TITLE OF RESEACH REPORT:

DESIGN AND DEVELOP NEW GLASS BOTTLE RECYCLING SYSTEM IN KUANTAN COMMUNITY

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FACULTY OF MANUFACTURING ENGINEERING

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TITLE OF RESEACH REPORT:

DESIGN AND DEVELOP NEW GLASS BOTTLE RECYCLING SYSTEM IN KUANTAN COMMUNITY

Prepared by:

PERWIRA PUTRA BIN ISKANDAR FA08031

Thesis submitted in fulfillment of the requirements for
the award of the degree of Manufacturing in Engineering

FACULTY OF MANUFACTURING ENGINEERING
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JUNE 2012

SUPERVISOR'S DECLARATION

"I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Manufacturing Engineering."

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STUDENT DECLARATION

I declare this thesis entitled "Design and Develop New Glass Bottle Recycling System" is the result of my own research except as cited in the reference. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

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"In the name of **ALLAH**, the Most Merciful and the Most Compassionate"

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ABSTRACT

Glass is an ideal material for recycling and in some cases can be used repeatedly without any deterioration in its physical properties. In recent years new legislative and fiscal drivers have contributed to increasing the desirability of recycling glass.This has been the case with the glass manufacturing industry , encouraging them to use more recycled glass cullet in place of virgin raw materials. However as with all markets, pressure from legislation can only be effective if the recycled bottle glass supplier can ensure that using recycled materials meet their customers' quality requirement .Furthermore, the type of glass available for recycling is not the type most demanded by the end market.To meet demands for higher quality cullet, new glass bottle collection system is been developed and introduced to the glassmaking industry that enables processors to improve cullet quality and make production more efficient.The development of new collection system and alternative markets for recycled glass has further contributed to the development of new technologies. Processing technologies have needed to keep pace with the variety of specifications introduced by these new end markets.

ABSTRAK

Kaca merupakan bahan yang sesuai untuk dikitar semula dan dalam sesetengah kes, boleh digunakan berulang kali tanpa sebarang kemerosotan dalam sifat fizikalnya. Dewasa ini, undang- undang dan peraturan baru Alam Sekitar telah menggalakan dan menyumbang kepada peningkatan kebaikan kitar semula botol kaca. Program kitar semula botol kaca yang telah dilaksanakan dalam industri pembuatan kaca ,lebih menggalakan mereka untuk menggunakan hablur kaca yang dikitar semula berbanding dengan penggunaan bahan mentah dalam pembuatan kaca Ini kerana pengguna hablur kaca kitar semula dalam industri pembuatan botol kaca lebih menjimatkan tenaga dan kos.Tetapi halangan terbesar bagi cadangan ini ialah untuk yang digunakan adalah tidak tercemar dan memenuhi keperluan kualiti pembuatan kaca.Untuk memenuhi permintaan hablur kaca kualiti tinggi sistem baru kutipan botol kaca dibangunkan dan diperkenalkan kepada industri pembuatan kaca.

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Kg : Kilogram

Km : Kilometer

% : Percent

LIST OF ABBREVIATIONS

MPK : Majlis Perbandaran Kuantan

GCC : Glass Collection Center

CHAPTER 1

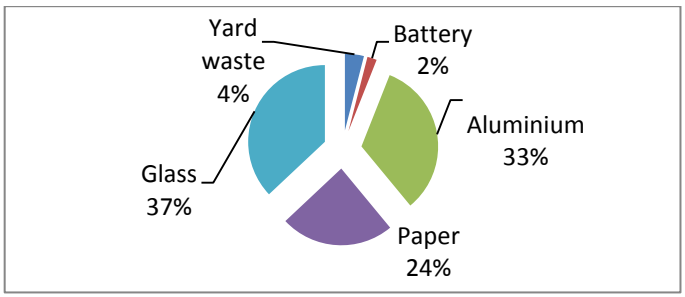
INTRODUCTION

1.1 Introduction

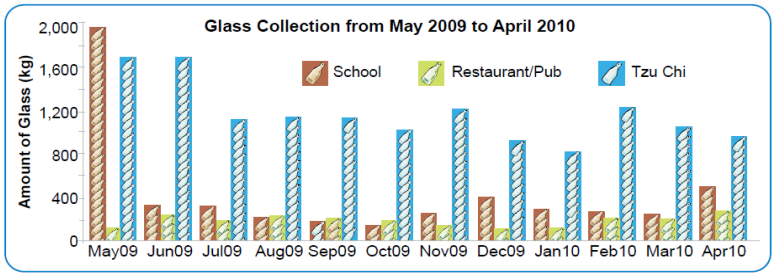
Glass is an ideal material for recycling and in some cases can be used repeatedly without any deterioration in its physical properties. In recent years, the demand for glass bottle containers is increasing resulting increase in the desirability of recycling glass.With all markets, pressure from demand can only fulfill and effective if the processors can ensure that using recycled materials meet their customers' quality requirements. Furthermore, the type of glass available for recycling is not always the type most demanded by the end market.The development of new and alternative markets for recycled glass has further contributed to the development of new technologies.

In Kuantan glass is the most recycled household items based on the data given by Kuantan Municipal Council (MPK) (Figure 1.1). Figure 1.2 shows the amount of glass collected at MPK Glass Collection centre (Glass recycling programme) per month from May 2009 to April 2010.Based on the figure 1.2 the glass collected at the residential area is the highest followed by schools and then restaurant/hotels. Glass recycling awareness in Kuantan is still low. Many of the used glass bottle end up at landfill or Alam Flora rubbish tank .All the glass that ended at Alam Flora or land fill will be contaminated and are not suitable to recycle as glass container or glass bottle.

Mixed glass cannot be used to make new containers because colour purity is essential. It must go to alternative uses such as a road laying material; glasphalt. Glasphalt contains about 30% recycled glass and it has been estimated that approximately 14 million used glass bottles is made for Other uses include fibre glass manufacture and material wool insulation.



(Figure 1.1: Recycled household items in Kuantan)



(Figure 1.2: Glass collection from May 2009 to April 2010,)

Based on the figure 1.2, 20 tonnes of glass were being collected throughout the programme or 1.7 tonnes of glass is collected per month for this programme. Recently, in 2011 the amount of glass collected by the MPK Glass Collection Centre is continue to drop drastically especially from schools and residential area. The purpose of this project is to maximize the amount of glass bottle collection through optimizing a new design system of collection in the supply chain (consumer, Municipal council and recycling agents) that is more efficient. This system will ensures that, glass bottles will not be wasted at landfill or Alam Flora rubbish tank which will lead to contamination to the glass and will prohibit the glass from being recycled to glass container such as bottles.

1.2 Problem Statement

Glass containers such as glass bottle are being consumed for various usages especially for storing sauce and ketchup for various brands. The usage of glass bottle is increasing since the demand for its domestic usage is increasing. The increase in the demand of glass bottle will result in the increase on the production of glass bottle from the manufacturer. In terms of manufacturing the production of glass bottle from recycled glass bottle saves 40% energy than producing from its raw material. However, recently most of the used glass bottle is not being recycled but were littered at landfill and thrown in the garbage bin. This is due to lack of awareness, motivation and effective collection system. This will also lead to big loss to the most valuable source of silica in glass production and promote environmental pollution because glass bottle is not degradable.

1.3 Aim and Objective of the Study

The aim and objective of this study is to develop and design a new and effective glass recycling system within consumer, Municipal council and recycling centers. This study is also being done in order to discover the behavior of consumers toward glass recycling in particular.

The aim is supported by subsequent objectives as follow:

i. To create a system of glass bottle collection so that glass bottles can be collected as maximum as possible in more systematic manner.
ii. To design a more dynamic collection center which can be reach easily by the consumer through out the particular area.
iii. To know the behavior of consumer towards glass recycling and target group to run the new system.

1.4 Scope of Study

This study will be focusing on two main areas, creating a new glass recycling system for Consumer, Municipal Council and Recycling centres and to discover consumers' behaviour towards glass bottle recycling. During the study, the current or conventional glass bottle recycling system is being studied to know the weaknesses and the strength of the current system.

Throughout the study, questionnaires will be prepared and distributed to the public consumer at targeted area. The questionnaires will evaluate the behaviour of consumers towards glass recycling and to identify target group for the new system.

1.5 Significant of Study

This study is significant to study and develop a new glass bottle collection system so that glass recycling process becomes for efficient and effective within consumer, Municipal Council, and Recycling Centres. In addition , this study will also reveal other issue regarding glass recycling such as the behaviour of consumers towards glass bottle recycling and which group in the society contributes the most and the least in glass bottle recycling.

1.6 Expected Outcomes

It is expected that this study will be able to offer better understanding regarding the importance of glass recycling and to promote glass recycling habit among consumers. Concurrently, it is likely that this study will be able to instill good practice in recycling and can avoid pollution in general.

CHAPTER 2

LITERATURE REVIEW

2.1 Glass Properties

The properties of glass provide attributes for many commercial products. As some of these products reach the end of their useful life and are discarded, there is the opportunity to have the material recycled into other useful products. This alternative is preferred over having the material enter a municipal waste stream for landfill disposal. Glass can be re-melted and re-fabricated over and over again without any deterioration of the material properties. Limitations for recycling of glass involve the level of contamination from other.

Categories or colors of glass, as well as from a variety of non glass materials. For successful recycling, glass must be processed to meet the requirements of the glass manufacturing industry. To promote glass recycling ,it is crucial to firstly promote recycling itself.

2.2 Consumers Behaviour in Recycling

Ludwig, et. al, 1998, in his study Increasing recycling in academic buildings shows that the ease and convenience of recycling behavior plays a critical role in determining whether or not it will occur. The study divided an experimental period into three temporal sections. These sections included a baseline period in which recycling bins were placed in a hallway, an intervention period in which recycling bins were moved into a classroom, and a return to the baseline The findings showed an increase in recycling behavior when bins were moved inside the classroom and return to original recycling frequency when bins returned to the hallway.

Quantitative and qualitative analyses of household recycling among young adults, based on the survey interview it shows that Participants in these interviews indicated a number of barriers to recycling that includes inconvenience associated with recycling, lack of information, existing household habits, and feelings that recycling did not have a meaningful impact. Furthermore, almost all of the interviewed participants characterized themselves as being lazy and suggested this as a reason for not recycling. Such evidence indicates that recycling is associated with some work or hassle and that to participate in recycling behaviors requires effort. Knussen, K., & Yule, F. (2008), in their study stated that participants without significant past recycling behavior who also had limited intention to recycle in the future did not necessarily have negative attitudes toward recycling .

This shows that attitude may not be a strong indicator of behavior. These findings are supported by another study by Nooney, et. al, 2003 concluded that one's environmental worldview and his or her actual environmental behavior are not significantly related. The study measured the environmental worldview of participants using a survey of questions relating to the balance between humans and nature, natural limits to growth, and a hierarchical relationship between humans and their environment. A measure of environmental behavior was taken using a survey questioning past eco-friendly behavior, such as recycling. The study concluded that people do not behave with respect to abstract views about the environment and that factors such as practical and political feasibility of environmentally conscious behaviors may have a greater impact .

Knussen & Yule,2009, in their study stated that, One important indication of such findings is that people often recognize the difference between their attitudes and behaviors.

For example, participants with a positive attitude toward recycling who do not participate in recycling behavior might change their attitude to match their behavior rather than increasing their personal recycling tendencies This could be a potential barrier in changing recycling behaviors, as the easier and more convenient way to deal with cognitive dissonance is to change attitude before altering behavior. It is also important to note that although attitude does not necessarily predict behavior, a person with negative environmental attitudes remains significantly less likely to recycle than a person with positive environmental attitudes.

Anna Carlson (2001) hypothesizes about the existence of a social norm in favor of recycling in the U.S. Most Americans who recycle regularly, according to Carlson, are not doing it for monetary reasons. Instead, they do it for the satisfaction of doing the right thing and approval of their peers and neighbors. (Granzin and Olson, 1991) their findings indicated that there was a relationship between what they referred to as "helping behaviors" and factors such as media use, demographics and knowledge/education of recycling.Study published in The Journal of Public Policy and Marketing, it was found that attitudes about recycling have a strong effect on recycling behaviors and what the authors call "recycling shopping behaviors," which is defined as the purchase of recyclable or recycled materials.

A 1993 study operationalizes these behaviors at a community level (Derkson and Gartrell) pose their question in consideration of access: Can concern for the environment overcome lack of access to recycling facilities? They make use of existing knowledge obtained from research studying the relationship between age and recycling behavior (a weak positive correlation) and effects of incentives upon recycling behavior wherein it was determined that any type of incentive, no matter how small, increased recycling behavior over the baseline. 1991, that very question was raised by a pair of researchers who questioned how socioeconomic status, in combination political characteristics and local population, affect the success of recycling programs (Folz and Hazlett).

What they already determined, based on previous research, is that success of recycling programs are more dependent upon the policies chosen and how they are implemented than on the culture of the local population. In a related study published in The Journal of Public Policy and Marketing(2000), that economic incentives can promote increased recycling behaviors, due to the continuing downturn in value of recyclable materials, a large-scale improvement in recycling behaviors will coincide with a change in public opinion about recycling. In the same vein, Hong and Adams (1991) hypothesize that the implementation of unit pricing programs will significantly increase recycling rates at the household level.Previous studies confirmed that unit pricing programs were successful in increasing recycling efforts when combined with other types of incentives. Dr. Janey Qian Wang (2009) there is only a weak positive correlation between education level and actual frequency of recycling, but a strong positive correlation between average household salary and frequency of recycling.

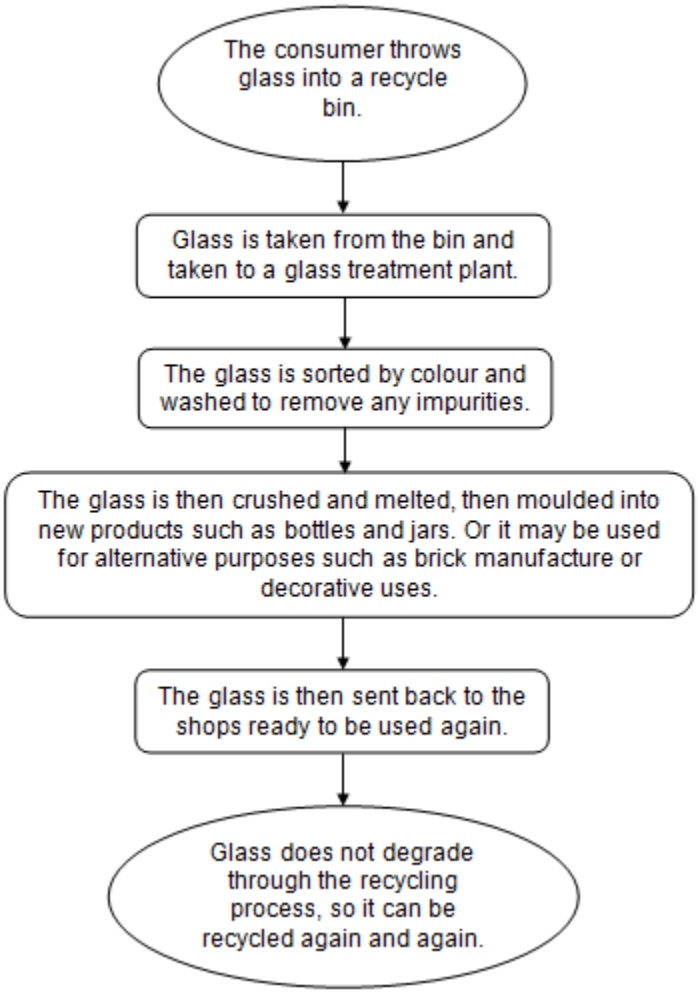
2.3 Glass Recycling

Kirk Othmer, Glass Recycling (2005) stated that containers, and all other uses. While the glass container manufacturers can theoretically use all the color sorted cullet collected to make new containers, for many communities, there are significant barriers: These include transportation cost, the problem of either marketing mixed colors, and more recently, having them processed with electromechanical glass sorting equipment . Used and recovered, i.e., post consumer, commercial glass, as well as off-specification glass, suitable for remelting, is referred to as cullet.

The 22% glass recycling rate reflects the percentage of containers actually being recycled into commercial products by manufacturers, not just the amount being collected. This percentage is based on the total number of all jars and bottles sold, not just a specific segment of the container market. Recycled glass (cullet) is not only made into new bottles and jars, but also used for secondary markets such as fiberglass and glasphalt, i.e., paving asphalt utilizing crushed cullet as a grog constituent, replacing stone aggregate.Commercial glass can be recycled when sufficient quantities can economically justify the development of a processing infrastructure. A variety of classification and separation issues must be addressed.

There are chemical differences between the largest glass product categories, including glass containers; window and automotive glass; electronic glasses, e.g., light bulbs, fluorescent tubes, and TV tubes; fiberglass, including insulating wool and textile types; and home cookware . Typically, only post consumer container and flat glass is recycled commercially. A significant proportion of past cullet recycling has been in the glass container industry.

Other segments, such as insulating fiber glass, are increasing the use of post consumer cullet. Approximately 12.6 million tons of glass containers (41 billion containers) are manufactured in the United States annually. In addition, an estimated 800,000 tons of glass containers are imported annually into the United States. Normally, glass containers are the second largest contributor by weight to a recycling programs, exceeded only by newspapers. In 2003, there were 8,875 curbside municipal solid waste [MSW] recycling programs, down slightly from 9,700 in 2001. Cullet is one of the four principal ingredients in container glass. From a nonmanufacturing perspective, using cullet conserves landfill space for disposal of non recyclable materials .



(Figure 2.1: Shows the process involve in bottle glass recycling**)**

(Figure 2.2: shows glass cullet based on colour)

2.4 Benefits of glass recycling

Glass recycling counts (2008) analyse that glass recycling produces lots of benefits, for instances glass recycling reduces pollution and emissions, reduces energy consumption and more controllable raw materials also improving the environment for everyone. Emissions of CO2 the main gas associated with global warming, arereduced by 56% through glass recycling .Glass recycling conserves the landscape saves hundreds of thousands of tonnes of primary raw materials each year. This saves resources, reduces the need for quarrying and conserves the countryside.Glass recycling also reduces landfill where every tonne of glass recycled extends the life of our increasingly scarce landfill sites and conserves the British countryside.Glass recycling cuts waste disposal costs, about 8% of the household rubbish collected by local authorities is glass. In 2003 this amounted to over 1.4 million tonnes of glass, collected at a cost £35 per tonne and sent to landfill at a cost of £30 per tonne, a total cost of over £93 million. Any increase in the amount of glass recycled means savings on these waste collection and disposal costs. Local authorities may also receive income from the sale of their glass and in some cases a recycling credit paid by the government.

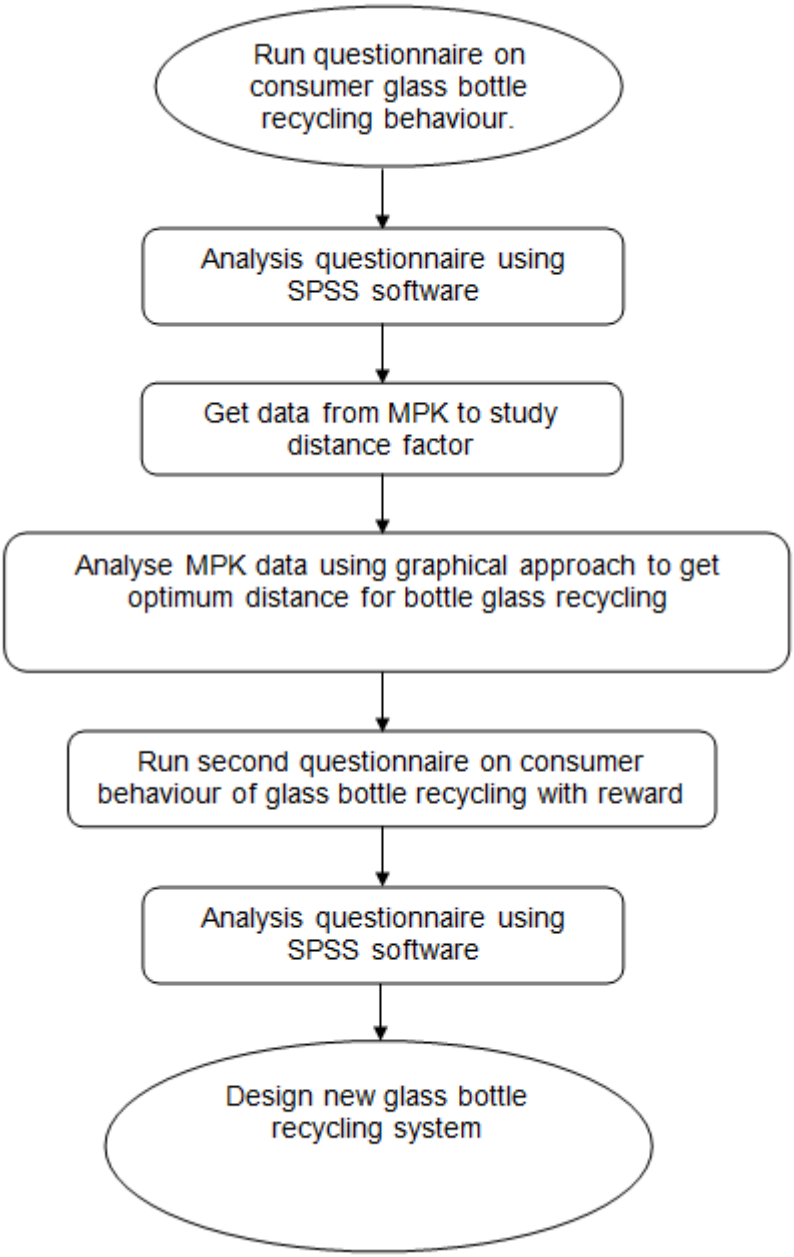
CHAPTER 3

METHODOLOGY

3.1 Introduction

The basis of this study was conducted through literature reviews. The literature review offer perspectives of glass recycling and consumer's behavior towards recycling. Further analysis of data collection is required in order to achieve the objectives as mentioned in Chapter 1 previously. A flowchart in Figure 3.1 depicts the methods for gathering data and information. The approaches used are entitled with:

a) Design and run questionnaire on consumers behavior on glass bottle recycling.
b) Analyze questionnaire using SPSS software.
c) Acquire data from MPK (distance factor study).
d) Analyze MPK data using graphical approach (finding optimum distance for bottle glass recycling).
e) Run second questionnaire on consumer behavior of glass bottle recycling with reward.
f) Analyze second questionnaire using SPSS software.
g) Design new glass bottle recycling system.



(Figure 3.1: Flow Chart for methodology)

3.2 Literature Review

Literature study is an initial move to acquire the primary vision with the purpose to identify problems and scope of the study. Literature review engages with reading process, discussion and observation which is completed before the data collection begins. The main area of study is bottle glass recycling.

3.3 Location Background

The surveys research is done in two different places which in Damansara Damai Selangor and Gambang Pahang. Damansara Damai is located at Petaling Jaya Selangor. Damansara Damai, a thriving 400-acre mix-development township, is located at the northern edge of Petaling Jaya, at the 11th Mile on the Jalan Kepong-Sungai Buloh and next to Bandar Sri Damansara. Damansara Damai has a population of 46,000 people, population base is expected to double in up coming future. The township is relatively young considering the fact that the properties were done in April 2001.

Gambang is a transit town in Pahang, Malaysia. It is about 30km from the state capital, Kuantan. It is located at a junction between Federal route MEC Highway (Federal route) and Tun Razak Highway (Federal route). The Malaysia Electric Corporation (MEC) town (Bandar MEC) and electrical appliances manufacturing factory is located here. It is accessible via the Gambang Interchange of the East Coast Expressway (ECE). Population is approximately 607,778 and comprise of 57% Malay, 32% Chinese, 10% Indian and 1% other races.

Figure 3.2: Damansara Damai map

Figure 3.3: Gambang map

3.4 Data collection

3.4.1 Primary data

Primary data is the spine of every research. The data is dividing into two category, quantitative data and qualitative data. Quantitative or numbers oriented data are gained from questionnaire and qualitative data is from interview and source such MPK Glass Collection Center glass collection statistic. One approach to accumulate data from respondent is through questionnaires. The questionnaire consist of twenty various questions that cover the entire research objective. This questionnaire is distributed randomly to the citizen of Damansara Damai and also Gambang.

A sample size of hundred respondent appeared to be sufficient in giving a 90 % confidence level with a population of 34 000 in the study area (Mohd Yusof et al., 2002). The objective of questionnaire is to investigate how far the consumers awareness regarding recycling especially glass bottle recycling. Another objective is to obtain responses from the consumer regarding their behavior in glass bottle recycling. Another approach is through interview session with person in charge from Kuantan Municipal council at Bukit Ubi whereby the glass bottle collection is also located there. It is a detail interview to understand the current trend and system of glass bottle recycling especially in Kuantan and generally in Malaysia.General observation indeed is an optional approach to self-monitor recycling culture and also potential problems in the current glass bottle recycling.

3.4.2 Secondary data

Secondary data is obtained from books, journal and newspaper article that are related to the glass bottle recycling .Generally this type of data is essential to establish the conceptions for the section of literature review. It is used as a guideline and for additional information in order to support and strengthen all the statements exist in conducting this study.

Supplementary information is retrieve from the internet source which consists of several relevant websites. The latest fact retrieved from the source are applied in the study field in order to gain additional knowledge and understanding regarding current practice of glass bottle recycling and other issue linked from the subject.

3.5 Data analysis

In data analysis stage, all the collected data will be analyze. The data from the questionnaire is analyzed based on software Statistical Package for Social Science (SPSS) and Microsoft Excell 2003. SPSS software used to analyze 20 questionnaires retrieved from the citizen of Damansara Damai where the questionnaire consists of 10 questions in the questionnaire.

The second set questionnaire is run at the citizen of Gambang .There are 4 questions in this questionnaire whereby, only question number 4 is analyzed using average index . The computation of average index is using spreadsheet (Microsoft Excell) and the values were interpreted to its category .overall, the analysis process has applied both SPSS and Microsoft Excel software to analyze the statistical data and come out with graphical and tabulated presentation. Graphical approach is also used in this study analysis.

3.5.1 Average Index

One of the statistical approaches to analyze data from the questionnaire is Average Index .The approach is calculating average index value from all respondents worth as the standard respond of the respondents. This simple calculation is performed by using Microsoft Excell. The equation of average index is as follow:

$$\text{Average Index} = \sum a_i \sum x_i \sum x_i$$

Where,

a_i = constant with represent i

x_i = variable represent the respondent frequency for i

i = 1,2,3,4

Abdullah (2007) has remarked the compute value of average index is graded to four categories which as follow:

1. Most important 3.5 < Average Index< 4.0
2. Important 2.5 < Average Index< 3.5
3. Average 1.5 < Average Index< 2.5
4. Less important 1.0 <Average Index <1.5

CHAPTER 4

ANALYSIS AND DISCUSSION

4.1 Introduction

Primary data is essential to study the system of glass bottle collection and recycling and waste management. The study is focused on Kuantan upon the reason that Kuantan is the only state in Malaysia which has the glass collection center which is located at Bukit Ubi .This collection center is under the authority of Kuantan Municipal council.

Interview sessions and feedback from the authorized personnel Kuantan Municipal council Glass Collection center is fundamental in this study in order to obtain precise information regarding the current statistic of glass collected and also the current trend of glass recycling in Kuantan. The interview is held the Kuantan Municipal Council Glass Collection Center. The representative of Kuantan Municipal Council Glass Collection Center is Tuan Hj Amran which is the manager and also person in charge of bottle glass collection at the center.

General observation is include to observe the process of crushing of the collected glass bottle and the current system that they are using to collect the glass bottle and also to identify potential problem and improvement in the current bottle glass collection management. The analysis is based on several positive and negative aspects with the purpose to upgrade bottle glass recycling and collection system and to put stop to bottle glass littering at landfill which will cause waste of space and pollution. For glass recycling, 2 main factor will be studied in this chapter that is distance factor and reward factor.

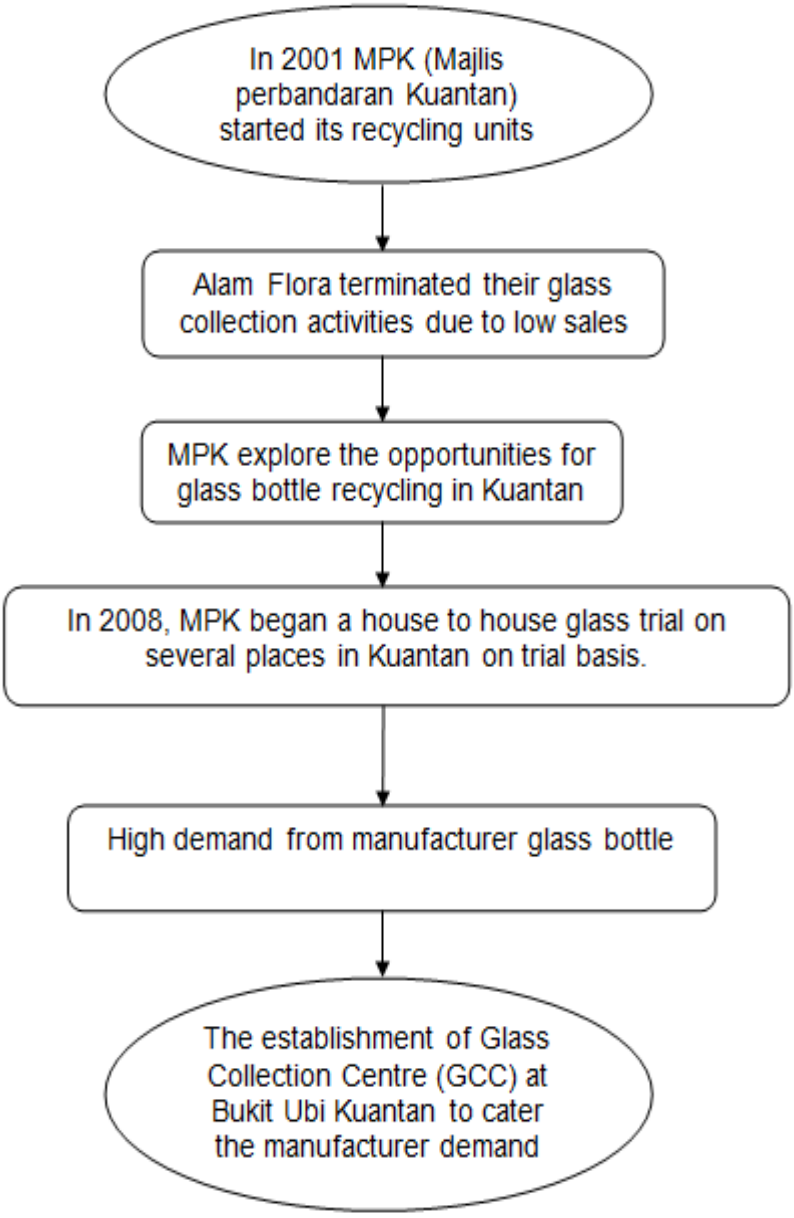
4.2 Feedback from Personnel

4.2.1 Responsibilities

In 2001, Majlis Perbandaran Kuantan (MPK) started its recycling unit. This unit was made responsible for deploying recycling bins for the collection and recycling of paper, plastic and metal. At the same time, MPK began a recycling awareness programme for schools. The council conducted awareness talks at different schools each month to foster public participation. Along with this, MPK established a “Club 25” programme that referred to school environmental clubs aiming at achieving a recycling rate of 25%.

At this point in time, however, glass recycling was not yet included in the programme. At that time, no systematic collection for glass bottles was in place at the East Coast of Malaysia. Glass recycling in Kuantan remained limited to a few sporadic initiatives undertaken by local non-governmental organisations (NGOs) such as Tzu Chi and the waste contractor, Alam Flora. Recycled glass bottles from these initiatives were often sent tobuyers in Thailand.

Later, Alam Flora terminated their glass collection activities as the volume of glass was low and the subsequent sales value did not justify the expenses incurred by collecting and handling the glass Realising the many benefits of glass recycling, MPK was eager to explore the opportunities for expanding recycling in Kuantan to include glass. Whilst the benefits of glass recycling are obvious, a number of issues needed further exploration to gauge whether or not glass recycling is viable and practical before a decision could be made.



(Figure 4.1: Chronology of the establishment of Glass Collection Center (GCC) in Kuantan.

4.2.2 Implementation of work

Glass Collection Centre, MPK has implemented implemented a permanent glass collection programme whereby 200 2-wheeled bins (120 litre) and 100 drum bins (100 litre) were purchased. The plastic bags used during the preliminary glass collection were replaced with new wheeled glass collection bins. MPK further expanded their existing Recycling Unit by hiring a driver. Once every fortnight, the glass collection team visited each site to collect the glass.

4.2.3 Facilities and vehicle

Glass Collection Centre, MPK is required to provide bins and also assigned truck to facilitate the glass collection process. The collection was divided into 2 half-day collection rounds where the glass from approximately 27 bins was collected per collection round. In addition, the staff used 2 hours to crush the glass per half day collection. In total, MPK has used approximately 1.5 working days per fortnight collection. MPK further expanded their existing Recycling Unit by hiring a driver. An existing MPK truck was made available for the programme. Once every fortnight, the glass collection team visited each site to collect the glass.Besides that, a glass crushing machine was purchased in order to mechanise and speed-up the glass crushing activity and to reduce the health and injury risks for the workers. At the same time, the Recycling Unit hired 2 additional workers. One of them was attached to the Recycling Unit to manage the glass crushing machine and store the glass at the MPK collection centre while the other worker was attached to receive incoming calls.

(a)

(b)

(c)

Figure 4.2 shows the facilities and operation involve at the glass collection center

(d) (e)

(f)

Figure 4.3 shows the crushed bottle, the bins involve and the bottle glass recycle product

4.2.4 Specification

MPK (Kuantan Municipal council) decided that a Glass Collection Centre should be established prior to initiating the permanent collection. A location within the premise of the mechanical section of the council at Jalan Bukit Ubi was identified for the centre. A detailed design of the centre was prepared and the cost of construction was estimated. The construction of the centre commenced on 17 October 2008 and was completed by December 2008. The centre consisted of a wall-less shelter equipped with glass storage bins. The operation of the Glass Collection Centre involved 2 workers from the Council Recycling Unit who manually crushed the glass by using large hammers. This was performed because crushed glass will take up significantly less space as compared to uncrushed glass, allowing MPK to store larger volume of glass at the centre before transporting it to the recyclers and hereby, optimising the transportation costs .

When the storage containers at the Glass Collection Centre were full, MPK coordinated with PUM Cullet to deliver the mixed glass to its collection hub at Meru, Klang Valley. During the trial collection, 2 trips with 1.75 tonnes and 8.9 tonnes of glass respectively were delivered . MPK identified 175 collection sites from 13 different categories of generators. Each site was provided with 1-2 bins for glass collection. The sites included 14 residential areas, governmental offices, schools, office buildings, restaurants, petrol stations, industries, etc.

4.3 Feedback from consumer

4.3.1 Survey 1

Seventy questionaire have been distributed randomly involving two different places 20 questionaire is distributed to the residents of Damansara Damai and 50 questionaire is distributed to the residents of Gambang.Total feedback obtain from the consumer is 70 out of 70 respondent. This mean that 100 % of respondent answered the questionaire.The analysis of background of respondent is based on three element gender , race and occupation. Figure 4.5 shows the race composition which involve in the survey research at Damansara Damai.The first 20 set of questionnaire is distributed around Damansara Damai residential area.In this questionaire question 1and 2 is the consumer demography detail which is shown below.

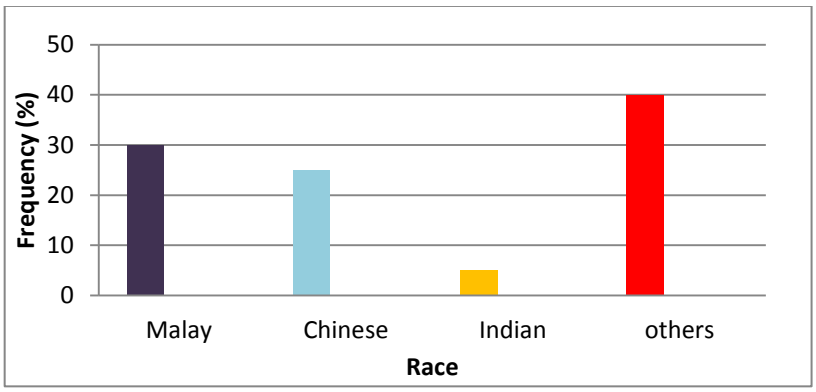


Figure 4.4 : Consumers race composition at Damansara Damai

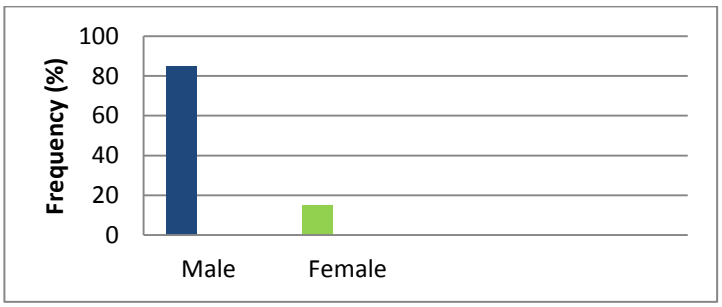


Figure 4.5 : Consumer gender composition at Damansara Damai

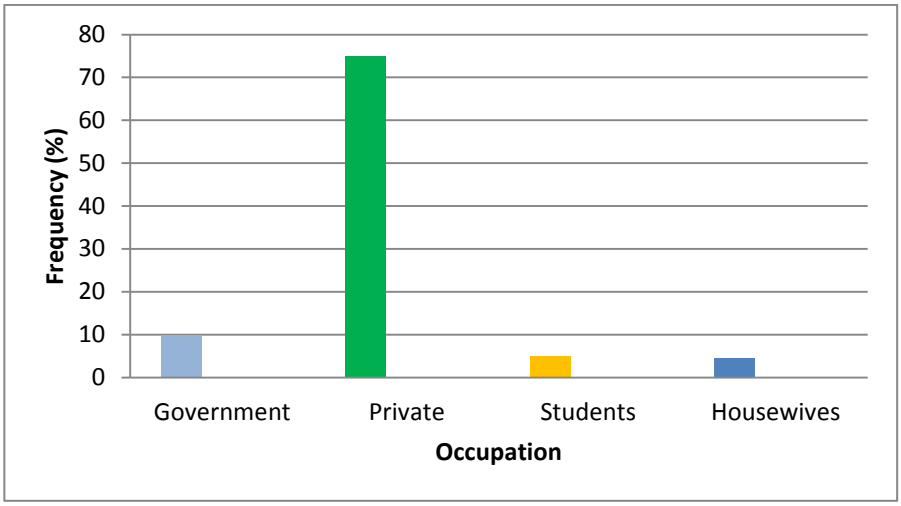


Figure 4.6: Percentage of consumer according to occupation at Damansara Damai

4.3.2 Glass bottle recycling behaviour.

Question 5, and 7 is regarding the consumers behaviour towards Glass bottle recycling .Question 5 asked whether they have recycled glass bottle or not. For this question,45% respodents said yes they have recycled bottle glass and 55% said no they haven't recycled bottle glass. This shows that consumer are still lack of awareness of the importance of recycling bottle glass.

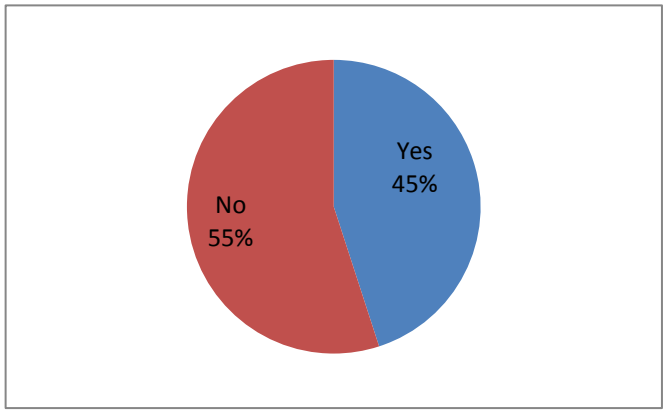


Figure 4.7 : Consumer glass recycling experience at Damansara Damai

For question 7, consumers is asked whether they will recycle bottle glass if reward is introduced for every kilogram of recycled bottles. 95 % respodents answered yes they would recycle and 5% respondents answered not they would not recycle . This indicates that reward play an important role in raising the motivation of consumer towards glass bottle recycling.

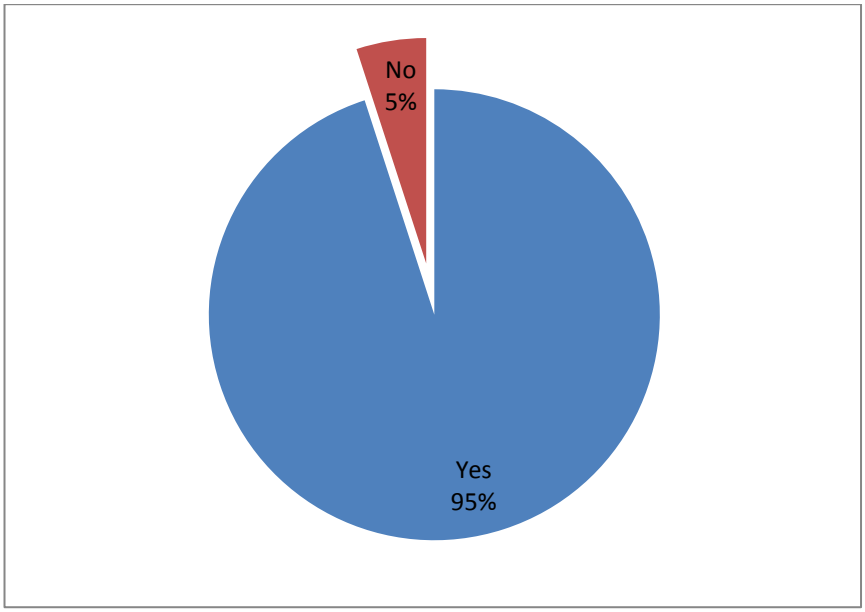


Figure 4.8 : Consumers response toward recycling bottle glass with reward at Damansara Damai

Based on the observation to the outcome of question 7 analysis ,it can be concluded that reward is a significant factor in boosting the motivation of the consumers in bottle glass recycling.

4.3.3 Glass bottle recycling determinat factor.(observational study)

Based on the analysis of the current glass bottle recycling system these are the two determinat or dominat factor which will influence consumer to recycle .The two factors are distance factor and reward factor.For distance factor an analysis is done based on the given data from MPK Glass Collection Center. Below is the outcome of the analysis .

X= Cl	ΔX= $Cl - RC$ (Km)	Y(Kg)
KRT AIR PUTIH	4.3	110
INDERA MAHKOTA 14	3.7	440
SG ISAP	2.5	110
PERMATANG BADAK	17.3	50
BERSERAH	23.4	24
BALOK	8.9	300
TELUK CHEMPEDAK	5.9	100
KUANTAN	3.7	150
BUKIT UBI	6.6	20
JALAN BESAR	7.1	40
BUKIT RANGIN	12.3	10
TAMAN TAS	10.8	15
SG LEMBING	22.7	10
SEMAMBU	18.3	30

Table 4.1: Recycling Bin Collection schedule From January to December of 2011
Source: Kuantan Municipal Council, Bukit Ubi

X = Consumer location (C*l*).

ΔX = Distance between Recycling Centre involved (Rc) in glass recycling programme and Consumer Location (C*l*).

Y = Weight of glass bottle collected by the recycling centre involve in the glass recycling programme.

4.3.4 MPK data analysis (Distance Factor)

Based on the analysis it shows that the nearer the recycling center the higher the weight of glass bottle collected(except for several places whereby this conclusion does not apply).This suggest that, distance between consumer and recycling center plays an important role in motivating consumer to recycle bottle glass. Based on this analysis also, the optimum distance for bottle glass recycling can also be determined. Based on the results the optimum , distance for bottle glass recycling is in the range of 2.5km to 8.9km.

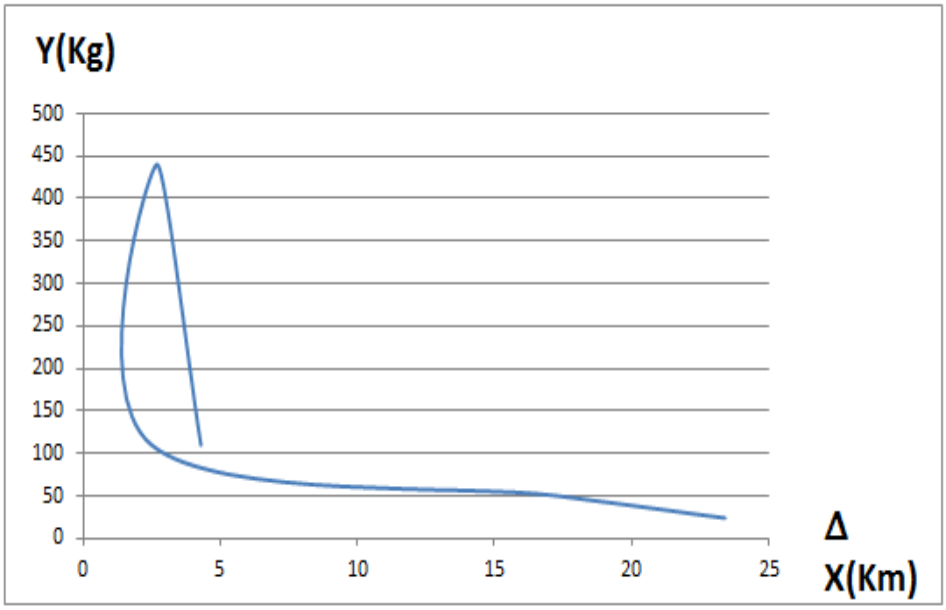


Figure 4.9 : Result ouctcome for distance factor analysis.based on MPK data

4.3.5 (a) Survey 2 (Average Index)

For reward factor second set of questionaire is distributed at Gambang residential area .The main objective of this research survey is to discover how reward can influence and convince consumer to recycle bottle glass. There are one questions in this survey questionaire which were analyzed by using average index method which is question 1, due to respodents responding differently for each category of statement .The choices of opinion are narrowed down to Strongly Agree, Agree and Disagree. The average index range is classified as follow :

1. Strongly agree 3.5 < Average Index< 4.0
2. Agree 2.5 < Average Index< 3.5
3. Disagree 1.5 < Average Index< 2.5
4. Strongly Disagree 1.0 <Average Index <1.5

The sample calculation of Average Index is shown below :

Table 4.2 : Data from second set questionaire

	Constant	Frequency
Strongly Disagree	1	3
Disagree	2	5
Agree	3	23
Strongly Agree	4	19

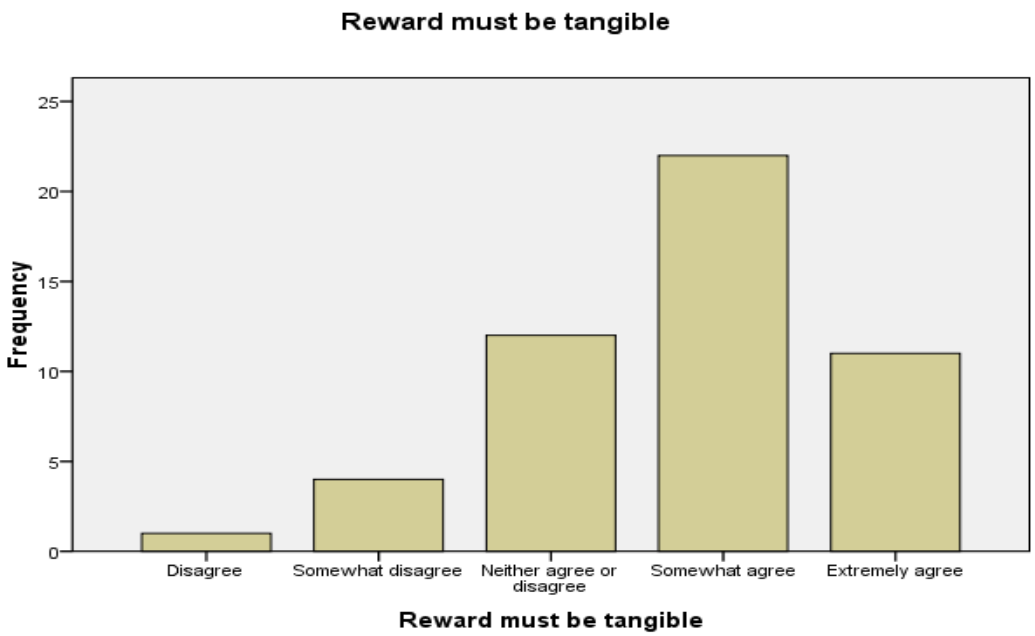
The average index = (1x3)+(2x5)+(3x23)+(4x19)/50 = 3.16
This average index is then categorized as **Agree.**

From the table it can be concluded that the consumers agree with the introduction of reward in the glass bottle recycling system .This indicates on how reward really influences the recycling habit and also increase consumers motivation towards glass bottle recycling.

(b) Survey 2 (SPSS Analysis)

Question 1 :

Question 2 :



Question 3 :

Question 4 :

Question 5 :

Observation :

Based on the Survey Research it can be concluded that reward is an important factor in in stimulating and increasing the motivation of the consumers in recycling bottle glass

Due to the fact that the questions thrown in Damansara Damai (refer Survey 1) is different from the question survey in Kuantan (refer Survey 2), therefore, the outcome of this survey research is still exposed to variation . For future improvement, refer Chapter 5 (Recommendation).

4.3.6 Conventional glass bottle collection system by MPK

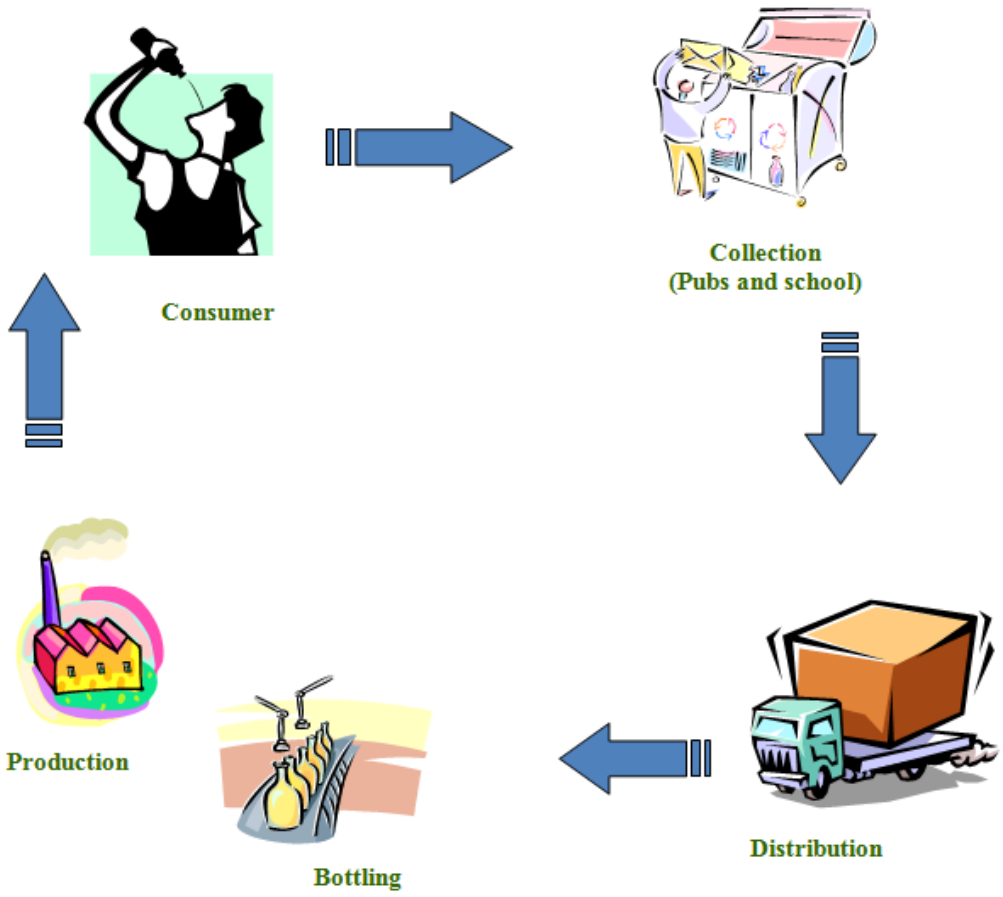


Figure 4.10 : Conventional glass bottle collection system done at MPK

4.3.7 Conventional glass recycling system

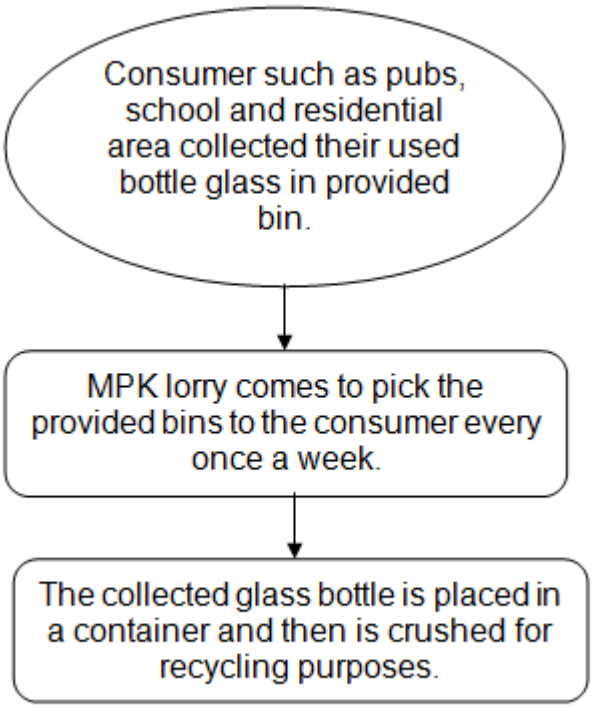


Figure 4.11: Conventional glass bottle recycling system

4.3.8 New glass bottle collection system

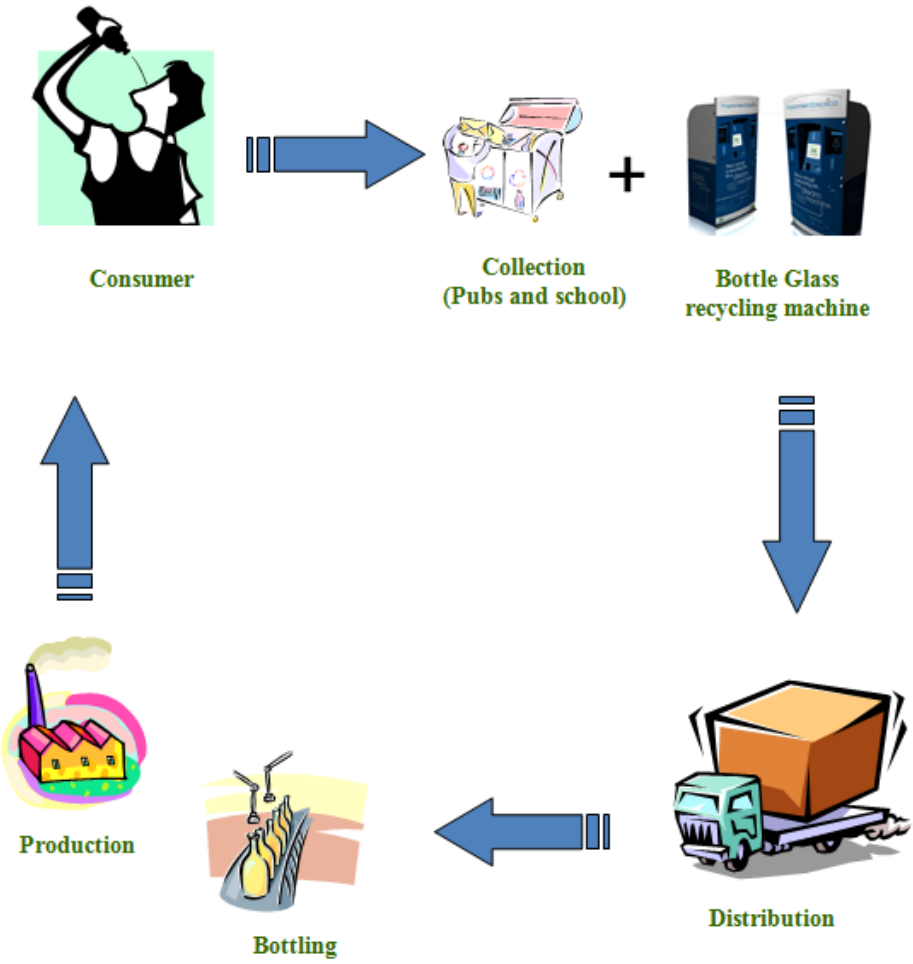
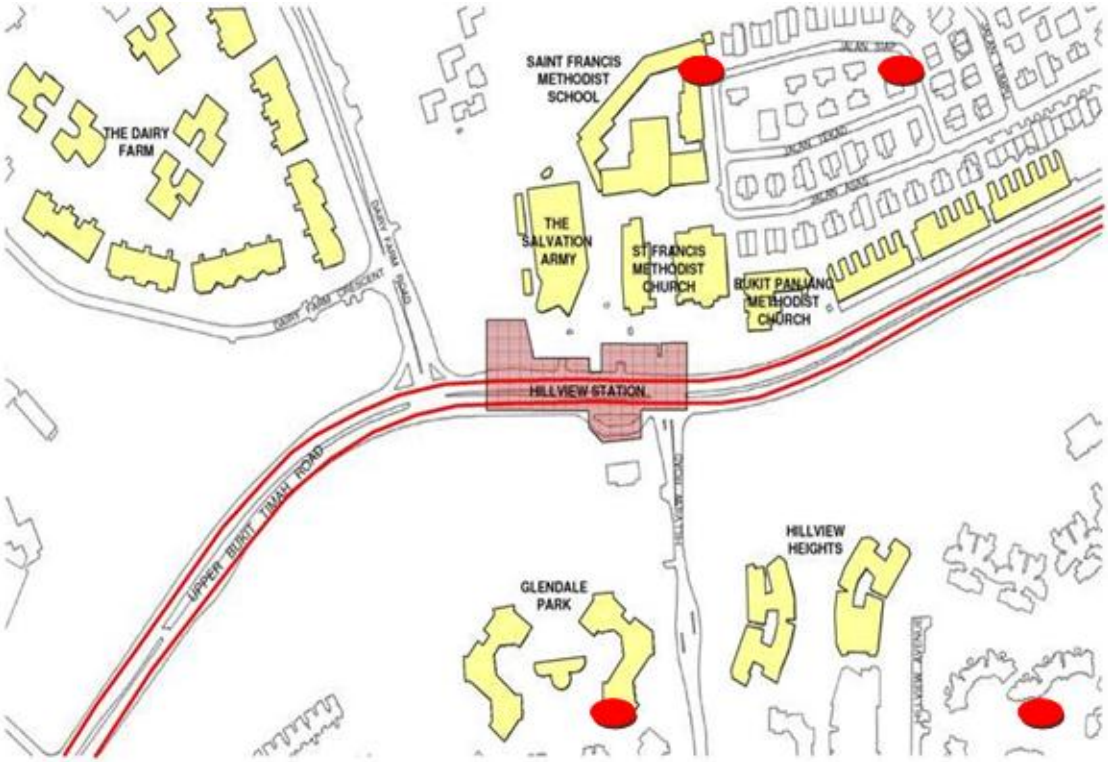


Figure 4.12: New glass bottle collection system

4.3.9 Location of glass bottle recycling machine



= **Glass bottle recycling machine**

Figure 4.13 : Example of location of glass bottle recycling .machine installation.

4.3.10 New bottle glass recycling system

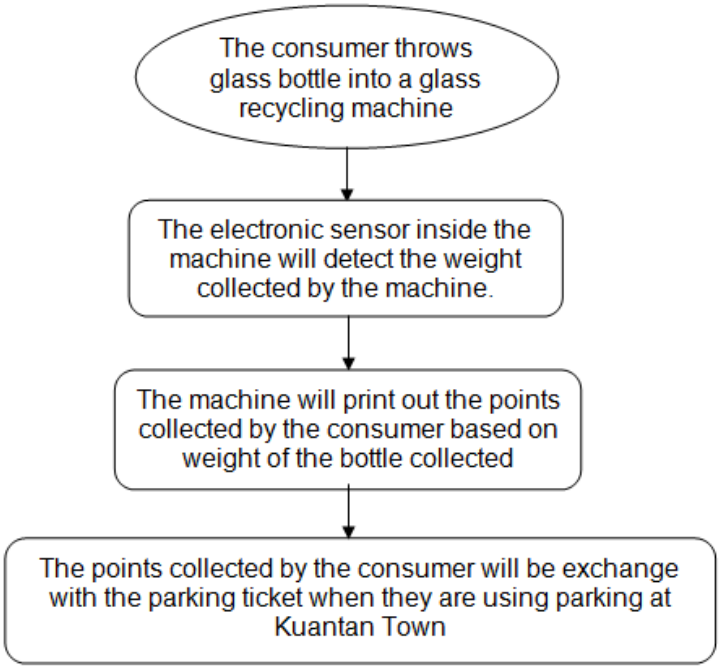


Figure 4.14 : Process flow of New glass bottle recycling system

New bottle glass recycling system illustration

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study is focusing on designing new bottle glass recycling system and recycling behaviour and culture as well. The achievements of the objectives of study are summarized as follow .

Objective 1 : To study the current bottle glass recycling system.

This study is focused on investigating the current bottle glass recycling system . MPK Glass Collection Center was supportive in providing the details of waste collection . There are four type of service done at MPK Glass Collection Center that is collecting the bottles , crushing the bottles and also deliver the crushed bottle glass to the glass bottle manufacturer .

Objective 2 : To study the behavior of consumer towards glass recycling.

This study also focused on the study of behavior of consumer in bottle glass recycling. Consumer plays an important role in recycling. Consumer contributes almost 100% of bottles glass amount collected by MPK Glass Collection Center. The study of consumer bahaviour towards recycling is important in order to discover factors that influences the consumer in bottle glass recycling.Observation from the survey suggest that having an acessible location plus with some reward would increase the bootle glass recycling frequency.

Objective 3 : To provide recommended solutions to improve and promote bottle glass recycling among consumers .

Several recommendations are proposed based on the data analysis , Mainly the recommendation are proposed in terms of sistem improvement and implementation. The proposal is discussed in detail in the next subtopic .

1. Encourage community involvement
2. Provide recycling facilities
3. Introduce new system of glass bottle recycling
4. Research data improvement (Survey data)

5.2 Recommendation

5.2.1 Encourage community participation

First attempt to conquer bottle glass recyling problem is by changing the mindset of the community. It means , giving the community the awareness , knowledge and skill to take action on enviromental matter. Besides that, the introduction of incentives such as reward for every recycled bottles is a good approach in order increase consumer motivation to recycle bottle glass . it is also a good approach to promote glass bottle recycling among consumers.The most fundamental in recycling is awareness and knowledge. Both awareness and knowledge are potentially promoted to the community through commercials and public education.

5.2.2 Provide recycling facilities.

It is proposed that the recycling facilities such glass bottle recycling machine should be strategically located in the areas of residential , institution and premises so that it reachable and easier to access for consumer.Practically with the present of recycling machine placed at public properties, the publiic will think twice when discarding their used glass bottle . it is recommeded to facilitate recycling machine in every residential area.

5.2.3 Introduce new system of glass bottle recycling.

New glass bottle recycling is recommended to be introduce to replace the conventional glass bottle recycling system. The as mentioned earlier is coporation between systematic recycling system and also reward system. This network of incoporated system is hoped to increase glass bottle collection and also promote glass bottle recycling .This new invented system is hoped to regenerate the interest of glass bottle among consumer. This new glass bottle recycling system can also help in preventing pollution especially at landfill whereby the bottle is littered because there is no motivation to recycle glass bottle.

5.2.4 Research data improvement (Survey data)

Due to the fact that the survey research 1 and 2 is done in two separate towns , it is recommended that, to conduct the same set of survey to more than one places to increase the stability of the results.

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APPENDIX A: Questionaires

BORANG SOAL SELIDIK KESESUAIAN CARA BARU UNTUK KITAR SEMULA BOTOL KACA DALAM KALANGAN PENGGUNA

(KEIKHLASAN ANDA DALAM MENJAWAB BORANG SOAL SELIDIK INI DIDAHULUI DENGAN UCAPAN TERIMA KASIH)

[✓] Tandakan jawapan anda.

BAHAGIAN JENIS DAN KATEGORI RESPONDEN

1. JANTINA

   [ ] LELAKI

   [ ] PEREMPUAN

2. BANGSA

   [ ] MELAYU

   [ ] CINA

   [ ] INDIA

   [ ] LAIN-LAIN, SILA

   NYATAKAN ……..

3. UMUR

☐ BAWAH 17

☐ 18 - 30

☐ 31 - 54

4. PEKERJAAN (**JAWAPAN BOLEH DITANDA LEBIH DARIPADA SATU**)

☐ SEKTOR KERAJAAN

☐ SEKTOR SWASTA

☐ PELAJAR

☐ SURI RUMAH

BAHAGIAN PERINCIAN RESPONDEN TERHADAP PROGRAM BARU UNTUK KITAR SEMULA BOTOL KACA

5. PERNAHKAH ANDA MENGITAR SEMULA BOTOL KACA SEPERTI BOTOL KICAP DAN BOTOL SOS?

☐ YA

☐ TIDAK

6. JIKA YA , BERAPA BANYAK BOTOL KACA YANG ANDA KITAR SEMULA DALAM SEBULAN ?(**TIDAK PERLU ISI JIKA JAWAPAN DI 1 ADALAH TIDAK)**

☐ 1-5

☐ 5-10

☐ 10-15

☐ LEBIH DARIPADA 15

7. ADAKAH ANDA AKAN MENGITAR SEMULA BOTOL KACA JIKA DIPERKENALKAN SISTEM GANJARAN BAGI SETIAP BOTOL YANG DIKITAR SEMULA ?

☐ YA

☐ TIDAK

8. ADAKAH ANDA AKAN MENGITAR SEMULA BOTOL KACA JIKA DITEMPATKAN MESIN UNTUK MENGUMPULKAN BOTOL KACA YANG ANDA KITAR SEMULA ? (MESIN TERSEBUT AKAN MEMBERIKAN GANJARAN KEPADA PENGGUNA BERDASARKAN BERAT BOTOL YANG DIKITAR SEMULA OLEH PENGGUNA)

☐ YA

☐ TIDAK

9. ADAKAH ANDA BERSETUJU JIKA MESIN TERSEBUT DITEMPATKAN SECARA KEKAL DIKAWASAN PERUMAHAN ANDA?

☐ SANGAT SETUJU

☐ SETUJU

☐ KURANG SETUJU

☐ TIDAK SETUJU

10. ADAKAH ANDA BERSETUJU JIKA MESIN TERSEBUT DITEMPATKAN DIATAS KENDERAAN SEPERTI LORI YANG AKAN MENGUTIP BOTOL KACA KITAR SEMULA DARI RUMAH KE RUMAH ?

☐ SANGAT SETUJU

☐ SETUJU

☐ KURANG SETUJU

☐ TIDAK SETUJU

11. ADAKAH ANDA LEBIH SUKA UNTUK KITAR SEMULA BOTOL KACA KEDALAM MESIN KAMI SECARA PUKAL ATAU SECARA SATU PERSATU?

    ☐ PUKAL

    ☐ SATU PER SATU

12. CADANGAN ANDA UNTUK PENAMBAHBAIKAN PROJEK INI.

    ……
    ……
    ……
    ……
    ……

SURVEY QUESTIONAIRE

The purpose of this survey is to discover consumer interest on type of reward should be offered in order to promote bottle glass recycling in the society. Please answer the following question completely. We appreciate your cooperation and time .Thank you.

Please underline your responses and answer the following questions:
For example, Male Female .

1. Gender: Male Female

2. Race/Ethnicity: Malay Indians Chinese Other_____
(specify)

3. What is your occupation : _____

4. With respect to this course, please rank on a scale from 1 to 5 by circling your response.
1= Disagree (Not at all agree), **2 = Somewhat disagree**, **3 = Neither agree or disagree**, **4 = Somewhat agree** and **5 = Extremely agree.**

a. Reward is a great motivation for recycling	**1 2 3 4 5**
b. Recycling reward must be tangible (such as goods /product)	**1 2 3 4 5**
c. Recycling reward must be intangible (Points which converted to goods)	**1 2 3 4 5**
d. The enhancement on recycling habit depends on reward	**1 2 3 4 5**
e. Reward will instil bad habit of recycling	**1 2 3 4 5**

Can you suggest any other method except reward to increase the interest of consumer to recycle bottles?

APPENDIX B : SPSS output.

Frequency Table

GENDER

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	lelaki	17	85.0	85.0	85.0
	perempuan	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bawah 17	2	10.0	10.0	10.0
	18-30	10	50.0	50.0	60.0
	31-54	8	40.0	40.0	100.0
	Total	20	100.0	100.0	

RACE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Melayu	6	30.0	30.0	30.0
	Cina	5	25.0	25.0	55.0
	India	1	5.0	5.0	60.0
	lain lain	8	40.0	40.0	100.0
	Total	20	100.0	100.0	

JOB

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	kerajaan	2	10.0	10.0	10.0
	swasta	17	85.0	85.0	95.0
	suri rumah	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Pernah kitar semula botol kaca?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ya	9	45.0	45.0	45.0
	tidak	11	55.0	55.0	100.0
	Total	20	100.0	100.0	

Berapa banyak botol kaca yang anda kitar semula?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	4	20.0	44.4	44.4
	5-10	2	10.0	22.2	66.7
	lebih daripada 15	3	15.0	33.3	100.0
	Total	9	45.0	100.0	
Missing	System	11	55.0		
Total		20	100.0		

Adakah akan kitar semula kaca jika diberi ganjaran?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ya	19	95.0	95.0	95.0
	tidak	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Adakah anda akan mengitar semula jika diperkenalkan mesin ganjaran ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ya	19	95.0	95.0	95.0
	tidak	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Adakah anda bersetuju jika mesin ditempatkan kekal dikawasan perumahan anda?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	sangat setuju	15	75.0	75.0	75.0
	setuju	2	10.0	10.0	85.0
	kurang setuju	3	15.0	15.0	100.0
	Total	20	100.0	100.0	

Adakah anda suka untuk kitar semula botol kaca kedalam mesin secara pukal atau satu per satu?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	pukal	13	65.0	65.0	65.0
	satu persatu	7	35.0	35.0	100.0
	Total	20	100.0	100.0	

Adakah anda setuju jika mesin itu ditempatkan diatas kenderaan seperti lori?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	sangat setuju	3	15.0	15.0	15.0
	setuju	9	45.0	45.0	60.0
	kurang setuju	7	35.0	35.0	95.0
	tidak setuju	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Frequencies

[DataSet0]

Statistics

		Reward is a great motivation for recycling	Reward must be tangible	Reward must be intangible	Enhabcement of recycling habit depend on reward	Reward will instill bad habit of recycling
N	Valid	50	50	50	50	50
	Missing	0	0	0	0	0

Frequency Table

Reward is a great motivation for recycling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	2.0	2.0	2.0
	Somewhat disagree	4	8.0	8.0	10.0
	Neither agree or disagree	10	20.0	20.0	30.0
	Somewhat agree	18	36.0	36.0	66.0
	Extremely agree	17	34.0	34.0	100.0
	Total	50	100.0	100.0	

Reward must be tangible

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	2.0	2.0	2.0
	Somewhat disagree	4	8.0	8.0	10.0
	Neither agree or disagree	12	24.0	24.0	34.0
	Somewhat agree	22	44.0	44.0	78.0
	Extremely agree	11	22.0	22.0	100.0
	Total	50	100.0	100.0	

Reward must be intangible

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	7	14.0	14.0	14.0
	Somewhat disagree	17	34.0	34.0	48.0
	Neither agree or disagree	19	38.0	38.0	86.0
	Somewhat agree	3	6.0	6.0	92.0
	Extremely agree	4	8.0	8.0	100.0
	Total	50	100.0	100.0	

Enhabcement of recycling habit depend on reward

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Somewhat disagree	7	14.0	14.0	14.0
	Neither agree or Disagree	22	44.0	44.0	58.0
	Somewhat agree	16	32.0	32.0	90.0
	Extremely agree	5	10.0	10.0	100.0
	Total	50	100.0	100.0	

Reward will instill bad habit of recycling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	17	34.0	34.0	34.0
	Somewhat disagree	13	26.0	26.0	60.0
	Neither Agree or Disagree	17	34.0	34.0	94.0
	Somewhat agree	2	4.0	4.0	98.0
	Extremely agree	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

APPENDIX C : Gantt Chart

Gantt Chart 1(FYP 1)

No	Activity/ Process	2011				2012						STATUS
		September	October	November	December	January	February	Mac	April	May	June	
1	Project Title											
	1.1 Breifing from FYP supervisor											100%
	1.2 Choose title for project											100%
	1.3 Submit title to FYP supervisor											100%
	1.4 Receive title from FYP supervisor											100%
2	Small Grop Activity											
	2.1 Form discussion group											
	2.1.1 Reaserch related information											100%
	2.2 Feasibility study											
	2.2.1 Reaserch related information from journal											100%
	2.2.2 Interview with Municipal council (MPK)											100%
	2.2.3 Compilation of information											100%
	2.2.4 Weekly discussion with project supervisor											100%
	2.2.5 Prepare project proposal											100%
	2.2.6 Present project proposal											100%

Actual

Plan

Gantt Chart 2(FYP 2)

No	Activity/ Process	2012						STATUS
		January	February	Mac	April	May	June	
1	Design new bottle glass recycling system							
	1.1 Questionaire research 1 (Glass bottle behaviour)							100%
	1.1.1 Design research questionaire							100%
	1.1.2 Distribute questionaire to targeted area							100%
	1.1.3 Analyze questionaire using SPSS							100%
2	Experiment for distance factor							
	1.2 Distance factor experiment							
	1.2.1 Gathering data from MPK							100%
	1.2.2 Start Experiment							
	1.2.3 Analyze Experiment outcome data							100%
	Questionaire research 2 (Reward factor)							100%
	1.3 Reward factor analysis							100%
	1.3.1 Design research questionaire							100%
	1.3.2 Distribute questionaire on targeted area							100%
	1.3.3 Analyze quetionaire using SPSS							
3								
	New glass bottle recycling system (design and development)							
	1.4 New glass bottle recycling system							
	1.4.1 Design new glass bottle recycling system							100%
	1.4.2 Incoporate glass recycling system with machine							100%
	1.4.3 Run the new glass recycling system							100%
	1.4.4 Calculate the weight collected by the new system							100%