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JUDUL: DEVELOP A WEIGHT DETECTION UNIT OF THE GLASS COLLECTION MACHINE WITH REWARD SYSTEM

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Saya, **KHAIRUL AZRI BIN NGADIMEN(880629-01-5815)**
(HURUF BESAR)

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Alamat Tetap:
E5, rumah k/tangan ldg
FELDA Tenggaroh 13,
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KARTINA BT JOHAN
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DEVELOP A WEIGHT DETECTION UNIT OF THE GLASS COLLECTION MACHINE WITH REWARD SYSTEM

KHAIRUL AZRI BIN NGADIMEN

A report submitted in partial fulfilment of the requirements
for the award of the
Degree of Manufacturing Engineering

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of Degree of Manufacturing Engineering

Signature
Name of Supervisor: KARTINA BT JOHAN
Position: LECTURER
Date:

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ID Number: FA09073
Date:

DEDICATION

First of all, I would like to show my expression of gratitude to Allah s.w.t whose guidance, help and grace was instrumental in making this humble work a reality. I would like to express my gratitude to my supervisor Madam Kartina Bt Johan and to the entire lecturer without whose wise suggestions, helpful guidance and direct assistance, it could have neither got off the ground nor ever been complete.

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ABSTRACT

Nowadays glass had become some of the solid waste produce by the society. Glass is primary ingredient for window, bottle, or as container to store for consumer and can be glass water for drinking. Glass had its unique property of material because it can be recycle after use it, and for the recycle process its only need 40% of energy required from the virgin material to produce a new glass. Awareness in the consumer about recycling is still low, it because glass recycling in Malaysia is still in its infancy. Less than 30% of new bottles are made from recycled glass compared to 80% in Thailand and 60-70% in Europe. A vast majority of glass still ends up at landfills (MPK, 2009). This project is about design and fabrication of weight detection unit that can detect glass weight and convert weight to bonus point. It has advantage because it is independently weight detector that can be used to detect any weight and can be attach to any machine. As the conclusion, this project had achieves its entire objective successfully. This project was done around thirteen week included almost all steps of the report such as design, analysis, fabrication process and others.

ABSTRAK

Pada masa kini kaca telah menjadi sebahagian daripada hasil sisa pepejal oleh masyarakat. Kaca adalah bahan utama untuk tingkap, botol, atau sebagai bekas untuk menyimpan untuk pengguna dan boleh menjadi air segelas untuk minum. Kaca mempunyai kandungan yang unik bahan kerana ia boleh dikitar semula selepas menggunakannya, dan untuk proses kitar semula hanya memerlukan 40% daripada tenaga yang diperlukan dari bahan asli. Kesedaran di kalangan pengguna tentang kitar semula adalah masih rendah, kerana kitar semula kaca di Malaysia masih di peringkat awal. Kurang daripada 30% daripada botol baru dibuat daripada kaca yang dikitar semula berbanding dengan 80% di Thailand dan 60-70% di Eropah. Majoriti kaca masih berakhir di tapak pelupusan (MPK,2009). Projek ini adalah mengenai reka bentuk dan penghasilan unit pengesanan berat yang boleh mengesan berat kaca dan menukarkan berat ke titik bonus. Mempunyai kelebihan kerana ia adalah pengesan berat yang boleh digunakan untuk mengesan apa-apa berat dan boleh digunakan kepada mana-mana mesin. Kesimpulannya, projek ini telah mencapai objektif keseluruhan berjaya. Projek ini dibuat sekitar minggu 13 termasuk hampir semua langkah laporan seperti reka bentuk, analisis, proses fabrikasi dan lain-lain.

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INTRODUCTION

1.1 Project Background

In the nonmanufacturing area, lean is applied to minimize waste or resource to make new process because it added value to the available product at the market. This project main objective is to develop glass recycle machine with the redemption system. There are three main parts of this project, first is develop a supply chain for the glass recycle for customer to the retailer, second is develop machine for glass recycle and third is develop weight detection unit for the glass collection system with redemption system. With the combination of these three objectives it will produce a glass recycle machine with redemption system. This thesis will based on the third part of the project which is to develop weight detection unit for the glass collection system with redemption system.

Glass has been a major building and optical material for hundreds of years. It becomes one of the earliest production materials used. The development of glass growing rapidly since the past two centuries. Then became more popular during the industrial revolution, there are many ways of it mass manufacturing technique of glass develop such as window, bottle, lighting and more research is being done to increase the availability of bulk glass. After glass being rapidly develop by manufacturing there are some issue occur such as toughness of glasses produce, chemical properties, and large part processing

from glass, shorter development times and alternative fuels and advanced control capabilities to reduce production costs.

Glass is the primary ingredient for windows, bottles, or as container and can be used as glass for drinking water. Glass has its unique property of material because it can be recycle after being used, and for the recycle process it only required 40% of energy from the virgin material in order to produce a new glass. This energy assumption is the same as the sum of energy produce by television for 1.5 hour. It can also save valuable landfill space from being invaluable storage of a tonne of useless glasses.

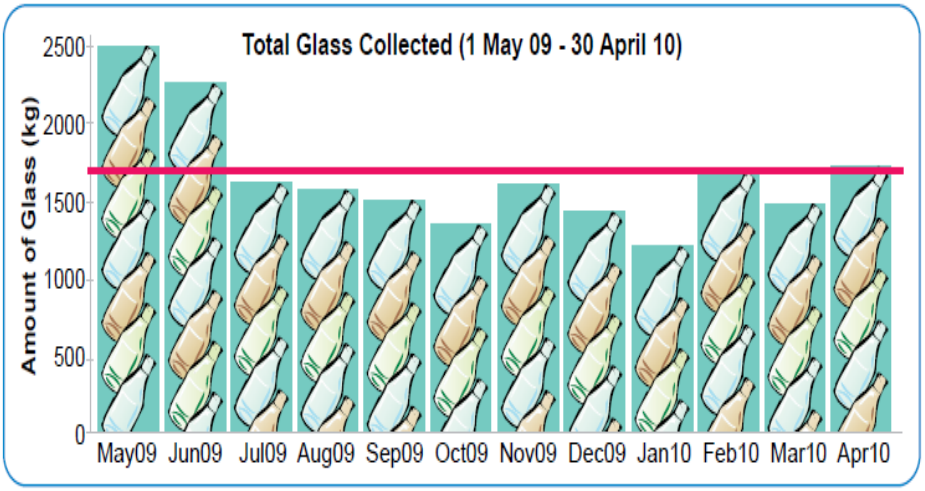

Figure 1.1: Total Glass Collected by MPK (1 May 09 – 30 April 10)

According to figure 1.1, number of total glass being collected by MPK in 12 month is 20 tonnes or 1.7 tonnes per month. This number of glass collection shows decreasing trend. It can be seen from figure 1.1, for may 2009 amount of glass collected is 2500kg, but after may 2009 number of total glass collected is below 2000kg. This statistic of collection glass is produce by the MPK after Alam Flora stops it services (MPK, 2009).

1.2 Problem Statement

Nowadays glass has become some of the solid waste produce by the society. Glass is the primary ingredient for windows, bottles, or containers and can be used as glass for drinking water. Glass had its unique property of material because it can be recycle after use it, and for the recycle process its only need 40% of energy required from the virgin material to produce a new glass. This energy assumption is same as the sum of energy produce by television for 1.5 hour. Land or soil is very important to our nature. Thus, by inventing this kind of machine, it can help to save the land from being wasted by the glasses residue that are being thrown away. Therefore recycle glass can reduce manufacturing cost to produce new glass, save energy, raw material and landfill space. Yet, glass recycling in Malaysia is still in its infancy. Less than 30% of new bottles are made from recycled glass compared to 80% in Thailand and 60-70% in Europe. A vast majority of glass still ends up at landfills (MPK, 2009). The mechanism for collecting glass recycle in Malaysia is still use traditional method by collect glass manually from shop to shop. Glasses is collected in broken pieces is dangerous for consumers and MPK workers to collect thus can discourage recycling. The collection route is not efficient because MPK workers need to collect glasses from many places. To overcome this problem, a new recycle machine is created with redemption system, this machine have a detector sensor and screen to attract consumer to recycle.

1.3 Project Objective

This paper is about to design a redemption system for a glass recycle machine. It contains information on how the system will process accordingly. The system function is to recognize and then classified it into their own category such as 500 mL, 1500 mL and others. There are three main objectives to be discussed in this project. The objective is as below:

1 To design mechanism for glass collection machine that can calculate glass weight.

2. To develop weight detector units that will be part of the glass recycle machine.
3. To develop calculation system that calculates solid glass weight.
4. To convert the weight to reward.

1.4 Scope of Project

This project is about the design for a reward and a detector sensor that can detect glass weight. The weight detection unit for collection and reward system can be part at the glass recycle machine.

(i) To build a blue print for weight detection unit that can calculate solid glass weight which is convertible to reward for the glass recycle machine.
(ii) This study is done based on MPK previous feasibility study at selected area.
(iii) To study the effectiveness of the glass recycle system machine by using solid glass as the product of interest.
(iv) Material used is based on what is available in the market.
(v) Parameter use for weight detection unit is weight of solid glass detector sensor, computer programming coding and reward.
(vi) The system will identify weight of glass and then sum the value and produce redemption point.
(vii) This project will refer to sensor application book and computer programming book.
(ʌi) Recycle material is use to develop product and mechanism to reduce waste and added value to the material.

1.5 Significant of Project

Awareness in the consumer about recycling is still low, it because glass recycling in Malaysia is still in its infancy. Less than 30% of new bottles are made from recycled glass compared to 80% in Thailand and 60-70% in Europe. A vast majority of glass still ends up at landfills (MPK, 2009).

Based on the MPK data, there is still a lot of improvement need to be done to encourage the society to participate activity in recycling. By having a glass recycling system with built in redemption system, it may help to encourage awareness about recycle.

1.6 Flow Chart

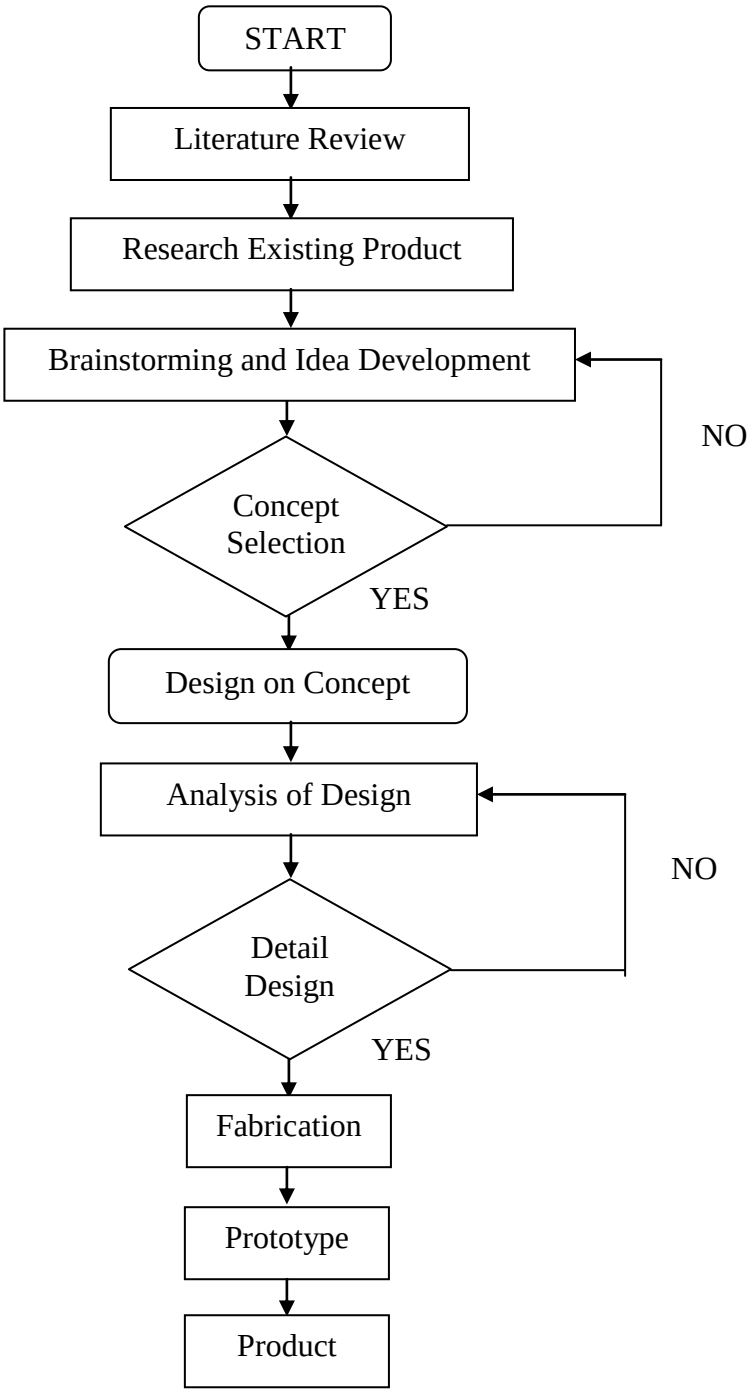

Figure 1.2: Project flow chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Glass has been a major building and optical material for hundreds of years. It becomes one of the earliest production materials used. The development of glass grew rapidly since the past two centuries. Then became more popular during the industrial revolution, there are many mass manufacturing techniques of glass develop such as window, bottle, lighting and more research is being done to increase the availability of bulk glass. After glass being rapidly develop by manufacturing, some issues occurred such as the toughness of glasses produce, chemical properties, large part processing from glass, shorter development times and alternative fuels and advanced control capabilities to reduce production costs (S.Freiman, 2007).

In the environment view, the main issue faced by the manufacturer is how to balance market and product development with environmental regulation. As the environment product liability is concern, the product development is eventual dispose or recycle effort, as manufacturer are concern is to increase their productivity and efficiency against governmental and regulation. But consumers have their right of choice to buy environmental product thus produce manufacturing technique that environmental friendly (S.Freiman, 2007).

Glass surface had chemical reactivity, it governs the adhesion strength of polymer to glass, a subject of high relevance for the fabrication of laminated glazing or the elaboration of glass fibre reinforced polymer. Surface reactivity is also a limiting factor for the durable grafting of organic functions on glass. Nowadays science work hard to improve glass structure because it has always been plagued by its brittle failure at relatively low loads. Some of the technique that had a great deal of successful at strengthening glass by the development of surface compressive stresses, hence they are looking for more batter or less expensive variant of technique for strengthening glass (S.Freiman,2007).

This improvement is important because with higher strangeness glass can be dividing in two different categories: ordinary "inexpensive" product such as window glass, bottle, etc and hi tech, high valued added glasses such as light guides, flat panel display substrates (S.Freiman, 2007).

Glass recycle is a process to transform waste glass into usable glass. Glass recycling in Malaysia is still in its infancy. Less than 30% of new bottles are made from recycled glass compared to 80% in Thailand and 60-70% in Europe. A vast majority of glass still ends up at landfills (MPK, 2009).

In the USA Gonnermanet al. (2000) analyzed community participation in selective waste disposal schemes in the state of Iowa; they randomly telephoned a total of 830 over-eighteen-year-olds, most of whom confirmed that they returned empty drinks bottles and cans either to the store where they had been purchased, or to a waste collection centre. Result that emerged from the study carried out for the Iowa Department of Natural Resources is that 85% of those polled were aware of some of the recycling programs run in their neighbourhoods. In Spain, waste is treated selectively in 87% of homes (Ecoembes, 2002).The purpose of this activity and campaign is same that is to change people mind and habit in Asia about recycle waste batter than Europe. It is not an easy job to do but must be done because every year there is increasing number of people living in each state. Various studies, e.g., Fullerton and Kinnaman (1995), consider the case of the mandatory deposit–refund systems,

and these studies show that a deposit–refund system is an optimal fee structure when compared to several other methods.

In the UK glass industry, approximately 3.7 million tonnes of glass produce each year. These glass produce can be divide into four main categories that is container glass, fibre glass, flat glass and domestic glass. The main sources of this glass are come from manufacture of containers for food and drink, glazing for the automotive and the construction industries. All of this sources accounted for about 90% from all glass produce in the UK in 2006. Lately glass processing plants have appeared and been develop over recent years, demand for recycle glass from industry and aggregates business has increased (DEFRA, 2003).

In the 2006, there was 1.3 million tonnes of cullet is been recycled to produce new glass containers, including for 54% of the total waste stream. In the UK, clear glass has the higher value because most of the glass containers are made from clear glass. But somehow, green glass had been received for recycle most than clear glass. It happens because UK now imports huge quantities of colour glass, and pre filled wine bottles for local market. For recycling process, mixed glass cannot be remelts because colour purity is vital. Some of the system applies for recycle glass collection in UK are kerbside collections. As the result of the system are increases in collection for glass in tonnes of cullet from the market place (DEFRA, 2003).

When the amount of cullet in the market continue arise, not only glassmakers benefited but other industries that use cullet such as grit blasting, road surface material and water filtration business. The figure for 2005 shows that about 280,000 tonnes of recycled glass went to alternative markets. According to Defra figures almost 234,000 tonnes of glass packing was exported for recycling in 2005, taking the total amount of UK glass bottle and jars recycle about 1.26 million tonnes per year. (DEFRA, 2005)

Figure 2.1: Glass recycle machine at Tesco England

In Europe, there are lots of glasses recycling machine and each of this glass recycle machine is more advance and user friendly to consumer. Ergonomic factor is one of the important factors that make recycling simple and easy to use. The process for recycle in Tesco is first, drop recyclable items one time into the machine. Second is wait for the items being scanned by a laser reader. Third, buckets carry accepted item to a conveyor that deposits it in specific bins. Lastly, the item is smashed, crushed and granulated. This mean it takes up less room, meaning fewer collections and fewer Lorries on the roads, thus reducing CO2 emissions. The glass recycle machine also equipped with redemption system by using green Club card point. One point for every two aluminum can recycle.

Figure 2.2: Glass recycle machine from Pepsi. Co America

Early 2010 Pepsi. Co introduces a new bottle tossing machine. The purpose of this machine to save environment and design to fulfill Americans needed. This machine allocated at 150 Rite Aids across North Carolina, it is design like ATM recycling kiosks with pepsi logo at it. This machine also equipped with redemption system that exchange empty cans and bottle for all sort of goodies. Pepsi also plan to install 3,000 of this kind of machine in southern California by summer's end. This machine is named as the Dream Machine and its work process is, first it scans the bottle, and then tosses it into a chute. Secondly, the machine register how many points its worth and print out a receipt. Thirdly, for redemption visit web site Greenopolis.com to redeem points for Blockbuster certificates and discounts at Johnny Rockets. Some of the Europe country like Norway and Germany use cash for redemption for each bottle been recycle.

Figure 2.3: Vending machine at Australia

Vending machine is usually used to sell drink at junk food, but Envirobank has developed a standard vending machine as recycle machine that receive bottles for recycle. The machine is design to accept, clean and crush recyclable material and to reduce emissions by preparing the recycled materials for direct shipment to a glass recycling plant. This machine also equipped with redemption system which its offer coupons, cash credit or vouchers to be used at neighboring shops for anyone who needs that extra incentive to recycle their

waste. The manufacturer of the machine Envirobank, has deployed a few machines throughout Australia on a trial basis.

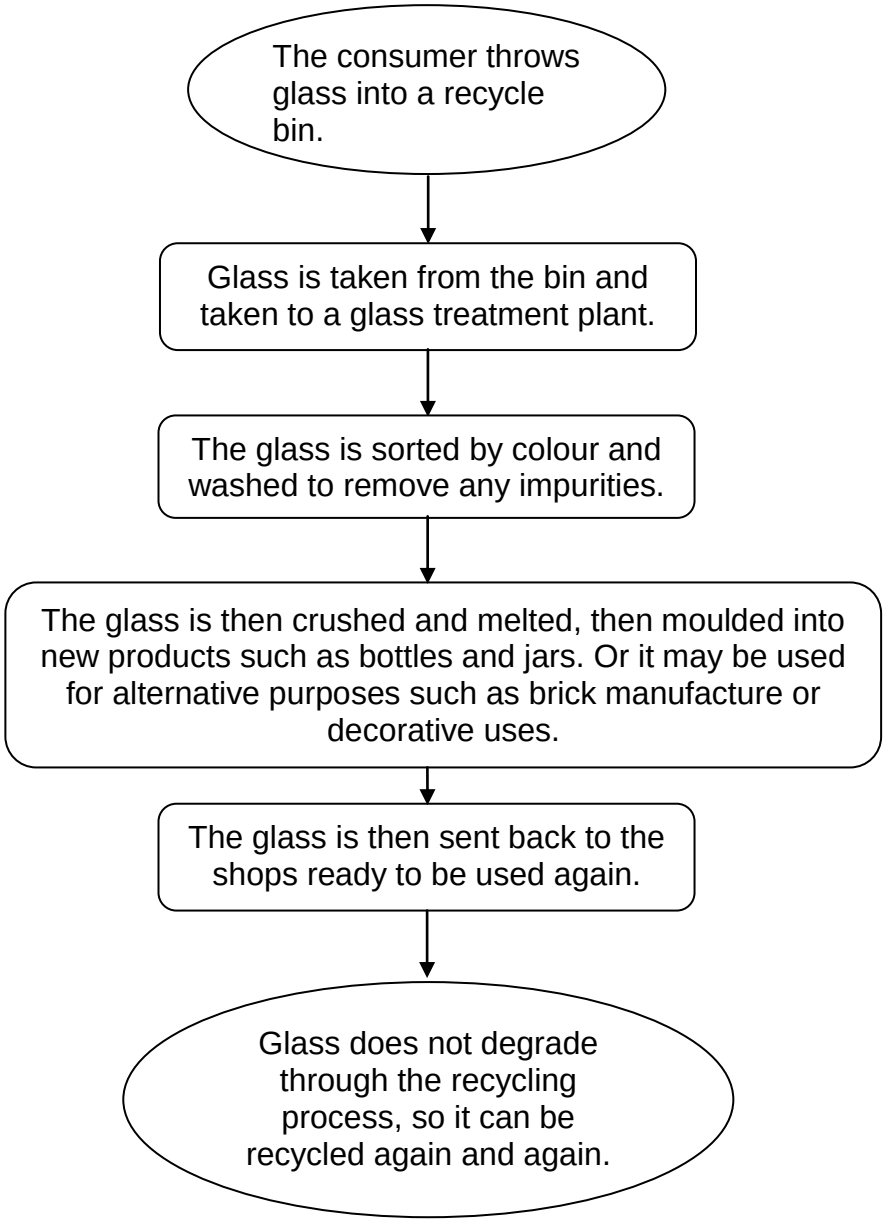

Figure 2.4: Flow chart for glass recycles process

From figure 2.4 we can see flow chart of the glass recycling process that had been done in Europe. The recycle process is started went consumer throw the glass bottle into bins located near consumer location. This bins location is depend on the supply chain design by the management. Some of this supply chain contain loop retailer that sell the glass bottle and consumer, the buyer of

the product. Then the glass is taken from the bin and taken to the treatment plant. Glass is taken from the bin by using transport such as lorry. The glass is pick up manually and the sorting the glass according to the glass color. This process done because went it come to the treatment, glass different color cannot be mix because of their different properties. After the glass is being sort, it will be wash to remove any impurities. The impurity is an obstacle to the none identifies object fail the recycle process. When it had been clean and sorted, the glass is being crushed and melts. The glass is melt to form a new shape. To form the shape it then moulded into new products such as bottles and jars. Beside the melt glass is being use as the glass bottle some of this being made or used for alternative purposes such as brick manufacture or decorative. Then the finish product of the glass is ready to be brought to shop again and sold to the consumer. This recycle process of glass is can be repetitive because glass does not degradable during recycle process. So glass can be recycling again and again.

2.2 Reward System

Most of businesses in the world are not running by volunteer, every employee is working in the company want something for the effort. So something needs to be done to compensate employee such as reward, bonus and higher salary. This concept is also same as the system apply in the all activity done such as recycle glass bottle. With the reward as the encouragement to support every activity done.

Reward also used to be called “pay” and then became “remuneration” is today often termed “reward”. It refers to all of the monetary, non-monetary, and psychological payments that an organisation provides for its employees (Koala, 2008).

Some of the reward system is not use only as a payment but it also can be the attraction to the others to doing very good job, appreciate the good performance and to maintain commitment to the organization. Reward as the

attraction is to attract and retain suitable employee to the company. It also can be use to develop spirit between employee to do a good job. By having reward also can maintain and improve performance for the worker. It because reward can motivate worker to compete with other worker to improve working performance.

Performance-related pay is very popular in today's organisations. In Canada, over 70 per cent of companies offer it in some form. Some companies have three different kinds of performance-related pay: individual, team, and organisation (Koala, 2008). With the reward system, it can serve to maintain strengthens and value of teamwork.

2.2.1 Type of Reward System

Many managers in the organization believe that people work in the company for reward. But there are two type of reward system.

There are *extrinsic rewards*, which cover the basic needs of income to survive (to pay bills), a feeling of stability and consistency (the job is secure), and recognition (my workplace values my skills). In Maslow's Hierarchy of Needs, these are at the lower end. We could also call these the financial rewards (Koala, 2008).

On the other hand, there are *intrinsic rewards*, the most important of which is probably job satisfaction, a feeling of completing challenges competently, enjoyment, and even perhaps the social interactions which arise from the workplace. These are at the upper, self-efficacy end of the need hierarchy. We could also call these psychological rewards (Koala, 2008).

There a direct and indirect pays by the company to the employee. Direct pays is what the employee receive in their account bank or cash such as salary, overtime, and bonus. Indirect pays is also known as benefit such as insurance, company car and health care. In Europe and North America, the government has a very strong influence over employee reward. Taxes reduce the size of the

direct pay received by employees. Yet even indirect pay can be taxed: in some countries, such as Finland, the tax on benefits such as company cars is so high, that many employees who qualify for them prefer to opt out (Koala,2008).

2.2.2 Deposit Refund System

A deposit refund system shifts the responsibility of controlling pollution, monitoring and enforcement to individual producers and consumers by charging them in advance for the potential damage (Panayatou,1995). Deposit refund system can be apply in the every sector either involve manufacturing or non manufacturing. From handbook of economic instrument for environmental management Malaysia, some study had been done in the Cameron Highlands most farmers just throw away used pesticide containers on their farms or bury them. The 20 litre containers are often used to store water to mix and dilute pesticides. The study involve two option for the working group for this pilot project, first is a cash based system and second is a voucher based system.

Table 2.1: Comparison between cash based and voucher based systems

Cash-based system	Voucher-based system
Allows farmers to redeem used containers for cash.	Removes cash from the deposit-refund system and replaces it with a voucher.
Requires consistent practice by all retailers/sellers to be successful. Dishonest retailers can take advantage of the new system, as cash is involved, especially at the start of its implementation.	Can be implemented in a clear-cut manner with new containers clearly marked with a voucher label. Hence, the start date is irrelevant as new containers are easily distinguishable.
When fully functioning, it involves farmers and retailers. Manufacturers are not affected.	Affects the manufacturer, because vouchers have to be attached to containers.

From table 2.1, it shows comparison between cash based and voucher based system for the reward given to the consumer. Before decision is made, two dialogue sessions were held between WG and farmer in Cameron Highlands included lecturer and discuss about risk of excessive pesticide use, the problem with containers being indiscriminately dispose and usefulness of economic approaches in solving this problem. The second dialogue discuss about agreement to establish a pilot project for a deposit refund system for used pesticide containers for a one year period. The reason why Cameron highland is selected as the pilot project is because it geography and suitable location, which is can be control and administered. It also the mapping area that provide detailed sitting of the retail outlets, storage facilities, lorry transport structure and logistic related issue such as collection and storage sites. In economics, property rights refer to a bundle of entitlements, privileges and limitations defining an owner's rights to use a resource as ownership rights (Tietenberg 1998).

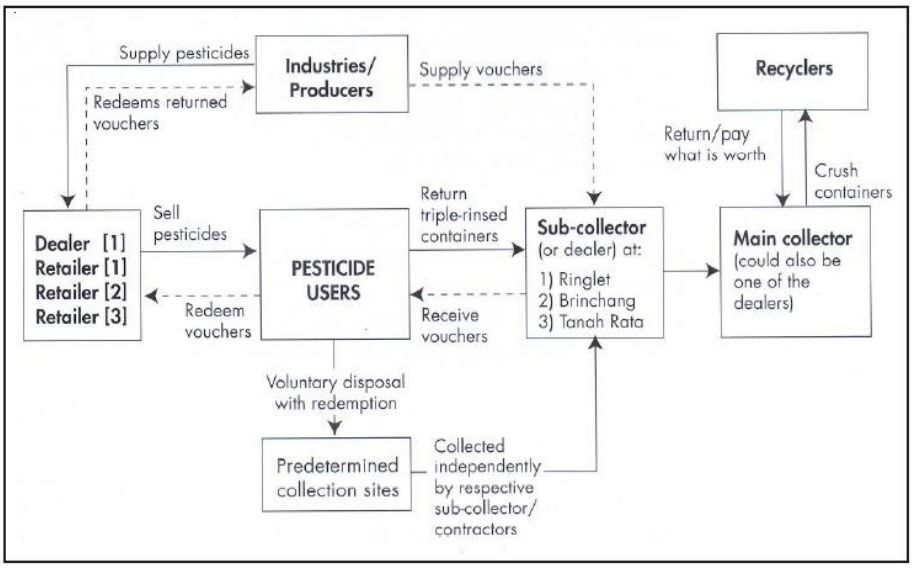

Figure 2.5: Loop for voucher based system

After some recommendation WG had decide to apply voucher based system as the deposit refund system. The loop of this system is as shown in figure 2.5, through this system retailer in Cameron Highland, discount is given for the next purchase when the voucher was redeemed. The value of the voucher is depending on the size of the purchase item. Three value of redemption were recommend (Economic Unit Planning, Malaysia, 2004), RM1, RM 2 and RM 4.

Size of plastic container	Value (RM)
> 4 litres	4
> 1 litre	2
1 litre and below	1

Figure 2.6: Payment per size of container

Base on figure 2.6, three value of recommended, RM 1, RM 2 and RM 4. But the value is decided with a RM 1 value. Then the manufacturer prints this voucher. With this voucher, consumer will redeem it with one brand of product

and cannot exchange the brand when redeem it. Hence, this system also gives profit to the manufacturer because it can be turn into a loyalty programme.

Table 2.2: Before and after of the deposit refund implementation

BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION
A) THE SUM NEEDS TO BE SUFFICIENT HIGH TO MAKE IT WORTHWHILE FOR CONSUMER TO RECYCLE. B) FARMER THROW OUT CONTAINER OR BURY CONTAINER IN THEIR FARM. C) NO REWARD SYSTEM APPLY TO ENCOURAGE CONSUMER TO RECYCLE.	A) WHEN THERE IS LOW NUMBER OF BOTTLE RECYCLE CAN BE DONE. B) CONTAINER IS RECYCLE AND NOT POLLUTE ENVIRONMENT. C) THERE ARE SYSTEM ESTABLISH KNOW AS VOUCHER BASED DEPOSIT REFUND SYSTEM.

The deposit-refund system is widely applied in European countries. In Denmark, the sale of beer and carbonated soft drinks is only permitted if they are packaged in containers that can be either refilled or recovered. These systems have been successful and the return rate is estimated to be as high as 99 per cent for beer and carbonated soft drink containers, 90 per cent for wine and spirits' containers, and 65 per cent for all other glassware. These make up about 20 per cent of municipal waste collected from households (COWI A/S, 1999).

The deposit-refund system is used with success in Taiwan. All manufacturers of PET bottles must submit a recycling and disposal plan to municipal authorities. Industry members formed a foundation to administer a joint recycling fund to cover the costs of collecting and recycling the bottles. The funds are replenished from a levy on the sale of bottles (Panayatou, 1996). The programme accomplished a recycling rate of 41 per cent by the third year and 80 per cent by the fourth year. The use of other packaging not only destroys

the competitiveness of glass bottles, it also undermines the objectives of the deposit-refund system. Therefore, the design of the economic instrument.

The UK recycling rate for household waste stood at 15% in 2003 (DEFRA, 2003) and increased to 27% by 2006 as a result of initiatives by local authorities such as the establishment of practical recycling schemes. In order to develop the infrastructure for the collection of recyclates, the HouseholdWaste Recycling Act (2003) placed a duty on English local authorities to provide a collection of at least two types of recyclable waste from every household by 2010 (C.D.H. Wilson, I.D. Williams,2007). However, because recycling is a voluntary activity, several authors have highlighted that the success of local authority recycling programmes is dependent upon public participation, e.g. McDonald and Ball (1998a,b), Tucker et al. (1998), Read (1999),Williams and Kelly (2003), and Williams and Taylor (2004). Other studies show although that existing recyclers are most likely to support new recycling schemes (Burnley and Parfitt, 2000; McDonald and Ball, 1998a, b), they still require successful education and awareness rising programmes to participate effectively and maximise diversion rates (Evison and Read, 2001; McDonald and Ball, 1998a, b; Thomas, 2001). In the UK, a range of techniques are used to encourage households to participate in recycling; a detailed review of approaches taken has recently been published (Martin et al., 2006).

2.3 Mechanism of Collecting Glass for Recycle

Collecting solid waste is crucial part of a plan for solid waste management. There are many type of solid waste disposal such as glass, paper, can and box. In Unites State, collection start with the containers holding materials that a generator has designated as no longer useful (solid waste and recyclables) and ends with the transportation of solid waste or recyclables to a location for processing, transfer and disposal (H.Theisen,2004).

The term collection includes not only the collection of solid wastes from the various sources, but also the hauling of these wastes to the location where

the contents of the collection vehicles are emptied and the unloading of the collection vehicle (Tchobanoglous et al., 1993). The principle types of collection service that are now used at United State are commingled (unseparated) waste and source separated wastes. All the summarize in table 2.3 (H.Theisen, 2004).

Table 2.3 : Typical collection service for comingled and source separated solid waste

Preparation method for waste collected	Type of service
Commingled wastes	Single collection service of large container for commingled household and yard waste Separate collection service for (1) commingled household waste and (2) containerized yard waste Separate collection service for (1) commingled household waste and (2) noncontainerized yard waste
Source-separated and commingled waste	Single collection service for a single container with source-separated waste placed in plastic bag along with commingled household and yard wastes Separate collection service for (1) source-separated waste placed in a plastic bag and commingled household waste in same container and (2) noncontainerized yard wastes Single collection service for source-separated and commingled household and yard wastes using a two-compartment container Separate collection service for (1) source-separated and commingled household wastes using a two-compartment container and (2) containerized or noncontainerized yard waste Separate collection service for (1) source-separated waste and (2) containerized commingled household and yard wastes Separate collection service for (1) source-separated waste, (2) commingled household waste, and (3) containerized yard wastes Separate collection service for (1) source-separated waste, (2) commingled household waste, and (3) noncontainerized yard wastes

There are various type of collection done in US, some of the system for collection solid waste are low raised detach dwelling. This system is apply include at alley, curb, setout, back yard, and setout setback.

Manual method still being apply in US, according to (H.Theisen, 2004) manually method commonly use for collection are direct lifting and carrying of loaded containers to the collection vehicle for emptying, the rolling of loaded containers on their rims to the collection vehicle for emptying, containers equipped with wheels to the collection vehicle for mechanically assisted emptying and the use of small lifts for rolling loaded containers to the collection vehicle.

Before this method is apply, in the past the system are using large container or drop cloths into which is small container before drop it into the collection vehicle.

Figure 2.7: Worker drop solid waste into side collection vehicle

Figure 2.8: Worker drop solid waste into rear collection vehicle

From figure 2.7 and 2.8 shows that worker drop solid waste into collection vehicle manually. By using this technique, the process need to use

two and three person crew for collection waste in many parts of the United States.

Some of the common vehicle use in the United States as the collecting vehicle shows in figure 2.8. There various type uses depend on it capacity and capability.

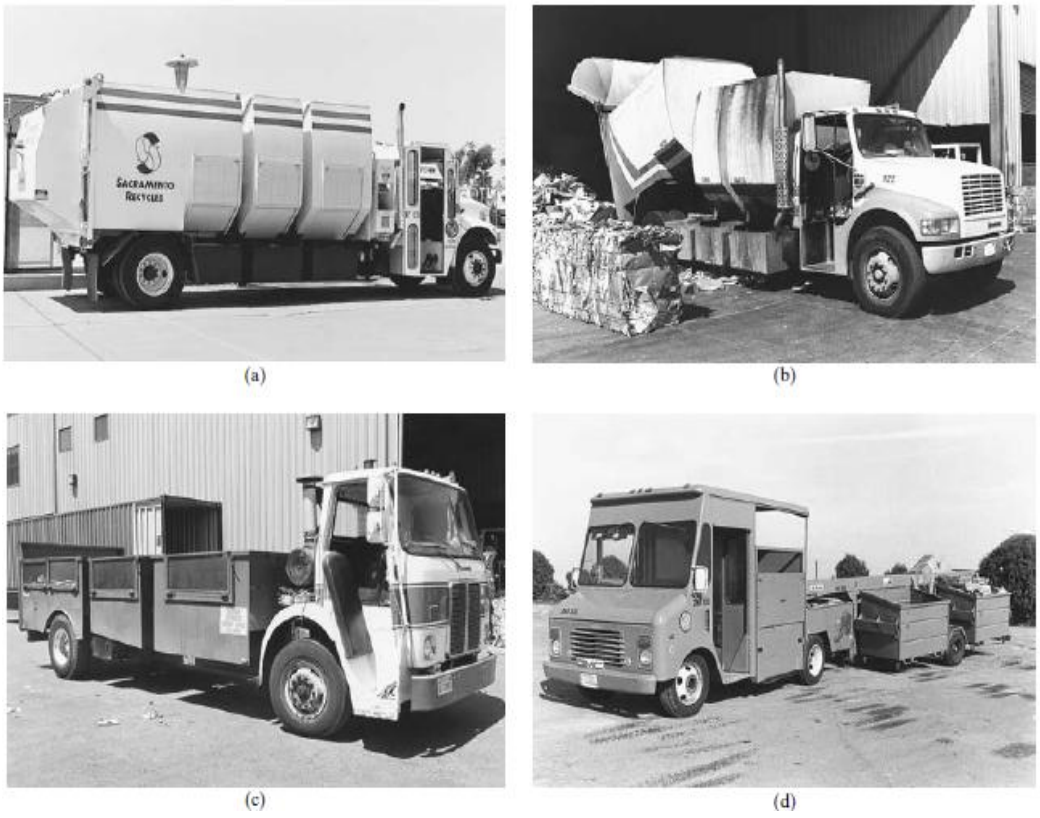

Figure 2.9: Common collecting vehicle use in the United States

From figure 2.9 shows typical collection vehicle use to collect solid waste in the United States. For picture a shows stand up right hand drive side loaded collection vehicle with three separate compartments, using low collection through that are emptied mechanically. For picture b shows that right hand drive open side loaded collection vehicle. For picture c shows stand up right hand drive side loaded collection vehicle with three low loading height compartments. For picture d shows stand up drive collection vehicle with mobile containers. When the containers are filled they are emptied by using forklift.

Table 2.4: Characteristic of vehicle used for collection of waste separation at source

Item	Comment
Standard packer trucks	Packer trucks used for waste collection can also be used for collection of recyclables. Many communities use packer trucks in their recycling programs. Rear-loading packers have been used for newspaper, cardboard, and magazines with trailers attached to them for cans and glass. Front-end loaders have been used to service large containers containing newspaper recovered from apartment buildings. Some cities use side- and rear-loading packer trucks to pick up newspaper one week and glass and cans the following week. When collecting glass and cans, the compacting mechanism is not used because glass is highly abrasive and would damage the packer plate. Also, by not compacting, the majority of the glass remains unbroken and is, therefore, easier to sort into different colors at the processing site.
Closed-body recycling truck	This truck consists of an enclosed steel body installed on a lowered truck chassis, and a low-entry walk-in cab with dual left- and right-hand driving controls (allowing one-person operation). Adjustable hinged dividers on the body can be used to create from two to four compartments for different materials. One or both sides are opened for manual loading. Removable aluminum side panels are used to contain the load as the level of material rises. The overall capacity of the truck can range from 27 to 31 yd^3, although operational capacity when manually loading is 20 to 25 yd^3. The truck is equipped with a front-mounted telescopic hoist and rear body hinge for dumping. Each compartment is discharged separately by opening the rear door, unlocking the appropriate divider, and tipping the body.
Mobile container system	The mobile container system is essentially a steel frame with sets of hydraulic forks that can be used to transport large bins. The number of bins on a trailer range from three to six, and have a low-pull or gooseneck (fifth-wheel) style. To load the trailer, the forklifts are lowered to the ground and the bins are wheeled over them so that the forks slide into channels on the underside of the bins. The bins are then hydraulically raised and secured to the trailer frame. An empty set of bins can be left to replace the full ones. A pickup truck is used to pull the trailer.
Modified flatbed truck	Some curbside programs use a standard flatbed truck with a hydraulic dumping box mounted on the truck bed. The box is usually divided into three or four compartments and has a standard capacity of approximately 15 yd^3.
Open-bin recycling truck	The open-bin recycling truck is a specially designed vehicle with two or three open-top, self-dumping bins. Source-separated wastes are emptied into low-mounted troughs, which are emptied mechanically into the open bins. The front bins are typically 6 to 8 yd^3 and can be specified to unload right or left. The back bin, which dumps to the rear, has a capacity of 10 to 12 yd^3. The cab can be designed for right-hand stand-up drive to allow the loading function to be performed by the driver.

Source: Adapted from Tchobanoglous et al. (1993).

Table 2.4 shows that specialize characteristic of vehicle used for collection of solid waste in the United States. It shows that large container is empty mechanically not using manually technique. With this new technique number of worker can be reduce and work can become more efficient and faster.

In UK, there are also recycle collection scheme introduce by the government, these scheme include time for collection recycle item and mechanism to collect it. The mechanism are by using some form of alternate

weekly collection, particularly with wheeled bins, these mechanism becoming increasingly popular amongst UK local authorities; in 2004, 21% of all collection authorities in England used this type of service (CIWM, 2004). The reason why this mechanism is so popular to apply are local authority don not need to invest high for worker and vehicle since do not need to differ the waste according to it type such as glass, paper and others.

2.3.1 Practice for Mechanism of collecting Glass Bottle in Malaysia

In Malaysia, such practice like mechanism of collecting glass bottle is hard to be found. Because of this reason Kuantan municipal council had done a project specialize for collecting glass bottle in all Kuantan area. On 9 November 2007 and 8 April 2008 meeting was conduct involve glass collector such as Alam Flora, Tzu Chi, Kuantan Coffee Shop Association, and Industrial Association of Pahang to establish glass collecting program.

As the project run along the time, the mechanism use to collect the glass bottle is by manually. Due to the expansion for the existing recycling unit, MPK hiring a driver and a truck also was made available for the programme. The mechanism use for collecting are once every fortnight, the glass collection team visited each side to collect the glass. As picture shown in figure 2.10

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Figure 2.10: Glass collection team visited site to collect glass

The collection was divided into 2 half-day collection rounds where the glass from approximately 27 bins was collected per collection round (MPK, 2009).

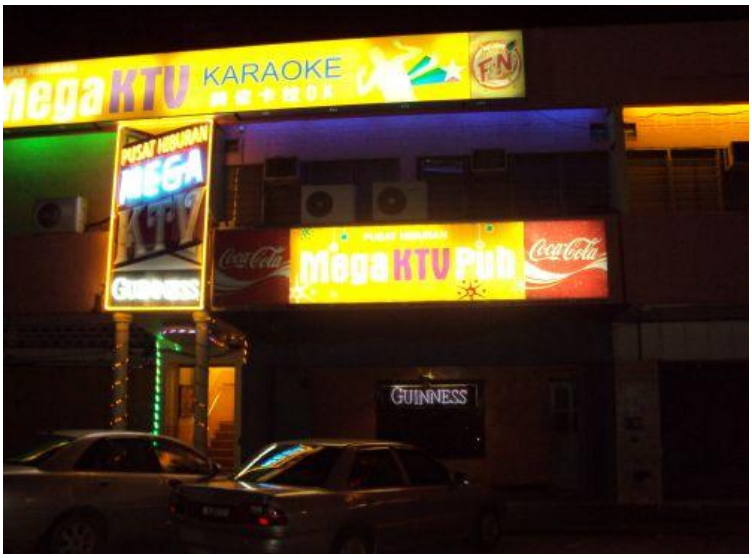

Figure 2.11: Place visited by glass collection team

Businesses such as restaurants, pubs and coffee houses. A total of 18 restaurants, bars and coffee houses along 4 selected streets (Jalan Kubang Buaya, Jalan Wong Ah Jang, Jalan Air Putih and Jalan Alor Akar) have participated in the trial collection (MPK, 2009).

Figure 2.12: Glass transfer to MPK collection centre

After all the glass is collected from collection area, it then transfers to MPK collection centre by using lorry as the main transport.

Figure 2.13: Crushing process by using crusher machine

After the glass is collect at the collection centre, the glass then crush by the machine to make it easy to store. The staff used 2 hours to crush the glass per half day collection. 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. Throughout the operation, the workers were equipped with protective gears such as rubber boots, masks, goggles, gloves and ear protectors (MPK, 2009).

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CHAPTER 3

METHODOLOGY

3.1 Project Flow Chart

Methodology is a process to identify method and the feasibility of the study, fabricate and analysis of the glass recycling process from the first process until the last process. Stated below are several processes that need to be done to develop mechanism for collecting glass and reward system.

From the flow chart, refer to the figure3.1; this project is started with design circuit and reward system. In the design circuit and design reward system, an electronic system is developed to detect weight of glass that will be recycled. After it is being identified by the sensor, the information is converted into electrical signal and transfer to the computer programming to be converted into variable. This variable will be changed into the bonus point according to the survey done at selected area. This point will go to the reward centre and be kept as the data storage in the main computer at MPK. The purpose of this activity is to create a reward system that can give benefit to the consumer and encourage consumer to recycle glass often.

After the design experiment and reward system is done, the circuit is build and being test to see it functionality. The result from the experiment will be analyzed. The data analysis is done by comparing the actual weight of the glass

bottle with the data produced by the computer programming. The data produced by the computer must be the same as the actual data in order to prove the data collected by the computer programming through the sensor is correct. If the analysis is successfully done, the result will be concluded and all of the activity done is summarized. On the other hand, if the result of analysis shows error or any significantly different between the weights, then the analysis needs to be done again in order to find the cause of error.

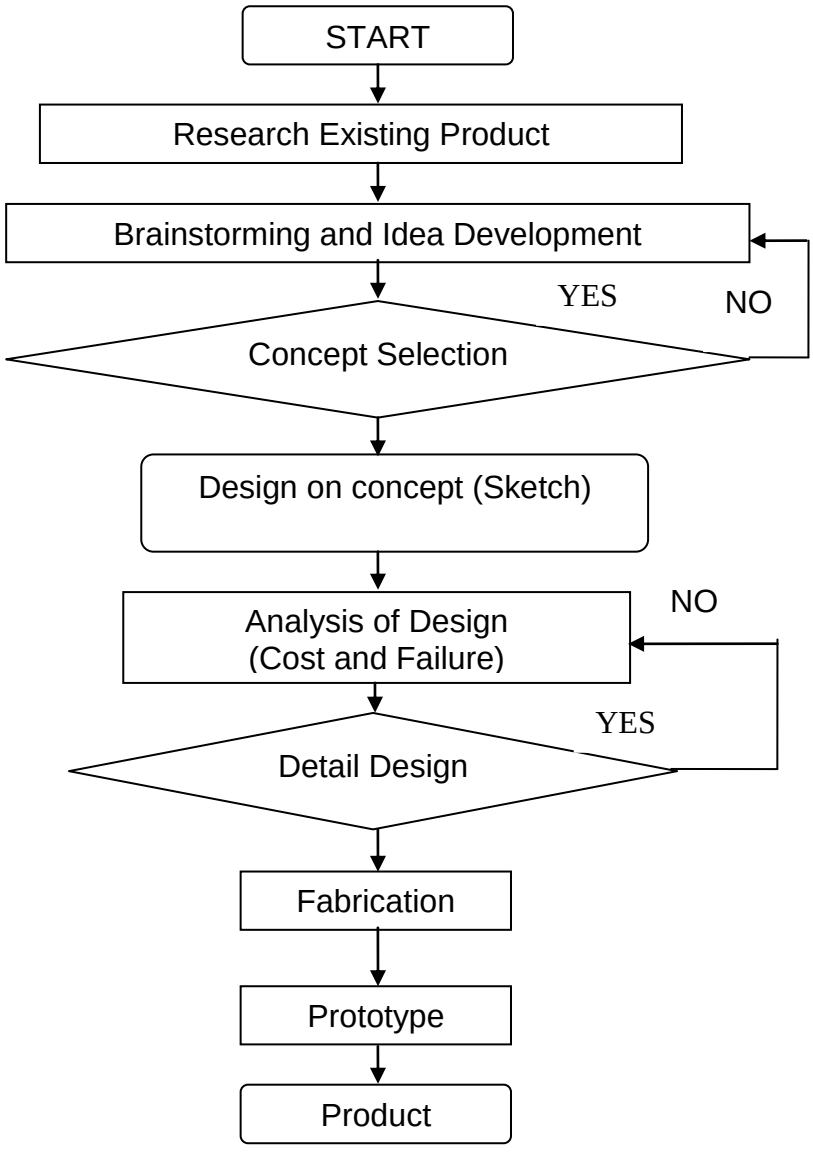

Figure 3.1: Project Flow Chart

3.2 Interview With MPK

From the literature finding, MPK already did some research and project about glass recycling at the Kuantan area. The project also included target group, method or mechanism to collect glass from public area and private area. Based on this information, an interview is made with Tuan Haji Mohamed Amran Bin Mohamed Yasin (PEN. PEGAWAI KESIHATAN PERSEKITARAN) Kuantan Municipal Council. Several questions are asked during this interview:

i) To know the current status of glass recycling process in Kuantan area. According to table 3.1, glass recycle is collected only by MPK after Alam Flora stop collecting glass bottle.

Table 3.1: Current status for glass recycling in Kuantan

BEFORE INTERVIEW	AFTER INTERVIEW
COLLECTED BY ALAM FLORA, MPK	COLLECTED BY MPK

ii) To know how the mechanism being applied in the whole project to collect glass bottle for recycle, whether by using traditional method or machine. According to table 3.2, glass recycle is collected using traditional method by MPK and Alam Flora.

Table 3.2: Mechanism to collect glass recycling in Kuantan

BEFORE INTERVIEW	AFTER INTERVIEW
TRADITIONAL METHOD	TRADITIONAL METHOD

iii) To know if there are reward system is applied when MPK collect glass bottle from consumer. According to table 3.3, there is no reward for each glass recycle collected by MPK and Alam Flora.

Table 3.3: Reward for recycle glass in Kuantan

BEFORE INTERVIEW	AFTER INTERVIEW
NO REWARD	NO REWARD

Figure 3.2: Interview with MPK Representative

3.3 Design Concept

To design a good mechanism, there are several factors must be considered before designing the mechanism. The factors are concluding all aspect of the principle in the design. The factors are:

i) Ergonomic : The mechanism must be friendly use in the society, easy to use
ii) Strength : The strength of the mechanism can support maximum 3 kg glass weight.
iii) Material : The material used to fabricate for this product can be found in the market.
iv) Cost : The cost of the material and process must be reasonable.
v) Environment : This product must be suitable to use at all places

such as house, laboratory, market, industrial, and school.

3.4 Drawings Concept

The drawing concept for this mechanism can be divided into two categories. The categories are:

i) Sketching : Firstly, the new product design will be sketch roughly on the paper because it is easy to modify the idea. After sketching process is done, one new design will be chosen by using the Pugh concept.

ii) Schematic drawing : After the sketching and concept selection, the design will be converted into schematic drawing. In this drawing conclude complete circuit combination, type of material use, and others.

3.5 Sketching And Concept Selection

In the sketching and concept selection discuss about type of concept generation idea trough sketching. Besides that, it also discuss on how the selection of concept generation trough Pugh concept selection.

3.5.1 Concept A

There are many advantages of using electric and electronic mechanism for the recycle machine. Firstly, data is measured by weigh scale and can be stored automatically besides, can be use as bonus point, less weight of part using for mechanism, and can be used in small area.

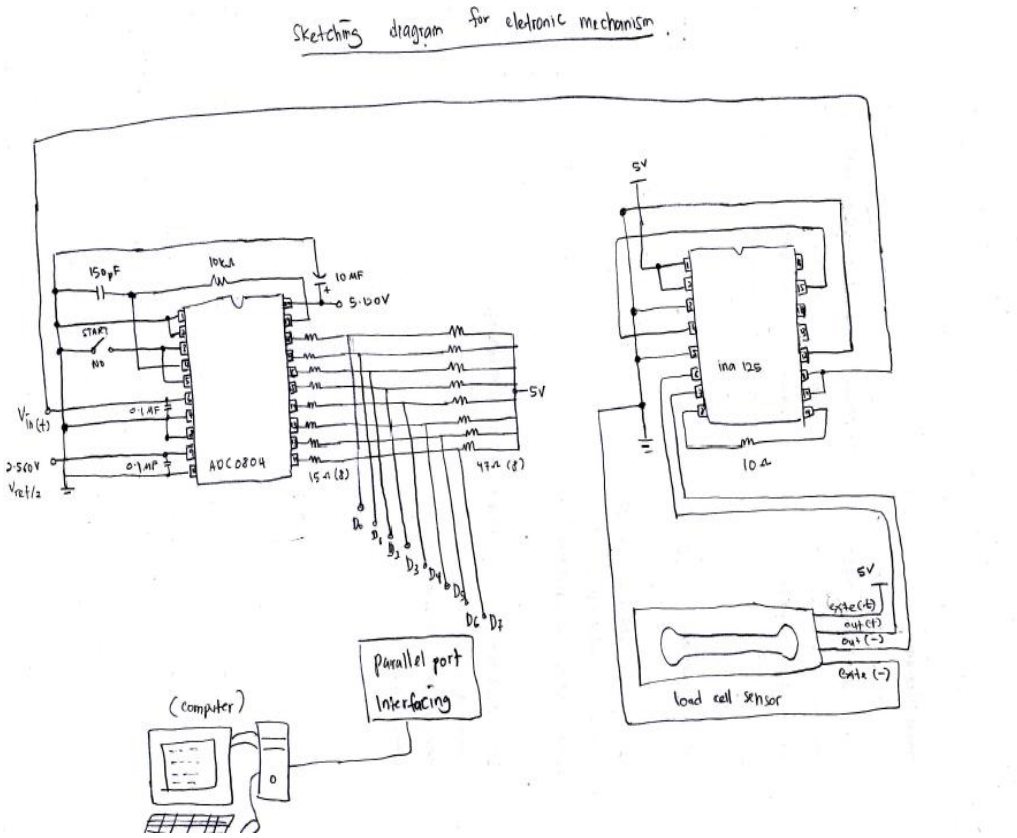

Figure 3.3: Electric and electronic mechanism

3.5.2 Concept B

There are many advantages of using mechanical mechanism for the recycle machine. Firstly, it is easy to design the mechanism and easy to assemble besides, can be used in small area.

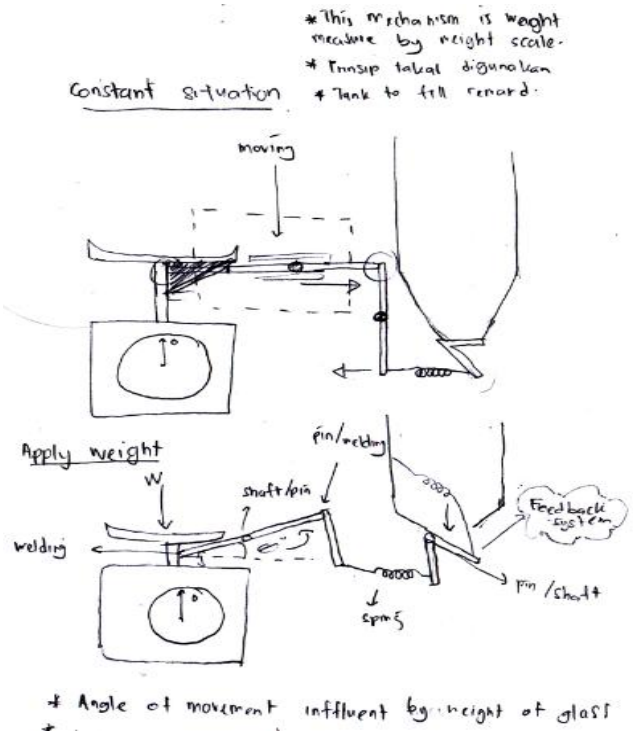

Figure 3.4: Mechanical mechanism

3.6 Concept Generation and Selection

After brainstorming process, several types of concept had been choose to be alternative choice for the recycle machine mechanism and reward system. The concepts are:

i) Electrical mechanism

This electrical mechanism can be defined by design the mechanism through electric and electronic point of view. For this mechanism the design is more focusing on using sensor to scale the weight of glass and transfer into computer programming data. Some of the suggestions are single point load cell to measure weight of glass, analog to digital converter (ADC) and amplifier (OP AMP).

ii) Mechanical mechanism

In this mechanical mechanism, the design of the mechanism is through the mechanical base function. The mechanism is designed through the sketching and the main of the objective of the mechanism is to scale glass weight and produce reward after scale process.

Table 3.4: Pugh Concept

	CONCEPT		
CRITERIA	**A**	**B**	BEST CONCEPT
MEASURE WEIGHT	****	***	**A**
RESTORE DATA	*****	*	**A**
MANUFACTURING EASE	***	****	**B**
STABILITY	****	***	**A**
STRENGTH	***	****	**B**
LOADED MAXIMUM 3KG	*****	***	**A**
REWARD SYSTEM	****	***	**A**
EASE TO HOLD	***	****	**B**

VERY GOOD	*****
GOOD	****
MEDIUM	***
POOR	**
VERY POOR	*

CONCEPT	A	B
TOTAL	5	3
RANK	1	2
SELECT	√	**X**

3.7 Concept Applied

This project developed a mechanism for glass recycle collection with redemption system and is applied in the concept one piece flow. One piece flow is a concept to move one part at a time, in between operations at the work place. This process can improve time of process and safety while operate this recycle machine. In the recycle machine, one piece flow concept is applied when consumer needed to fill the glass bottle by one bottle per time in the recycle machine and to make sure it weight is calculated before the process is repeated by consumer. This can ensure safety and long life for recycle machine.

From table 3.4, the chosen concept for this project is electric and electronic mechanism. The comparison done in the table 3.4 showed that electric and electronic mechanism is more suitable to achieve the objectives of this project which are to design mechanism for glass collection machine that can calculate glass weight, to develop machine that will be part of the glass recycle machine, and to develop calculation system that calculate solid glass weight and for reward.

There are many advantages to design a redemption system for glass recycle machine by using electric and electronic mechanism. It contains information about how the system will process accordingly. The system function is to recognize and then classify it into each category such as 500 mL, 1500 mL and follow the three main objectives that are discussed in this project.

3.8 Raw Material Use

The main material used in this project is single point load cell or weight detector. Circuit and computer programming software are important in order to make this device function well.

3.8.1 Bill of material for design electronic circuit

For the overall material used in the project are showed in the Table 3.5. All of the material use in the project is available in the market and easy to find. This table also indicate the function of each component.

Table 3.5: Bill of Material and It Function

i) List of Component Required.

No.	Component/part	Description	Qty	Price
1	Resistor 15 Ω	Power rating: 0.5 W	10	RM2.00
2	Resistor 47 Ω	Power rating: 1 W	8	RM2.00
3	Resistor 1k Ω	Power rating: 0.5 W	10	RM1.50
4	Resistor 1.5k Ω (5k Ω)	Power rating:0.5 W	2	RM0.30
5	Resistor 10k Ω	Power rating:0.33 W	1	RM0.12
6	Capacitor 10µ F	Available in lab	3	RM3.00
7	Capacitor 0.1µ F	Available in lab	2	RM2.00
8	Capacitor 150p F	Available in lab	1	RM1.00
9	Switch	Detector	1	RM3.00
10	OP-amp INA123	Wide supply range : single supply :2.7v-36v	1	RM70.00
11	ADC0804	No. of Pins: 20	1	RM14.00
12	Single Point Load Cell	Load capacity: 3kg	1	RM900.00
Total				RM998.92

ii) List of Equipment Required.

No	Equipments	Description	Qty	Price
1	Circuit Board	Available in lab	2	RM40.00
2	Probe(pair)	Available with oscilloscope	2	
3	DC Power Supply	Input:15v, Output:15v	1	
4	Parallel Port	Available in lab	1	RM50.00
5	Multimeter	Available in lab	1	
6	Oscilloscope	Available in lab	1	
7	Load Cell Holder		1	RM50.00
Total				RM140.00

Total cost needed: RM1138.92

All of these material are important to develop electronic circuit that can run single point load cell. The electronic part is joined by using protoboard. Other component is attached to the board by using solder and connected to the parallel port to read output produce by load cell.

3.9 Electric and Electronic Mechanism

This mechanism is created as weight detector sensor to measure weight of the glass and transfer data into C programming. In this study, it focus more on creates a measurement for weight scale. The steps to create the weight detection unit are shown in figure 3.5.

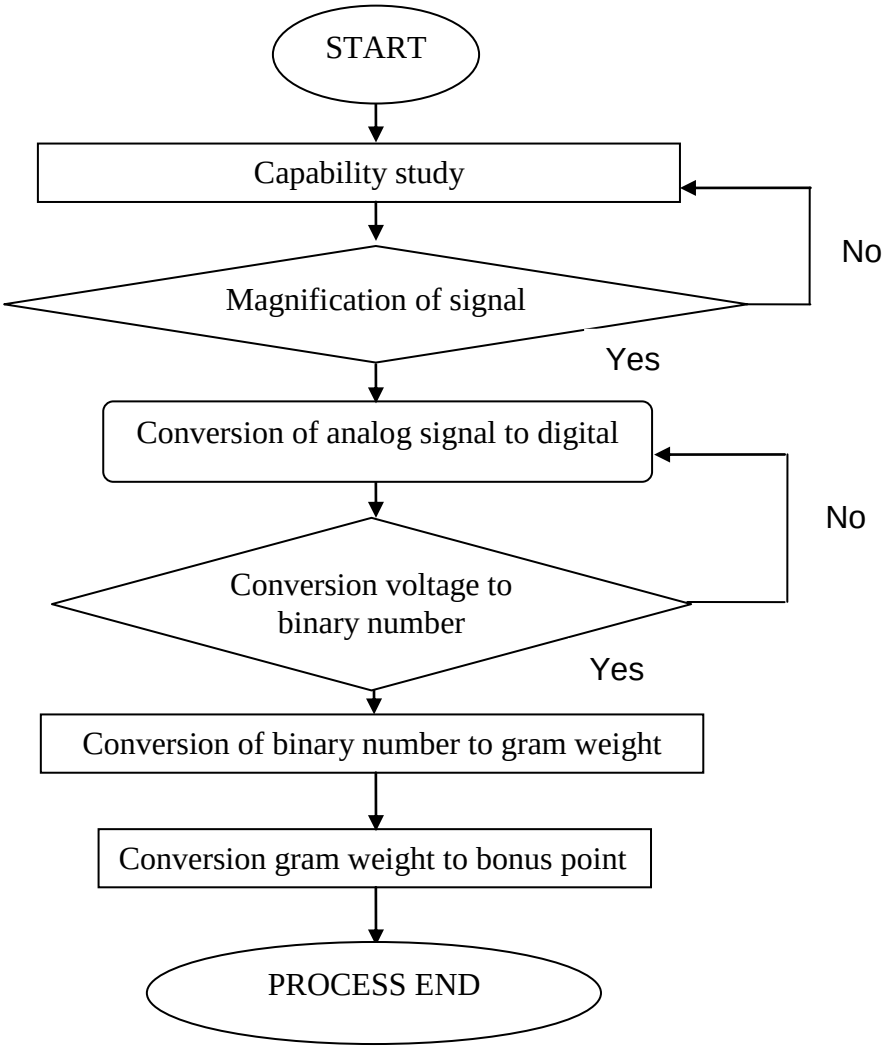

Figure 3.5: Flow process of electronic mechanism

The critical part of the electrical and electronic mechanism is magnification process and conversion voltage to binary number. It because if one of the part of the circuit cannot read the data given to the component, hole process of the circuit cannot be done. In order for the circuit to successfully function, the circuit must be correct and have enough voltage to activate the component function.

3.9.1 Single point load cell

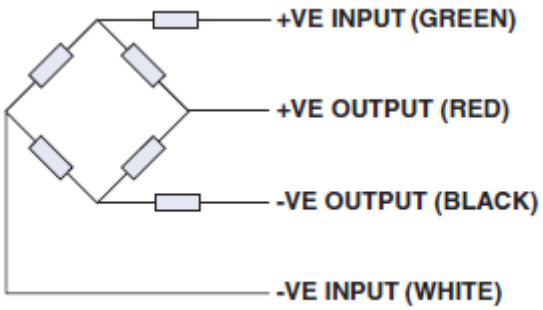

Figure 3.6: Wiring schematic diagram

Single point load cell is a transducer that is used to convert a force into electrical signal. The force being sensed to deform a strain gauge. The strain gauge converts the deformation (strain) into electrical signals. From figure 3.6, the electrical signal output is typically in the order of a few millivolts and requires amplification by an instrumentation amplifier. The output of the transducer is plugged into an algorithm to calculate the force applied to the transducer. Table 3.6 below shows the specification of single point load cell from supplier:

Table 3.6: Specification of single point load cell

Model	1004
Capacity	3kg
Calibration Mode	Compression
Input Impedance	415 +/- 20 Ohms
Output Impedance	350 + / - Ohms
Test Excitation	10 v

3.9.2 Operational amplifier

Operational amplifier is a high gain voltage amplifier. It has different input and has single ended output. The used of op-amp is to produce voltage large than given voltage. It gains voltage typically hundred thousand times larger than given voltage. The purpose of op amp is to enhance the magnitude of the voltage from single point load cell so the signal can be read by computer.

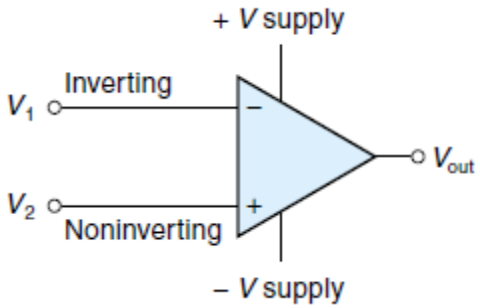

Figure 3.7: Op-amp symbol

There are many types of op-amp can be used to amplified voltage from low voltage to high voltage. The first way to do op-amp is to recognize the characteristic of op-amp that used because each of this op-amp has its own different function like shown in figure 3.7. There are many types of op-amp can be used such as:

i) Inverting op-amp

ii) Non inverting op-amp

iii) Summing amplifier

iv) Differential amplifier

In this project, type of op-amp use is differential amplifier. Since the single point load cell had two output which is output + and output -, it is suitable to apply differential amplifier. For this project type of amplifier use is INA 125. It had been selected because it use low power, high accuracy with a precision voltage reference.

3.9.3 Analog to digital converter

ADC is a device that converts an analog signal to digital number. ADC is stand for analog to digital converter. The ADC0804 is a CMOS 8-bit successive approximation A/D converter using a resistive ladder and capacitive array together with an auto-zero comparator. This converter is designed to operate with microprocessor-controlled buses using a minimum of external circuitry.

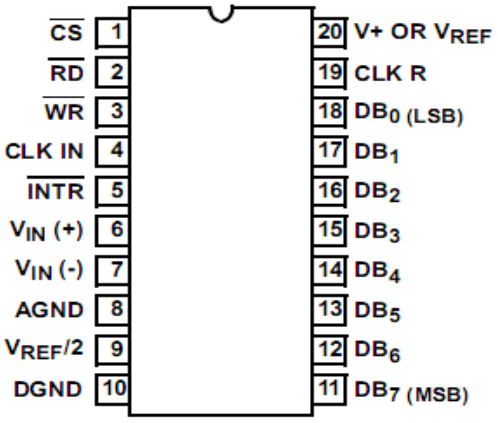

Figure 3.8: ADC 0804 symbol

For this project type of ADC use is ADC 0804. From figure 3.8 shows the function of ADC is to convert analog data receive from op-amp into digital data. ADC circuit design in this project is personal by using eagle software and printed circuit board (PCB) drilling machine. Detail parameter for ADC is shown in table 3.7.

Table 3.7: ADC0804 parameter

PARAMETERS/ VALUES	**ADC0804**
RESOLUTION	8 BITS
INPUT CHANNELS	1
INTERFACE TYPE	PARALLEL
DIFFERENTIAL INPUT	YES
MAX SAMPLE RATE	10 KSPS
MIN SUPPLY VOLTAGE	4.5 VOLT
MAX SUPPLY VOLTAGE	6.3 VOLT

REFERENCE SOURCE	EXTERNAL
TEMPERATURE MIN	-40 DEG C
TEMPERATURE MAX	85 DEG C

3.9.4 Conversion of analog signal to digital

Any real-world device can be interface to the controller for control purposes. In general, there are three types of controller devices, personal computer (PC), microcontroller and programmable logic controller (PLC). In this project, PC is use as the controller. In computers, ports are used mainly for two reasons first are as device control and second as communication. Parallel ports are mainly meant for connecting the printer to the PC. Parallel ports are easy to program and faster compared to the serial ports. But main disadvantage is it needs more number of transmission lines. Because of this reason parallel ports are not used in long distance communications. Basic difference between working of parallel port and serial port is in serial ports, there will be two data lines, one transmission and one receive line. To send a data in serial port, it has to be sent one bit after another with some extra bits like start bit, stop bit and parity bit to detect errors. But in parallel port, all the 8 bits of a byte will be sent to the port at a time and an indication will be sent in another line.

3.10 Software Use

To complete the design of the circuit, software to read the output of the sensor is important. There are various type of software use nowadays such as Java and C programming. There are many advantages of this software, but this software can do the same function and can be used for this project.

3.10.1 Code Block Programming

Code block programming also known as C++ software. In this project C++ programme is mainly used because it is easy to learn and understand the output from single point load cell. Types of function use for reading the output produce from the single load cell are input and output and simple calculator program that can multiply number for total glass had been recycle.

In this project, computer programming is applied in almost all part such as to convert data from calculation into the bonus point and read output voltage from adc circuit. All the data collected at the programming will be transfer into the Municipal Council (MPK) and will be store at the main serve there. To determine whether to use cash or bonus point, it depends on the survey questionnaire done before.

3.11 Schematic Drawing

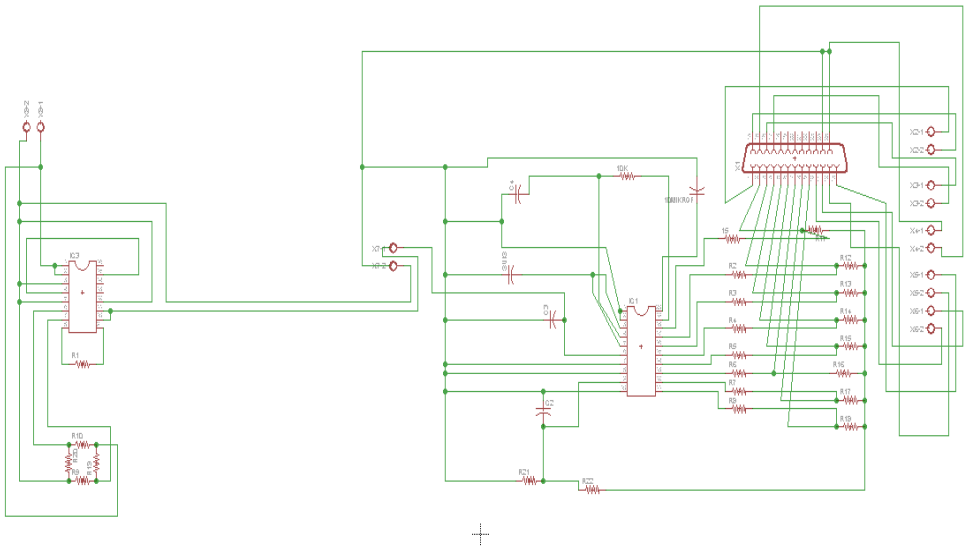

Figure 3.9: Schematic drawing circuit

From figure 3.9 shows that schematic drawing of single point load cell, amplifier, and analog to digital converter and conversion from gram weight to bonus point.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Final Prototype Mechanism

The prototype was finally fabricated. The step of fabrication for prototype is followed according to the project flow chart with capability study, magnification, conversion of analog signal to digital, conversion voltage to binary number, conversion of binary number to gram weight and conversion gram weight to bonus point

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4.1.1 Result of prototype product for weight detection unit

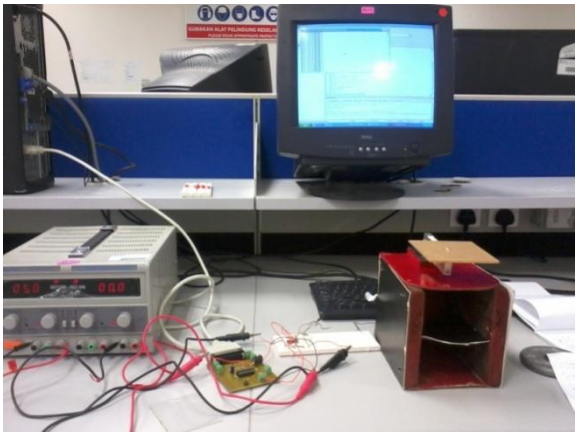

Figure 4.1: Prototype for the weight detection unit

From figure 4.1 showed a complete circuit for weight detection unit. This model is the prototype that contain single point load cell holder.

4.2 Testing, Result and Analysis

This process is done before the fabrication of circuit. The purpose of this testing is to find the accuracy and effectiveness of the part of the circuit that had been design during the fabrication process. Following the objective of the project; to design mechanism for glass collection machine that can calculate glass weight, to develop a weight detector unit that will be part of the glass recycle machine, to develop calculation system that calculate solid glass weight, and to convert the weight to reward.

4.2.1 Single point load cell

Single point load cell is a load measurement sensor. It is uses to measure weight by using deflection concept from force applied to its body. Every sensor had its own limitation and sensitiveness. To find either the sensor is in good condition or not, a capability study had been done according to the recommended test by the supplier which is bridge resistance test, leakage resistance test, and zero balance test.

4.2.1.1 Bridge resistance

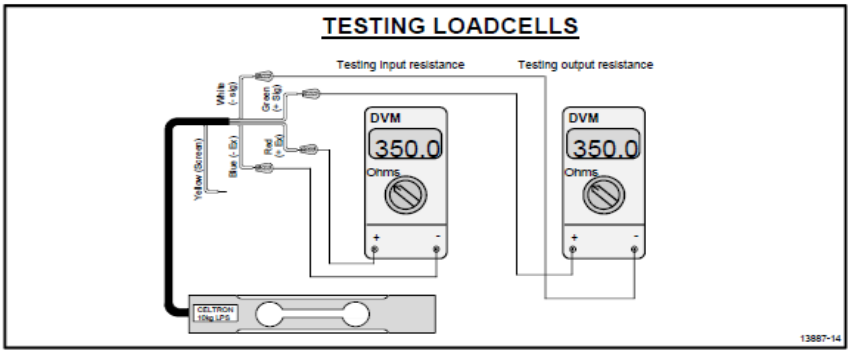

Figure 4.2: Bridge resistance test

The objective of this process is to obtain input and output resistance for load cell. The tolerance for both output and input must have equal value. If the tolerance is not equal, the load cell is damage and need replacement.

Table 4.1: Bridge resistance test to load cell

Input resistance (Ohms)		Output resistance (Ohms)	
Trial 1	292.6	Trial 1	293.3
Trial 2	292.7	Trial 2	293.3
Trial 3	292.1	Trial 3	292.8
Trial 4	292.2	Trial 4	292.9

From the test figure 4.3, all the result is collect and put into table 4.1. The result showed input and output resistance of the load cell is both equal and this showed that the load cell in good condition.

4.2.1.2 Leakage resistance

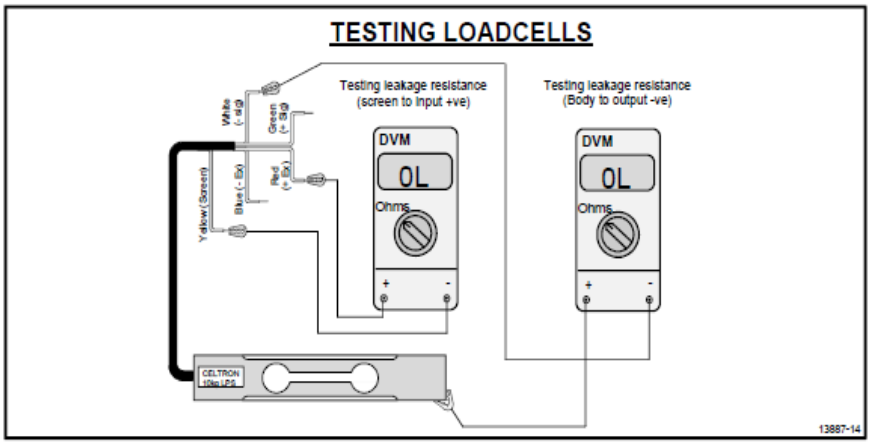

Figure 4.3: Leakage resistance

This process is done to ensure the reading should be greater than 1000 Ohms and to see if less load cell has leakage between the internal circuit and the body of load cell.

Table 4.2: Leakage resistance test to load cell

Input resistance (M Ohms)			Output resistance (M Ohms)		
Trial 1	→	O.L	Trial 1	→	O.L
Trial 2	→	O.L	Trial 2	→	O.L
Trial 3	→	O.L	Trial 3	→	O.L

From figure 4.3, all the result is collected and put into table 4.2. The result showed input and output resistance of the load cell is both larger than 1000 Ohms. O.L mean multimeter cannot read higher than 1000 Ohms and this showed that the load cell in good condition.

4.2.1.3 Zero balance

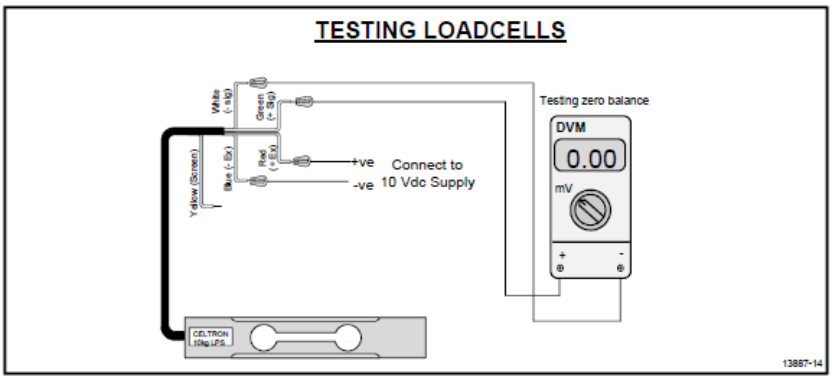

Figure 4.4: Zero balance

The objective of this process is to check for mechanical overload. This process is done by connect load cell on DC power supply between 5 volts to 10

volts. The meter should read 0.00mV when 0V give to load cell. Small overload can be detected because it can affect linearity of the load cell.

Table 4.3: Zero balance test to load cell

DC Power supply (Volts)		Load Cell Voltage (Volts)
Trial 1	0.00	0.00
Trial 2	5.00	1.48
Trial 3	10.00	2.97

From figure 4.4, all the result is collected and put into table 4.3. The result showed load cell voltage is 0V when DC powers supply gives 0V and this showed that the load cell in good condition. For the overall assumption, this load cell is followed the supplier specification, signal output can be detected, and very sensitive to force. Table 4.4 showed assumption single point load cell sensor suitable use for this project. The single point load cell being used in this capability study is limited to maximum of 3 kg only. The type of single point load cell based on the availability of the equipment at the result of the experiment.

Table 4.4: Single point load cell specification

Model	1004
Capacity	3kg
Calibration Mode	Compression
Input Impedance	415 +/- 20 Ohms
Output Impedance	350 + / - Ohms
Test Excitation	10 v

4.2.2 Operational amplifier

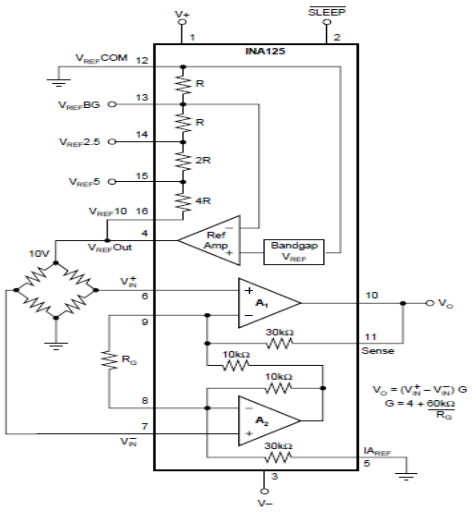

Figure 4.5: Amplifier INA125

Based on the capability study done before, output signal produced by the load cell after giving 5V is below millivolt. Amplifier is used as to enhance the magnitude of the millivolt so the signal can be read in voltage. This output of the load cell must be gained because adc circuit read output voltage in volt. There are many types of op-amp can be used to amplify voltage from millivolt to volt. But there are unique characteristic for each of this op-amp such as for inverting and no inverting receive single output voltage from the sensor while summing and differential op-amp can receive many output voltage. In this project case, there are two output voltage produce by single point load cell. The suitable op-amp for this project is summing or differential op-amp. For the research summing op-amp is op-amp that receives multiple positive outputs to be gain. It received all output at the same point of terminal while for the single point load cell; it has two outputs at different terminal. So this condition is suitable with the differential op-amp that has two outputs at different terminal. For this project differential op-amp INA 125 as figure 4.5 is used. Engineering had been done to test the suitable gain trough formula below:

$V_o = (Vin+ - Vin-)\ G$ (4.1)

V_o = Output voltage

Vin+ = Positive input voltage

Vin- = Negative input voltage

G = Desire gain

Equation 4.1 is used to define output voltage produce by the op-amp. Value of the output voltage is influent by number of gain and voltage input given by the single point load cell sensor. To define number of gain, it is depend on the value of resister use for the op-amp. The equation to get number of desired gain is:

$G = 4 + (60k\Omega / Rg)$ (4.2)

G = Desire gain

Rg = Value of desire resister

From equation 4.2, desire gain to be amplifier for op-amp can be defined. Value of the resister can be manipulated to get higher desire gain. For this project, an engineering test is conducted to define relation between the value Rg and G. The result for the engineering run is shown in Table 4.5.

Table 4.5: Engineering run for op-amp

Trial run	1	2	3	4	5	6	7
Voltage [V]	5×10^{-4}	5×10^{-4}	5×10^{-4}	5×10^{-4}	5×10^{-4}	5×10^{-4}	5×10^{-4}
Resistance [Ω]	10	100	300	600	1000	3000	10000
Gain	6004	604	204	104	64	24	10
Voltage [Vo]	3.00	0.30	0.10	0.05	0.03	0.01	0.005

From the equation 4.1 and 4.2 desired gain and output voltage to amplify are as shown below:

Determine desire gain G:

$G = 4 + (60k\Omega / 10\Omega)$ (4.2)

When $Rg = 10\Omega$

$G = 6004$

Determine output voltage V_o:

$V_o = (10 \times 10^{-4}V - 5 \times 10^{-4}V)\ 6004$ (4.1)

$Vin+ = 10 \times 10^{-4}V$

$Vin- = 5 \times 10^{-4}V$

$G = 6004$

$V_o = 3.00V$

From the equation 4.2, gain use for the amplifier is reasonable for this project. The gain calculate from the equation is 6004 time input voltage. By using equation 4.3, output voltage amplifies from 0.0005 volt to 3 volt. This value can be read by analog to digital converter circuit.

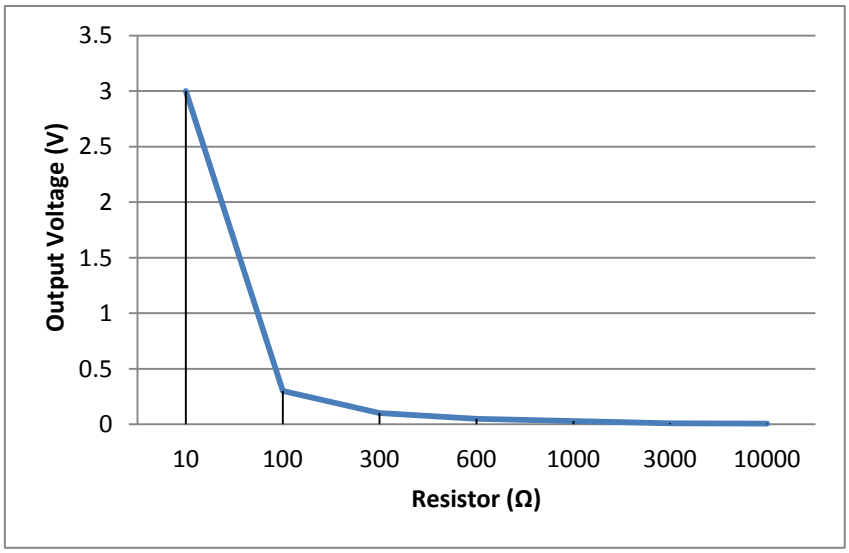

Figure 4.6: Graph for Value output voltage vs Resistor

The result from the magnification study in figure 4.6 showed that the higher value of resister uses for the amplifier circuit, the lower value it can gain from the amplifier circuit. Suitable resister used for this project is between 6Ω to 90Ω. For this project, resister value used is 10 Ω. Type of amplifier use in this project are summarizing in table 4.6.

Table 4.6: INA125 amplifier specification

PARAMETERS/ VALUES	**INA125**
LOW QUIESCENT CURRENT	460MA
PRECISION VOLTAGE REFERENCE	1.24V,2.5V,5V OR 10V
LOW OFFSET VOLTAGE	250MV MAX
LOW OFFSET DRIFT	2MV/°C MAX
LOW INPUT BIAS CURRENT	20NA MAX
HIGH CMR	100DB MIN
16 PIN DIP	-
16 SOIC PACKAGE	-

4.2.3 Analog to digital converter

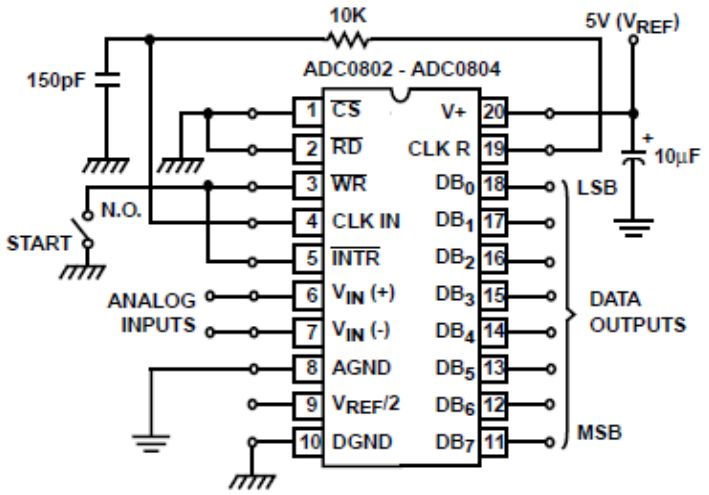

Figure 4.7: ADC 0804 diagram

The purpose of using ADC0804 in this project is for conversion analog output signal produce by the op-amp to digital. Based on figure 4.7, to active the adc circuit, 5 voltages is supply trough the Vref at leg number 20, and 2.5 voltages to Vref/2 at leg number 9. Output voltage produced by the op-amp will be supply to the leg number 6. Output voltage from leg number 6 then will be transferred as data output trough the parallel port to computer. Parallel port wire will be connected to the leg from 11 to 18. This data will be converted from analog form to digital to be read by the computer programming.

4.2.3.1 Testing A/D converter

There are several ways to test analog converter. The simplest one is by supply analog input to the converter and use LED to display result as digital output.

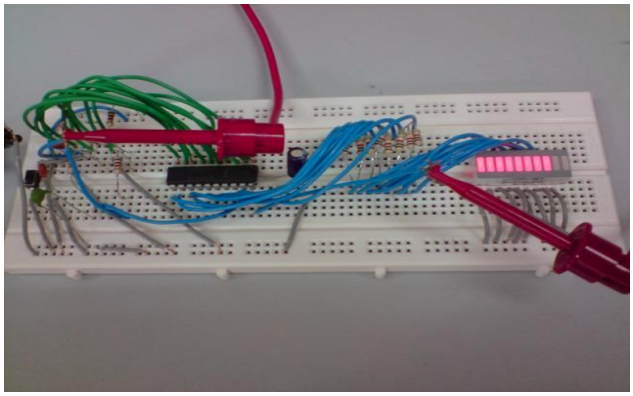

Figure 4.8: Free running ADC0804 with LED

From figure 4.8 showed that the ADC0804 is free running with LED during when 5 voltages apply by the power supply. This proved that the circuit that been built are functional.

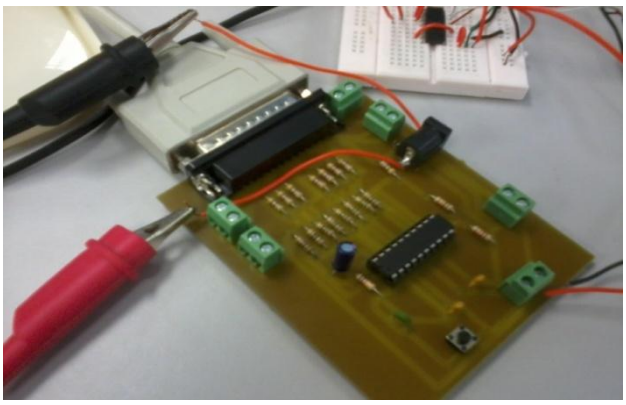

Figure 4.9: Running ADC0804

After the circuit is tested, it had been modified shows in figure 4.9. The LED and 1kΩ resistor is then taken off and replace with 15kΩ, 47kΩ and connected to parallel port to interface ADC with PC. Based on table 4.7, the changed of value of equivalent decimal value when voltage input is change.

Table 4.7: Value input voltage vs Output (decimal value)

INPUT(volt)	OUTPUT(equivalent decimal value)
0	0
1	51
2	101
3	153
4	207
5	255

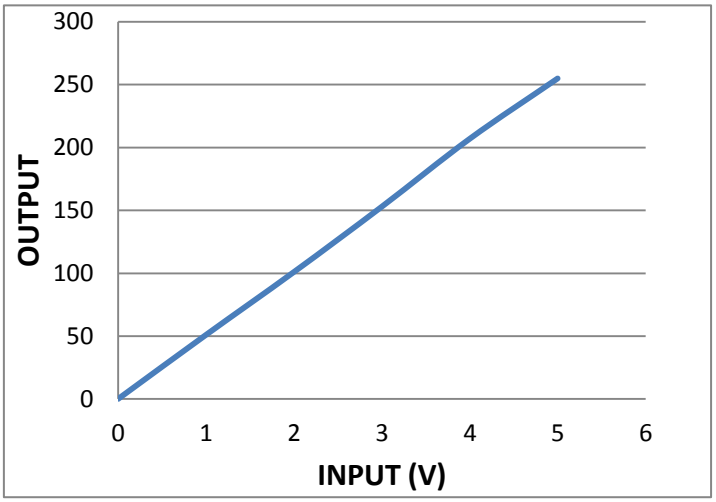

Figure 4.10: Graph for Value input voltage vs Output (decimal value)

Through figure 4.10, the voltage that been supply is direct proportionally to the equivalent decimal value read by computer programming. This showed that when the voltage supply is increase the equivalent decimal value will also increase. The equivalent decimal value can control to get desires voltage input.

Table 4.8: ADC circuit specification

PARAMETERS/ VALUES	ADC0804
RESOLUTION	8 BITS
INPUT CHANNELS	1
INTERFACE TYPE	PARALLEL
DIFFERENTIAL INPUT	YES
MAX SAMPLE RATE	10 KSPS
MIN SUPPLY VOLTAGE	4.5 VOLT
MAX SUPPLY VOLTAGE	6.3 VOLT
REFERENCE SOURCE	EXTERNAL

From table 4.7 showed that analog and digital converter (adc) specification for this project. As the assumption, adc0804 is use for conversion of analog signal to digital. Complete circuit diagram can be referred to figure 4.7.

4.2.4 Conversion voltage to binary number

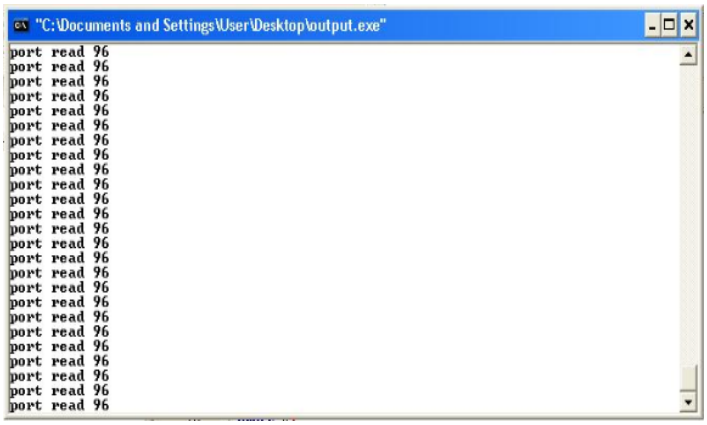

Figure 4.11: Output for pin value

After digital signal is received from the adc circuit, the signal will be transferred to the personal computer (pc) trough parallel port such as in figure 4.11. In the pc, there is D25 type of connector having 25 pins. In this project only pin number 2 to 9 is used to transfer signal and number 25 for ground signal. Pin structure is explained in Table 4.9.

Table 4.9: Pin structure in pc parallel port

Basic command	Byte value	Bit value in byte	Wire connector
Out 888,0	0	00000000	1
Out 888,1	1	00000001	2
Out 888,2	10	00000010	3
Out 888,4	100	00000100	4
Out 888,8	1000	00001000	5
Out 888,16	10000	00010000	6
Out 888,32	100000	00100000	7
Out 888,64	1000000	01000000	8
Out 888,128	10000000	100000000	9

4.2.4.1 Parallel input testing

To test input for parallel port data, C programming is created by using programming in appendix 1. First trial done is by using 47 Ohm resistor. The objective of this testing is to get input data from data port by using parallel port. 5 volt voltage is use as input supply so that current pass through the device is 0.1060 Ampere. Example of the calculation is by using equation (4.3).

$$V = IR \qquad (4.3)$$

V = voltage

I = current

R = resistor

From equation (4.3):

5 = I(47)

I = 5/47

I = 0.1060A

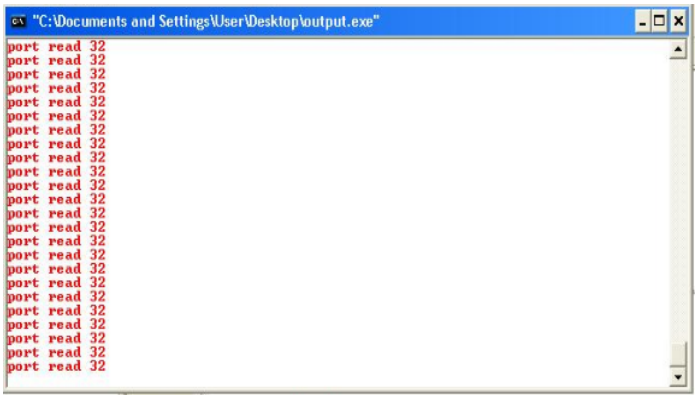

Figure 4.12: Input testing using wire 7

Figure 4.13: Input testing using wire 7 and wire 3

From figure 4.12, when 5 volt is given to wire connector 7 the input value can be read is 32. Assumption from this test, current is passed the resistor according to the calculation and table 4.9. From figure 4.13, when 5 volt is given to pin 7 and pin 3 at same time, the value read is 34. This showed that pin 7 and 3 are successfully transferred data trough the parallel port because when decimal value for pin 7 and 3 is added it equal to 34.

4.2.4.2 Parallel output testing

To test output for parallel port data, C programming is created by using oup32 programming in appendix 1. Testing is done by using 15 Ohm resistor. The objective of this testing is to get input data from data port by using parallel port. 5 volt voltage is used as input supply so that current pass through the device is 0.3333 Ampere. Example of the calculation is by using equation (4.3).

$V = IR$ (4.3)

V = voltage

I = current

R = resistor

From equation (4.3):

$5 = I(15)$

$I = 5/15$

$I = 0.3333A$

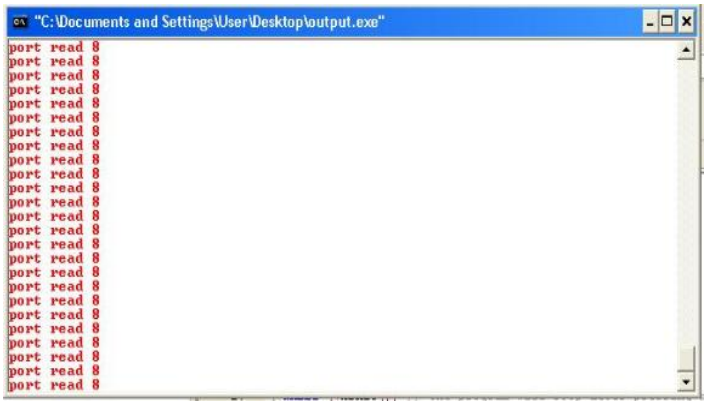

Figure 4.14: Output 8 testing using c programming

Figure 4.15: Output 255 testing using C programming

From figure 4.14, 5 volt is given trough the C programming. When the programming is written 8, led pin number 8 turns on. Assumption from this test, current is passed the resistor according to the calculation and table 4.4. From figure 4.15, 5 volt is given trough the C programming. When the programming is written 255, all light is turn on.

After the testing and analysis is done, the assumption can be defined is data transferred from the parallel port can be read by using pc. It is used as conversion voltage to binary number the transfer binary number to decimal number as the output.

4.2.5 Conversion from decimal number to gram weight

Table 4.10: Weight value base on output reading

WEIGHT (GRAM)	OUTPUT READING
0	80
200	128

Load cell sensor is weight sensor that provides output with proportional to force, by using the data get from the magnification study in Table 4.10, equation (4.4) is created:

$$\frac{x - x_1}{x_2 - x_1} = \frac{y - y_1}{y_2 - y_1} \qquad (4.4)$$

$$\frac{x - 80}{128 - 80} = \frac{y - 0}{200 - 0}$$

$$200\,(x-80) = 48\,(y-0)$$

$$200x - 16000 = 48y$$

$$y = 4.1667x - 333.33$$

From the calculation by using equation 4.4, y is identifying as 4.1667x – 333.33. When the equation is put in the C programming the output define in gram as shown in figure 4.16.

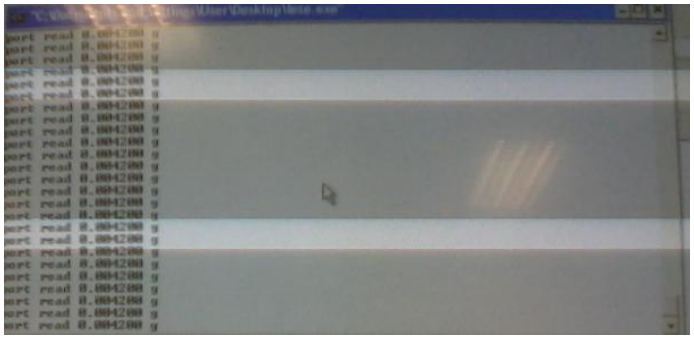

Figure 4.16: Conversion output voltage into gram weight.

4.2.6 Conversion gram weight to bonus point

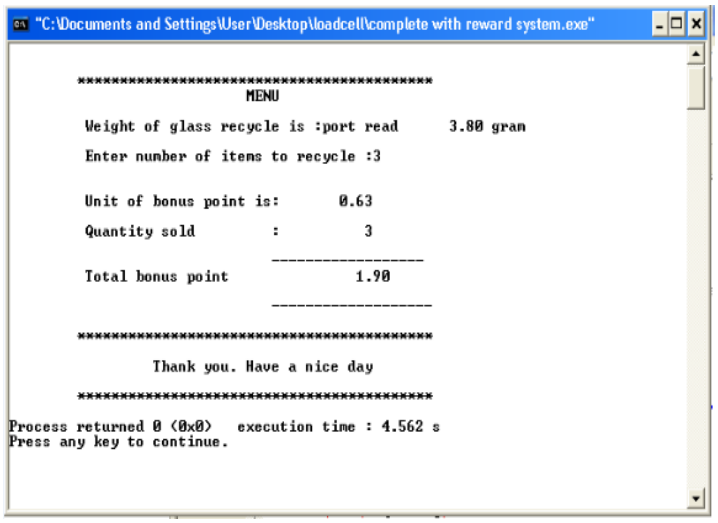

Figure 4.17: Reward programming

In figure 4.17 showed the conversion gram weight to bonus point. In here, it discussed about type of reward for the society and how the conversion of gram weight to bonus point.

4.2.6.1 Reward programming

The main function of reward system programming is to read output data produce by the sensor and change the data into bonus point. This programming is design to read output data sent by single point load cell trough the op-amp and ADC circuit. Data sent then will be read weight of glasses to be recycled and then the weight will be converted to the bonus point data as the reward for recycle glass at this machine.

4.2.6.2 Converting glass weight into the bonus point

The data sent to the parallel port will be received by computer programming. It then being analyzed by programming and read as integral data. The flow process of converting weight into bonus point showed in figure 4.18.

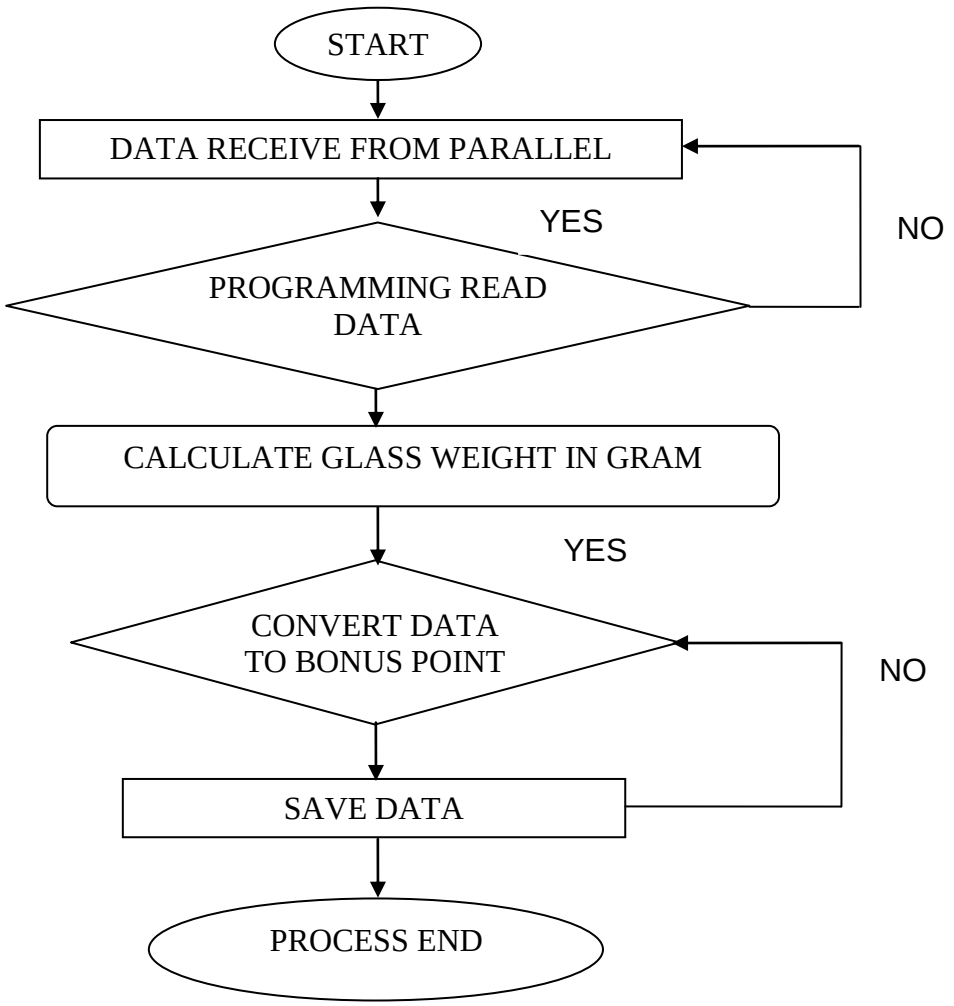

Figure 4.18: Flow process of reward system

The critical part of weight detection unit is programming read data signal and convert data signal to bonus point. It is because if one of the part from data receive cannot read data given, whole process of the reward system cannot be done. In order to the reward system to successfully function, the reward system must be correct and can multiply number without fail.

4.3 Summary

As the summary, this chapter generally discusses the result obtained from the test and process done to complete this project of develop weight detection unit for recycle glass using single point load cell. The result obtained shows that single point load cell was successfully develop because it had achieve the main objective of this project that is to develop weight detection unit that can calculate glass weight in gram and covert gram weight into bonus point. However, single point load cell has two limitations which are; maximum weight can be measure by the sensor is three kilogram and sensor assembly is very sensitive to force. Since the load cell is very sensitive sensor, it will react even on small interference. When it is interferes the precision of load cell measurement will have +- 10 gram.

CHAPTER 5

CONCLUSION AND RECOMENDATION

5.1 Introduction

This chapter is discussing about the conclusion of the whole flow of the project from the planning project, literature review, and design of the product, analysis and fabrication of the prototype product.

5.2 Conclusion

In conclusion, this project is to develop weight detection unit of the glass collection machine with the reward system. The project has achieved it main objective successfully. This weight detection unit also has achieved its objective to be part of the glass recycle machine. The function of measurement system in this project is to measure solid glass weight and convert it into reward. In this project, reward is categorized as the bonus point. The function of measurement system has achieved the third and fourth objective for this project that is to develop measurement system that measure solid glass weight and for reward. This project has achieved its entire objective successfully. This project was done in twenty-eight days including all the report such as design, analysis, fabrication process and literature review.

5.3 Recommendation

These are the recommendations to enhance this project and for future final year project:

a) Another method of measuring weight of recycle glass by using pressure sensor and weight scale.
b) Conversion from gram weight to bonus point can be done with collaboration with MPK by using MPK as main server that collect all data and save the data for consumer to redeem after recycle glass.
c) Reward system of the recycle machine can be enhancing by others who will continue this project due to the time constraint. It can be enhanced by adding server and online data transfer from recycle machine to recycling centre.
d) Develop one slot at the machine that can print data after recycle glass for consumer to redeem the bonus point at authorize place and data can be compared to the MPK server data receiver for conformation.
e) To integrate weight detection unit to the glass recycle machine and buy-off the capability.
f) After the integration of recycle machine with weight detection unit, trial is done with the machine to find tolerance weight it can measure.

5.4 Future Work

Future planning for this weight detection unit of glass collection machine with reward system is by using other method to measure glass weight by using pressure sensor. Design of the op-amp and adc circuit can be made by using one circuit board and independent power sources from the universal adapter. This project can be used by the students to gain knowledge and understand the mechanical and electrical process such as adc circuit, op-amp circuit, computer programming, and drilling. In the future this weight detection unit for glass collection machine with reward system should be more ergonomic by adding a slot at the actual machine. It will also provide more functions for the consumer by having sensor to detect colour of glass recycle.

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APPENDIX A

Input and output programming

```
#include <stdio.h>
#include <conio.h>
#include <windows.h>
typedef short _stdcall (*inpfuncPtr)(short portaddr);
typedef void _stdcall (*oupfuncPtr)(short portaddr, short datum);
//Adress PCI card ECD8
int main (void)
{
   HINSTANCE hLib;
   inpfuncPtr inp32;
   oupfuncPtr oup32;
/* Load the library */
hLib= LoadLibrary("inpout32.dll");
inp32= (inpfuncPtr) GetProcAddress(hLib, "Inp32");
oup32= (oupfuncPtr) GetProcAddress(hLib, "Out32");
short x;
while (!kbhit()) // the program will stop after pressing any keyboard key
{
   (oup32)(0xECD8,4); //to send all data port pin low
   x = (inp32)(0xECD8); //read data port
   printf("port read %d\n",x);
}
/* Unload the library */
```

```
FreeLibrary(hLib);
return 0;
}
```

APPENDIX B

Conversion gram weight to bonus point programming

```
#include <stdio.h>
#include <conio.h>
#include <windows.h>

typedef short _stdcall (*inpfuncPtr)(short portaddr);
typedef void _stdcall (*oupfuncPtr)(short portaddr, short datum);

// Address PCI card ECD8

int main(void)
{
  HINSTANCE hLib;
  inpfuncPtr inp32;
  oupfuncPtr oup32;
  /* Load the library */
  hLib = LoadLibrary("inpout32.dll");
  inp32 = (inpfuncPtr)GetProcAddress(hLib,"Inp32");
  oup32 = (oupfuncPtr)GetProcAddress(hLib,"Out32");

  float x;
  float y;
  int quantity;
  float subTotal;
```

```
 float total;
 int score;
 int grade;
 int Total;
// while (!kbhit())// the program will stop after pressing any keyboard key
{
  (oup32)(0xECD8,135);
  x= (inp32)(0xECD8);
  y= (0.1*x)-19.9+0.6;

  printf("\n\n\n\t*****************************************");
  printf("\n\t\t          MENU                  ");
  printf("\n\n\t Weight of glass recycle is :");
  printf("port read %9.2f gram\n",y);
  printf("\n\t Enter number of items to recycle :");
  scanf("%d", &quantity);



   total    = y/6 * quantity;

   printf("\n\n\t Unit of bonus point is:  %9.2f\n",y/6);
   printf("\n\t Quantity sold        :     %6d\n", quantity);

   printf("\n\t                    ----------");

   printf("\n\t Total bonus point         %9.2f\n", total);
   printf("\n\t                    ----------\n\n");
   printf("\t*****************************************\n");
   printf("\n\t\t Thank you. Have a nice day\n\n");
   printf("\t*****************************************\n");
}
/* Unload the library */
```

```
 FreeLibrary(hLib);
 return 0;
}
```

APPENDIX C

GANTT CHART

PERIOD: 1 SEPTEMBER 11 – 30 JUN 12

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 Group 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%
3	Fabrication activity and Report Writing											
	3.1 Design stage											
	3.1.1 Prepare for material											100%
	3.1.2 Prepare BOM for project											100%
	3.1.3 Submit BOM to supervisor											100%
	3.1.4 Discuss BOM and process with LAB Coordinator											100%
	3.1.5 Get approval from LAB Coordinator for equipment											100%
	3.1.6 Design LED circuit											100%
	3.1.7 Design ADC circuit											100%
	3.1.8 Design Op Amp circuit											100%
	3.1.9 Combine ADC and Op Amp circuit											100%
	3.1.10 Circuit combination for single load cell											100%
	3.1.11 Create programming for single load cell											100%
	3.1.12 Trial run for single load cell											100%
	3.1.13 Take data single load cell circuit											100%
	3.1.14 Measure parameter for collection mechanism											100%
	3.1.15 Measure parameter for reward system											100%
	3.2 Analysis stage											
	3.2.1 Experiment for circuit effectivness											100%
	3.2.2.Experiment for reward system effectivness											100%
	3.2.3 Collect data from experiment											100%
	3.2.4 Make data comparison											100%
	3.2.5 Do pilot test											100%
	3.2.6. Conclude experiment											100%
	3.3 Report writing											
	3.3.1 Make full report											100%
	3.3.2 Present final report											100%