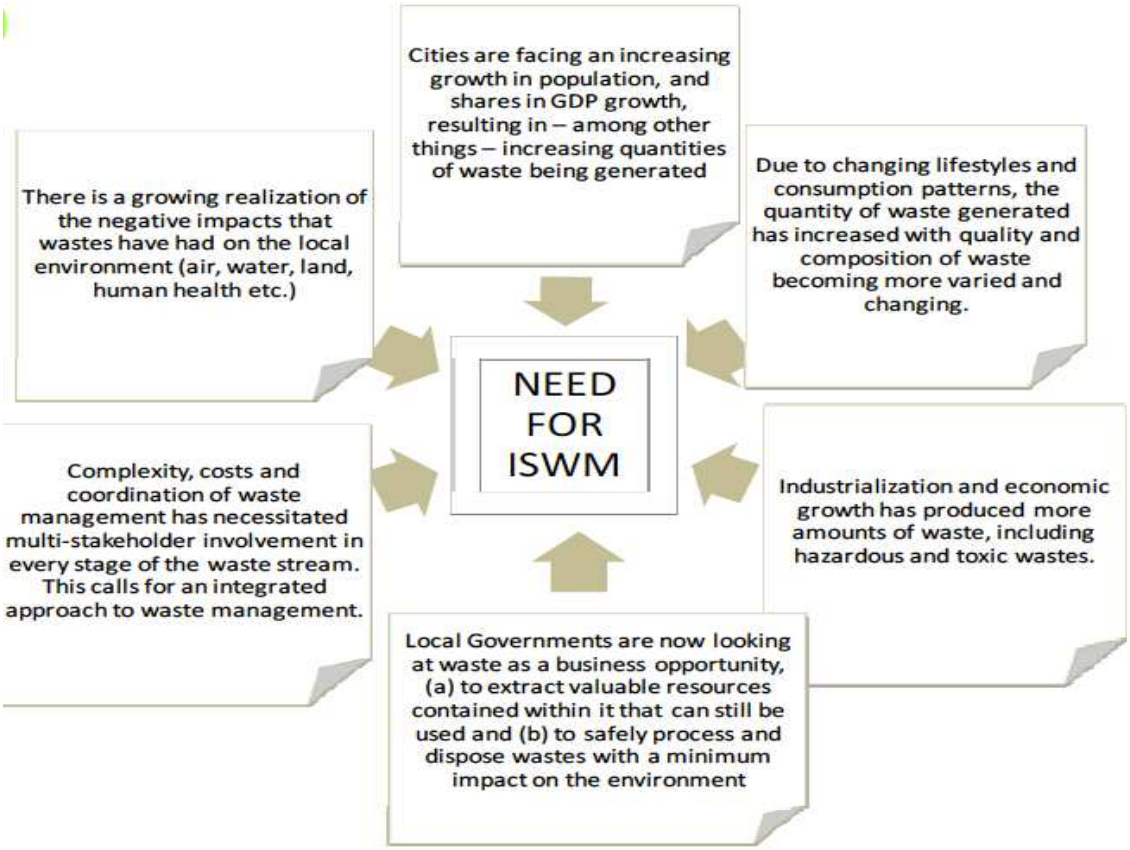

Figure 1: 3R's Policies and Strategies; Highlights, the need for Integrated Solid Waste Management Source, UNEP, 2009.

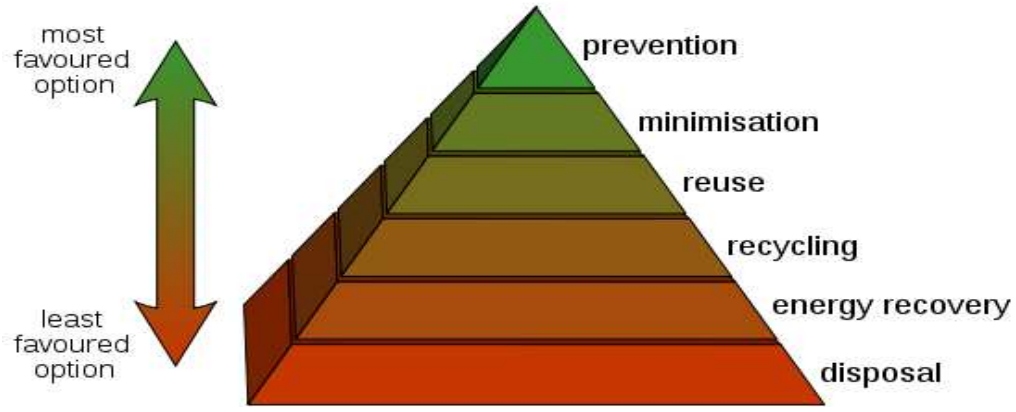

Figure 2: Waste hierarchy refers to the "3 R's" Reduce, Re-use and Recovery [33].

In it is report Talloires Declaration, encourages universities to engage in research and education towards a sustainable future, and to set an example of environmental responsibility by establishing programs of resource conservation recycling and waste reduction at universities, [29].

During the year 2009, the Office of Asset and Development in Universiti Teknologi Malaysia (UTM) report that, the waste generation in within Skudai campus is between 14-15 tonnes per day but with increase population, build up areas and other infrastructures the quantity of waste has increased to about 16 tonnes per day in which if not well managed and disposed, it may pose to: (1) Potential risks to human health and that of other living organisms. (2) Environmental effects (CO_2 and CH_4 methane gas emission) and (3) Increase in cost implication.

WASTE MANAGEMENT HIERARCHY

Refers to the "3Rs" (Reduce, Reuse and Recycle), which classifies waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance - a ranking of waste management operations according to their environmental or energy benefits. The purpose of the waste management hierarchy is to make waste management practices as environmentally sound as possible.

Several SWM Plans have been developed around the world. Many of them have been used as illustrations in this as well as the following chapters. However, there was no standard methodology for ISWM planning, most of these plans highlight only the problems of MSW and are therefore incapable to handle the total waste management problem in an integrated manner. This could have also resulted due to lack of standard methodology for ISWM planning. In order to cope with the problems of SWM, The United Nations Environmental Program (UNEP) through International Environmental Technology Centre (IETC),

INTEGRATED WASTE MANAGEMENT HIERARCHY

The EC strategy has been developed into the concept of “hierarchy waste management”:

[26], Highlight the principles of Integrated Waste Management are defined in terms of the integration of six functional elements.

Reduction

The first in the hierarchy shows that waste production should be reduced. It is realized by the development of clean technology and by the use of such processes which require less material and produce less waste during manufacture.

However HEI’s has to reduce the demands made on all the items that are not re-usable and recyclables, so that the supplies will be reserved for the feature generations. [5] emphasises that, society needs a culture of reduction, not ever-growing consumption.

Re-use

The second step in hierarchy. There are many examples of suitable re-use technologies – tyre re-treading, glass bottles (e.g. from beer and milk). Re-use is not profitable in every case, but environmental aspects can outweigh the benefits.

Recovery

The last step in the hierarchy which has a number of different types:

Recycling - involves reducing the useful parts of material (items or products) by extraction and re-manufacture process, [5].

Materials recycling – using waste material for producing a marketable product. A typical example is the recovering of glass, because scrap glass can be ground and used for new glass production. In the CR, recycling of PET material is very high, and PET is re-used for many products, e.g. load-dependent carpets, car parts (steering wheel, dash-board), fillings for sport clothing. These examples show very suitable process of changing wastes to products, often with energy savings in comparison with obtaining raw materials. But the recycling process assumes that there is a market for recycled materials. Otherwise, waste is produced.

Energy recovery - this technology produces energy by incineration of wastes or by combustion of landfill gas. The energy potential of MSW is high, and has recently been increasing. The problem is that the incinerator installations require high initial capital costs. An additional problem is the necessity to install sophisticated flue gas cleaning equipment.

Composting - uses the decomposition of the organic waste fraction to produce a stable product similar to fertilizer. But there is a problem with the pollution of raw material by heavy metals and toxic organic compounds. In the CR and other EU countries, there are very strict requirements on the quality of compost; all chemical properties concerning heavy metals and organic compounds are limited.

Disposal - the last possibility of how to get rid of waste. The most common method is landfilling, which is the predominant method of waste disposal in Europe and North America. The problem is production of methane and therefore the necessity of gas emission controls to prevent potential air pollution. [10].

Table 1: 3R's Critical Success Factor

	Issues	Gaps	Proposed Interventions
1.	Prevention:	√ HEI's is yet to develop a law governing indiscriminate waste generation. √ HEI's lacks appropriate technologies/ To handle solid waste. √ Lack of policies for handling solid waste generation.	√ Develop policy / law on indiscriminate solid waste generation. √ Develop technologies solid waste recycling (incubator) √ Develop policies for handling solid waste within HEI's
2.	Minimization (Reduce)	√ Excess packaging in plastics. √ No institutional enforcement of policy on paper printing. √ No policy on throw away culture.	√ Discourage through levies. √ Enforce printing on only important signatory documents √ promotes awareness and levies on unsustainable throw away.
3.	Reuse:	√ Nonchalant attitude of double sided printing, use of re-fill contents, polythene bags etc. √ Unhelpful attitude that "low class people reuse"	√ Promote reuse of double sided printing on paper, portable water containers, polythene bags and food containers when needed. √ promotes awareness to change attitude on reuse perception.
4.	Recycling:	√ Insufficient facilities, such as recycling bins. √ Low commitments to recycling initiatives within HEI's √ Higher demands of plastics of different grades within the HEI's.	√ Sufficient facilities should be provided within strategic places. √ Provide initiatives enforcement of recycling practices. √ The rampant use of plastics should be addressed; instead polythene should be used.

Public Awareness Towards 3R's System

3R's is meant for the public, and, without the public's cooperation, the system cannot be operated or maintained appropriately. Hence, it is necessary to make the public aware of 3R's through active participation in the system. In practice, system efficiency is directly proportional to the number of participating citizens for 3R's systems. Without public participation, it may be difficult to maintain cleanliness in a city, and resource recovery systems may become less effective if wastes are poorly separated at the source.

However the purpose of the study is to: (i) Identify the awareness level of 3R's system within HEI's. (ii) To determine the attributes factors contributing to the awareness level of 3R's system.

Descriptive analysis is used to identify the level of awareness on 3R's amongst the public within the metropolis and factor analysis was used for determining the attributes of each factor.

CRITICAL SUCCESS FACTOR ANALYSIS

Below are the key observations, which point to limited control of the 3R's in SWM in Higher Educational Institutions, and improving public awareness on the importance of 3R's system, as it was reflected in the waste management hierarchy: (a) Insufficient facilities that will improve the 3R's practice; (b) No institutional enforcement of policy of waste on the role of 3R's in ISWM; (c) Indiscriminate dumping and throwaway culture by the waste generators within HEI's.

METHODOLOGY

Literature search has been done extensively; questionnaire has been administered randomly, non-probability sampling were used within Universiti Teknologi Malaysia, to a target population sample of 60 respondents, among which only 40 questionnaires were retrieved back for analysis. [25], recommends using the sample technique for a large population, in which participants are selected in a purposeful way. Personal observations and interviews were conducted; distributed questionnaires within the university are measured by a 5- point Likert scale type (1. Strongly Agree, 2. Agree, 3. Not Decided, 4. Disagree, 5. Strongly Disagree) the method has been used by different researchers, [13; 31; 30].

Table 2: Rotated Component Matrix

	Component			
	1	2	3	4
You have heard of Reduce, Reuse and Recycle (3R's) system within your University.	.836			
You have the knowledge to differentiate between Reduce, Reuse and Recycle (3Rs).	.688			
You are familiar with the issues on sustainable solid waste management.	.685			
Public education is not essential to helps and promotes the benefit of 3R's.	.618			
There is a need of more recyclable bins within your University.	.591			
You always separate reuse items and recyclable materials from garbage bags.				
Your Institution have provides a training program on how to reduce waste generation within the university		.773		
You always minimises the use of environmental friendly food containers in your University for waste free university.		.731		
Double sided printing of documents when needed, saves costs and environmental impact for sustainability.		.557		
Imposing some 3R's restrictions will contribute to the decrease of carbon emission.		.504		
Reusing a second hand items, will reduce the cost implication in solid waste management			.845	
You are reusing used food containers and water bottles for sustainable HEI's			.774	
Your institution provides you with sufficient recycle bins for solid waste collection services.			-.502	
Recycling of items used will help to improve the effectiveness of Integrated Solid Waste Management.				.600
3R's campaign is efficient enough to raise public awareness on the importance of Recycling by-products.				-.505

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Section A includes a Demographic comprises questions about Respondent category, and level of education, while section B were designed to measure the awareness levels amongst the staff and students about 3R's system for an integrated solid waste management (practices, benefits, responsibilities), also measuring the availability of the needed facilities for 3R's, and ability for attending and participating in 3R's programs.

RESULT AND DISCUSSION

Factor analysis is used to discover patterns in the relationships amongst variables and enables reduction of the number of variables into factors combined from these variables. Principal component analysis (PCA) is a statistical technique which is used to replace a large set of variables by a smaller set of variables which is the best representation of the larger set. PCA is the most commonly used method for extracting factors in factor analysis. Simple form of factor analysis was used to explain the correlation in a set of data and relates variables to each other. A principal component analysis was also used as a classical statistical method which enables the author to reduce and use the generated set of variables called principal factors. The raw data which comprises of 15 variables indicating the attributes of 3R's were used in achieving the analysis of the component factors. The component factors which include the 3R's awareness, Current practice and policy initiatives have accounts for several observed variables.

Table 3: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.104	20.694	20.694	3.104	20.694	20.694	2.999	19.993	19.993
2	2.205	14.702	35.395	2.205	14.702	35.395	2.226	14.837	34.830
3	1.971	13.142	48.538	1.971	13.142	48.538	1.981	13.205	48.035
4	1.383	9.222	57.760	1.383	9.222	57.760	1.459	9.725	57.760
5	1.322	8.816	66.576						
6	1.064	7.096	73.672						
7	1.009	6.724	80.396						
8	.708	4.719	85.116						
9	.609	4.060	89.176						
10	.449	2.995	92.170						
11	.343	2.286	94.457						
12	.281	1.876	96.333						
13	.227	1.514	97.847						
14	.203	1.352	99.199						
15	.120	.801	100.000						

EXTRACTION METHOD: PRINCIPAL COMPONENT ANALYSIS

After performing Principle Component Analysis also known as Factor Analysis, four principle components were extracted. (See Table 2) These are indicated as F-1, F-2, F-3, and F-4 in both Table 2 and Table 3. Four factors were satisfactory to explain 54.766% of the variance for correlation.

Factor 1 Consist of 19.993% of variance in Rotation Sums of Squared Loadings, which represents the general awareness of 3R's amongst the waste generators within the university shows that, most of the waste generators are have a little knowledge of 3R's, but still are yet to display it into practice. This factor clearly shows that the components in this factor are having a positive impact on the 3R implementation, which is mainly influence by the awareness level.

F**actor 2** explains 14.837% of the total variance and loads positively with higher loading of parameters on Waste Reduction, This could be considered as the slogan Waste Reduction or minimization is have a

higher loading of Category and is significant to the successful implementation of waste free environs in HEI's.

Factor 3 explains 13.205% of the total variance rotation sums of square loadings which includes moderate loading for Waste Reuse components, this factor shows that the waste generators were not re-using the second hands and other reusable items, rather they buy a new products or refilling the reusable containers. Only one of the components indicates a negative that the recyclable bins are not sufficient enough within the university.

Factor 4 explains in the Rotation Sums of Squared Loadings, which contained 9.725% of the total variance shows the lowest loadings among the four factors. This factor could be considered as Waste Recycling. The parameters within these factor will affect the recycling program, were the subject contribute to the low awareness and practice of recycling the unwanted products produce within the HEI's.

The explained values in principal component, Eigen values and percentage of variance are evaluated using varimax rotation method which is represented in Table 3. Four factors were satisfactory to explain 57.760% of the variance for correlation. The total variance distributed in four factors is shown in Table 3. These total variances explained in four factors are 20.694 by Factor 1, 14.702 by F2, 13.142 by F3 and 9.222 by F4 respectively. The largest component loading either positive or negative, suggests the meaning of the dimensions; Positive loading indicates that the contribution of the variables increases with the increasing loading in dimension and negative loading indicates a decrease, [16]. The highest significant variables which are represented by the high loadings in the components were taken into consideration for the evaluation of the components.

CONCLUSION

The evaluation studies of the data by factor analysis leads to the conclusion that, the four factors which include 3R's Critical Success Factor and awareness, are found to be in good correlation with the respective factor loadings in accordance with their respective status. The data were analysed for factor analysis and first four components were chosen, which contribute 57.760% of the total variance. The principal component analysis were considered which shows that, the awareness to promote 3R's program amongst the public within Higher Educational Institutions were not sufficient a few recyclable products such like bottles, papers, cans, and aluminium are being disposed in a mixed disposal bin, and later dispose off into RO-RO bin before transporting to Landfills. Most of the sweepers and cleaners in the HEI's are trying to separate the mixed waste in three categories, the Recyclables, Reusable and biodegradable accordingly, thus they sold out the first two categories to scavengers. According to [1], the activities of scavengers can have a great impact on the economy and waste management (if the scavengers are properly organized, enlightened, and provided with the necessary economic and institutional support. At present, however, their contributions are limited by the absence of government policy to encourage reuse and recycling. In cities across the world, millions of people sustain themselves and their families by reclaiming reusable and recyclable materials from what others have cast aside as waste, [18].

The Majority of the respondent doesn't know sufficiently on how or where to recycle, this is due to the fact that efforts for effective recycling programs and implementation in HEI's is very low, it seems that the awareness program which offered is not sufficient and needed to be more efficient in a strategic way. From the survey it is apparent that waste separation at point of generation is not encouraging in HEI's, thus the facilities are not yet available and other reasons, Lack of awareness among the public regarding 3R's (practices, benefits, responsibilities) and the unwillingness among the majority of staff and students to cooperate in waste separation.

Yet in HEI's, the committed policy initiatives on 3R's system was at its early stage and very slow. Introduction of 3R's concept and its adoption by both staff and students can stimulate research in waste reuse and cut wasteful practices, apart from increasing production efficiency, commitment to the waste management policy of reuse and recycling is a positive step towards reducing environmental risk while improving economic performance.

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