SOLID WASTE MANAGEMENT DURING WAREHOUSE RACKING INSTALLATION IN PANGLIMA GARANG SITE

ABSTRAK

Pengurusan sisa pepejal yang berkesan semasa proses pemasangan rak di gudang sangat diperlukan untuk mengelakkan kesan negetif kepada kesihatan pekerja dan alam sekitar. Ia merupakan satu cabaran dan harus dirancang dan dikendalikan dengan betul dan selamat. Strategi untuk mengawal penghasilan sisa pepejal dari proses pertama hingga proses yang terakhir mestilah menggunakan cara yang terbaik dan sesuai. Kawalan ke atas penghasilan sisa pepejal dapat membantu mengurangkan sisa pepejal dihantar ke tapak pelupusan sampah. Oleh itu, adalah penting untuk mengkaji dan memperbaiki strategi kawalan sisa pepejal. Penyelidikan telah terbukti bahawa penghasilan sisa meningkat sebanyak 3% setiap tahun disebabkan oleh pelbagai sebab seperti penghijrahan bandar, kemakmuran dan perkembangan pesat. Oleh itu, kajian ini memberi tumpuan untuk memperbaiki dan mengawal strategi sisa pepejal dalam proses pemasangan rak di gudang. Dengan ini dapat mengurangkan sisa pepejal dihantar ke tapak pelupusan dan melaksanakan 3R (reduce, reuse, recycling). Di samping itu, mengelakkan kesan negatif kepada kesihatan pekerja dan persekitaran disebabkan pengurusan sisa pepejal yang tidak berkesan. Terdapat beberapa kaedah yang digunakan untuk menjalankan penyelidikan ini; pemerhatian melalui lawatan tapak, kajian soal selidik dan rujukan melalui jurnal dan buku. Daripada hasil kajian menunjukkan bahawa sisa yang dihasilkan dilupuskan dengan kaedah yang tidak betul. Terdapat beberapa saranan untuk menggalakkan pekerja mengambil bahagian dalam menguruskan sisa pepejal antaranya adalah mendedahkan para pekerja manfaat pengurusan sisa pepejal dan memaklumkan kepada mereka kesan negatif sisa pepejal terhadap kesihatan dan persekitaran apabila pengurusan sisa pepejal yang tidak betul diamalkan di tempat kerja.

SOLID WASTE MANAGEMENT DURING WAREHOUSE RACKING INSTALLATION IN PANGLIMA GARANG SITE

ABSTRACT

An effective solid waste management in warehouse racking installation is very necessary to avoid related impacts on workers health and environmental. Current practice of solid waste management in warehouse racking installation is a challenge that must be planned, handled properly and safely. Strategies to control the solid waste generation from the first process until end process are among the best and appropriate way must be applied. Control over the generation of solid waste can help to reduce solid waste being sent to landfill. Therefore, it is significant to study how to improve solid waste strategy and control in warehouse racking installation process. Research has been proven that waste generation increased by 3% annually due to many causes such as urban migration, affluence and rapid development. Therefore, this research is focusing on how to improve solid waste strategy and control in warehouse racking installation process. This due to reduce the solid waste generated being sent to landfill and implement waste hierarchy as known as 3R (reduce, reuse, recycling). Besides that, avoid the negative impacts on workers health and environment due to ineffective solid waste management method. There are several methods used to conduct this research included; the observation through the site visit responded by staffs through questionnaire given and reviews through journals and books. From the finding indicates that wastes generated during the warehouse racking installation weren't disposal properly. There are some recommendations for encourage workers participate in managing solid waste during warehouse racking installation. The best practice to do is by expose workers the benefits of managing solid waste and keep inform them the negative effects of solid waste on workers health and environment when poor managing solid waste is apply in workplace.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

ABC	Action Plan for the Beautiful and Clean Malaysia
CAPEX	Capital Expenditure
CH_4	Methane Gas
DSWMP	Department of National Solid Waste Management
EPI	Environmental Performance Index
GhG	Green House Gases
LA	Local Authorities
MHLG	Ministry of Housing and Local Government
MSW	Municipal Solid Waste
MSWG	Municipal Solid Waste Generation
NGO	Non Government Organization
NSWMP	National Solid Waste Management Policy
OPEX	Operational Expenditure
SWG	Solid Waste Generated
SWM	Solid Waste Management
SWMPC	Solid Waste and Public Cleansing Management Corporation Act
UNEP	United Nations Environment Programme
UTM	Universiti Teknologi Malaysia
3R	Reduce, Reuse, Recycling

CHAPTER 1: INTRODUCTION

1.1 Background of the Research

Waste management is a problem in an urban and rural area that related to the economic status of a country and the lifestyle of its population. According to Tchobanoglous (1993), solid waste management can be defined as a discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes and in spite of the aggressive economic development in Malaysia, the solid waste management is relatively poor (Malaysia Ministry of Housing and Local Government, 1988; Nesadurai, 1999). Currently, in Malaysia over 23,000 tons of waste is produced each day. However, by the year 2020 is expected to rise to 30,000 tons. Modern waste management is shifted to a more flexible waste hierarchy concept, also called as 3R (reduce, reuse, recycle) policies (Tanaka, 1999; Wilson, 2007). The developing Asia counts as the fastest and largest waste generator globally and a closer inspection reveals a mix of general and specific elements of policy dynamics in the evolution and adoption of waste management policies (UNCRD *et al.*, 2009).

Today, waste and waste management has given rise to many pressing issue (Bjorklund, 1998; Japan International Cooperation Agency, 2006) such as expensive land prices, strict environment regulations (Fullerton & Kinnaman, 1995), health and safety issue, improper management of waste disposal sites (Ministry of Housing and Local Government Malaysia, 2005), landfill spaces becoming limited (Bartelings & Sterner, 1999), policy problems (Chloe & Fraser, 1999) and the unwillingness of local communities to accept new technologies and facilities in their own back yards (Petts, 1995). Failing in managing solid waste leads to increased operation cost and damaging the environment (Agamuthu, 2001; United Nations

Development Programme Malaysia, 2008; Weitz, Thorneleo, Nishtala, Yarkosky & Zannes, 2002). In Malaysia, solid waste management is not only responsibility under Local authorities but most government agencies such as the Ministry of Housing and Local Government, Ministry of Environment, Ministry of Health, the various academic institutions and NGOs should work together to improve solid waste management strategy and control.

In Malaysia, majority of waste composition is municipal solid waste (MSW) which is 64 percent (%), followed by industrial waste is 25 percent (%), commercial waste is 8 percent (%) and construction waste is 3 percent (%). In Asia, waste material management require fast respond especially in countries like China, Malaysia and South Korea which have been categorized as emerging industrializes state (S. Wahidah & A. Ghafar, 2017). The increased of waste in Malaysia is a fact that the industrial waste is one of the contributors to the waste generation. Developing country like Malaysia also have challenges from the aspect of manpower, land scarcity, technology and lack of infrastructure to accommodate and mange the increasing of waste (S. Wahidah & A. Ghafar, 2017). This issue is expected to increase over several years corresponding to the economic development, urbanization and population growth as the Malaysia's population is expected to reach 33.4 million in 2020 and 37.4 million in the year 2030 (Abd Hamid *et al.,* 2015).

1.2 Problem Statements of the Research

An effective solid waste management in warehouse racking installation is very necessary to avoid related impacts on workers health and environmental. Current practice of solid waste management in warehouse racking installation is a challenge

that must be planned, handled properly and safely. The challenges of solid waste management in warehouse racking installation are following:

i. Lack of awareness on good sanitary practices in the site management where is most of the workers involve in warehouse racking installation weren't exposure the consequences of poor managed solid waste because it can cause pollution, resources degradation and health problem.

ii. Inadequate legal and regulatory knowledge where is the most of installation warehouse racking workers are foreign workers and they are not familiar with Solid Waste Legislation in Malaysia.

iii. Inadequate training among the worker to manage solid waste in the site. Most of them are contract worker and they are hired based on the project. Company has difficulty to schedule the training on the contract workers.

Strategies to control the solid waste generation from the first process until end process are among the best and appropriate way must be applied. Control over the generation of solid waste can help to reduce solid waste being sent to landfill. Therefore, it is significant to research how to improve solid waste strategy and control in warehouse racking installation process.

1.3 Objectives of the Research

The main objective of this research is to improve solid waste strategy and control in warehouse racking installation process. The specific objectives are:

a) To recommend some recommendations on managing wastes generated during the warehouse racking installation through the suitable disposal methods (recycling, incineration and landfill).

b) To minimize or zero amount of wastes generated through waste hierarchy concept, as called as 3R (reduce, reuse, recycle).

c) To provide suggestion on reducing negative effects of waste on workers' health and environment.

1.4 Scope of the Research

The scope of the research determined at an early stage in an accessibility review of literature and information gathering is focusing on the site visit and interview during the site visit. Lastly, it covers the analysis from a set of questionnaire that is designated to achieve the objectives of this study. The scope of the research includes:

a) Solid waste management in warehouse racking installation.

b) Site study has been carried out at Panglima Garang, Selangor.

1.5 Significance of the Research

Research has proven that waste generation increased by 3 percent (%) annually due to many causes such as urban migration, affluence and rapid development. Therefore, this research is focusing on how to improve solid waste strategy and control in warehouse racking installation process. This due to reduce the solid waste generated being sent to landfill and implement waste hierarchy as known as 3R (reduce, reuse, recycling). Besides that, avoid the negative impacts on workers health and environment due to ineffective solid waste management method.

1.6 Outline of the Research

Overall this research has five chapters. Begin with introduction given in this chapter. Secondly, follow by chapter 2 which presents a review of related literatures of solid

waste management in Malaysia. Chapter 3 presents the methodology use to the research study. The research questions would be handled using quantitative data collection techniques. Chapter 4 presents finding and discussion. The last chapter of the research is the conclusion from the finding and also some recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Solid Waste Legislation in Malaysia

Local authorities provide solid waste management (SWM) to the community by given the services contract to the small contractors before enforcement of Act 672 & full privatization. Enforcement of Act 672, the development of Regulation of Scheme & Licensing is subject to the following legislations of all categories of solid waste is subject to the following regulations:

- Regulations on Household and Institutions Solid Waste Collection
- Regulation on Construction Solid Waste Collection
- Regulations on Transportation Services of Solid Waste Collection
- Regulation on Compounding Offences
- Regulation on Development of Prescribe Solid Waste Management Facilities
- Regulation on Business (Commercial and Industrial) Solid Waste Collection
- Regulation on Provision of Public Cleansing Services
- Regulation on Separation at Source

On 1997, Interim Privatization Concession companies were introducing by Local Government and State Government. The Solid Waste and Public Cleansing Management Act 2007 (SWMPC) have been passed by Parliament on 30th January 2007 by placing executive authority on the Federal Government to implement solid waste management and public cleansing. It started enforcement on 1st September 2011 in 8 states (Johor, Melaka, Negeri Sembilan, Perlis, Kedah, Kuala Lumpur, Putrajaya & Pahang) and Federal Territories (Peninsular Malaysia). The SWMPC consists of twelve (12) parts containing 112 sections and no schedule that included no amendment. Twelve (12) parts of SWMPC including as below:

- Part I: Preliminary
- Part II: Administration
- Part III: Approval for the Construction, Alteration or Closure of Prescribed Solid Waste Management Facilities
- Part IV: Licensing Provisions
- Part V: Charges
- Part VI: Tribunal for Solid Waste Management Services
- Part VII: Assumption of Control
- Part VIII: Control of Solid Waste Generators and Persons in Possession of Controlled Solid Waste
- Part IX: Enforcement Provisions
- Part X: Reduction and Recovery of Controlled Solid Waste
- Part XI: General
- Part XII: Savings and Transitional

The main objectives of SWMPC were introduced are to standardize the level of Solid Waste Management and Public Cleansing across all Local authorities and to create an economically and environmentally sound Solid Waste Management Industry. The waste category under this act included household, commercial, construction and demolition, industry, institution, public and imported while for public cleansing areas included streets, public area, public toilets, public drainage, markets, Hawker centre, illegal dumping, beaches, roadside grass cutting and removal of carcasses. Overall issue and not just collection of garbage and construction of dumps and is responsible to monitor, supervise and enforce solid waste management and public cleansing in the country was viewed by the

corporation. It also implants public awareness for sustainable management of public waste and cleansing and is also accountable for recycling technology.

Department of National Solid Waste Management (DNSWM) has gazette on 30th August 2007 and established under Solid Waste and Public Cleansing Management Act. DNSWM is centralized under the Ministry of Urban Wellbeing, Housing and Local Government. The function of DSNSW in solid waste management included to propose plans, strategies and also establish standards, codes and specifications practices as well as also to enforce laws and regulations, set guidelines, monitoring and approvals Act 672 defines solid waste as a waste material or undesirable excess material or rejected product arising from the application of any process; any material required to be disposed of as a broken, worm, polluted or damaged. The Act 672 focuses on recycling and has the provision for disposal at its source. With 900 employees at 52 districts and state offices nationwide as well as with people's support, the company is optimistic towards making Malaysia a clean nation with its vision. The Act 672 empowers the Federal Government to enter into agreement with any person to undertake, manage, operate and carry out solid waste management or public cleansing services.

The key aspects as following:

- The local Authority shall not be liable for the on SWMPC
- Local Authority staff will provide the opportunity to join Concession Company.
- Integrated solid waste management system, concessionaires' Vs others.
- Priorities on 3R

National Solid Waste Management Policy (NSWMP) has been introduced under Department of National Solid Waste Management (DNSWM) as guidance in the management of solid waste management system including collection, transportation and disposal. The targets of the NSWMP are:

i. Establish an integrated solid waste management system, which is holistic, cost effective, socially acceptable and sustainable which is emphasizes the environment conservation, affordable technology and securing the public health; and
ii. Implement solid waste management based on solid waste hierarchy which emphasizes waste minimization through 3Rs (Reduce, Reuse and Recycling), solid waste treatment and final disposal.

To clarify further, six (6) objectives have been introduced by the DNSWM such as:

i. A solid waste management that is integrated and cost effective, which includes collection, transportation, intermediate treatment and disposal.
ii. Minimization of solid wastes from the domestic, commercial, industries, institutions community and construction through 3R.
iii. Services those are efficient and cost effective through privatization.
iv. Selection of technologies that are proven, affordable in terms of capital expenditure (CAPEX) and operational expenditure (OPEX), and environment friendly technologies.
v. Ensure conservation of the environment and public health.
vi. Establish institutional and legal framework for solid waste management.

(Department of National Solid Waste Management, 2014)

Improper disposal of wastes can pollute the environment and present a serious threat to humans. Solid waste management (SWM) services include separation, storage, collection, transportation, transfer, processing, recycling, treatment and controlled of disposal solid waste which divided into 8 categories including commercial, construction, household, industry, institutions, import, public and others that may is fixed from time to time. Collection of household solid waste and similar solid waste has been privatized on 1st September 2011. Three contractors were appointed for waste collection in South area (Johor, Melaka & Negeri Sembilan), Northern area (Perlis & Kedah) and Central & Eastern area (Kuala Lumpur, Putrajaya & Pahang). **Figure 2.1** (Mutalib, 2013) shows the concession companies based on area in Peninsular of Malaysia were appointed by Malaysian Government. South area is operated by SWM Environment Sdn. Bhd, Northern area is operated by Environmental Idaman Sdn. Bhd while Central & Eastern area are operated by Alam Flora Sdn. Bhd.

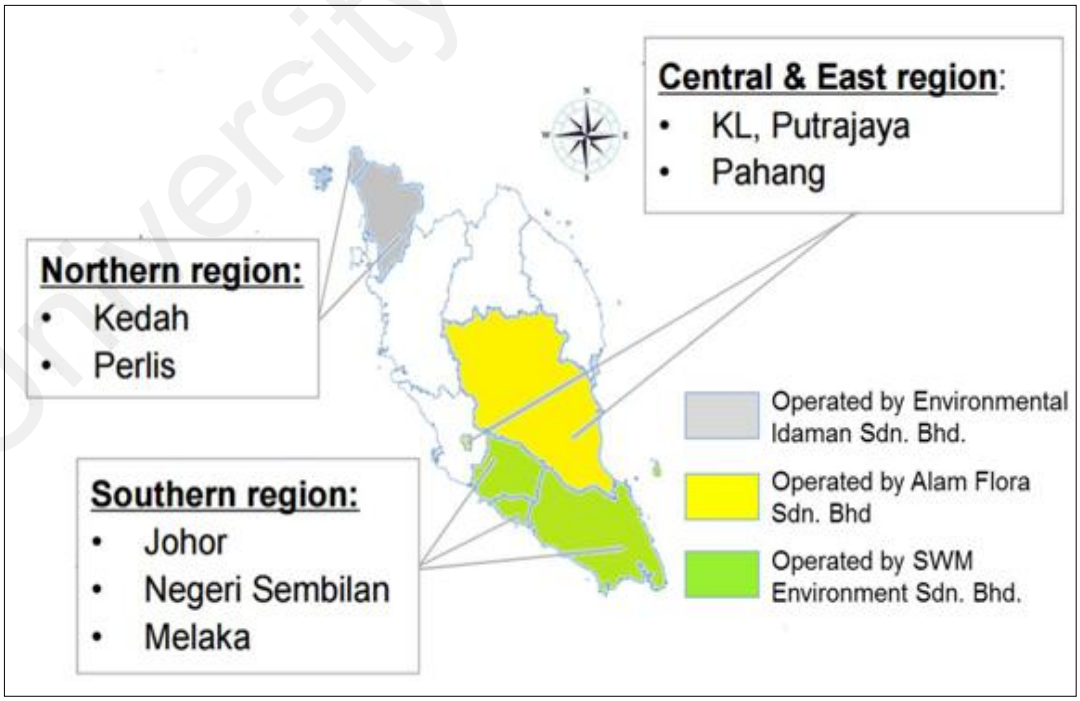


Figure 2.1: Concession Companies based Region in Peninsular of Malaysia (Mutalib, 2013)

In Malaysia, the related Acts of solid waste management that has been introduced and amended by Malaysian Government included:

- Act 672: Solid Waste and Public Cleansing Management Act
- Act 673: Solid Waste and Public Cleansing Management Corporation Act
- Act A1311: Local Government Act (Amended)
- Act A1312: Street, Drainage and Building Act (Amended)
- Act A1313: Town and Country Planning Act (Amended)

2.2 Solid Waste Management Concept

Solid waste is unnecessary things that generated by the human activities from the various industries. According to Pichtel (2005), solid wastes contain a constant volume, weight and mass. Solid waste can be classified to the several classes which are industry wastes, electric and electronic wastes, construction wastes, agriculture wastes and municipal wastes (World Bank, 1999a). In fact, the classification of solid waste is depend on the place of solid wastes have generated. Although, the solid waste came from the various industries, it shows the unfinished usage of natural resources and raw material. Therefore, world, country and individuals itself had financial loss (Holmes, 1996).

2.2.1 Definition of Solid Waste

According to World Bank (1999a), there are abundant meanings of solid waste classification and constitutes. The solid waste has been defined by the most countries based on their own act (Read, 1999). According to World Bank (1999a), early 1989, solid waste defined as a thing that cannot be recycle or reuse and will go to landfill under solid waste regulation. Therefore, different country has the different meaning of solid waste.

The definition of solid waste is defined by United Nations Environment Programme (UNEP) in the Agenda 21 have similarities with the other countries included Malaysia (United Nations, 1992b). Solid waste came from all types of domestic waste those not harmful to human or living things (Read, 1999; Hansen *et al.,* 2002; Pichtel, 2005).

Besides that, the meaning of solid waste between Malaysia Act 672 and the European Union Framework Directive on Waste (91/156/EEC) are quite similar which are any unwanted substances or scrap materials disposed by individual (World Bank, 1999a). The unwanted substances or scarp are classifies as solid waste. In Malaysia, solid waste are divided into three (3) major groups and will be managed under different government department for each group which are municipal solid waste under Department of Ministry of Housing and Local Government, scheduled hazardous waste under Department of Environment and clinical waste under Department of Ministry of Health (Manaf *et al.,* 2009).

2.3 Generated Solid Waste in Malaysia

In developing countries like Malaysia, it is having problem of increasing the generated waste and the way to dispose waste. According to GAIA Global Meeting Data (2003), overall about 16,000 tons of domestic waste is generating per day is by local communities and the amount of domestic waste per day is around 0.45 to 1.44 kg per day that depending on the status of economic for the concerned areas. The generated waste per day on the average is about 1 kg per capita (GAIA Global Meeting Data, 2003). **Figure 2.2** (World Bank, 2012a) shows the percentage of waste generated rates is influenced by the development of economic, the degree of public habits, industrialization and local climate. 46 percent (%) of high income

countries has contributed to the world solid waste generated followed by 29 percent (%) of upper middle income countries, Lower middle income countries is 19 percent (%) and 6 percent (%) by lower income countries.

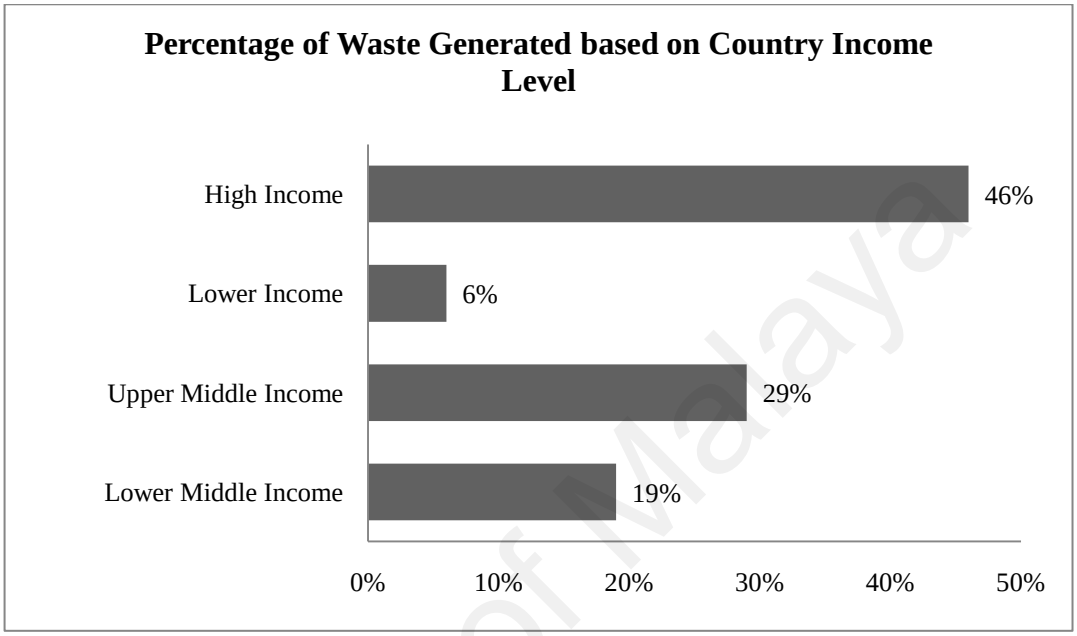


Figure 2.2: Percentage of Waste Generated by Country Income Level (World Bank, 2012a)

Moreover, generated waste by region, country and cities has the different rate. **Table 2.1** shows the data of solid waste generated based on region. From the data, it shows that East Asian countries is the example countries lower waste generated per year (270 million tones/year) compare to European countries (572 million tones/year) although East Asian countries in urban population have much higher peoples with 777 million than European countries (729 million peoples). The quantity of generated waste is keep increase due to continue urbanization.

Table 2.1: Solid Waste Generated based on Region (World Bank, 2012a)

Region	Urban Population (million)	Waste Generated (million tones/year)	Waste Generation (kg/person/day)
Africa	260	62	0.09 - 3.0
East Asia/Pacific Region	777	270	0.44 - 4.3
Eastern/Central Asia	227	93	0.29 - 2.1
Latin America/Carribbean	399	160	0.1 - 1.4
Middle East/North Africa	162	63	0.16 - 5.7
European countries	729	572	1.1 - 3.7
South Asia	426	70	0.12 -5.1

The quantity and nature of solid waste produced greatly important in managing solid waste management (Tchobanoglous *et al.*, 1993). Therefore, most of the previous studies conducted on waste produced and natures are focused on solid waste collected and waste disposed at landfill. In Malaysia, municipal waste generation data collected still limited and unfinished in certain area as compare to European countries (Manaf *et al.*, 2009).

Demography factors and urban lifestyle are one of the factors that influenced the solid waste generated rate and pattern (Vergara & Tchobanoglous, 2012). In Malaysia, the generation of solid waste is estimated around 26 million tons in 2007. 30 percent (%) from the total quantity of solid waste generated is contributed by municipal solid waste (Larsen, 2007). Statistics data show the municipal solid waste generated in Malaysia from the household is nearly 50 percent (%) followed by commercial waste, street cleansing, institutional, industry and construction (Saeed, 2009).

Table 2.2 shows the composition of municipal solid waste generated in Malaysia from 1975 until 2005. In 2005, organic waste generated is reducing 18.9 percent (%) **c**ompared to the year 1975. Moreover, inorganic waste generated is increasing in

average nearly 7 percent (%) in 2005 which higher contributed by plastic waste followed by paper and glass waste. This scenario happens due to the change of Malaysian population lifestyle during this period.

Table 2.2: Percentage (%) of the Solid Waste Composition in Malaysia (Agamuthu *et al.*, 2009)

Physical Composition	Types of Solid Waste	1975	1980	1985	1990	1995	2000	2005
Organic	Food / garden	63.7%	54.4%	48.3%	48.4%	45.7%	43.2%	44.8%
Inorganic	Paper	7.0%	8.0%	23.6%	8.9%	9.0%	23.7%	16.0%
	Plastics	2.5%	0.4%	9.4%	3.0%	3.9%	11.2%	15.0%
	Glass	2.5%	0.4%	4.0%	3.0%	3.9%	3.2%	3.0%
	Metal	6.4%	2.2%	5.9%	4.6%	5.1%	4.2%	3.3%
Others	Others	17.9%	34.6%	8.8%	32.1%	32.4%	14.5%	17.9%

There are three different of waste disposal categories which are solid waste, medical waste and hazardous waste. In Malaysia, 70 percent (%) from the total amount of waste generation is contributing by Kelantan, Terengganu, Pahang, Selangor and Kuala Lumpur. **Figure 2.3** shows the composition of waste. Domestic waste is the highest waste generated at 64 percent (%). 25 percent (%) represents by the industrial waste while 8 percent (%) by commercial waste at 8 percent (%) and from institutions and construction waste is 3 percent (%).

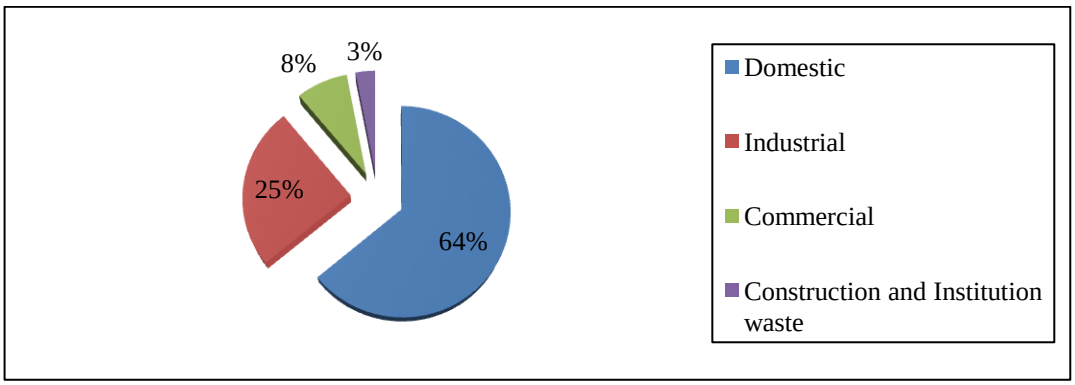


Figure 2.3: Waste Generation (Kelantan, Terengganu, Pahang, Selangor, Kuala Lumpur)

Source: Roundtable on Urban Solid Waste Management. Privatization Management on Solid Waste in Developing Countries, The Malaysia Experience. 27-28 September 1998.

2.4 System of Waste Disposal in Malaysia

Currently, the categories of waste disposal in Malaysia are solid waste incineration, medical waste incineration and hazardous waste incineration. According to Malaysia Country Report of Consumer's Association of Penang (2001), the final disposal of solid waste is through landfill. From GAIA Global Meeting (2003), reported that in Malaysia, there are 168 disposal sites and 7 out of 168 disposal sites are sanitary landfills. There are 161 open dumps and about 80 percent (%) of them have been filled up and have to be closed in 2005 (GAIA Global Meeting, 2003). RM 20.9 million had spent by the federal government to build 9 of new sanitary landfill and upgrade 27 existed landfills in 34 chosen areas. However, these landfills are inadequate to patch the generated waste cause of the generated waste keep increase due to population of urbanization and people population is high. From **Table 2.3** stated overall total of landfill in Malaysia are 302 sites and only 161 sites are operated and the balance 141 sites are closed. Sarawak is the state that have more landfill sites which are 49 sites followed by Sabah which is 19 sites while Wilayah Persekutuan, Melaka and Perlis are the state that only have 1 landfill site. It shows that the disposal waste in Malaysia is total dependency on landfill and waste

disposal in landfill is using an over capacity of landfill. It can cause the lack of land especially within major conurbation and corridors. Moreover, only 14 sanitary landfill sites all over the Malaysia. The negative effects of disposal waste at landfill are increasing methane gas (CH_4) and green house gases (GhG) emissions.

Table 2.3: Current Operation Landfill in Malaysia

State	Landfills in Malaysia	
	Operation	Closed
Johor	14	23
Kedah	7	8
Kelantan	11	8
Melaka	1	7
Negeri Sembilan	6	13
Pahang	16	16
Perak	17	13
Perlis	1	1
Pulau Pinang	2	1
Sabah	19	2
Sarawak	49	14
Selangor	8	14
Terengganu	9	11
Wilayah Persekutuan	1	10
Overall Total	161	141
	302	

Hence, incinerator plants are building up in developing towns and cities are now considering by federal and state governments. According to the research by Japan Society for the Promotion of Science, the problem of land filling has potential to solve through incineration as the total generated waste can be reduced up to 95 percent (%) and 75 percent (%) respectively. Therefore, the lifetime of the existed landfill sites will up to 10-20 times. According to GAIA Global Meeting (2003),

reported that RM 17 million was used up by the government in the 7th Malaysia Plan (1995-2000) to purchase 7 mini incinerators with the maximum volume of 5 to 20 tons per day waste to be performed on the resort islands of Langkawi, Pangkor, Tioman and Labuan. Recently, a law on solid waste management also introduced by government where for integrated waste management the rule processes selection is being classified in a system. According to Malaysia Country Report of Consumer's Association of Penang (2001), in the system having hierarchy for disposal waste that starting which waste minimization, reuse, material recycling, energy recovery and landfill. In December 2000 a recycling campaign also launched by the Malaysian and a target was sets for 22 percent (%) of recycling of the generated waste by 2020 (Malaysia Country Report of Consumer's Association of Penang, 2001).

2.5 Problems and Challenges of Waste Management in Malaysia

A few problems having in the waste management include not often collect waste due to some areas are far away from center collection, collection services are not frequent, waste collector used inadequate equipment, no air and water pollution control on crude open dumping and burning, provision of law and resources constraints are inadequate. In Malaysia, few factors are caused these problems that give an effect on effectiveness of waste management system development.

These problems caused by institutional constraints. The State Department of the Environment and municipal councils are the example of several agencies that involved in waste management. They frequently have no clear function to waste management. There is no agency to officially choose to coordinate of their activities and projects. According to World Health Organization Western Pacific Regional Environment Health Centre (EHC) (1997), due to the lack of coordination among

the relevant agencies often resulted in duplication of efforts in waste management, wasting of resources and overall waste management programs are no sustainability.

Ineffective of legislation in waste management is one of the reason why its function is unclear is partially responsible and lack of coordination among them. According to Ben (2003), on December 2003, 50 drums of toxic waste of the illegal dump near a golf course and a residential area in Kelana Jaya, Selangor. 500 drums of paint sludge and glue at a ravine in Ijok, Selangor, in November 2003 was an illegal dumping. There are rules available for illegal dumping. The companies involved will be punished under Section 34 (b) of the Environmental Quality Act 1974 which carries a maximum fine of RM 500,000 or prison for five years or both. Some companies take advantages from ineffective of lack legislation to do illegal dumpling due to lower penalties. According to Ben (2003), the total cost of waste disposal is RM 12 million in case of illegal dumping. Dumping of wastes until today in open areas and rivers are normal. According to study by Murad & Siwar (2007), waste disposal in Kuala Lumpur showed that open burning disposal is 31.9 percent (%) while dumped into the river system is 6.5 percent (%). Hence, in Malaysia the environmental safety is secondary and from study by Hassan *et al*., (2000), most municipalities have a hard time finding a new landfill because the existing landfill is almost exhausted.

Kuala Lumpur is desperate to reduce its dependence on landfills for increasing the density day to day and building incinerator as a difficult alternative solution. Therefore, in Malaysia managing solid waste remains a major challenge. Malaysia is looking for innovative solutions to solve the inadequate and inefficient services provided by local authorities. A waste audit is an official process will be carried for the quantity and type of waste generated. Audit can be carried out on office waste, municipal waste, commercial waste and industrial waste and construction waste.

Government should be understood that waste audits are main process to develop waste and source reduction programs. The solid waste composition of selected locations in Peninsular Malaysia is shown in **Figure 2.4** (Wahid, 1996). The predicted result of total municipal solid waste generated (per day and per year) is shows in **Table 2.4** (Nasir, 2004). The prediction of solid waste generation of various sectors is shown in **Table 2.5** (Fauziah, 2003).

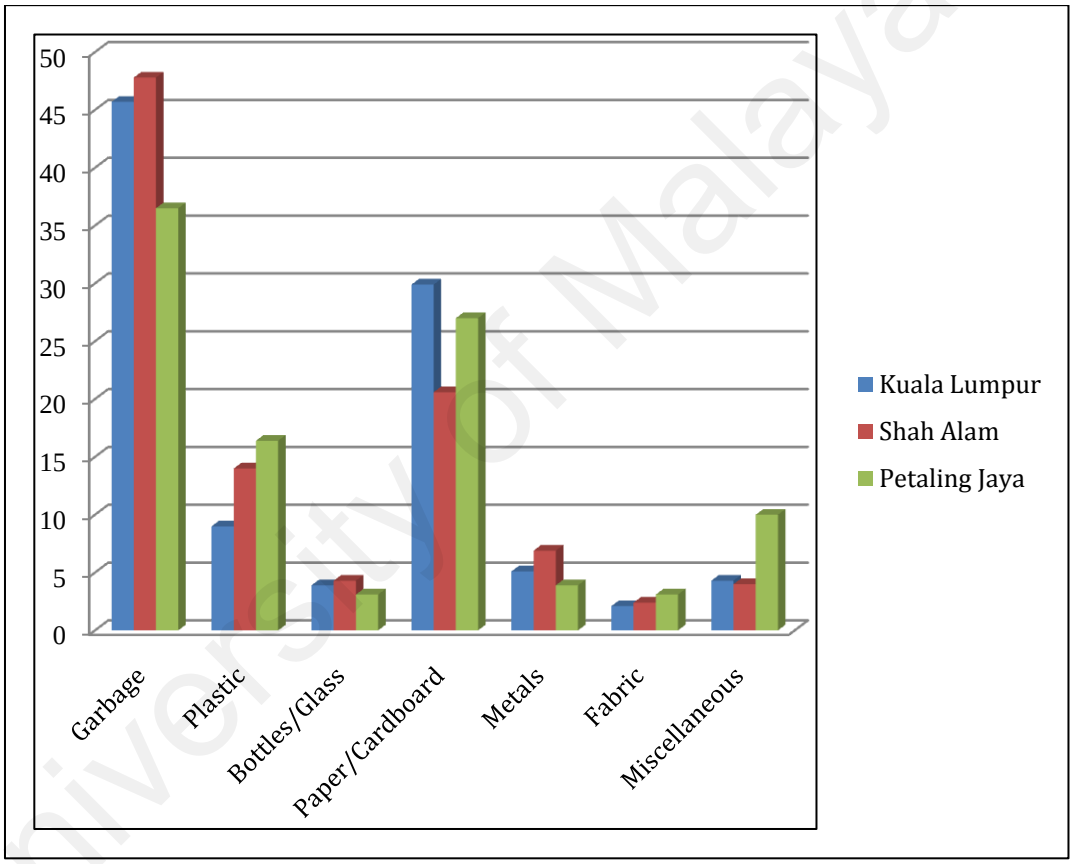


Figure 2.4: Solid Waste Composition of Selected Location in Peninsular Malaysia (Wahid, 1996)

Table 2.4: Prediction of Total MSWG of Kuala Lumpur (Nasir, 2004)

Year	Population of K.L city Millions	MSWG Kg/Cap./day	MSWG Tons/day	MSWG Tons/year
2009	2.43	1.66	4029.85	1470895.25
2011	2.63	1.72	4534.78	1655194.70
2013	2.85	1.79	5102.97	1862584.05
2015	3.08	1.87	5742.35	2095957.75
2017	3.33	1.94	6461.85	2358575.25
2019	3.60	2.02	7271.50	2654097.50
2021	3.90	2.10	8182.59	2986645.35
2023	4.21	2.19	9207.84	3360861.60

Technical constraints also contribute to the problem due a lack of human resources at national and local levels with the technical expertise required necessary in the planning and operation of solid waste. Many government officers do not have little or no technical background or training in engineering or management involved in managing solid waste. There is small possibility that a project initiated by a qualified waste management can be effectively implemented without adequately trained staff. Beside this, the solid waste management at local and national level is the lack of overall plans. According to World Health Organization Western Pacific Regional Environment Health Centre (EHC) (1997), solid waste technology is frequently selected regardless of the suitability of the entire solid waste management system.

Table 2.5: Prediction of Sectoral SWG of Kuala Lumpur (Tons/day) (Fauziah, 2003)

Year	Residential (48%)	Street Cleansing (11%)	Commercial (24%)	Institutional (6%)	Construction & Industry (4%)	Landscape (7%)
2009	1934.33	443.28	1025.97	241.79	161.19	282.09
2011	2176.69	498.83	1088.35	272.09	181.39	317.43
2013	2449.42	561.33	1224.71	306.18	204.12	357.21
2015	2756.33	631.66	1378.16	344.54	299.69	401.96
2017	3101.69	710.80	1550.84	387.71	258.47	452.33
2019	3490.32	799.86	1745.16	436.29	290.86	509.00
2021	3927.64	900.09	1963.82	490.96	327.30	572.78
2023	4419.77	1012.86	2209.88	552.47	368.31	644.55

2.6 Waste Minimization in Malaysia (1995 – present)

Based on the principles of the 3R waste hierarchy, rising per capita waste generation raises questions of whether the disposal is sustainable action. The policy objective is the goal of reducing the waste requires socialization of the 3R idea on a larger scale and this government maximizes the attention on the waste hierarchy. Campaign information was the stage for promoting 3R and the aim of 3R is to raise awareness and change attitudes and behaviors. The countary-led approach to waste management is prefers in Malaysia. Two ways for effective waste reduction are through production system and technical changes as well as through a regulatory system that can provide money for internal organization modification.

2.6.1 Waste Minimization, Resource Recovery and Climate Benefits

In Malaysia, waste minimization programs cannot be implemented effectively without reliable data on waste composition and generation (Hassan *et al*., 2000). In year 1992, less than 2 percent (%) of the amount of solid waste separated at the source for recycling purposes but the actual rate may be as high as 15 percent (%). In 2000, National Recycling Program was initiated and Malaysia issued the National Strategic Plan for Solid Waste Management (2000-2020) in 2005 and waste minimization is known as one of priorities. According to Pederson (2008), article 102 of the Act stipulates that the government may place responsibility for the collection of products at manufacturer, assemblers, importers, or merchants.

2.6.2 Waste Minimization Hierarchy

It is everyone responsibility to minimize the amount of waste generated and to dispose waste generated in trend that have small impact on environment

and health. The purpose of Waste Management Hierarchy is to minimize or reduce the amount of waste generated from entering the landfill/dump sites. 3R initiatives are the top three initiatives in the waste management hierarchy. According to Hashim (2011), to foster a 3R culture in society, it is important to train groups of people by creating awareness program on the implementation of 3R initiative. The 3Rs principle is helps to improve waste management system and reduce human ecological footprint. It cultivates initiative to boost economic activity, reducing health and environmental impacts from waste disposal and preventing loss of resources and prolong the life of landfill operation. 3Rs are more successful in developed countries than in developing countries (Agamuthu *et al.*, 2001).

The hierarchy of municipal solid waste management is globally applied and practice concept in many countries especially in the developing countries like Malaysia. According to the study by Cooper (1996) and Clarke (1993) shows that the concept is used as a guideline for planning modern municipal solid waste management facilities. In course of privatization or concession, contractors such as Alam Flora Sdn Bhd will try to implement the hierarchy of municipal solid waste management in their waste disposal including waste minimization, waste separation and recycling, waste processing such incineration and composting and dispose to landfill for waste that cannot processing. This integrated strategy requires participation from all levels included government, industries, public and the waste management concessionaires (Zaini *et al.*, 2002).

The waste hierarchy is being established to assist government in managing generated waste based to a sustainable agenda. According to Challenger (2007), waste management hierarchy is a concept that promotes cyclical

approach to waste management. The goal of the waste management hierarchy is to minimize the environmental impact on waste disposal (Rasmussen *et al.*, 2009 & Wolf, 1988). Waste hierarchy has been developed in 1970s (Challenger, 2007; Kirkpatrick, 1993; Rasmussen *et al.*, 2009); waste minimization, reusing, recycling, composting, incineration and disposal. According to Barr (2007), waste hierarchy is a command as waste management behavior related to recycling, reusing and reduction. Refer **Figure 2.5** for waste minimization hierarchy and **Table 2.6** shows the Goal-attitude-outcomes of waste minimization hierarchy.

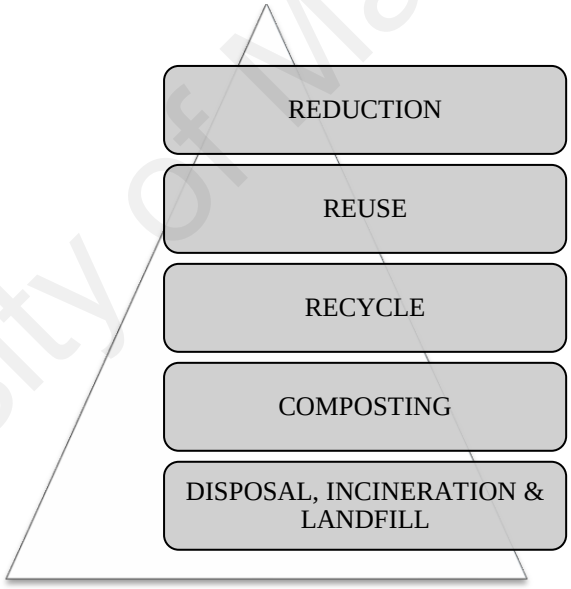


Figure 2.5: Waste Minimization Hierarchy

Table 2.6: Goal Attitude Outcomes of Waste Minimization Hierarchy (Gertsakis & Lewis, 2003)

Goal	Attribute	Outcome
Reduce	Preventive	Most Desirable
Reuse	Predominantly ameliorative, part preventive	
Recycle	Predominantly ameliorative, part preventive	
Treatment	Predominantly assimilative, partially ameliorative	
Disposal	Assimilative	Least Desirable

Several changes is undergoing for waste management hierarchy. Incineration, which has been in the hierarchy in the first stage of the evolution has been criticized for its cost (Rasmussen *et al.*, 2009) and affects the environment (Connett & Sheehan, 2001). Thus, in the recent hierarchy, incineration has been removed from the hierarchy and replaced with treatment (Gertsakis & Lewis, 2003); or thermal treatment (Sarifah Yaacob, 2009); or recovery (Pongracz, Phillips, & Keiski, 2004); or wastage to energy (Ministry of Housing and Local Government Malaysia, 2005). It is important to begin to educating people with knowledge. The volume of generated wastes can be reduced through the following steps as below:

2.6.2.1 Source Reduction or Waste Reduction

Source reduction or waste reduction generally recognized as a waste prevention which means reducing waste from source. It can come from a variety of ways to reduce from the source, including reuse or

donate items, mass purchase, reducing packaging, redesigning products and reducing toxicity. In manufacturing, reduction of sources is also important as it can save on natural resources, saving energy, reduce pollution and toxicity and at the same time can save money for businesses and consumers. Waste reduction helps to reduce waste generated before recycling process taking place. It also can reduce the process of recycling, composting, land filling and combustion happen. Other than that, its help to reduce handling costs of waste disposal. Waste reduction can be a success at several levels including the reduction of waste generated per capita through public awareness and government policy initiatives.

2.6.2.2 Reuse

It can be defined as use again especially in a different application or after reclaiming or reprocessing or for use in lower grade applications. Reuse can also be classified to use more than once items such as conventional reuse where items are used again whether for same or different functions. In the economic terms, reuse can be defined as offering quality products to people and organizations in a limited ways.

2.6.2.3 Recycling

Recycling included the process of using waste for other purposes or treating and reusing in the same application. Recycling is the waste reduces process including the collection of good used, reused or unused items; sorting and process recycled products into raw

materials; and repacking raw materials recycled into new products. Through recycling can prevents the negative effects on environment and human such as the greenhouse gas emissions and water pollutants, saving energy, supplying valuable raw materials to the industry, creating more jobs, promoting green technology development, saving resources for future generations and reducing new landfills and burners. It also included the reuse or recovery of in-process material or material produced as a further product that can be further processed. Therefore, it can improve production efficiency, profitability, good neighbor image, product quality and environmental performance.

RM70 million is annual allocation for awareness creation to public. Poster, pamphlets, bulletin and electronic medium were used. Exhibitions were conducted. Carnivals and seminar were held. High awareness among the public but some of them is practicing to recycle wastes and make it as habits. Government also provided facilities to encourage public to recycle wastes such as recycling bins and recycling centers. The location of recycling centers also located at the easily to access especially near the residential area and industrial area. Paper, plastics and bottles are three types of recyclables items in Malaysia but a small of these items are recycled. For example, the current recycling rate for generated waste in Kuala Lumpur is at 4.5 percent (%). According to Ministry of Housing and Local Government (MHLG) (2003), government has a plan to increase the recycling rate. In 2005, a plan to increase the recycling rate to 16 percent (%) and to 20 percent (%) by 2020. The newspaper article

published in The New Sunday Times, described Malaysia's attitude towards recycling as a Not-In-My-Backyard (NIMBY) syndrome when it was a waste problem. People are also cautions but still Malaysians only recycle less than 5 percent (%) of all waste (New Sunday Times, 2002). This opinion is supported by other sources claiming that the awareness of waste in Malaysia is poor and most people do not want to take more personal effort in matters that are mostly related to dirt and odor. According to, this fact is possible, Malaysians have started recycling as Malaysia launched its first official recycling program in Peninsular Malaysia at that time in 1993 and started by MHLG (A. K.Karen *et., al* 2003).

The objectives stated in the national recycling program are:

i. To transfer valuable resources in the waste stream from disposal
ii. To help control waste management costs.

The recycling program of Local Government is envisaged comprising the establishment of shopping malls and container drop-drop placements for recycling in strategic locations such as schools, shopping centers and so on. According to a report at the beginning of the national recycling program, 23 Local Governments of Peninsular Malaysia have become volunteers to become program participants but cause of poor planning and lack of public participation, the number of program participation dropped to only 10 Local Government participated in 1998, many Local Governments then not interested to continue their recycling program. To promote public

participation in this second recycling program, MHLG launched the services of one of the local public relations companies in the city to carry out production of pamphlets, posters and billboards, commercial advertisements and recycling songs to cheer up the event. In addition, many shopping malls in Malaysia are set up for easy deposition of recyclable materials. Other than that, a few of companies that were major producers of recyclable materials are participated in this recycling program. In this second recycling program, up to 145 municipalities around the country are participated. The main objectives of this recycling program are to minimize the solid waste management costs and save the resources. Although, the recycling activities are increasing, the materials recycling industry in Malaysia are demanded compare to the amount of recyclables. For example, Malaysia News Print Industries Sdn Bhd had to import 50 percent (%) of its material and Kuala Lumpur Glass Manufacturing Sdn Bhd also imported 20 percent (%) of the materials (New Strait Times, 2001). **Figure 2.6** shows the world recycling rate. In Malaysia, the recycling rate is low as compare to other country. The recycling rate is only 17.5 percent (%) as potential to recycling rate in Malaysia is 70.90 percent (%).

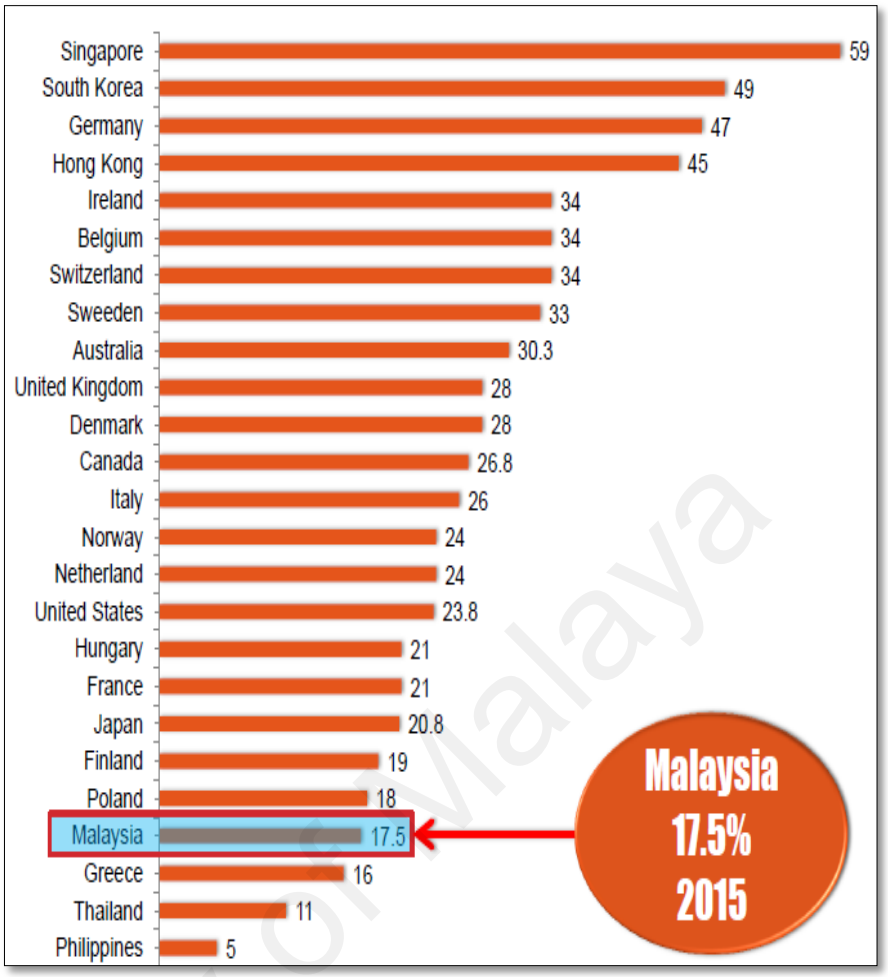


Figure 2.6: World Recycling Rate

2.6.2.4 Composting

It includes basic neutralization and composting to microbiology degradation of organic matter to produce organic products for use in agriculture, etc. Although, the composting municipal solid waste technology is well set up, only a few of the refuse composting plants are economically successful. Composting require high cost and low value of the compost products. While composting in Malaysia, composting is not applied as a solution to MSW disposal problems. The reason is the quality of products depends on the waste and therefore separation of waste is important. Composting can be a major role in removing organic waste from disposal facilities. More

area requires for compost plant. Lack of markets for compost and economies of scale for quantities for the recyclable market also contribute to the problem.

2.6.2.5 Disposal/ Landfill Operation / Incineration

The generated wastes that cannot be recycled, reduced, reused or energy recovered will goes to the landfill for disposal. Landfill is more preferred way of disposal in Malaysia than incinerator. Wastes that cannot be reduced or recycled will manage in land filling. Therefore, in Malaysia landfill is preferred than incinerators because it is cheaper to operate and maintain compare to incinerators. It can be implemented where landfill is limited and located in far away area from the actual MSW generation centre. Modern incineration and flue gas cleaning technologies make waste incineration an environmentally viable method.

2.7 Government Initiatives and Milestones

According to Francis (2010), the decentralization of wave has hit the world over the past 20 years, when national governments have handed over responsibilities in the lower stages of government and the correct incentives, decentralization are given to the state and provision government that can encourage greater competition and efficiency. In early September 6, 1995, Federal Cabinet decided to remove from government control and place it in private control of the Local Authorities (LA) in 1998. The solid management responsibilities of 48 LA have been privatized since 1st January 1997 to 2 concessions. One of the private companies was engage is Alam Flora for Central Region and for the Southern Region is Southern Waste while the

North is under interim for a year. From the Ministry of housing and Local Government website information, the solid waste management is under Local Government Act, 1976; Street, Drainage and Building Act 1974 and is now under National Solid Waste Management Corporation Act 1976. In the late 1980s, 3Rs were first launched in Malaysia and campaigns were more focused on recycling activities but to achieve targets for improving existing waste management failure. Policy for Integrated Solid Waste Management in Malaysia (2001), National Strategic Plan for Solid Waste Management in Malaysia (2005) and Master Plan on National Waste Minimization (2006) were introduced. According to Government report for the United Nations Conference on Human Environment, Solid waste collection is satisfactory but solid waste disposal is a problem as in any country and organized programs in this direction are needed. In many cases, local authorities are disrupted by inadequate of trained personnel, financial resources and knowledge.

2.7.1 Action Plan for the Beautiful and Clean Malaysia

The action plan for the Beautiful and Clean Malaysia (ABC) document in 1998 issued by the Ministry of Housing and Local Government had outlined the following:

- Local authorities need to strengthen to create efficient and effective of municipal solid waste management system in their respective areas.
- A regional approach to municipal solid waste management should be encouraged to increase economic and technical levels.
- All city centers should provide and implement municipal solid waste management plans that will be extended to the future including periodic reviews.

- All municipal solid waste management generated in urban and semi-urban areas should be collected and disposed of adequately in ways that will not create public health, environmental problems and will be technically and financially viable.
- Waste generator supported by the Rural Environment Program of the Ministry Housing and Local Government should remove all municipal solid waste generated in the rural areas adequately.
- Reduction of solid waste generation especially wastes disposal and household chemical wastes should be encouraged involving manufacturers and distributors of consumer goods and consumers themselves.
- Municipal solid waste management services shall be self-financing and user changes in accordance with any other means to achieve the goal of self-financing shall be imposed on the beneficing of such services.
- The private sector should be encouraged to become contractors for the collection and disposal municipal solid waste management services. In addition, the national automobile industry and other relevant industries should be encouraged to produce all vehicles and equipment require for MSWM in the country.
- The public should be continuously educated on cleanliness and resources recovery through health and environmental education, hygiene campaign and anti-waste law enforcement.
- Land for disposal municipal solid waste management should be identified and allocated for that purpose.

- According to Zaini (2002), research and development on municipal solid waste management needs to be strengthened to meet with the ever changing environment.

2.7.2 3rd Outline Perspective Plan (2001-2010)

The implementation of a comprehensive waste management policy considered by the government includes the installation of incinerator for efficient waste disposal and to develop strategies for reduction of waste, reuse and recycling. In 2001, 3R was re-launched by Ministry of Housing and Local Government (MHLG) and 5 percent (%) was the current recycling rate.

2.7.3 8th Malaysia Plan (2001-2005)

- The implementation of a comprehensive waste management policy to identify the issue of waste reduction, reuse and recycling.
- The conduct of related research and demonstration projects to learn or know the ability and acceptance of the waste recycling industry, the introduction of various initiatives and economic approaches appropriate by local authorities such as incentives and collection charges to reduce the amount of household waste.
- The house clearing mechanism is created to facilitate industry symbiosis, whereby industrial waste can be another." (8th Malaysia Plan – page 550)

2.7.4 9th Malaysia Plan

National Strategic Plan for Solid Waste Management has been implemented and upgraded clean-up of landfills were upgraded and the

construction of new landfills and transfer stations has been built with integrated material recovery facilities. Based on waste management hierarchy, it also aims to establish a comprehensive, integrated, cost-effective, sustainable and socially acceptable SWM that prioritizes reducing waste through 3R, providing comprehensive, standard and effective quality services for intermediate treatment and final disposal. They also aim to establish legislative, regulatory and institutional bodies and adopt SWM technology that is very environmentally friendly, cost-effective and proven (9th Malaysia Plan).

2.7.5 10th Malaysia Plan

Under the 10th Malaysia Plan (2011-2015), the Ministry of Natural Resources and Environment with Universiti Teknologi Malaysia (UTM) will work together to expand its environmental performance index (EPI) to calculate environmental management performance of states. The ministry's proposal which had to give help or assistance to the various federal agencies has agreed by cabinet. Based on quantitative data derived from the World Health Organization, United Nations Global Environmental Monitoring System, government agencies, NGOs and academia under Global EPI 2010, Malaysia ranks 54th among 163 countries worldwide. One of the three major environmental problems in Malaysia is solid waste. Now in Malaysia, more than 23,000 tons of wastes are generated daily. However, by 2020 the waste expected to be up to 30,000 tons. Increased population and development will contribute to the increases in the amount of waste generated. Besides that, less than 5 percent (%) of waste is being recycled.

In Malaysia, waste management standard are still weak though, large amounts and waste are generated. This includes the extensive and poor waste generation documentation and its composition, inefficient storage and collection systems, municipal waste with toxic and hazardous waste disposal, indiscriminate disposal or waste disposal and landfill use.

There are nearly 1800 rivers in Malaysia. However, more than half of these rivers have been contaminated and destroyed due to improper solid waste management. In appropriate solid waste management (SWM), it also contributes to the change of climate degradation waste-to produce methane and production of new products to meet the demand for emitting greenhouse gases and using natural resources (10^{th} Malaysia Plan).

2.8 Industrial Waste Management in Malaysia

In Malaysia, industrial waste management has become an important activity in line with the industrial process. In Malaysia during the 1950's after independence, environmental issues are neglected by industries and most of incidents unattended. In the 1960s, industries were practiced diluting and dispersing of pollutants. However, when environmental issues become national problems in Malaysia, the industries wastes are treated through end-of-pipe approach controlled by pollution standards establish by Malaysia Government. In the 1980s, cleaner production technology is using for waste reduction. The use of the latest and modern technology, enhancing awareness campaigns among consumers and industries. The application of approach focused on ecosystem conservation has been introduced and practiced in country. The application included the application of eco-efficiency, eco-design and use of life cycle assessment.

In Malaysia, end-of-pipe approach still remains practice in managing industrial wastes that focused on treatment and disposal. The negative effects of this approach are increased illegal dumping and incidents of environmental degradation. Therefore to managing industrial wastes, legislative framework has been established to manage the better industrial wastes. Managing industrial wastes are focusing on generator and of wastes. In Malaysia, industrial wastes are classified into two (2) types of waste as follows:

i. Solid waste, which includes wastes produced by manufacturing process, or activity or by product; and
ii. Toxic and hazardous wastes, which include any matter prescribed to be scheduled waste, or any matter in a solid, semi-solid or liquid form or in the form of gas or vapor which is emitted, discharged or deposited in the environment in such volume, composition or manner as to cause pollution.

The solid wastes are produced by industries were categorized as non-hazardous waste. The non-hazardous wastes are established under three (3) act which is Local Government Act 1976; Street, Drainage and Building Act 1974; and Town and Country Planning. Industrial solid waste doesn't have any specific definition under the Local Government Act 1976. However, according to Rahmah (2001), solid wastes were categorized as follows:

i. Waste materials, which include items of value or worthless product are reluctant or damaged products produced in the manufacturing process
ii. Trade waste, which includes waste generated by trading activity;
iii. Industrial waste including waste generated from the industry activity;
iv. Park waste including leaves, grass, branches or trees from the garden or from house or building compound or from land; and

v. All household, which include all types of household waste generated

Solid wastes generated by industries were managing by key stakeholders which are the Ministry of Housing and Local Governments, Department of Local Government, Local Governments, solid wastes concession companies and solid wastes recycler. Ministry of Housing and local Government leaded the government agencies to provide the guideline and legislative in managing industrial waste. The Local Government Act 1976 is provided the legislative and technical requirements to the local government, waste generator, waste operator, waste recycler and disposal sites operator as guidance in managing industrial wastes daily operation.

The way of handling industrial solid waste is not same as handling household. The quantity of these waste are huge and the different of characteristics. The collection of industrial solid waste in Klang Valley area has been privatized. In Klang Valley, Alam Flora Sdn Bhd has been awarded to manage the wastes. The generated industrial wastes which cannot be reused or recycled were going to landfill or dumpsite. The generated industrial solid wastes such as scrap iron, steel, aluminium, carton boxes, paper, plastics and glass will be recycled to produce a new product. One of recycling company in Malaysia is Meriahtek Sdn Bhd that recovers the electronic waste. Paper, plastic and aluminium are the most wastes have been recycled by public and industries in Malaysia. **Table 2.7** shows that 119 licensed solid waste recyclers have been issued by Ministry of Housing and Local Government by 2008.

Table 2.7: Number of Solid Waste Recycler Licensed by Ministry of Housing and Local Government by 2008

State	Number of Recycler
Johor	11
Negeri Sembilan	4
Perak	1
Sarawak	10
Selangor	44
Kedah	1
Melaka	2
Pahang	1
Pulau Pinang	20
Terengganu	1
Federal Territory Kuala Lumpur	22
Kelantan	2
Total	119

2.8.1 Industrial Waste Generation Trends

A high amount of industrial waste produced every day demands good management system and effective support of infrastructure. Limited number of landfill, recover wastes will be necessary due to the increasing volume of wastes. Plastic, steel, wood, glass and paper produced during manufacturing or packaging show having significant values. According to ADEME (1999), a system has been developed by industries to recover the industrial wastes by reuse or recycling. The decline of natural resources has created critical problems in the manufacturing industry. For example, with rising petroleum prices, plastic pellet prices for the manufacturing industry increase many folds. Therefore, the recovery of the plastic waste relief industry to get an alternative source and at the same time it will reduce their production costs. According to Azni *et.,al* (2004), Malaysian industries for the past 30 years ago

generated high quantity of wastes has provided enough supply of industrial wastes for recovery purposes. This will encourage reusing or recycling wastes from focus end-of-pipe approach. Recovering the industrial wastes also will reduce ecosystem weakness as it will reduce the need for new ones landfill since most landfills in Malaysia have reached their maximum capacity.

In Malaysia, the quantity of waste generated is increased from 16,200 tons per day in 2001 to 19,100 tons in 2005. In 2006, the average of generated waste per capita per day is 0.8 kilogram. In Malaysia, industrial wastes contributed 30 percent (%) of solid wastes. The generation wastes increased to 40 percent (%) annually. It is estimated that industrial solid waste generation increased from 7,721.58 tons/day in 1994 to 11,519.24 tons/day in 2005. The waste generation and industrial production show the significant relationship between them. **Figure 2.7** and **Figure 2.8** show the significant relationship where the industry production index and manufacturing index of waste generation are increased.

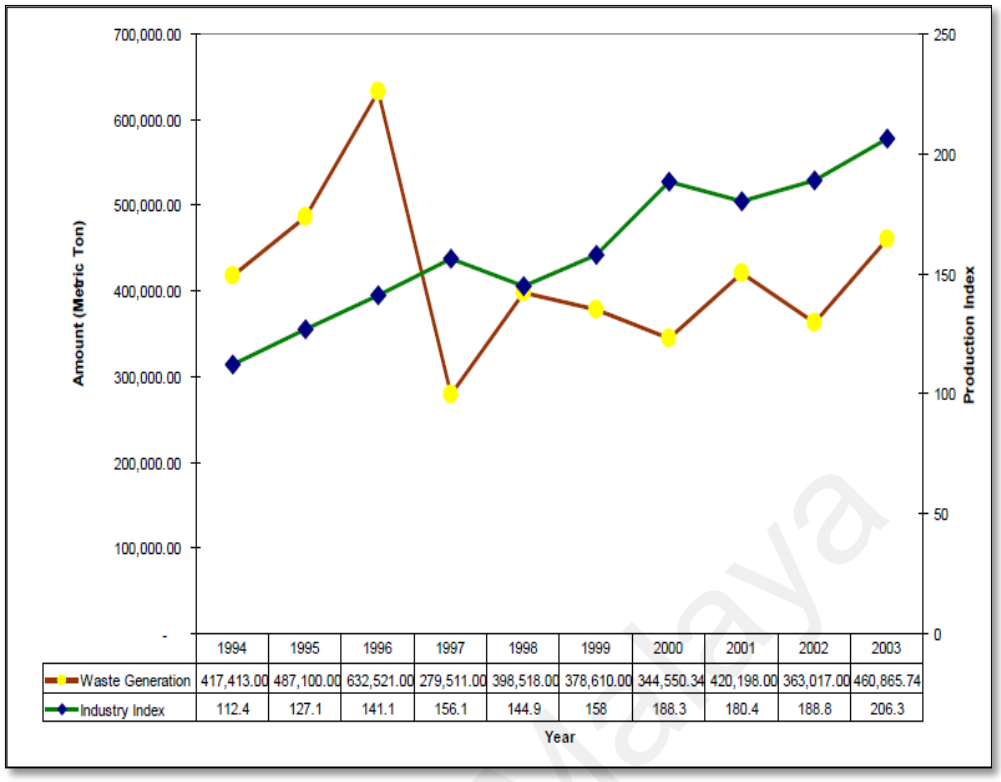


Figure 2.7: Relation between Industry Production Index and Waste Generation

Source: Department of Statistics, Malaysia 2005

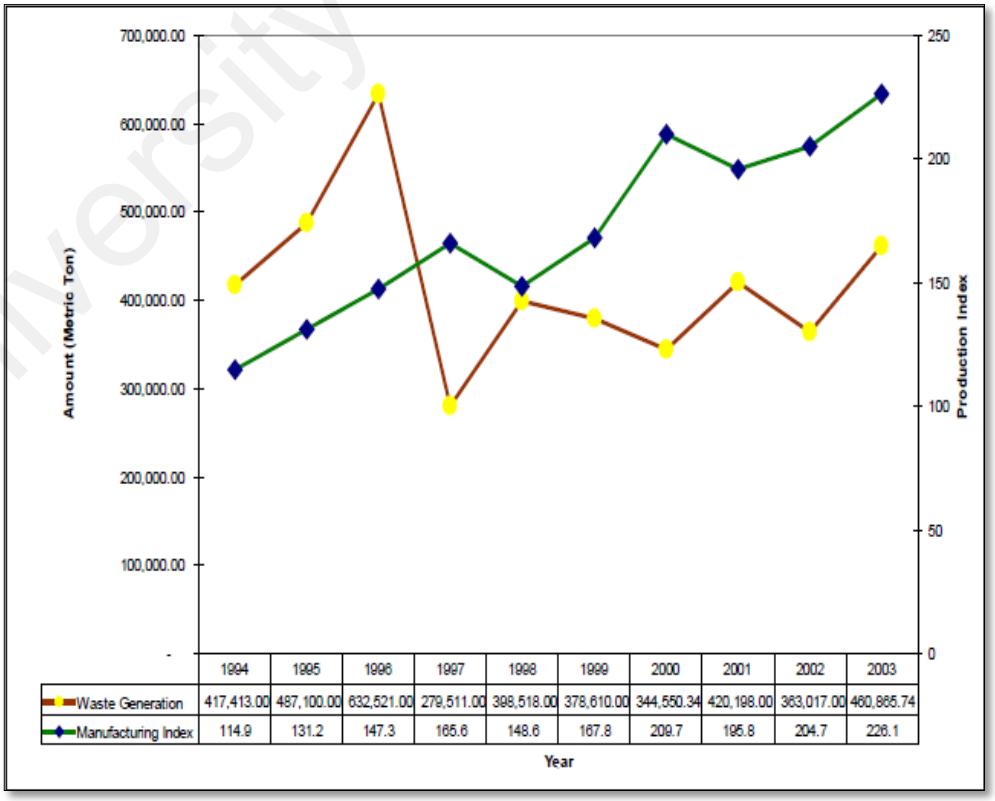


Figure 2.8: Relation between Manufacturing Production Index and Waste Generation

Source: Department of Statistics, Malaysia 2005

2.9 Warehouse Rack Industry

Warehouse rack and also known as pallet racking is one of industry that contributes to the industrial waste generation in Malaysia. Pallet racking system is an essential part in warehouse storage systems in many industries and also the backbone of internal logistics. Several types of pallet racking system provided by supplier to the industries such as warehouse, manufacturing facilities, retail centers, and other storage and distribution facilities. The most common types of pallet rack systems are used in the most industries include the following:

- Selective pallet racking
- Double deep pallet racking
- Very narrow aisle (VNA) pallet racking
- Drive-in pallet racking
- Push back racking
- Pallet flow racking
- Mobile pallet racking system
- Channel storage racking systems
- Pallet racking for automated (AS/RS) system
- Rack supported building
- Racking inspection
- Column and pallet rack protection

In this study, selective pallet rack system and drive-in racking system are used in the process of rack installation in warehouse at Panglima Garang site. Selective pallet racks are the most popular type of warehouse storage and pallet rack system in the market. This rack is an inexpensive design and the largest selection of sizes and accessories to be custom configures for warehouse storage application. Using

selective pallet rack system allows to fully utilizing warehouse floor space as well as efficiency manage worker time. The advantages of selective pallet racking included:

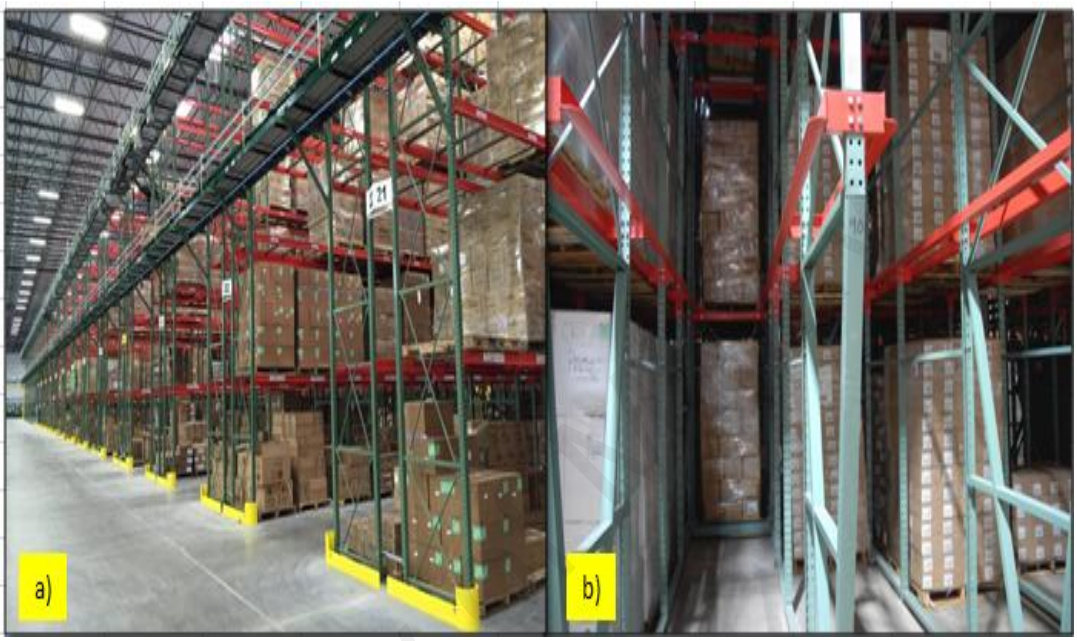
- Available in numerous capacities, sizes and configurations for custom fit
- Immediate access to all storage
- Can be made from roll formed, structural steel or a combination of both materials
- Easy to adjust shelf heights
- Inexpensive where the lowest coast option per square foot

The drive-in rack system offer maximum density storage of similar products and pallets in warehouse. Drive-in rack systems eliminate aisles in a warehouse facility because the drive-in system is made for storing high quantities of similar product which use the same entry and exit point for each bay or rack. Since drive-in rack systems are fork-lift accessible, this rack offer maximum density storage and product or pallets may be stored in lanes up to six or more positions deep on the rack. A forklift enters the racking from one side to load a pallet on to the back of the rack. From there, the pallets are loaded in working front to back that giving more depth and up to three times the amount of storage as selective pallet racking Drive in racking can be single entry where forklifts have access to one side only or double entry where the forklifts can access both sides of the racking structure. The advantages of drive-in pallet racking system included:

- Most cost effective-effective high0density system
- Can be constructed from roll formed or structural rack material
- Reduces square footage imprint up to 35 percent (%) compare to selective racks.

Figure 2.9 shows the structure of selective pallet racking and drive-in pallet racking system in warehouse.

Figure 2.9: Structure of a) Selective Pallet Racking System and b) Drive-in Pallet Racking System



2.9.1 Waste Generated in Warehouse Rack Installation

The previous studies haven't done on solid waste management in warehouse racking installation process. Industrial waste is the 2nd waste generation in Malaysia. Warehouse racking installation is one of industry in Malaysia that contributed to the increasing of waste. The processes of installation warehouse rack from the first process until end product are generated solid waste. The solid wastes generated in the process installation are included plastics, carton and paper, metal and wood. Most of the wastes are come from the packaging of the components for rack installation such as frames which are the vertical elements composed of two slotted uprights and are perforated along the length of the profile so that beams fit flush together. Frames are one of important components as a backbone to the warehouse rack. The industrial waste can be

categorized into two groups which are the hazardous industrial waste and industrial solid waste. The solid wastes generated are categorized as industrial solid waste which is consider as non-hazardous waste. The non-hazardous solid waste consider as waste that is not harmful to the human, animal or other living things but if poor managed will be affected to the health problem for humans and animals and also can cause pollution to the environment. This study focuses on industrial solid waste. The wastes generated in warehouse rack installation are consider as non-hazardous wastes, therefore the waste management are under three (3) act which are Local Government Act 1976; Street, Drainage and Building Act 1974; and Town and Country Planning. Solid waste management is synonym with the process of production, storage, source separation, collection, transportation, processing, recycling and disposal of various solid wastes. In this study, recycling method mainly focus on managing generated solid waste. All wastes will be prioritized to recycle and waste cannot be recycled will be sent to landfill. Besides that, avoid the negative impacts on workers health and environment due to ineffective solid waste management method.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This section will be described the methods used to carried out this study. The study methods are followed as explained by Hassan Basri (2012). I choose this study methods based on the data that was required to answer the research questionnaires. There are several methods will be used to conduct this study included:

i. Observation and interview through the site visit.

ii. Respond questionnaire by staffs and review through journals and books. The data and information will be collected and analyzed to access the result of the study.

All the information related to the solid waste management in the industries are identified and the reduction of generated waste in the warehouse racking installation site area will be reduced. Information and data will be collected and analyzed the results of the study. A summary of the methodology of the study are as in **Figure 3.1**.

3.2 Summary of Methodology Process

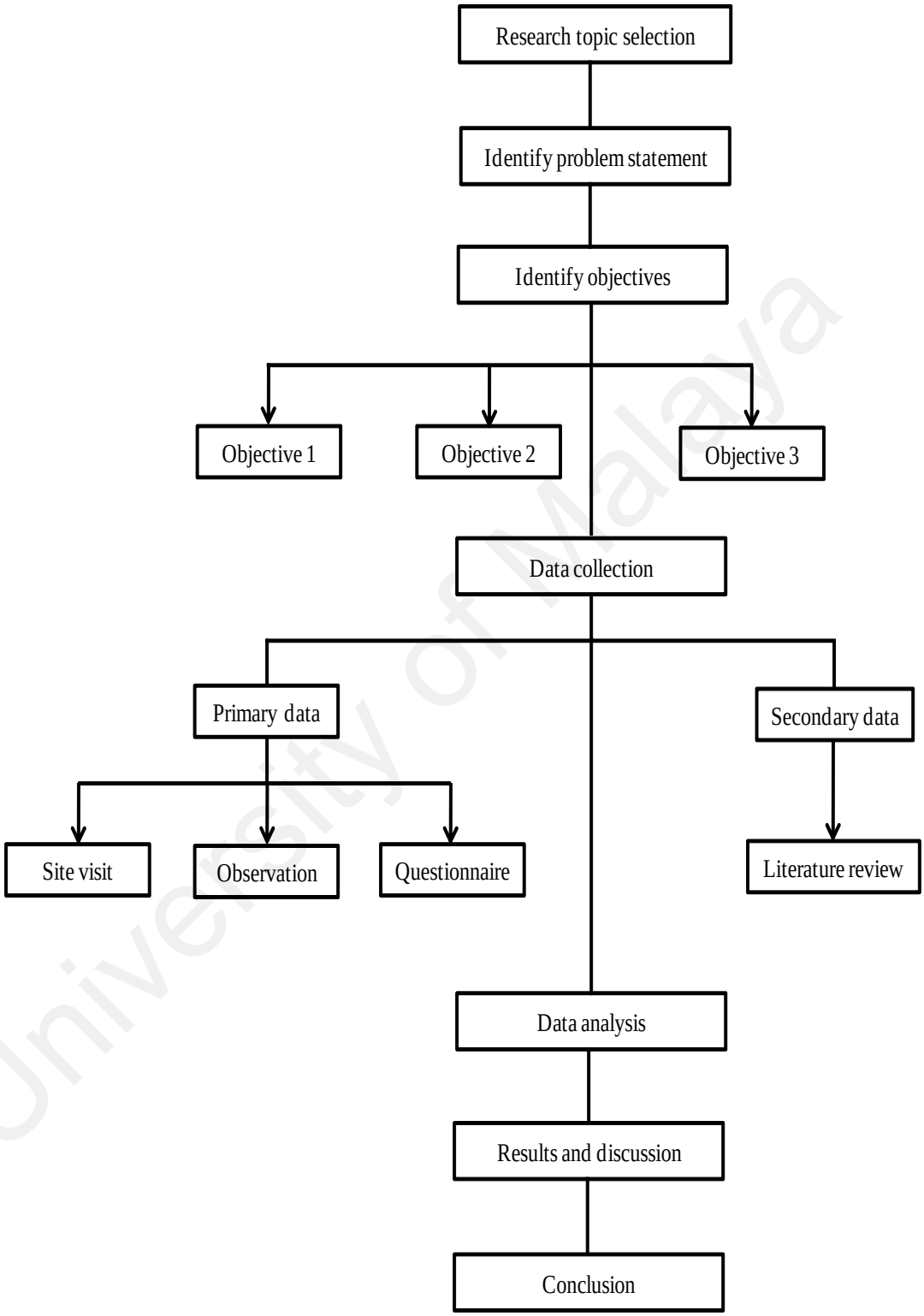


Figure 3.1: Flowchart of Research Methodology

3.3 Data Collection

According to the study, data collection will be divided into two types of data:

i. Primary data where is the main data in a study that obtained from the results of empirical studies carried out by using methods such as questionnaires, visits to site area and interviews.

ii. Secondary data where is the data from the previous related studies on the solid waste management in Malaysia Industrial.

3.3.1 Interview

Interview has been carried out against to the person in-charge during the site visit. This interview is done directly to the supervisor as a leader in the warehouse racking installation to get the information that related to the solid wastes generated during the process of warehouse racking installation and the disposal method of generated wastes. Based on the information from the interview during the site visit, questionnaire will be created and distribute to the workers. In this study, the interview method is not formally. It based on the observation during the site visit.

3.3.2 Observation at site visit

From the observation at site visit, the types of solid waste generated during the warehouse racking installation can be known and how workers handle the generated solid wastes. The ways of solid wastes generated handle by worker also can be identified, whether the generated solid wastes will be segregated follow the category of wastes before disposal or other methods are using such as recycling or reuse. Besides that, any negative effects of current practices disposal methods on workers' health and environment can be identified.

3.3.3 Questionnaire

A set of questionnaire will be framed based on the observation during the site visit and will be distributed to the one (1) people of supervisor and ten (10) people of installation warehouse rack workers. The aim of questionnaire is to get information regarding the solid wastes generated during warehouse racking installation if overlooked during the observation at site visit and how solid waste will be disposed and also any negative effects occur on workers' health and environment with current practices of disposal methods.

3.4 Work Schedule of Research

The research has been targeted to proceed and complete within a 6 months period. The estimated time and duration for each activity and task within the 6 months duration is as shown in the Grant chart as below. The scheduled time and activity started will be evaluated and updated according to the progress of the project upon initiation.

Figure 3.2: Research Scheduled Time and Activity

Activities & Task		**Month**					
		1	2	3	4	5	6
Literature review							
Data collection	Site visit						
	Questionnaire						
Data compilation & analysis							
Result discussion							
Report writing							

CHAPTER 4: RESULTS AND DISCUSSION

Data was gathered to get a description of current worker perception of solid wastes generated and management in warehouse racking installation at Panglima Garang site based from the current survey. Survey was located at Panglima Garang for one day site visit periods. A set of questionnaire has been framed based on the observation during the site visit and questionnaire was spread to respondents. The questionnaire was divided into three sections. The first section is a survey at the warehouse racking installation site visit. Second section is solid waste management at warehouse racking installation site while the last section is negative impact of ineffective management of solid waste on worker's health and environment.

From the first section, the respondents were asked whether they knew the type of solid wastes generated during the process of warehouse racking installation. This was asked to establish whether the workers bother their generated solid wastes. **Figure 4.1** represents the responses of the respondents from the generated solid wastes in site area of warehouse racking installation. From the questionnaires collected directly from the site (Figure 4.1), the results find that almost workers (total respondents) knew the type of generated solid wastes in warehouse racking installation. 26 percent (%) from the total respondents told that solid wastes came from plastics and woods. The plastics were come from plastic wrapping that are used to wrap the items in the warehouse racking installation process. Other than that, it also came from plastic bags of small material for installation process such as screws while woods were come from pallets that were used to put the materials of warehouse racking installation. 25 percent (%) respondents represent for papers and cartoon box while 23 percent (%) respondents told generated solid wastes came from metals. Paper and cartoon mostly came from boxes and layer papers that were used to cover the small materials from damaged and metals came from

the excess rack, excess screw and metal tight. In warehouse racking installation, solid waste came from glass weren't generated. The generated solid waste from wood such as pallets will be reused back for other purposes and this pallet will be recycle once it cannot be reuse when it damaged. Mostly paper and cartoon will be reused back to put the excess small materials from the warehouse racking installation such as screws and the small items. The other generated solid wastes weren't be reused such plastics that come from plastic wrapping and metal tight will be collected and recycled.

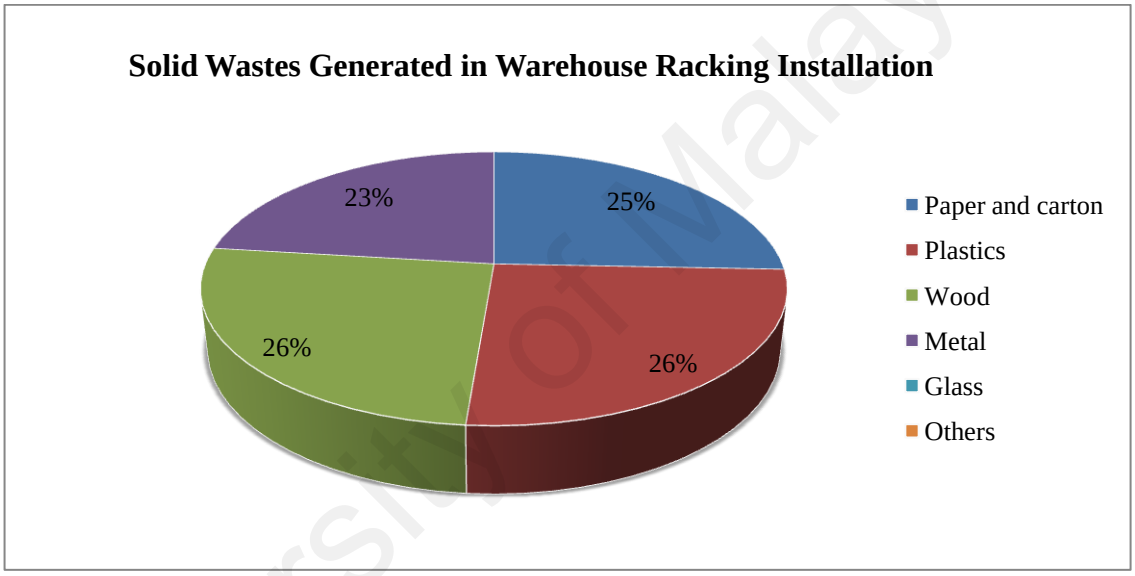


Figure 4.1: Solid Wastes Generated in Warehouse Racking Installation

The respondents were also asked the used container to collect solid waste. **Figure 4.2** represents the responses of the respondents the containers used to collect solid wastes. Majority from 10 of the total respondents (11 respondents) were used waste dustbin that provided by company to collect their solid waste. However, only one out of 11 respondents used plastic bag to collect. From the survey at the site visit, one industrial waste dustbin was provided by company in the site area and one temporary cartoon dustbin was making by worker to collect the generated solid wastes. The temporary cartoon dustbin can create an incident happen in site area. The reason is the structure of

the dustbin is not firm and has highest potential to collapse and injure the workers. Therefore, it also doesn't have a proper cover to cover the waste. Besides that, the collected solid wastes weren't separate with category by worker. The solid waste is put together and disposed of without separation in dustbin.

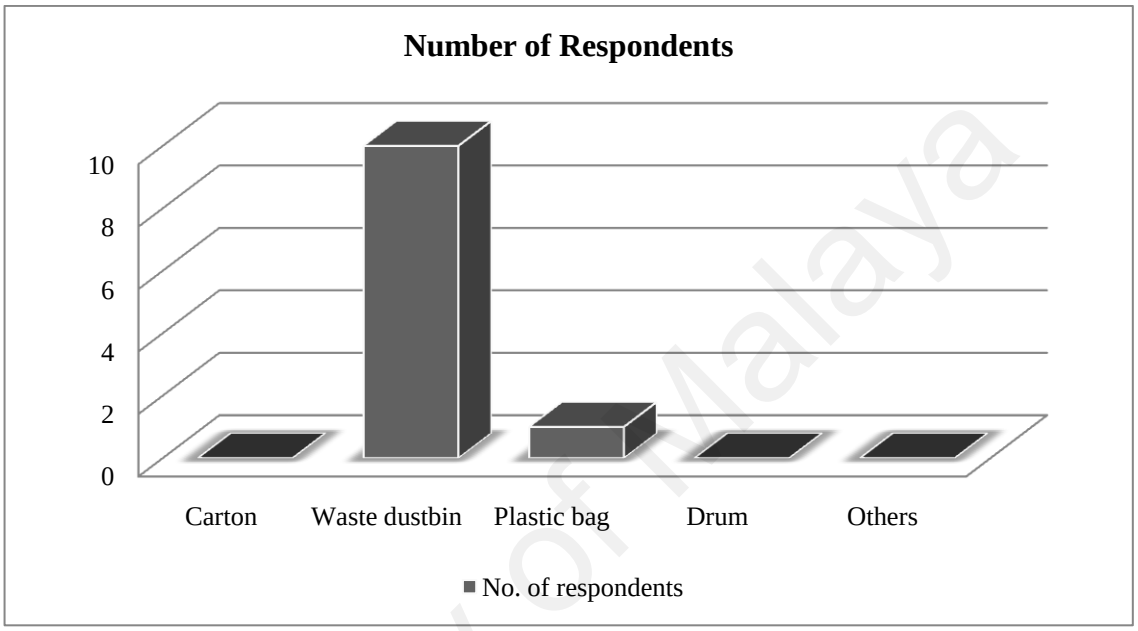


Figure 4.2: Type of Containers Use to Collect Solid Waste

Figure 4.3 represents the frequency of waste container emptied in site area. The majority 7 out of the 16 (43.75%) of respondents told that the frequency of waste container emptied is once in three days while 5 (31.25%) respondents told that the waste container emptied once in a week. The balance of 25 percent (%) respondents told that the frequency of waste container emptied is more than one week. From the data can conclude that company didn't provided a waste collected scheduled in the site. Workers didn't know the waste scheduled of collected wastes will be collected by waste collector. The collected wastes will be collected randomly by collector waste. The company didn't have proper manage their waste scheduled of their collected waste scheduled. An ineffective managing the waste scheduled collection will be impact on workers health and environment.

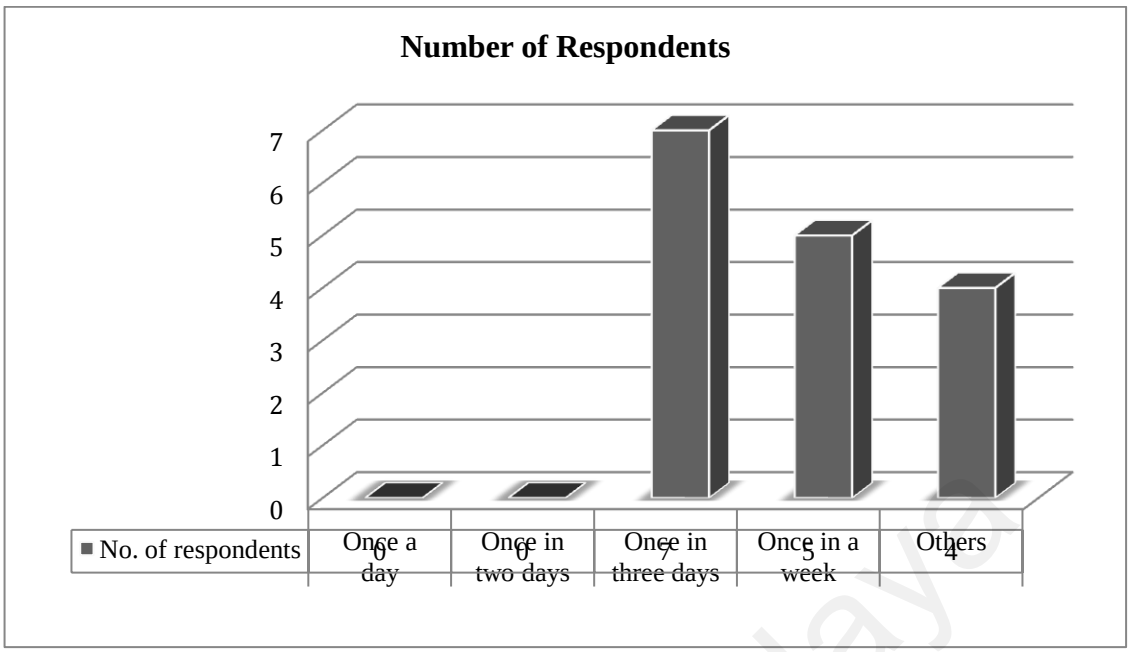


Figure 4.3: Frequency of Waste Container Emptied

From **Figure 4.4** the findings indicate that 50 percent (%) of respondents usually put away collected wastes on an open space in site area while another 50 percent (%) respondents dispose their collected wastes to the waste collector. Here, 50 percent (%) of respondents knew way of managing their generated solid wastes. However, another 50 percent (%) respondents didn't know a way to manage their generated solid waste. It shows that some of workers had better understanding managing their generated solid waste properly in site area. It shows that insufficient or lack of training to workers on managing solid waste in workplace. Besides that, this question also pointed out if there is burning and from data shows that no respondents burning their solid wastes in the site area. The generated solid wastes also didn't put away in the public bin but the collected wastes will be collected by the waste collector that appointed by company.

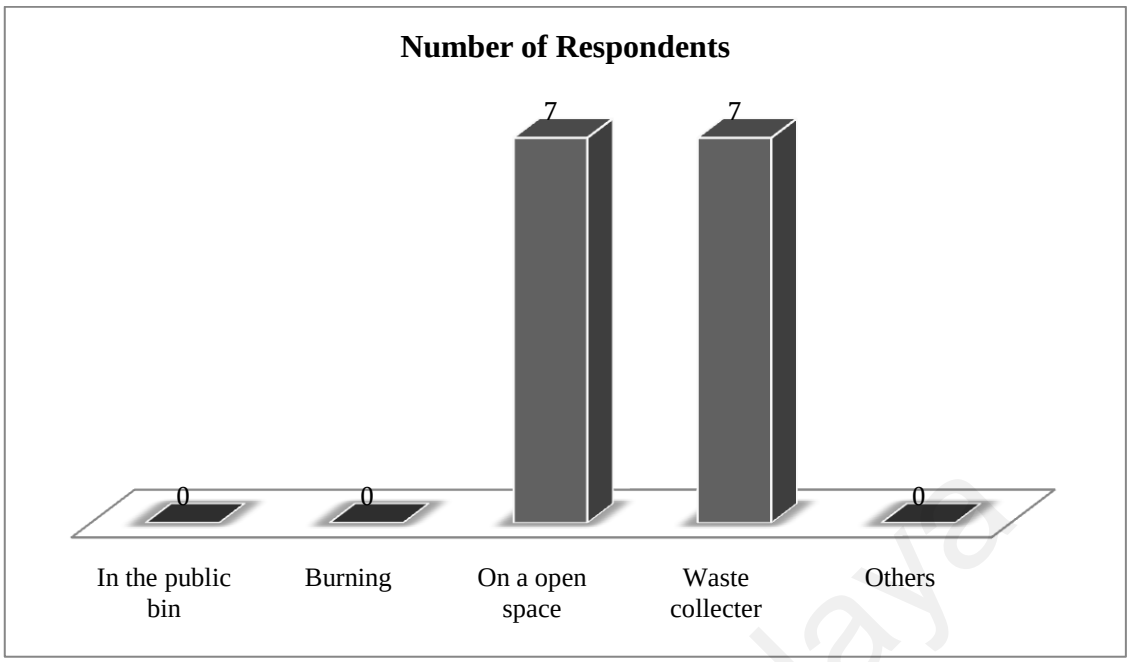


Figure 4.4: Location of Collected Solid Waste Put Away

From questionnaires collected in **Table 4.1**, the results find that almost all of the respondents (total respondents), 100 percent (%) noted that waste disposal method didn't occur a serious problem in site area. Besides that, mostly generated solid wastes can be reused and recycled. 100 percent (%) respondents told that recycling weren't practice in warehouse racking installation site area but some respondents have a better understanding about solid waste recycling. Several of them have no convinced reason to do recycle things. Therefore, total respondents said that they are willing recycle the solid wastes if a recycling program was set up by company. They are willing to separate materials into separate bags for collection purposes. Furthermore, there were some of total respondents noticed that managing solid waste management using suitable disposal methods will be improved housekeeping and also prevent hazard in site area.

Table 4.1: Respondents Perception on Solid Waste Management in Warehouse Racking Installation

No.	Statements (Questions)	No. of Respondents	% of Total Respondents
1	Do you think the waste disposal method is a problem in site	10	
	Yes	0	0%
	No	10	100%
2	Have your company implement recycling in racking installation area	10	
	Yes	0	0%
	No	10	100%
3	If a recycling programme was set up, would you be willing to separate materials into separation bags for collection purposes	10	
	Yes	10	100%
	No	0	0%

From **Table 4.2,** the finding shows that 100 percent (%) of the respondents noticed that there is open burning and health problems due to poor managing solid waste in site area. Besides that, 50 percent (%) of the respondents responded that sufficient information of the environment impacts of solid waste while another 50 percent (%) respondents responded that insufficient information of the environment impacts of solid waste in site area. It shows that the information of environment impacts due to poor managing solid waste weren't circulating effectively to the worker. All the total respondents agreed that most environmental issue in site area could be minimized if solid waste is managed properly.

Table 4.2: Respondents Perception on Negative Impact of the Ineffective Management of Solid Waste

No.	Statements (Questions)	No. of Respondents	% of Total Respondents
1	Do you ever notice open burning in site area	10	
	Yes	10	100%
	No	0	0%
2	Did you ever heard of health problems due to solid waste in site area	10	
	Yes	10	100%
	No	0	0%
3	There is enough information available about the environment impacts of solid waste in site area	10	
	Yes	5	50%
	No	5	50%
4	Do you think most environmental issues in your working area could be minimized if solid waste is managed properly	10	
	Yes	10	100%
	No	0	0%

From **Figure 4.5** the findings indicate that 29 percent (%) of the respondents had problem with mosquitoes, cockroaches and rats in site area. The presence of these animals in site area will cause disease to workers such as dengue and leptospirosis. Waste was not frequently collected by the waste collector is one of the reason these animals choose the waste area as their habitat. Here, the main reason this problem occur in site area when company didn't provided the scheduled waste collection. Other than that, 27 percent (%) respondents responded that they had problem with domestic animal likes dog. Some of dogs will give infection to victim once bitten. Worker's safety will be affected especially when they required doing overtime. Furthermore, 15 percent (%)

respondents noticed had fire in site area cause of open burning. Negative effects of poor solid waste management on workers health and environment will be prevent when company properly manage solid waste from the beginning process of racking installation until end process.

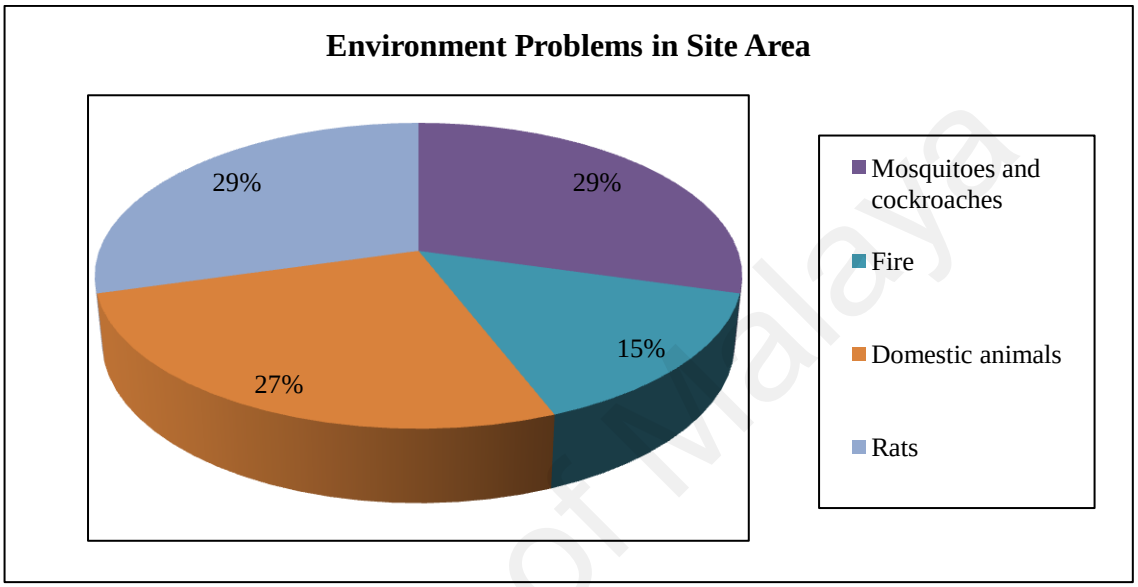


Figure 4.5: Environment Problems in Site Area

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusion from the findings and some recommendations for managing solid waste in warehouse racking installation.

5.1 Conclusions

From the finding indicates that wastes generated during the warehouse racking installation weren't disposal properly as the following activities:

i. Solid wastes weren't separate with category by worker. The generated solid waste is put together and disposed of without separation in dustbin.

ii. Insufficient of waste dustbin provided in the site area cause of the temporary waste dustbin that builds from carton can contribute hazard to the workers.

iii. Waste hierarchy concept 3R (reduce, reuse, recycling) wasn't practice in the site area.

iv. Company didn't provide waste scheduled collection in the site.

v. There is open burning in site area and give the negative effect on workers health and environment.

vi. Workers had problem with mosquitoes, cockroaches and rats in site area. The presence of these animals in site area will cause disease to workers and effected workers health.

Due to the poor management of solid waste in site area will affect workers health and environment. Other than that, it also increase hazard in the workplace.

5.2 Recommendations

There are some recommendations for encourage workers participate in managing solid waste during warehouse racking installation. The best practice to do is by expose workers the benefits of managing solid waste and keep inform them the negative effects of solid waste on workers health and environment when poor managing solid waste is apply in workplace. Therefore some recommendations can be recommended to the company to improve their solid waste management.

i. Provide more waste dustbin by waste category in site area at least three (3) dustbins. Three (3) are enough due to warehouse racking installation process are based on the phase because the number of rack installation workers are not more than 20 people. Color coded dustbin can be applied to segregate the waste by category such as plastic, paper, metal and general waste. As shows in finding, only one waste dustbin was provided in site area.

ii. An awareness training and education program should be developed once the desired solid waste management program has been defined. The awareness training can be conduct twice a year for the permanent staffs. The awareness program should provide information on the ways that they can influence the effectiveness of the solid waste management program. An awareness program may include the waste audits and cleaner production. Briefing on the waste management should be delivered to workers before the activities of installation works begin especially on contract workers.

iii. Waste scheduled collection should be provided in the site. Waste should be frequently collect by waste collector as in finding shows waste

scheduled collection was not frequently picked up and the frequency of waste collection is randomly.

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