"I hereby declare that I have read through this report entitled "Design, Development and Fabrication of Urinal Health Checking System" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechanical Engineering (Design & Innovation)"

Signature : ……

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DESIGN, DEVELOPMENT, AND FABRICATION OF URINAL HEALTH CHECKING SYSTEM

ADI ALIF BIN AZIM NG

This report is submitted in partial fulfilment of the requirements for the degree Of Bachelor of Mechanical Engineering (Design & Innovation)

Faculty of Mechanical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JULY 2012

"I declare that this report entitle "Design, Development, and Fabrication of Urinal Health Checking System" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree"

Signature : ……..…

Name : ADI ALIF BIN AZIM NG

Date : JULY 2012

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ABSTRACT

Nowadays, people are busy with their routine daily life without the awareness of their own health. The lack of awareness could prove fatal if a harmless and hard detected illness developed into an incurable illness. Time and travelling are the main factor that most people neglect the idea of a medical check-up. The purpose of this project is to construct a urinal health checking system. The urinal will able to detect and process the urinal user's urine using current technology sensors. The result of the urine will than displayed on a displayer attached to the urinal. The design will follow the engineering design development process. The expected output is a low-cost urinal health checking system that could operate at public toilets.

ABSTRAK

Pada masa kini, manusia sibuk dengan kehidupan seharian mereka tanpa kesedaran tentang kesihatan mereka sendiri. Kurangnya kesedaran ini boleh membawa maut jika penyakit yang tidak berbahaya dan sukar dikesan berkembang menjadi penyakit yang tidak boleh diubati. Masa dan perjalanan adalah faktor utama kepada kebanyakan orang mengabaikan idea pemeriksaan perubatan.Tujuan projek ini adalah untuk membina sistem tempat air kencing berkebolehan memeriksa kesihatan. Tempat air kencing akan dapat mengesan dan memproses air kencing pengguna menggunakan sensor teknologi semasa. Keputusan air kencing akan dipaparkan pada displayer yang tersambung di tempat air kencing. Reka bentuk akan mengikuti proses pembangunan reka bentuk kejuruteraan. Output yang dijangka ialah kos rendah system tempat air kencing memeriksa kesihatan yang boleh beroperasi di tandas awam.

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LIST OF ABBREVIATION

HOQ	=	House of Quality
PDS	=	Product Design Specification
QFD	=	Quality Function Development
CATIA	=	Drawing Software
CAD	=	Computer Aided Data
FDM	=	Fused Deposit Modeling

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CHAPTER 1

INTRODUCTION

1.0 Background

Urine is waste product from the body in liquid form. It is secreted by the kidneys through a process called urination. There are a lot of things that a sample of urine could tell about a health of a person. Even back in history, many physicians had resorted to examination of their patient‟s urine. Hermogenes, a Greek philosopher wrote that colour and attribute of the urine could indicate whether a person is healthy or not. Another philosopher, Abdul Malik Ibn Habib of Andalusia mentions hundreds of report regarding urine examination. Nowadays, medical doctor still practice urine analysis to cure patients. There are many characteristic of the urine that could be observed. Colour, Odour, Turbidity (Cloudy), pH, Volume and Specific Gravity are examples of the characteristic that may defer respectively due to various factors.

Urinal is a specialized toilet that serves as a urinating place. Generally, the urinal is designed for the male, but it is possible that the urinal could be designed for the females. Public urinal is usually is attached to a wall where the user could stand for urinating. It also often contains plastic mesh guard, a guard from solid objects such as cigarettes or chewing gum to enter the urinal‟s system. These solid objects could cause blockage and will disrupt the system from flowing. Nowadays, a lot of designed urinals are available all across the world which offer more comfort, user-friendly and designed based on green technology.

1.1 Problem Statement

In this fast moving life, the percentage of people getting ill grew larger as they are busy with their hectic daily life. They simply neglect the idea of health check-up due to several factor. One of the main factors is that they are confident that they are in good health thus reducing the probability of doing a medical check-up. This lack of awareness could lead a preventable disease from harmless to dangerous. Example of a disease is diabetes where an earlier prevention could save the patient from experience painful condition.

Another factor is the idea of travelling to nearby hospital for a simple medical check-up. Most people opinion is that the travelling and waiting process at the hospital is troublesome and neglect the importance of knowing the condition of their own body.

1.2 Objective

- To design, develop and fabricate a low cost urinal that is able to advise regarding a person‟s health

1.3 Scope

- The urinal focuses on male either the elderly, adult and even children.
- The urinal could either constructed at any public places for any user who wants to check their health conditions.
- The urinal is a preliminary device which advise user to prevent diseases.
- The urinal health monitor could analyze the urine by these following characteristics:

i. Colour
ii. Clarity
iii. Specific Gravity
iv. pH
v. Sugar level (Glucose)

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The process of designing a new product requires vast amount of research and observation. Research on current trend, studies, and design guideline are vital as it provides the leverage and guidance on constructing a new product. Literature review on related topic offers knowledge and information for the success of the product as it provides solid foundation of a new design.

2.1 Urine Information

Urine is waste in liquid form and waste product of the human body. Normally, the urine is has a clear and transparent yellow colour. Average amount of urine produced in 24 hours range from 1200 ml to a maximum of 1800 ml which is about 1,200 cubic centimetres. Chemically, the urine is basically a watery solution of salt (sodium chloride) and substances called urea and uric acid. Normally, it contains about 950 parts of water to 40 parts of solid matter. Abnormally, urine may contain sugar or glucose (diabetes), albumen, a type of protein (a form of kidney disease), bile pigments (jaundice), or abnormal quantities of one or another of its normal components (William C.S. and Melissa C.R., 2008).

Urine acts as window to understanding disease of the kidney and systematic disorders. It is the easiest bodily fluid to obtain that can be analysed in resource limited settings where it is of great value in enhancing diagnostic and therapeutic pathways (Dreyer G., 2010).

2.1.1 Urine content

D. F. Putnam, (1971) provides the detailed description of the composition elements in human urine with thorough chemical analyses for organic and inorganic constituents, analysis methods, chemical and physical properties and its behavior during concentrative processes such as evaporation, distillation and other physiochemical operations. Urine is an aqueous solution of greater than 95% water, with the remaining constituents, in order of decreasing concentration urea 9.3 g/L, chloride 1.87 g/L, sodium 1.17 g/L, potassium 0.750 g/L, creatinine 0.670 g/L and other dissolved ions, inorganic and organic compounds.

Table 2.1: Element contain in normal human urine (Source: Web MD, 2008)

Element contain in normal human urine	
Water	Magnesium
Urea	Calcium
Creatinine	Ammonia
Uric Acid	Phosphates
Sodium	Sulfates
Potassium	

The list of elements that is normally contained in the human urine is shown in Table 2.1. Different element has different percentage of amount exist. However, there are some other substances that may be abnormally increases, normally indicate that there is something wrong with the health condition of the human body (Armstrong, 1998).

Table 2.2: Abnormal content in human urine (Source: Web MD, 2008)

Abnormal substance in urine	Cause
Albumin	May indicate that nephrons, are damaged or destroyed. Albuminuria is another term for elevated albumin
Bilrubin	May indicate obstructive or biliary disease.
Glucose	May indicate that a person may have diabetes.
Ketone bodies	May indicate anorexia or diabetes. Ketone bodies may also be elevated during starvation or during fasting.
Mircrobes	May indicate urinary tract infection
Blood	May indicate kidney damage, such as in kidney disease or renal. Kidney stones may also be the reason for the present of blood
White blood cells	May indicate that there is infection in the kidney or other organs of the urinary tract.

The examples of element that are not supposed to exist in the human urine are shown in Table 2.2. These elements existence in the urine may act as an indicator of an illness. Urine testing is one of effective method of diagnosing the patient‟s illness.

2.1.2 Characteristic of urine

Urine could be characterized through different factors (David F.P, 2008):

i. Quantity

The average quantity of a person urine ranges from 1200 ml to 1800 ml in an adult man daily routine. It may vary with the amount of fluid intake of the body. In fact it is connected with the protein metabolism; higher is the protein intake, the higher will be the urinary output since the urea created from the protein needs to be flushed out from the body. Higher is the urea production in the body, the higher is the volume of urine to dispose it.

ii. Color

The color is normally to be clear pale amber without any deposits. However, a light flocculent cloud of mucus may sometimes be seen in the normal urine. Known color of urine:

- Dark yellow urine
- Yellowing/Light orange urine
- Orange urine
- Bloody urine
- Dark orange to brown urine
- Black or dark-coloured urine
- Fluorescent yellow/Greenish urine
- Reddish urine

iii. Specific gravity

It varies from 1.010 to 1.025. Specific gravity is determined with using a specific gravity meter, Urinometer.

iv. Odour

Slightly nutty odour but some disease may change the smell of the urine. Some are sweet, fruity while others are bad.

v. pH

The normal urine is has a slightly acidic characteristic with an average pH of 6.0.

2.2 Urine testing/Urinalysis

Urine tests works for offering information to aid inside diagnosis, monitoring and also treatment of many illnesses. Additionally, the urine test can easily determine whether a lady is ovulation or she is pregnant. Urine can also be examined to get a selection of substances concerning drugs substance abuse, both within rehab programs as well as in the world of professional sports activity. The urine can be examined swiftly utilizing a strip of special paper, which can be submerged with the actual urine just after urination. This may show any kind of irregular elements in the urine for instance glucose, protein, or perhaps blood. If further examinations are required to obtain more data, the particular urine will probably be examined in a clinical (Armstrong L.E., 1998).

The kidney secreted waste material, minerals, fluid, and other substances from the blood out in the liquid form of urine. Urine contains hundreds and hundreds of different body wastes. What kind of food ate, drank, how much exercise done, how well the kidney works can affect the content of the urine. A regular medical check-up urinalysis often includes tests of urine,,s color, clarity, specify gravity and etc (J.R Raymond, 1995).

2.2.1 Urine test: Color

A lot of things affect urine color, such as liquid stability, diet plan, medications, as well as illnesses. The color of the urine, whether light or dark colored, could tell a person‟s water intake. B vitamin can make the urine into bright yellowish color. Some medicines, blackberries, vegetables, rhubarb, or blood contained in the urine can change urine color to red-brown color.

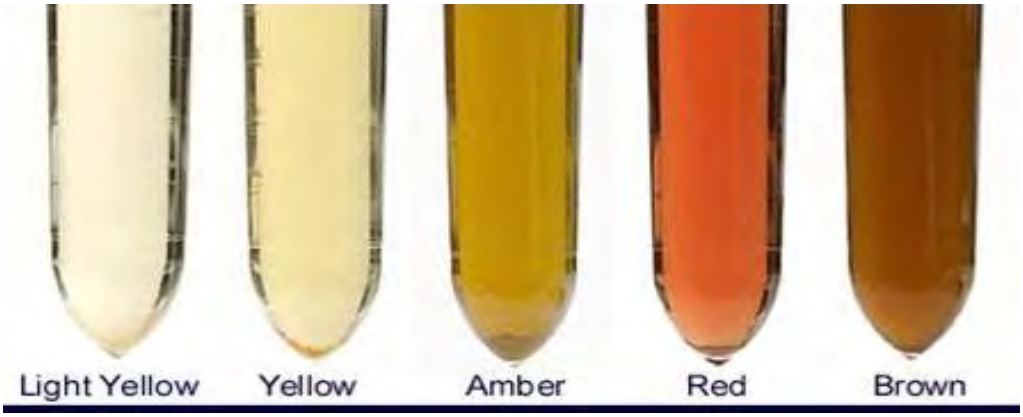


Figure 2.1: Example of urine color (Source: Jacobs, 2009)

Examples of colors that the urine may possess are shown in Figure 2.1. If the water in human body is balanced, the actual urine should typically a light yellow-colored. If the water intake is lesser than required, the urine may be amber in color Different type of food diet may affect the color of the urine such as red or brown. When normal mineral waters reduce in the body surpasses the water intake per-day, the kidney system have to conserve normal mineral waters, therefore making the actual urine a lot more concentrated with waste product and the color is darker. Dim yellowish urine is the perfect indicator how the individual is not properly hydrated which the particular fluid consumption should be improved.

If a person urinates under two times daily as well as/ or producing urine with darker color, this is a vital indicator regarding severe dehydration; the person need to consume water right away or the body will be in danger. Using the colour of the urine, testing whether the person is well hydrated could be tested.

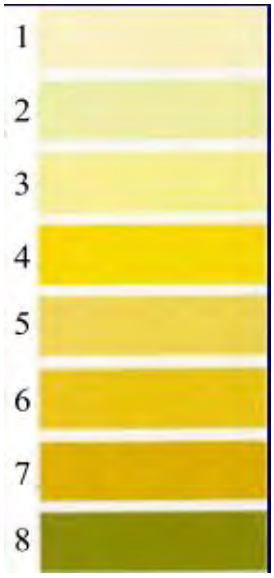


Figure 2.2: Urine test for dehydration chart (Source: Tactical Medics Int., 2000)

The color chart used in determining the concentration of the urine is shown in Figure 2.2. From the chart in Figure 2.2, the lower the number is in the chart, the better hydrated a person is. Number 1-3 is considered well hydrated condition while other numbers suggest that the person should increase the water intake. Precaution should be taken into consideration as some of the medicines and vitamins or food may change the color of the urine. However, if increasing the water intake doesn‟t change the urine color, it is advisable to visit nearby clinic or hospital.

2.2.2 Urine test: Clarity

Clarity is how transparent the urine is. Typically, a laboratory record the clarity from the urine while using following conditions: clear, slightly cloudy, cloudy, or turbid. "Normal" urine could be apparent or cloudy. Elements that cause murkiness that are regarded as unhealthy towards the body consist of mucus, semen as well as prostatic fluid, tissues in the skin color, regular urine crystals, as well as pollutants for example body lotions as well as powders. Other substance that may generate cloudy urine, similar to red blood cells, white blood cells, or microorganisms, reveals a condition that needs attention (Chad Hagen, 2001).

Past studies by Bulloch B., (2000) where their main objective is to search for link between clear urine (Clarity of the urine) by manual inspection with the absence of a type of bacteria, and to compare and contrast it with standard urinalysis. The test concluded that transparent urine using manual inspection cannot completely rule out the chance that a child have urinary tract infection. Fortunately, it is a repeatable easy test that provides the benefit of being simple, quick, and cheap. The observation of transparent urine should be considered as a reasonable and relatively effective bedside screen for the existence of a urinary tract infection.

2.2.3 Urine test: Odor

Usually urine does not have strong smell if person is well hydrated, but has a slightly "nutty" odor. Several conditions could possibly be the reason behind difference in the particular smell of urine. For instance, diabetes or perhaps undernourishment could cause the particular urine to be able to scent special, fruity scent. The particular difference in scent is normally momentary. These kinds of adjustments are generally not constantly the regarding condition. Food items and also drugs, which include vitamin supplements and also fruit, may possibly have an effect on your current urine's scent. For instance, asparagus causes a characteristic urine scent for the existence of asparagines, an amino acid. However, foul smelling urine may be due to bacteria, such as those responsible for urinary tract infections. Musty smelling urine could cause by liver disease or a certain metabolic disorder (Landry D.W., 2010).

2.2.4 Urine test: Specific Gravity

Specific gravity test of the urine test the quantity of ingredients within the urine. Additionally, it displays the actual kidneys stability the quantity of drinking water within urine. The higher the specific gravity is, the greater quantity of solid materials with the urine. Once the liquid consumption is actually higher, the actual

kidney generate urine having a higher quantity of drinking water cause the specific gravity of the urine to decrease. The other way around, when the kidneys generate urine having a smaller sized percent of drinking water, the particular the specific gravity increases.

Increase in the specific gravity value is most probably because of dehydration, diarrhoea, emesis, sweating, and decreased blood flow to the kidney. Decreased specific gravity may be associated with renal failure, diabetes insipidus, and excessive fluid intake. The normal specific gravity value is 1.003. If the specific gravity of urine is under 1.010, the body is considered hydrated. If urine specific gravity is above 1.020, the body is dehydrated (Armstrong L.E. and Soto, 1998)

2.2.5 Urine test: pH

The pH is a measurement of how acidic or alkaline (basic) the urine is. A urine pH of 4 is strongly acidic, 7 is neutral (neither acidic nor alkaline), and 9 is strongly alkaline. However, the pH of urine is affected by certain treatments.

A highly pH acidic urine frequently occur in acidosis, uncontrolled diabetes, diarrhea, hunger, insufficient water, and additionally respiratory system medical conditions. Highly alkaline urine occurs in urinary tract obstruction (UTI), renal tubular acidosis. The formation in renal calculi with the kidney is related to the urine‟s pH. Patients to be treated for renal calculi are usually given acceptable eating habits and / or pills to change the pH level of urine with the intention that kidney stones does not formed. Calcium phosphate, calcium carbonate, and additionally magnesium phosphate cultivate in alkaline urine; once it occurs, the urine is kept acidic. Uric acid, cystine, and additionally calcium oxalate precipitate in acidic urine, the urine have to be preserved alkaline or less acidic than normal (Israni AK, 2007).

2.2.6 Urine test: Glucose

Glucose is a form of sugar found in human blood. Typically, there exists almost no or no blood sugar inside urine. Glucose found inside urine usually indicates that the kidneys are usually broken or perhaps infected. Glycosuria or glucosuria is the excretion of glucose into the urine. In most cases, urine includes no glucose as the kidneys have the ability to get back each of the blocked glucose back into the blood vessels. Glycosuria is virtually constantly due to increased blood glucose ranges, mostly as a result of neglected diabetes mellitus. Glycosuria causes extreme water lost into the urine together with resultant insufficient water, a task named osmotic diuresis (Burton and Helmut, 1994).

2.2.7 Urine Test: Protein

Protein found in urine may indicate that the person have kidney damage, an infection, cancer, high blood pressure, or diabetes,systemic lupus erythematosus (SLE). Protein formation in the urine may also mean that leukemia, heart failure, poison (lead or mercury poisoning), or preeclampsia (if pregnant).

2.3 Urinal Design

Principle and rationale of designing urinals are:

i. Avoid using troughs design, use urinal bowl design. No-one prefers troughs because it offers almost no privacy. Nor do they wish to see other people‟s urine.

ii. Always provide privacy screens between urinals, to provide comfort and feeling of personal space.

iii. Presents privacy from unwanted sightlines utilizing additional privacy screens protection from other various spots examples hand dryers, entrance door, wash sink to the standard sizing.

iv. The region at the rear of males position at the urinal must not be the associated with movement circulation or entrance.

Urinal design should offer comfort, privacy and compatible to the user. The urinal should have a privacy screen so that the user is comfortable to urinate at a public toilet. Current urinal has 2 set of height, where one if for the average adult height and another for the children. The urine should flow smoothly to the urinal opening and a flush system that washes the excrement away (Middlemist, R.D, E.S. Knowles, and C.F. Matter, 2009).

2.3.1 Urinal: Behavior

Past work

The objective of the study is attracting the attention of urinating males to help in toilet training or to aid in keeping toilets, urinals and the areas around them clean. A study of the prior reveals that various types of devices could be used in attracting the attention of human males. The present invention uses a target structure which may be positioned low in the bowl of a toilet or a urinal and which will not have to be removed when the toilet is cleaned. The user also focuses more on the target rather than the environment which may be unpleasant (Public Toilet) (Joel S. Kreiss, 1996).

Figure 2.3: Target in toilet bowl (Source: Kreiss, 1996)

Position of the target in toilet bowl is indicated in Figure 2.3. This will help to change human behaviour to direct the urine to the target. This will not only benefit the cleaning process, but also to the comfort of the urinal user.

2.3.2 Urinal: Past Inventions

The ideas of implementing health monitor device with routine items are already acceptable by designers. Zhiying Yu and Siming, (2006) invention is a type of toilet has a monitoring health condition system. The invention has a weighing sensor provided on the lower surface of the toilet seat body for measuring weight. The toilet seat body is equipped with one displaying and processing device. The output signals from the weighing sensor are transport into the displaying and processing device. The advantage of the invention is that it enables frequent measurement of weight and physical constitution when a person uses the toilet. Meanwhile, the functions of toilet seat are highly diversified and the use frequency of measuring device increases accordingly.

Yossef S., Kirya K., Zvi H. and Haifa, (2005) stated that many system designed recently has instruments placed inside or alongside a toilet or other sanitary installation which directly receive and measure parameters and constituents of urine making it more expensive than conventional ones. It would be desirable to be able to produce a transportable system that could be used for analyzing and monitoring urine properties and characteristics. It would be also desirable if the cost of the design could be reduced. The system should be able to analyze urine through the use of light transmission, absorbance, reflectance, electrical conductivity, pH and temperature.

A personal health monitor designed by Ping and Manning, (1989) includes sensors for measurement patient‟s weight, temperature, blood pressure and ECG waveform. The sensors are placed on the seat of the toilet bowl where the measurements are taken. The scope of the invention is mainly to assist medical personnel in assessing the health of the patient. Both information regarding physical condition of the patient and patient compliance with the medication schedule are provided by the monitor. The invention used rechargeable battery which could be replaced with current electric system.

Another past invention by Kiyoshi and Yoshiki, (1993) proposed a networked health care and monitoring system has the ability of providing an updated version of reliable important information on the health condition of individuals and adapted to support home health care and maintenance. The invention provides a networked important information monitoring health system that is effective at finding as well as calculating essential symptoms without difficulty to the user.

CHAPTER 3

METHODOLOGY

3.0 Introduction

Methodology is defined as a body of methods, rules, and postulates employed by discipline. It is also defined as a particular procedure or set of procedures that refers to more than a simple set of methods. Methodology is a guideline in solving problem and in this chapter, the method of acquiring vital information and data. The method must be followed accordingly and with commitment.

3.1 Overview

To design a new product, a working principle on how to design a new product must be applied. These steps ensure that the product design came out in high quality and practical for the customer to use. Following are the methodology applied:

i. Define problem
   - Identifying customer needs / Brainstorming
   - Gathering information from customer
   - Customer Requirements
   - Engineering Characteristic

ii. Gather information

- Data and analysis
- Market
- Internet

iii. Concept Generation / Concept Design

- Function / Product Architecture (Product Decomposition)
- Morphological Method
- Concept Design
- Concept Selection

iv. Configuration Design

- Product Architecture
  - Sketching
  - Analyzing
- Generating Alternative Configuration

v. Parametric Design

- Design For Assembly and Manufacturing (DFMA)
- Modularity

vi. Detail Design

- Drawing
- Assembly

vii. Prototyping

- Identify objects and actions
- Fabricate
- Assemble

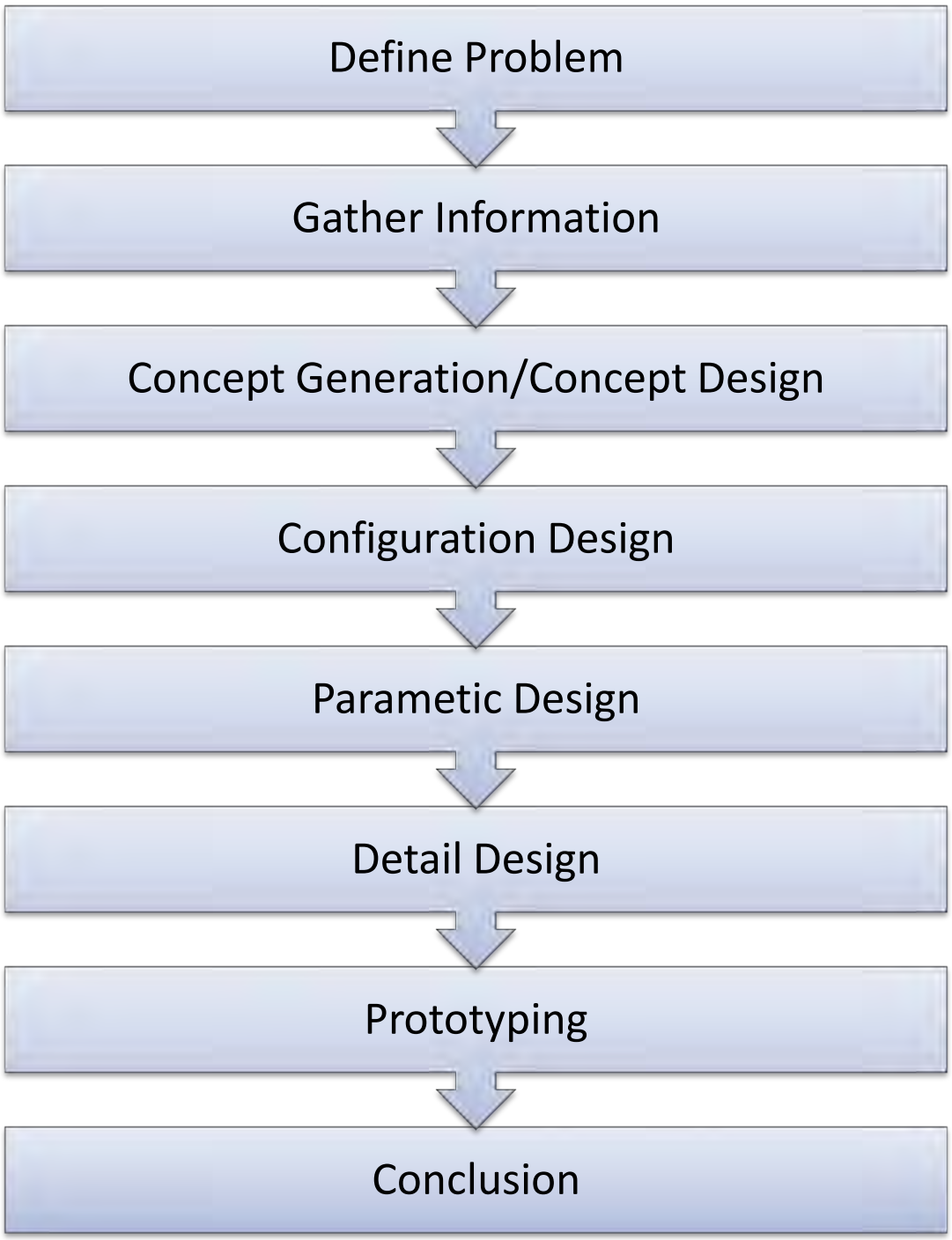


Figure 3.1: Methodology flow chart diagram

Process flow chart diagram of the methodology used is shown in Figure 3.1. The flow chart will help in organizing the process and provide the visual on how to achieve the objective. Every steps required in producing the final product is inserted into the process flow.

3.2 Methodology

3.2.1 Problem Definition

First, current problem has to be identified. From the problem statement, customer‟s requirement has to be formulated. There are several methods of attaining the customer‟s opinion:

(a) Interview
(b) Research
(c) Survey

Interview on customer is one of the effective ways of acquiring data. First hand information gives an insight into the customer‟s requirement. Research on recent trend and problem is the easiest and fastest way because of vast amount of information in the library and internet of previous research. Survey method has 2 steps where first pre-survey are hand-out to smaller group to test the effectiveness of the questionnaire. The real-survey is done on larger group of respondent based on pre-survey improvement. The questionnaire is designed to obtain urinal users regarding their preference, problems and improvement to the current urinal.

From the method above, the customer‟s requirement and engineering characteristics could be obtained. Customer requirement are key points in developing the new product. The main objective is to satisfy the customer‟s need. Engineering characteristic is formulated in brainstorming where it must link to customer‟s requirement. House of Quality (HOQ) will determine the ranking of which criteria is the most important to be implemented to the design. Product Design Specification (PDS) is the basic control and reference document for the design and manufacture of the product. The PDS is a document that contains all of the facts related to the outcome of the product development PDS should eliminate a tendency to design towards a particular design but also contain all the constraints required.

3.2.2 Gather Information

Information on related work on the product is vital to the development of the product. Data and analysis of previous studies could be used to prevent any failure to the product. The data of previous work could be the benchmark in developing the new product. Any errors should be counter-measured and improvement is a must. Market also provides the information on current technology and needs that should act as a reference. Information regarding urinal, urine, urine testing, urinal user behaviour and preference, journals and current studies is documented into literature review to help the progress of the product. Research on market will give an insight on the needs in the developed product and scope on customer, area, and design.

3.2.3 Concept Generation/ Concept Design

Concept generation uses brainstorming ideas to solve the problem statement based on the customer‟s requirement. First, when designing a new product, the product and function decomposition is listed down. Every components and function in order for the product to function must be listed down. From the list, several concept design idea for each part is produced and the choices are tabulated in morphological method.

Alternative concepts are generated to suit the key criteria that the customer seeks in the product. The ideas are also reviewed whether it is tangible / could be realized. Concept selection is used to help determine the suitable part that should be used in the design. Pugh‟s Concept Selection and Weighted Decision Matrix are example of concept selection that could be used. Using engineering characteristic and customer‟s requirement as a guideline, Pugh‟s Concept Selection is used to evaluate each part. Product Design Specification (PDS), House of Quality (HOQ), Quality Function Development (QFD) are method to generate the ideal concept.

3.2.4 Configuration Design

Configuration design is mainly the sketching of the product. Sketching of the product provide the imagery of the final product looks like. During configuration design, the product is analyzed and calculated to support the benchmark requirement for safety, reliability and other important parameters. Alternative configurations are also generated to find the compatible and quality product. The arrangements of the physical elements are stated in configuration design. Each part must have its placement in the final product, and any abnormality must be prevented. Urinal Health Checking System sensor system must be shown to observe the flow of the data from input to the output. Method on processing the urine must also be included.

3.2.5 Parametric design

In this parametric design, the critical parts and the product are analyzed. The parametric design is to test whether the product is reliable and quality. Design for Assembly and Manufacturing (DFMA) is a method used to design the product with ease and low in cost. The manufacturing and assembly process period is significantly decreased if the method applied correctly. Also, the method emphasizes on minimizing the parts number and this will directly increases the reliability of the product. Another section is the modularity of the product. The product may need maintenance and repair due to electronic components embedded into the design. The product should be able to be assembled and disassemble with ease to simplify the maintenance process.

3.2.6 Detail drawing

Detail drawing is the final phase of designing progress. Each of the components selected in the concept selection phase is assembled into the final product. The product will be drawn using computer aided design (CAD) and the assembly of the product prove the parts are fitting in dimension. CATIA is one of the software

available. The detail drawing will help in providing visual and any improvement could be adjusted through the analysis of the detail design. Detail design is important section before progressing the prototyping phase.

3.2.7 Prototyping

Alpha Prototyping a reduced-scale or full-scale part or product is prototyped using the same geometric features, materials, and layout as the intended final assembly. Alpha prototypes are not usually prototyped using the same manufacturing processes that will be used in the final production. Alpha -prototype tests are conducted in a company's laboratories and focus on a part or product. The prototype shows the appearance of the final product or its functionality. The visual of the product is important in design process development and prototyping gives designer to alter any constraint or function.

The idea of prototyping the urinal health checking system is to construct a supported urinal with the electronic components. The dimensions are one to one ratio plus the functionality could be observed after the product is assembled. Another available method is to use the rapid prototyping process. Each parts are either prototyped or purchase from local market.

CHAPTER 4

RESULTS

4.0 Abstract

The engineering design processes are conducted as in planning. The survey and interview result are obtained and the data are used to construct the customer‟s requirement and House of Quality (HOQ). From the customer‟s requirement, the idea concepts are generated. These concepts are selected using the Pugh‟s method of concept selection. This will ensure the product to meet the need of the customer. Product architecture shows how the product‟s arrangement of physical elements. The positions of the critical parts are designed to follow the Design for Assembly and Manufacturing (DFMA). Modularity is also another factor in designing the product. Detail design using Computer Aided Design (CAD) which CATIA software is used. Any improvement could be analyzed using the detail design.

4.1 Survey and Interview Result

The survey is distributed to 64 participants. The feedback contributes on developing the customer‟s requirement. Interview also helped in determining the opinion of the customer. The customer‟s requirement and engineering characteristic is needed to construct the House of Quality (HOQ). An example of questionnaire could be observed in the appendix.

4.1.1 Survey Analysis on Section A

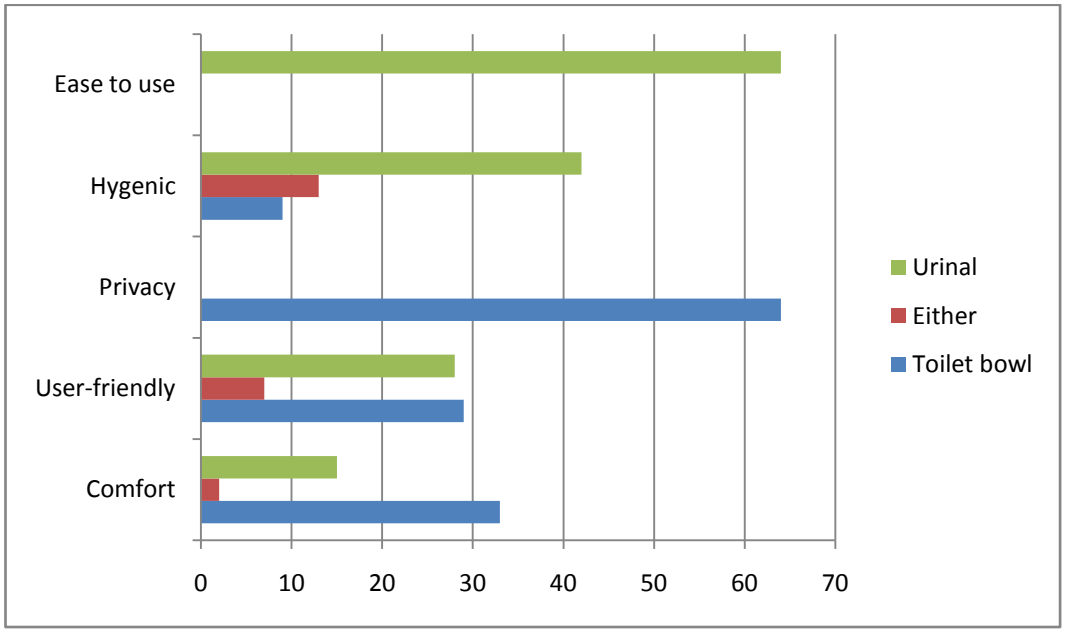


Figure 4.1: Comparison between toilet bowl and urinal

Section A of the questionnaire survey is shown in Figure 4.1. Section A is designed to obtain information on which product is preferable when it comes to urinating. From this section, the data could show which criteria that the urinal lacks. From the ease to use and hygienic question, the survey shows that the urinal excels more than the toilet bowl. The lacking criteria for urinal is that it offers little privacy as well as comfort. From the interview, most of the users prefer the toilet bowl than the urinal mainly because it offers much more privacy. The privacy relates to the comfort of the toilet bowl.

4.1.2 Survey Analysis on Section B

Table 4.1: Analysis of Current Urinal Section B

Question Number	Number of responses with 4 or 5 Rating	Relative Frequency, %
1	23	35.9
2	47	73.4
3	30	46.8
4	41	64.1
5	31	48.4
6	24	37.5
7	18	28.1
8	52	81.2

The data analysis of current urinal is shown in Table 4.1. The information is gathered from 64 participant and these data will be used in producing the important factor in concept generation. Each question will be observed of its number of response with four or five rating and the relative frequency. From the list, this will rank and categorize the main factor of customer requirement.

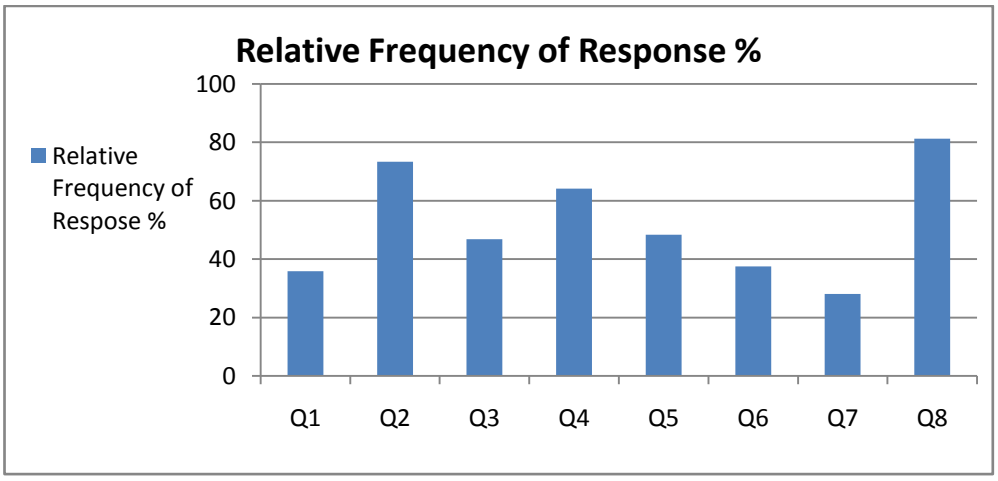


Figure 4.2: Relative Frequency of Response, %

Purpose of section B is to gain customer"s view on current urinal at public toilets. The main issue that could be observed is that the current urinal does not offer adequate privacy. The open area of the urinal causes the user to be uncomfortable when urinating. The neglecting of maintenance and repairing of the urinal contributes to complain of urinal users. When developing a urinal, the maintenance and repairing of the components must be taken into consideration. Interview provides more information that the cost of the development of the urinal to health checking system must not be over expensive.

4.1.3 Survey Analysis on Section C

Section C is placed inside survey to provide insight of the difficulty that the customer undergoes when go for medical-checkup. The urinal health checking system acts as an advising system to the user. However, the user must not neglect the idea of routine medical check-up. Around 40 percent of participants are not aware of urine testing being used in checking other health condition. They assume that the urine testing is related to determine pregnancy, drugs or alcohol.

4.1.4 Survey Analysis on Section D

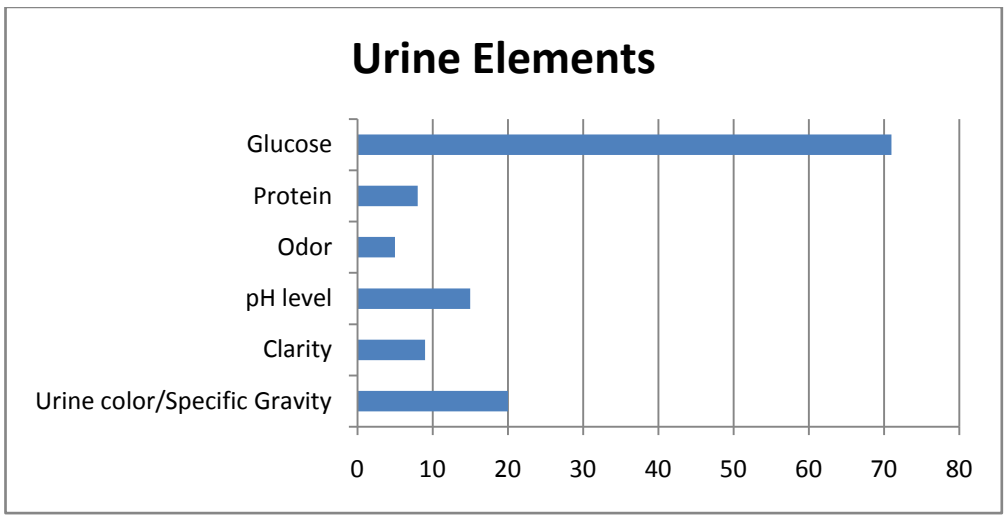


Figure 4.3: Urine Testing Analysis

Face to face interview provide the information that if a urine checking urinal is constructed, serious illness indication seems extreme to the user. With the information explained in the part d survey, around 90 percent of total participant chooses glucose, ph level and urine color. Diabetes is a well-known illness that may occur to anybody unnoticed. The excess sugar intake daily per person is the main reason for diabetes is fast in becoming the number 1 killer. This could explain the high chosen answer by participant.

4.2 Customer Requirement

The survey and interview will provide the customer needs and requirement required. The survey was done among students and working adults. A total of 50 participants gave feedback in the survey form. The survey obtained can be analysis from every perspective of various users. The interview strengthens the idea and provides the requirement of the customer needs in a urinal that could advises regarding user‟s health condition.

Information gathered from customers and research on products from market literature contributes in identifying the customer requirement.

- Comfortable

  The product should be comfortable to use and there are no limitation to the user when using. Customer seek urinal that is easy to use, such as a wide urinating platform. Automatic flushing sensor is one of the factors that need to be incorporate when constructing a urinal.

- Privacy

  Current urinal lacks the privacy factor when the user is using a urinal. Nowadays, the urinal is wide open and this will make the user feels uncomfortable. Privacy is also important as the urinal outputs the health condition of the user.

- Reliable

  The urinal should be reliable as health is a very serious matter. A system to confirm the result should be constructed. Each component must function accordingly as a simple error could produce the wrong information.

- Cost

  A low cost health checking urinal is preferable as the scope area of this product is in the public places such as shopping malls or airports. Due to the various, large amount location that this urinal could be placed, lower cost plays important role in the economic sector.

- Maintenance

  The maintenance of the urinal should not require high skill or knowledge. Maintenance should be done regularly maintain proper working condition. Special training and tools should be at a low cost.

- Repair

  If one of the components damaged, the cost of repairing should be at a low level. A replacement part is produced to replace any damaged component in the product.

4.3 Engineering Characteristics

Engineering characteristics are parameters that need to be evaluated according to the customer‟s requirement. The relation between customer requirement and engineering characteristics determine which section should be prioritized by ranking. The list of engineering characteristics that effected by customer requirement:

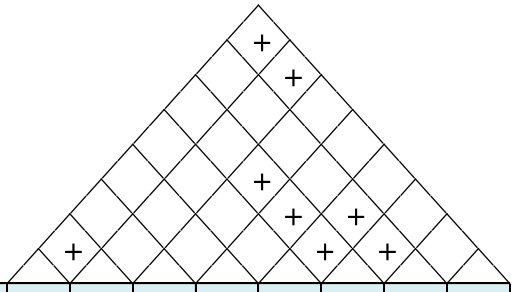
1. Size
2. Shape of urinal
3. Urine flow
4. Output display design
5. Sensor design
6. Urine cover design
7. Position of components
8. Weight

4.4 House of Quality (HOQ)

Correlations	
Positive	+
Negative	–
No Correlation	

Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼



Row#			Customer Importance	Customer Requirements (Explicit and Implicit) \ Engineering Characteristic	Size of Product	Shape of Urinal	Urine Flow Design	Output Display Design	Sensor Design	Position of Component	Time to process	Weight
				Column #	1	2	3	4	5	6	7	8
				Direction of Improvement	▼	▲	▲	◇	◇	◇	▼	▼
1			5	Cost	●	●	○	○	○	○		
2			5	Comfortable	○	●		○		○	●	
3			5	Privacy	○	●		●		○		
4			4	Maintenance			○	●	●	●	○	
5			4	Repair			○	●	●	●	○	
6			4	Reliable				○	●	○		○
7			4	Safety			○	○	○	●		●
				Raw Score	75	135	51	171	135	165	69	48
				Relative Weight %	8.8	15.9	6	20.1	15.9	19.4	8.1	5.7
				Rank Order	4	3	6	1	3	2	5	7

Figure 4.4: House of Quality (HOQ)

The House of Quality (HOQ) produced from the customer‟s requirement and engineering characteristics is shown in Figure 4.4. The correlation between customer‟s requirement and engineering characteristic could be observed in the House of Quality (HOQ). The customer importance is determined using the survey and interview method. The importance which is higher has a weight factor of 5. Each of the customer‟s requirements has a weight factor. The point system is rated at 9, 3 and 1 according to strong, moderate or weak relationship respectively. From the HOQ, the designing of the electronic components and position of the physical elements is rank as top priority in developing a urinal health checking system.

4.5 Product Design Specification (PDS)

The Product Design Specification is the basic control and reference document for the design and manufacture of the product. It is a document that contains all of the facts related to the outcome of the product development.

Product Identification

- Product Name:
  - Urinal Health Checking System
- Basic function:
  - The urinal could process the urine of the user to advise the user regarding their health.
- Special features:
  - Using sensor, the urine is processed and the output is a display. The displayer act as a communication between human and the system.
- Key performance:
  - The sensor could operate as it is intended, and the result is accurate and reliable.
  - Designing the right position for each component is important for the components to work together.

- Service environment
    - As the urinal is always in a wet/watery condition, the electronic system should be designed to never contract with the water. Any contact may cause damage to the system.
- Maintenance
    - Required a basic training on fixing/repairing the system.

Market Identification

- Targeted market and size
    - The target market is huge where any public places could use this urinal. Public place such as shopping malls, or airports could apply this product.

- Competing products
    - The rise of waterless urinal may be competitor to the urinal health checking system.

Key Project Dateline

- Time used: 28 weeks
- Dateline: 20 May 2012

Physical Description

- The urinal could operate smoothly by directing the urine to the sensor.
- The urinal offers privacy for the user, during the urinating and the display of the result.
- Sensor could operate as intended, process the sample urine, transferring the data to the control box.
- Control box will sent data to the output which is the displayer.
- A system that will flush the urinal and reset the result at the same time.

Financial Requirements

- The cost of constructing the prototype should be low.

4.6 Concept generation

From the information gathered from research, an idea of creating a health checking urinal could be done. Creativity methods and brainstorming ideas are one of proven tool of problem solving and critical thinking. Every idea formulated must not be bounded by any boundary. Even the idea is illogical or absurd; the idea may help other ideas to come into mind. Functional method decomposition will list each function that needed in ensuring that the product functions as planned.

4.6.1 Six Key Questions 5 W's 1 H

- Who

  Every male person of different age could use the urinal health checking system product. This will help by acting as a preliminary test to advise user if their urine does indicate abnormalities.
- What

  If the urine has abnormalities, the urinal health checking system will communicate with the user by display interface. Then the user should visit nearby clinic or hospital for further check-up.
- When

  If the product shows potential, the product should market as soon as it is finalized. Urine testing has been proven ages ago that it is an effective method in determining a person‟s health condition.
- Where

  The urinal could function at any public places. The main ideas of location are the shopping malls and airports.
- How

  After the product is tested thoroughly /detail, the product is reviewed by local clinic and hospitals for recognition. If all parties are satisfied with the outcome result, the product could market locally. After several years of stability, the product could market overseas.

4.6.2 Brainstorming: Flow of the system

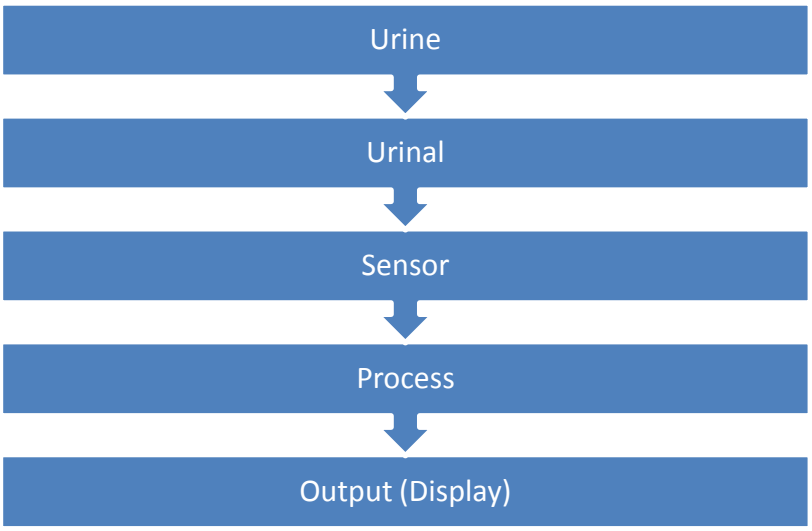


Figure 4.5: Flow of the system

For the urinal health checking system to operate, the process flow of the product operation is formulated shown in Figure 4.5. The urine will be directed to the urinal cover by the urinal platform. The sensor is located near the urinal cover where the flow of the urine is present. A sample of urine will be trapped for the sensor to process the result. The result will be output through displayer where the displayer acts as the interface.

4.6.3 Activity Analysis

Table 4.2: Activity Analysis

Use	Retire
Set up	Take down
Operating	Disassemble
Maintaining	Recycle
Repairing	Dispose

The activities that the product may encounter during the product‟s life are shown in Table 4.2. During usage, the product is set up at the operating location where the product will operate. The product will undergo maintenance and repair during the usage life time.

The retire activity includes the take down of the product which leads to the disassembly of the product. Recyclable components could be used again whereas others are disposed.

4.6.4 Component decomposition

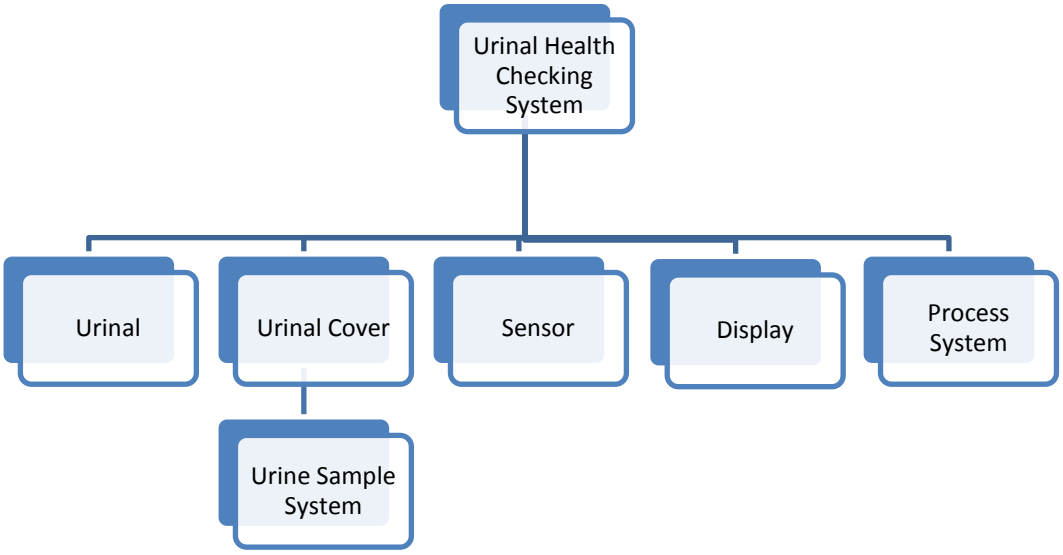


Figure 4.6: Component Decomposition

Part decomposition is important to plan the required components in order for the product to function accordingly. From ideas and research, there are six part needed to be generated which is the urinal, urinal cover, sensor, display, process system and the urine sample system. Each of the part has its own function to contribute to the final product. Any excess part may not be favourable as it will increase the cost and complexity of the product.

4.6.5 Function decomposition

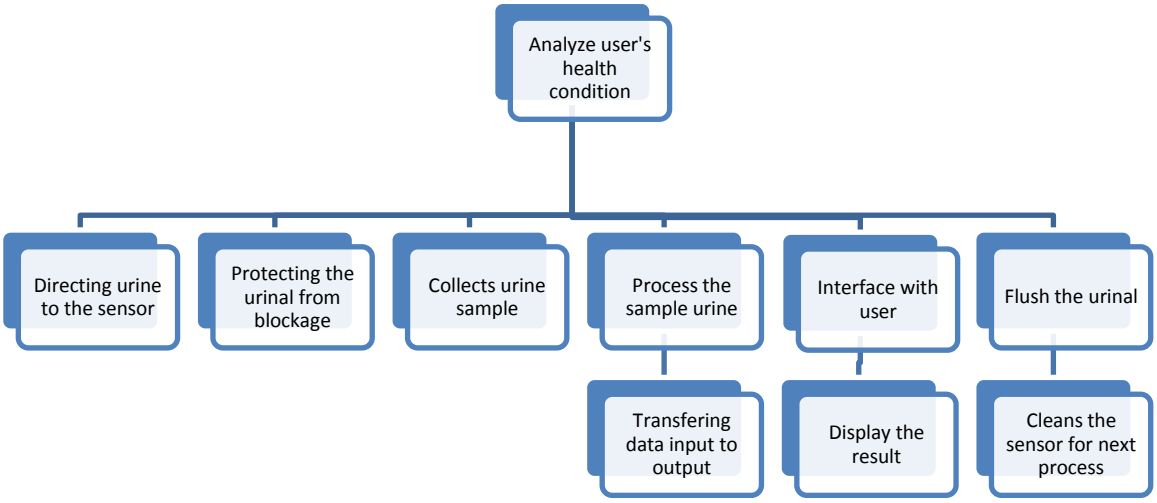


Figure 4.7: Function Decomposition

Function decomposition shown in Figure 4.7 is the elaboration of the part decomposition. From the part decomposition, function decomposition provides all the functions for the urinal health checking system to operate smoothly. Operating process could be formulated through the function decomposition. From directing urine to the output display, part and function decomposition is important in development process.

4.7 Concept Selection

In engineering design, concept selection helps determine which of the concept is the most suitable to satisfy customer requirement. The alternatives of each idea, part and component is first compared with each other before the making the final decision. The following are the method used in concept selection for urinal health checking system:

- Comparison Based on Absolute Criteria
- Pugh‟s Concept Selection Method

4.7.1 Comparison Based on Absolute Criteria

The concept will undergo 3 evaluations:

1. Evaluation based on judgment of feasibility of the design
2. Evaluation based on assessment of technology readiness
3. Evaluation based on go/no-go screening of the requirements

1.0 Evaluation based on judgment of feasibility of the design

This evaluation step needs placing of the concept into one of three categories:

a) It is not feasible
b) It is conditional
c) Looks as if it will work

From initial research on the concept design, the concept design could be placed in the second category. The system flow and components required in making the product are available resources in today‟s market. Function of each component suggests that the system could be realized. However, current technology sensor seems to be difficult to find.

2.0 Evaluation based on assessment of technology readiness

All the components in constructing the product can be manufactured by today‟s technology. The sensors are available in current market. The only concern is the availability of the sensor. Research on current sensors shows that glucose sensor are still under development.

3.0 Evaluation based on go/no-go screening of the customer requirements

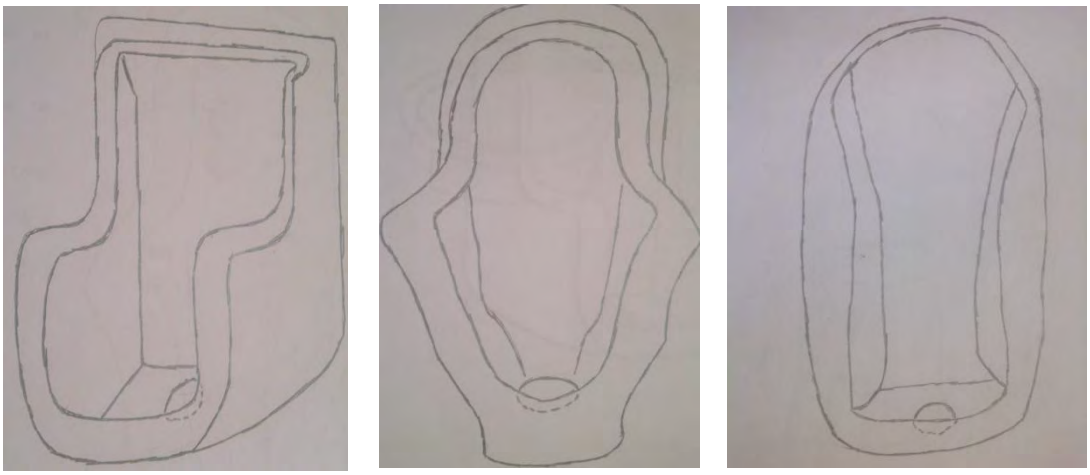
Comparing the idea planning and the customer need, the product will satisfy customer‟s requirement. The design concept emphasize on customer requirement during the development of the idea. The evaluation suggest the answer is maybe (go).

4.8 Concept Selection Method

Pugh‟s Concept Selection is used in determine the best concept that fits the requirement. This method will be used on each component respectively. The chosen components from each part will be assembled for the final product.

4.8.1 Urinal

Figure 4.8: Current urinal datum A (Source: Brackynews, 2011)



Concept B Concept C Concept D

Figure 4.9: Concept Generation for Urinal

The current urinal in public places is shown in Figure 4.8. The current urinal is set as the benchmark in producing a urinal that is closer to the customer‟s preference. Figure 4.9 is the concept generated for the urinal shape. The designs are formulated through a focus group. When generating the concept idea, important criteria gained from the customer‟s requirement plays an important role. Based on the customer‟s requirement, the privacy and comfort is lacking in the current urinal design. To implement the requirement, the urinal should construct a privacy screen to each of the urinal. The shape of the urinal should be wide enough and artistic to provide comfortable environment for the user. Ease of manufacturing and simplicity are also taken into consideration.

Concept design sketching

The main factor before formulating the concept design is that it will satisfy customer‟s requirement. The urinal should have an adequate privacy and comfortable. Comfortable for a urinal is that it is simple, calming appearance and has a wide platform for urinating.

Table 4.3: Pugh‟ Concept Selection for Urinal

Urinal Shape Design						
Row	Criteria		Concept			
			D	A	B	C
1	Cost		=	DATUM	-	-
2	Added Functionality (Privacy)		=		+	+
3	Simplicity of Design		+		=	-
4	Availability of Materials		=		=	=
5	Ease of manufacturing		=		-	-
6	Weight		-		-	-
7	Comfort		+		=	+
8	Shape Design		=		-	+
		Pluses	2		1	3
		Minuses	1		4	4
		Similar	5		3	1

The result of using the Pugh‟s Concept Selection Method is shown in Table 4.3. Criteria used in the selection method are designed to reach not only the customer‟s requirement, but to ease the manufacturer in the process of developing the final product. Cost, added functionality and simplicity of the design of each of the idea are compared using the pluses and minuses method. Each of the idea is compared to the datum where the idea with the most pluses is the suitable idea to be implemented to the product. However, further consideration should be done to weigh all the possible ideas. Concept D is selected among the 3 designs formulated.

4.8.2 Urinal cover

Figure 4.10: Current urinal cover datum A (Source: Brackynews, 2011)

Concept design sketching

Concept B Concept C Concept D

Figure 4.11: Concept Generation for Urinal Cover

Similar to concept development of the urinal shape, the datum used is the current product applied at current urinal. Figure 4.10 and Figure 4.11 is the datum and the concept generated respectively. The urinal‟s cover should protect the hole from other materials from entering the urinal‟s system. Only water forms are allowed through the system.

Table 4.4: Pugh‟s Concept Selection for Urinal Cover

Urinal Cover Design						
Row	Criteria		Concept			
			D	A	B	C
1	Cost		-	DATUM	+	-
2	Added Functionality		=		=	=
3	Simplicity of Design		=		+	-
4	Availability of Materials		=		=	=
5	Ease of manufacturing		=		-	-
6	Weight		=		-	+
7	Shape Design		+		+	+
		Pluses	1		3	2
		Minuses	1		2	3
		Similar	5		2	2

Using the same method, the Pugh‟s Selection Method determines which of the concept is suitable with the customer‟s requirement. Comparing the pluses and minuses, concept B is selected as it satisfies the criteria.

4.8.3 Display

There are 2 options in determine which display should be implemented into the system:

a) Light Emitting Diode(LED) Display

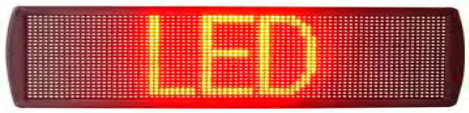


Figure 4.12: LED Display (Source: SK Pang, 2012)

b) Liquid Crystal Display(LCD) Display

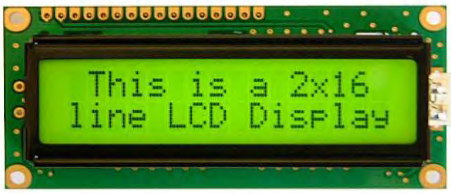


Figure 4.13: LCD Display (Source: SK Pang, 2012)

2 types of display available are shown in Figure 4.12 and Figure 4.13. LCD display offers a smoother display than LED display. This proves to be a lot softer to the eyes of the user. The LED display has a light intensity higher than that of LCD display causing strain to the eye. The LCD display also has a lower price than LED display, as manufacturing of LED display are a bit costlier.

LED display in the other hand has power consumption factor advantage to the display. Their power consumption is 40 percent lesser than LCD display. They are

also more eco friendly because mercury is not used in producing LED display. LEDs last longer than LCD, with little reduction in their power output over time, which makes these monitors long-lasting.

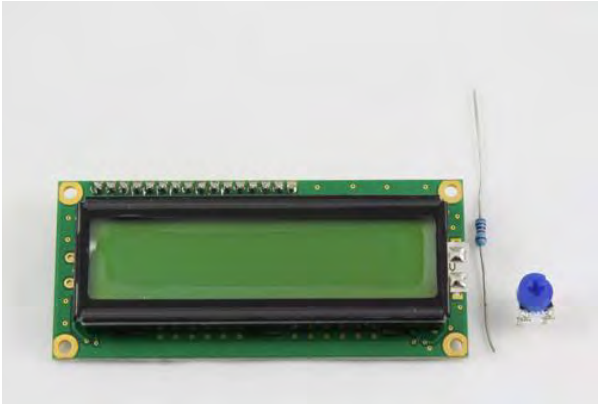


Figure 4.14: LCD display with LED display (Source: SK Pang, 2012)

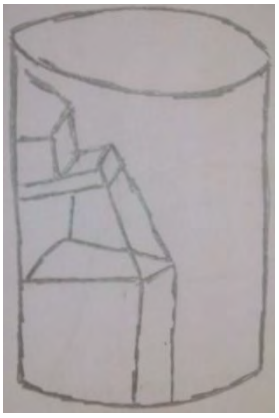
The LCD display and LED display backlighting could be observed in Figure 4.14.A display that has combination of LCD display and LED display backlighting will provide customer with a bit of both display‟s benefits. LCD display with LED backlighting saves energy and has better quality image. It also has low cost due to market.

4.8.4 Collecting Urine Sample System

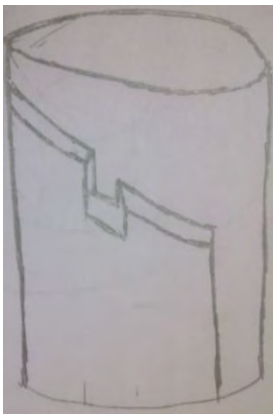
This system is designed to collect urine sample for the sensor to process. A small percentage of urine is trapped to allow the sensor to fully process the urine. The system also must be able to allow water from flushing to wash away the urine after process. The sensor must be free from the urine after process to process the next user‟s urine. For concept A, the outer piping system will cover the urinal cover thus allowing the urine to flow through the thread designed.

Concept Design Sketching

Concept A



Concept B



Concept C

Figure 4.15: Concept Generation for Trapping Urine System

The concept generation for trapping urine system is shown as in Figure 4.15. Trapping urine sample is vital to allow the function of process the urine. A small sample of urine will be trapped which will allow the sensor to be submerged in the urine to be processed. The trapping system must also allow the flow of flushing water to clean the trapping area and the sensor simultaneously. Focus group is used in developing the trapping system which produced 3 tangible ideas that could be implemented to the current urinal cover. There is no datum for trapping system as there is no current system that implements trapping urine system at current urinal cover. Therefore, concept A is used as a datum to be compare with other concepts.

Table 4.5: Pugh‟s Concept Selection for Trapping Urine System

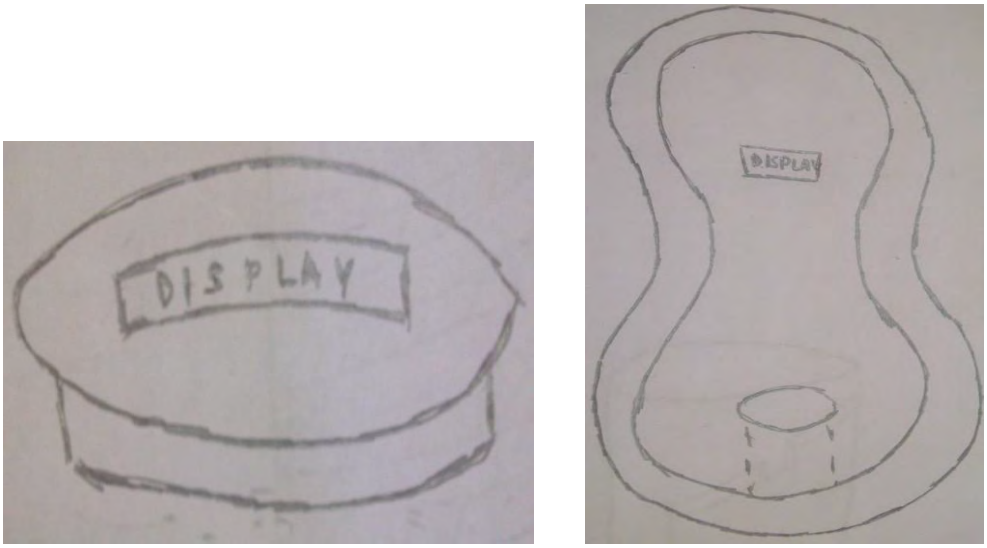
Collecting Urine Sample Design					
Row	Criteria		Concept		
			C	A	B
1	Cost		-	DATUM	-
2	Added Functionality		=		=
3	Simplicity of Design		-		-
4	Availability of Materials		=		=
5	Ease of manufacturing		-		-
6	Weight		+		+
7	Shape Design		-		-
8	Ability to prototyping		-		-
9	Amount urine flow into system‟s path		-		-
		Pluses	1		1
		Minuses	5		5
		Similar	2		2

The Pugh‟s concept selection for urinal cover is shown in Table 4.5. The outcome of the concept selection shows that both concept B and C have minuses criteria than the datum selected. Datum A is used as design concept to be implemented to the product.

4.8.5 Display location

The display acts as an interface between the system and human user. The display will show the result from the data received from sensor via control box. The display should be at a comfortable location for the user to see.

Concept Design Sketching



Concept A Concept B

Figure 4.16: Concept Generation for Display Location

In developing the display location suitable to the design, concept A is the most suitable as it provides privacy and comfort to the user to observe the result of the urine testing. Concept B does not provide the adequate privacy which unfavourable as the result is private and confidential information of the urinal user.

4.8.6 Sensors

The sensor is one of the important parts of urinal health checking system. The sensor should be able to process the urine using a sample of urine trapped. The sensor will send the result whether the user has abnormality in their urine or not. The sensor criteria‟s is that it is small enough to fit the urinal. The sensor must also be reliable as the result of the process is regarding health condition of the user. Using the water from the flush system, it will displace the trapped urine and at the same time cleans the sensor for the next user.

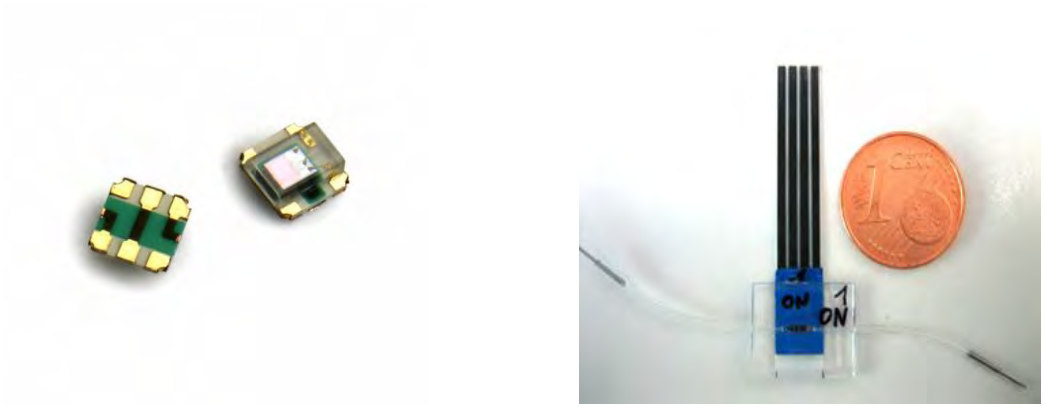


Figure 4.17: Light and Glucose Sensor (Source: http://parts.digikey.com)

There are 2 options of sensors that are suitable for the system which is the chemical sensor and the light sensor shown in Figure 4.17. The chemical sensors are sensors that detect the chemical compound exist in the urine. Glucose, Protein, and pH level are examples of the chemical abnormality that may exist in the urine. Chemical sensor operates by contact with the chemical compound where the sensor could sense the elements.

The light sensor could sense the colour of the urine. From the colour result obtained, it could determine whether a person is de-hydrated or having other illness. Light sensor could operate by 2 components where the transmitter will emit light from opposite the receiver. The light goes through the urine and the receiver will analyze the wavelength where the colour of the urine could be determined.

4.9 Product architecture

4.9.1 Arrangement of physical elements

Electronic process flow

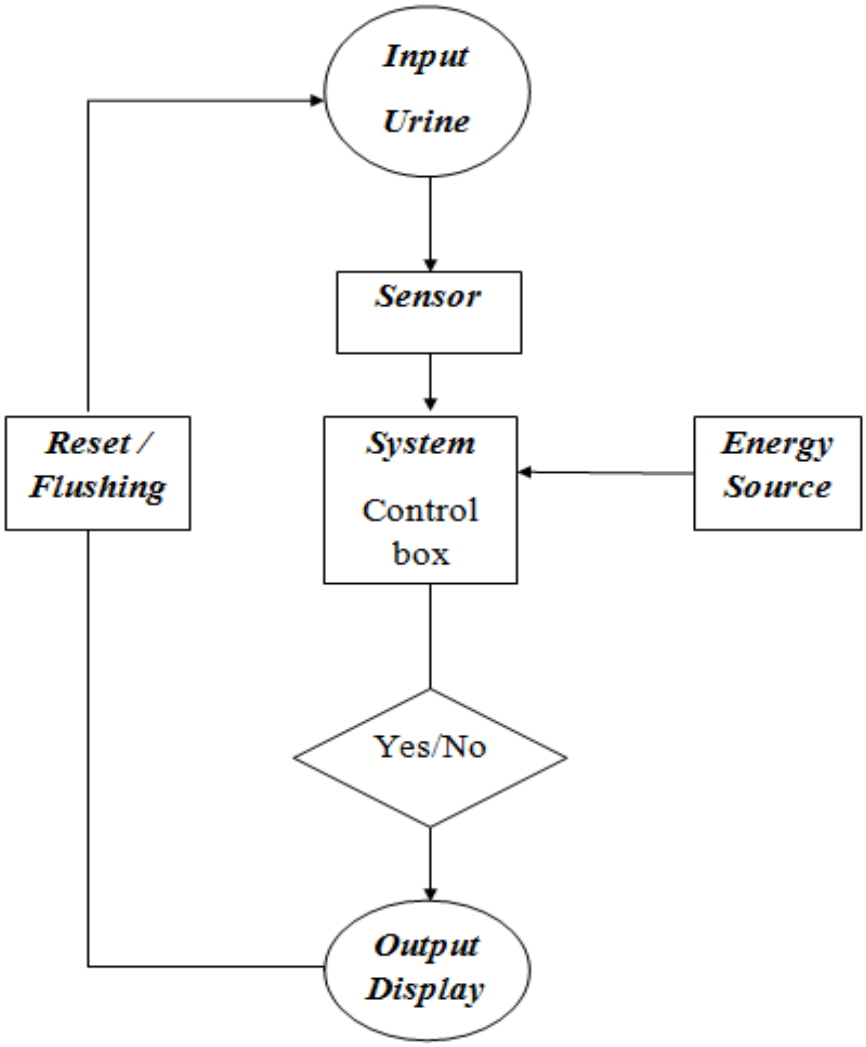


Figure 4.18: Schematic diagram of electronic components

The electronic system is placed inside the urinal cover. The displayer will be located at the top cap of the urinal cover.

4.9.2 Flow in the collecting urine sample

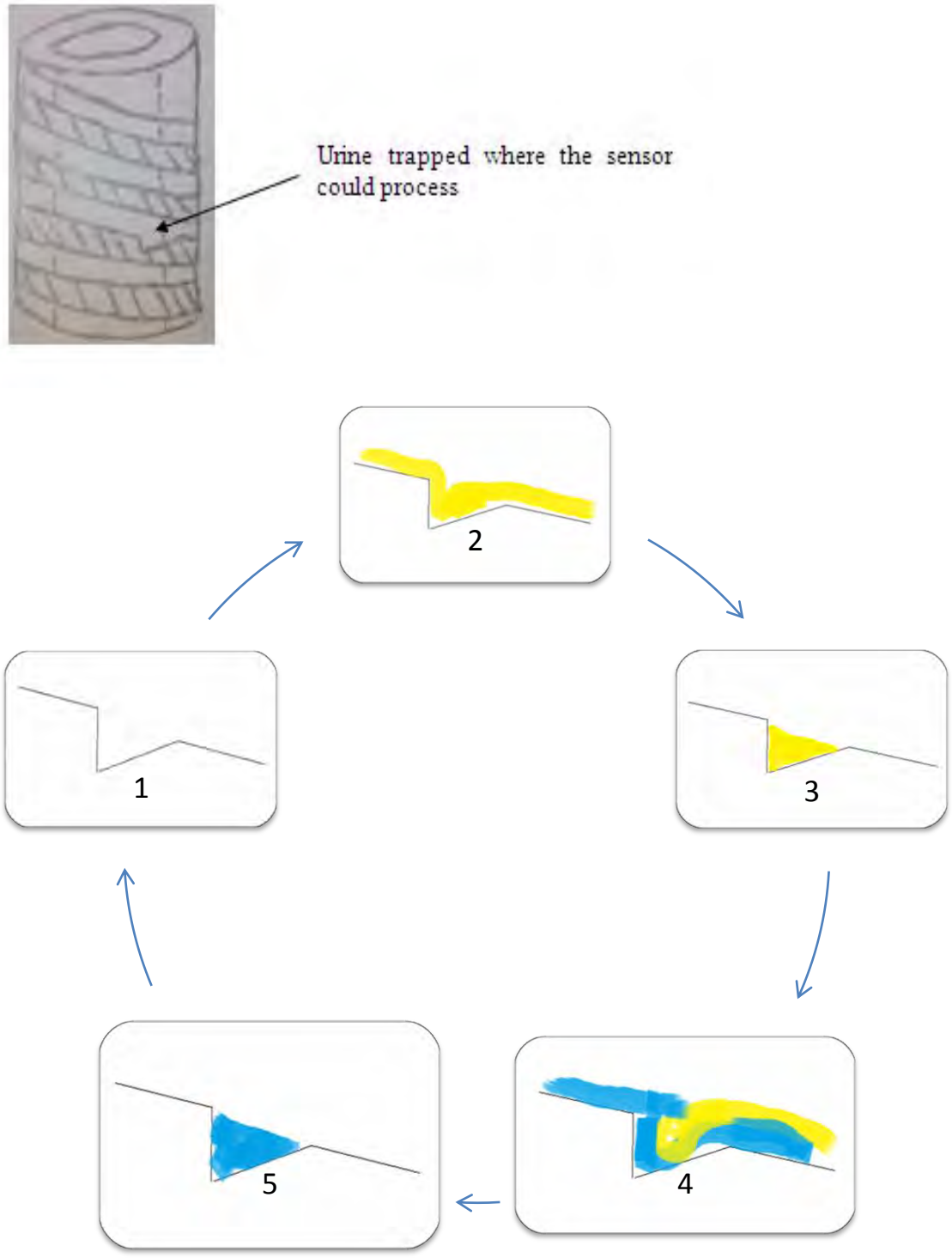


Figure 4.19: Flow in collecting urine sample system

The flow of the trapping shown in Figure 4.19 is as follows:

1. The trap system is designed to trap a sample of urine to be process. The sensor is placed at bottom slot of the trap.
2. The urine will flow through the system where sample urine will be trapped.
3. The urine trapped will be analyzed by the sensor. The data will be sent to the control box. The control box will use the display as interface. The display will indicate whether the urine is normal or abnormal.
4. After the result is known to the user, the flushing system will supply the water for cleaning. The water will displace the urine as well as cleans the sensor.
5. The trapped water will then be displaced by the next user‟s urine starting the process again.

4.10 Design for Assembly and Manufacturing (DFMA)

Design for Assembly and Manufacturing (DFMA) is implemented into the development of the product:

1. Minimize part

   The parts of the urinal health checking system are minimizes to reduce the total cost of manufacturing. The quality and reliability of product will also increase as there is less part available to failure or chance of misalignment.

2. Incorporating multiple function into one part

   The idea to incorporate electronic component into the urinal cover will make the assembly of the product easier. Maintenance and repairmen work is significantly reduce as the components are in one part.

3. Reduce the number of screws and screw types

   Reducing fasteners in the product will reduce the cost and complexity of the final product. For the urinal health checking system, screws usages are replaced with fitting components and snap fits.

4. Modular Assembly

   Modular Assembly will allow the placement and assembly of components easier. If components fail to function, modularity allows the disassembly of the product and to be assembled back after the maintenance.

5. Stack Assemblies

   Stack Assemblies is applied at the assembly of the electronic components in the urinal cover. The part is assembled from top to bottom makes automatic assembly possible. The electronic components are placed stack according to the orientation.

6. Assemble in open space, do not bury important components

   This method is incorporated into the electronic components. The important components must not be buried which is the sensor and the control box. If one of the components fails, the replacement of the component will be difficult as it is buried in the product.

7. Design mating features for easy insertion

   Assembly speed will increase as design mating features will help the assembler to locate the position of the component. This will also help with maintenance with the product as the components are easy to be identified.

4.10.1 Modularity

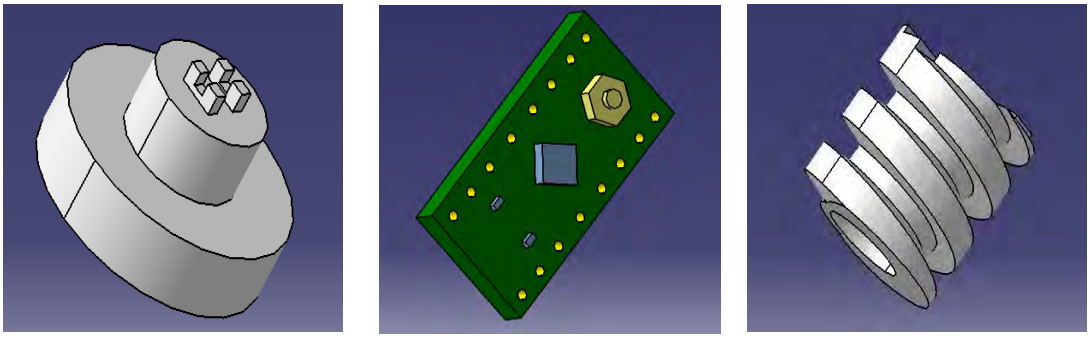


Figure 4.20: Modularity Bottom Body

The modularity of the bottom body is shown in Figure 4.20. The bottom cover is designed to hold the control box in place. The sensor is connected to the control box by wiring through the centre hole. When the control box is place in placement, the bottom is fitted into the body.

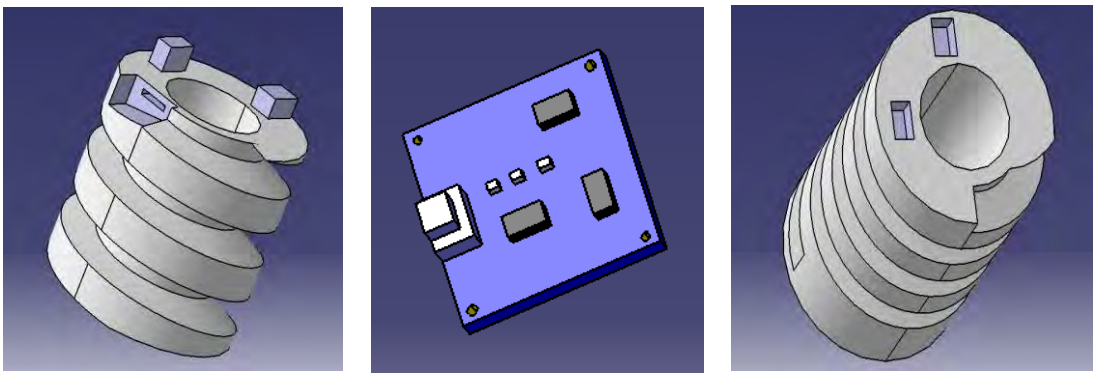


Figure 4.21: Modularity Middle Bottom

Modularity of the middle and the bottom body is shown in Figure 4.21. The sensor is slotted into the design slot where the connector to the control box is through the hole. The wiring hole will be designed with rubber to avoid fluid to enter through the hole. Existence of fluid in the system could damage the electronic system. The sensor will process the urine and the data will be sent to control box.

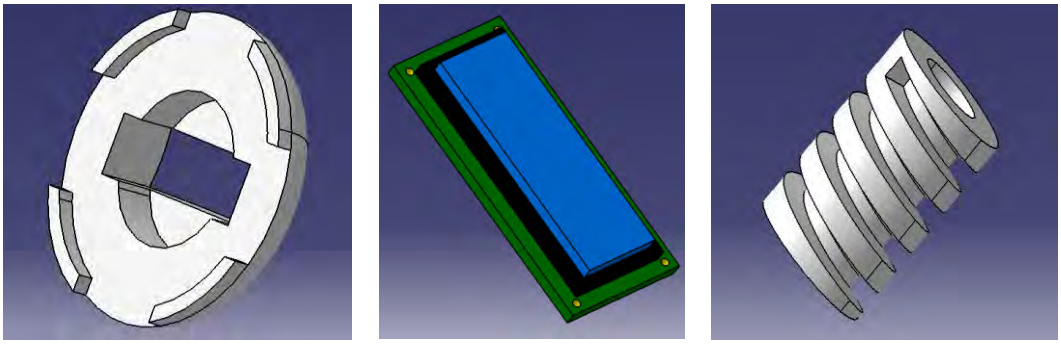


Figure 4.22: Modularity Top Cover

The display is slotted into the urinal cover. The display is connected to the control box where the output data will be received. The body and the urinal cap are snapped fitted together. The display is covered by plastic material to avoid the water inside the displayer. Figure 4.22 shows the components of the top and cover modularity.

4.11 Detail Design

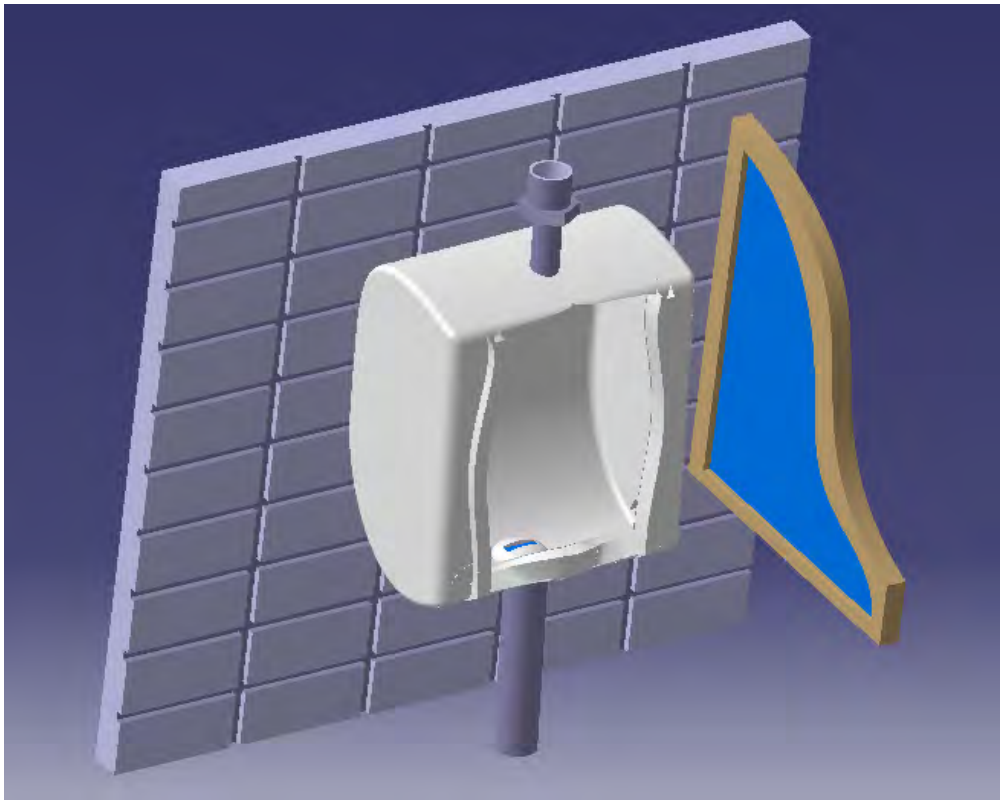


Figure 4.23: Detail Design of Urinal Health Checking System

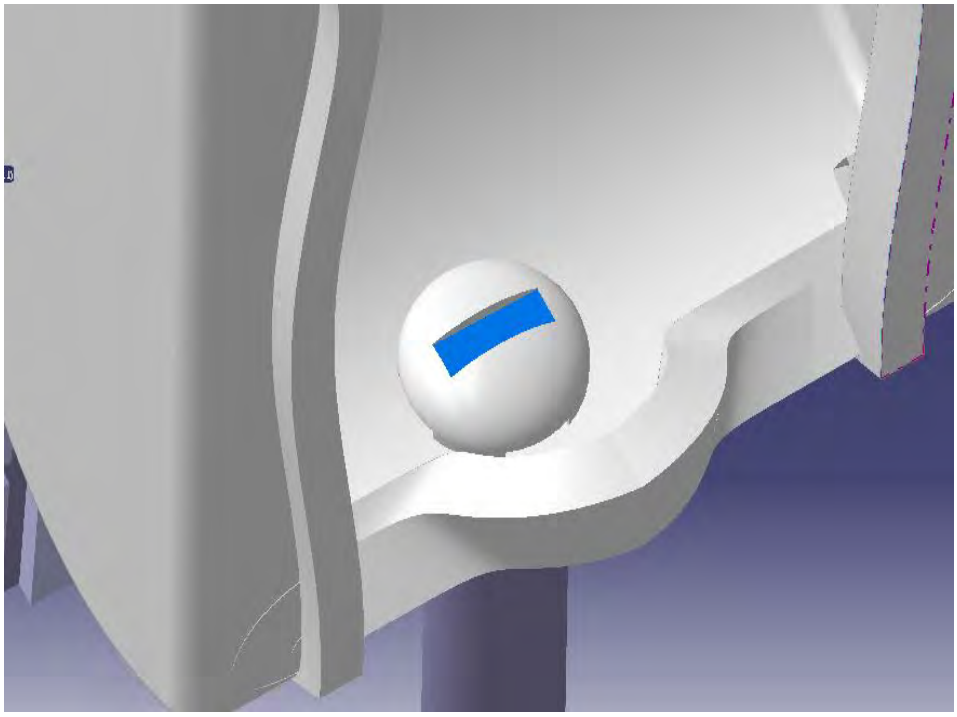


Figure 4.24: Urinal Cover Placement

Figure 4.25: Urinal Cover Appearance

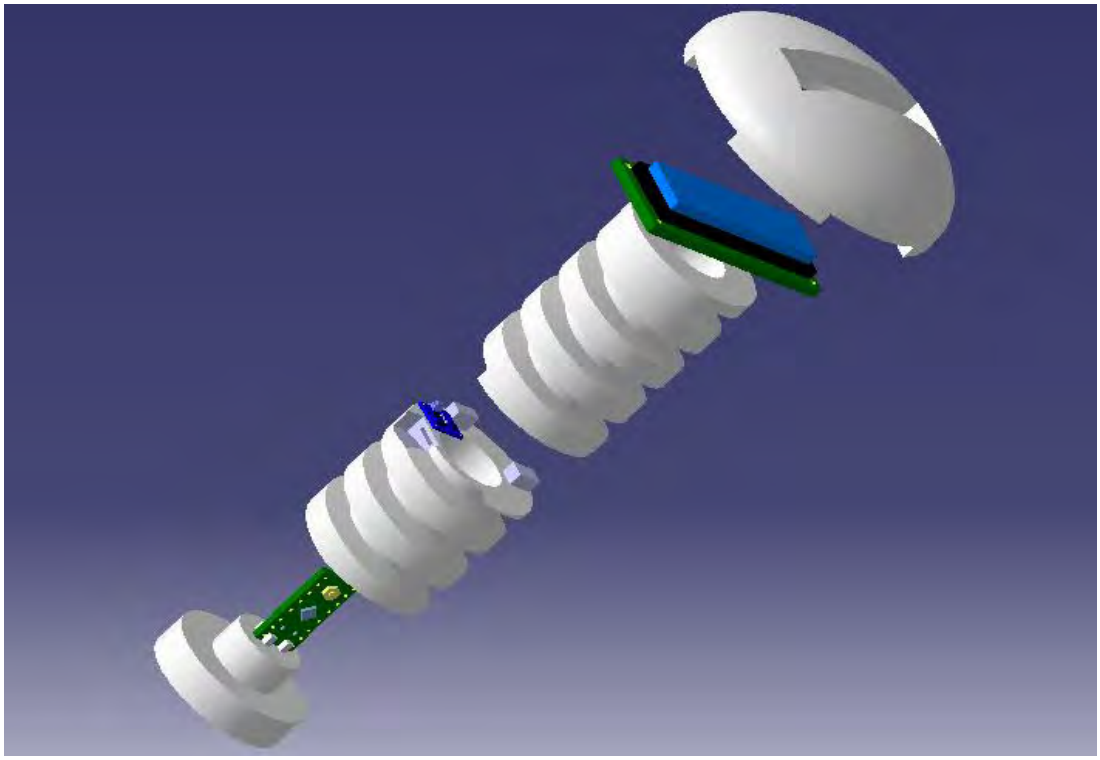


Figure 4.26: Exploded View of Urinal Cover

4.12 Prototype

4.12.1 Fused Deposition Modelling Machine (FDM)

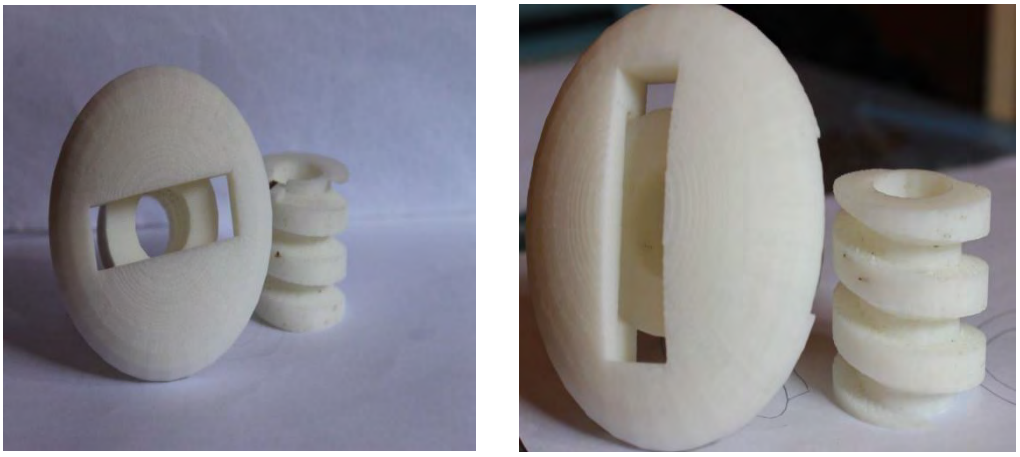


Figure4.27: Urinal Cover Prototype Using FDM Machine

4.12.2 Prototyping of Product

Cost and ease to prototype is main factor in prototyping the urinal cover. The urinal cover have respective placement for the electronic system. The Fused Deposition Modelling Machine could prototype the product with high accuracy. The product obtained is accurate with tolerances of 0.01cm between the connection fit.

Figure 4.28: Prototype of Product

Prototyping of the urinal support is fabricated to the current urinal dimension. The urinal cover prototyped using rapid prototyping follows the dimension of the standard urinal piping system. The electronics part required the purchase of sensor, control box and display. Wiring and programming of the electronic components are also needed in producing the processing system. The reliability of the electronic system is to be tested as customer requires the highest quality when it comes to health issues.

CHAPTER 5

DISCUSSION

5.0 Discussion of Development Process

The survey and interview helps determine what the customer needs. From the interview and survey, list of criteria that should implemented to the urinal are obtained. House of Quality (HOQ) is used by calculate the relation between customer‟s requirement and engineering characteristics. Ranking will determine which criteria should the product prioritized. From the analysis, comfort and privacy are the main factor in developing the urinal health checking system. Cost is another factor due to the added electronic components that could process the urine to the urinal.

Various ideas and alternative solution are generated in the concept generation. Criterions ranked earlier are the key that is in cooperated into the concept. Part and function decomposition is formulated to plan what components that should be used in building the new product. Each parts of the product are brainstormed into several alternative solutions to the problem. Alternative solutions are generated based on the customer‟s requirement. The next step is to determine which alternative is best suited the product. Pugh‟s concept selection is used and a focus group is formed to analyse each pros and cons of the idea generated.

After each of the components is selected, the product architecture process is conducted. The selection of components are then combined and assembled. The arrangement of physical elements is sketched to plan the flow of the product

operation system. Electronic components locations are determined on where the sensor could process and it is connected to the control box. Parametric design method such as Design for Assembly and Manufacturing (DFMA) and Modularity is applied to the product. Detail design using CATIA is used to provide visual and geometric limitation of the product. The parts should be able to fit and operate accordingly.

Prototyping step requires the planning of the replication process of the actual product. The electronic components are searched through local market whereas the urinal structure is fabricated. The urinal cover uses rapid prototyping process as the process could prototype with accuracy plus the material used is water resistant. Fused Deposited Modelling Machine (FDM) is the rapid prototyping machined used. The result is a well replica of the urinal cover. However, there are problem encountered regarding the electronic components which is the availability and cost of the sensor. From research the chemical sensors are difficult to obtain in local market and the cost of the sensor is expensive.

The weakness encounter is the fitting between the two bodies of urinal cover may occur leakage. Any leakage could damage the electronic system inside the product. Other types of connecting method such as screw fitting could be implemented. The bottom body is in the shape of the screw will fit into the top body where the thread fits the bottom body. This method could avoid leakage to the product. The top cover of the urinal cap is unprotected from theft as manually exerting force may remove the cap. A connector that will attach the urinal cover to the urinal will prevent

5.1 Strength & Weakness of Product

From the result gained from research and engineering process during development of urinal health checking system, the strength and weakness of the product could be observed.

5.1.1 Strength of Product

The strength of the urinal health checking system:

1. The total cost of the product is relatively low. The components of the product are minimized to focus on the main objective of constructing a low cost urinal health checking system.
2. The product is easy to be assembled and disassembled as the product implements Design for Manufacturing and Assembly method. The process of assembly is short and easy for the supplier. The maintenance and repair work are also made easy as the product could disassemble to check on the electronic components.
3. The urinal health checking system could operate at public places such as airports, shopping mall.
4. Easy to manufacture due to the simplicity of the product. The maintenance does not require high level of skill.

5.1.2 Weakness of Product

1. The difficulty to acquire the chemical sensor and the cost of the chemical sensor is expensive.
2. Leakage of urine at the urinal cover may cause the electronic parts to short circuit.
3. Customer uses the urinal health checking system as an excuse to avoid going for medical check-up.

4. . The top cap could just be removed with force manually as it has a low security to theft activity.

CHAPTER 6

CONCLUSION & RECOMMENDATION

6.0 Conclusion

From the design, development and fabrication of the urinal health checking system, the objective of develop a low cost urinal health checking system is achieved. The product could be produce with the right resources. Problem statement is the key purpose where the main goal is to solve the problem. From the problem statement, the objective of the project could be formulated. Planning for solving the problem statement is important in order to ensure the objective is achieved. Urinal health checking system requires the application of engineering design steps to develop the product systematically from every perspective. Concept generation, Concept selection and detail design are step that needs to be implemented to satisfy the market and customer needs. Fabrication of prototyping provides visual appearance and functionality of the product of the actual product. From the prototype, further improvement could be made to increase the quality and practicality of the urinal health checking system.

6.1 Recommendation

The prototype development project of design, develop and fabrication of urinal health checking system does not possess the electronic components. For future recommendation, electronic components should be able to be assembled inside the product according to the design of the product in this project. List of prototype components:

1. Control box
2. Chemical sensor
3. Displayer
4. Wiring
5. Connectors

The control box is programmed using the programming software to detect the data from the sensor. The process will determine whether the person have abnormality or normal urine content. The control box will sent the result to the output display where the displayer is programmed to display the data. Other recommendation is to design where the other sensors could be fitted into the design. The reliability of the electronic components are also analyzed and calculated.

This product could market to be attached into houses and direct information of the urine contents may link to nearby hospital for patient. This allows constant monitoring of the urine condition of the user. Another recommendation is to develop where the system could be used for woman. The system could be develop and apply at toilet bowl.

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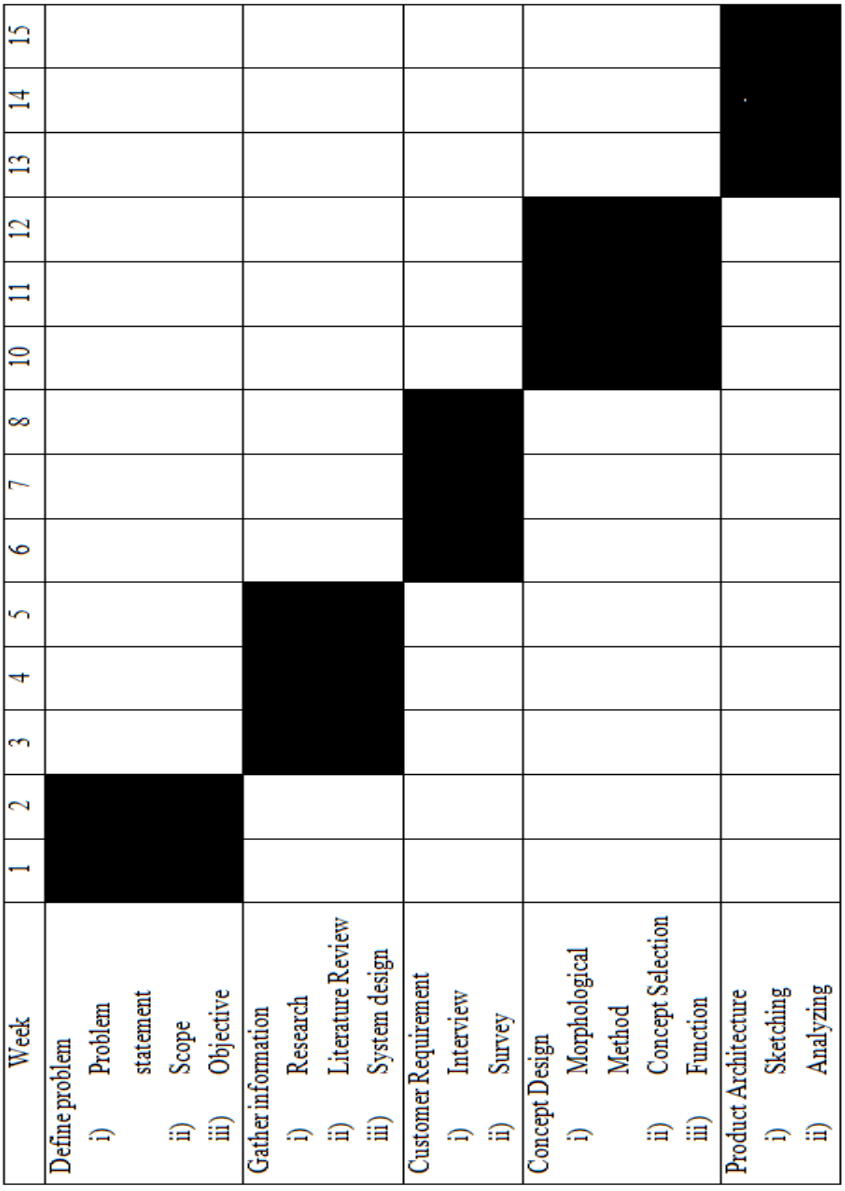
APPENDIX

APPENDIX A (1)

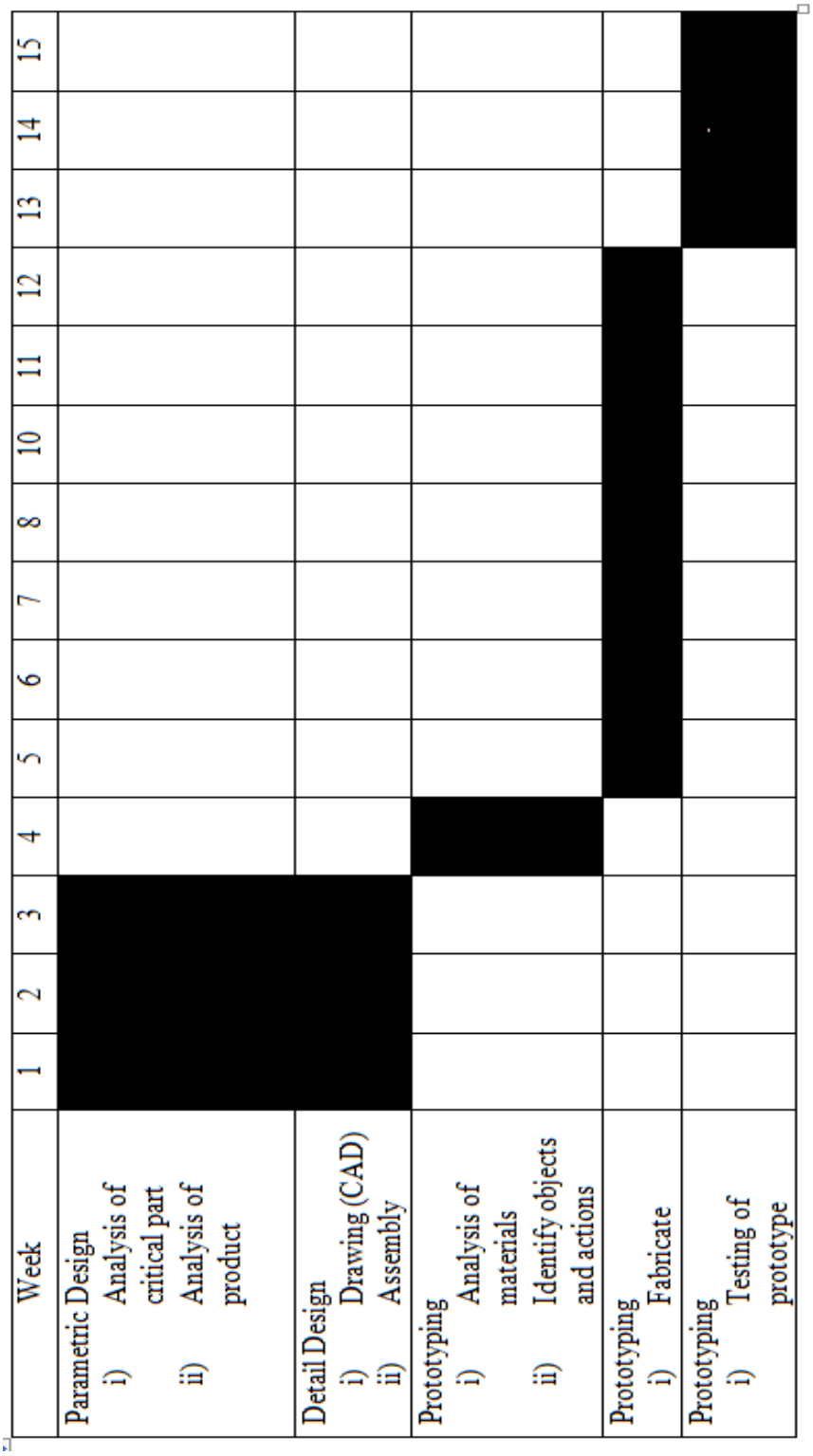
Gantt chart for Semester 1



Week	1	2	3	4	5	6	7	8	10	11	12	13	14	15
Define problem														
i) Problem statement														
ii) Scope														
iii) Objective														
Gather information														
i) Research														
ii) Literature Review														
iii) System design														
Customer Requirement														
i) Interview														
ii) Survey														
Concept Design														
i) Morphological Method														
ii) Concept Selection														
iii) Function														
Product Architecture														
i) Sketching														
ii) Analyzing														

APPENDIX A(2)

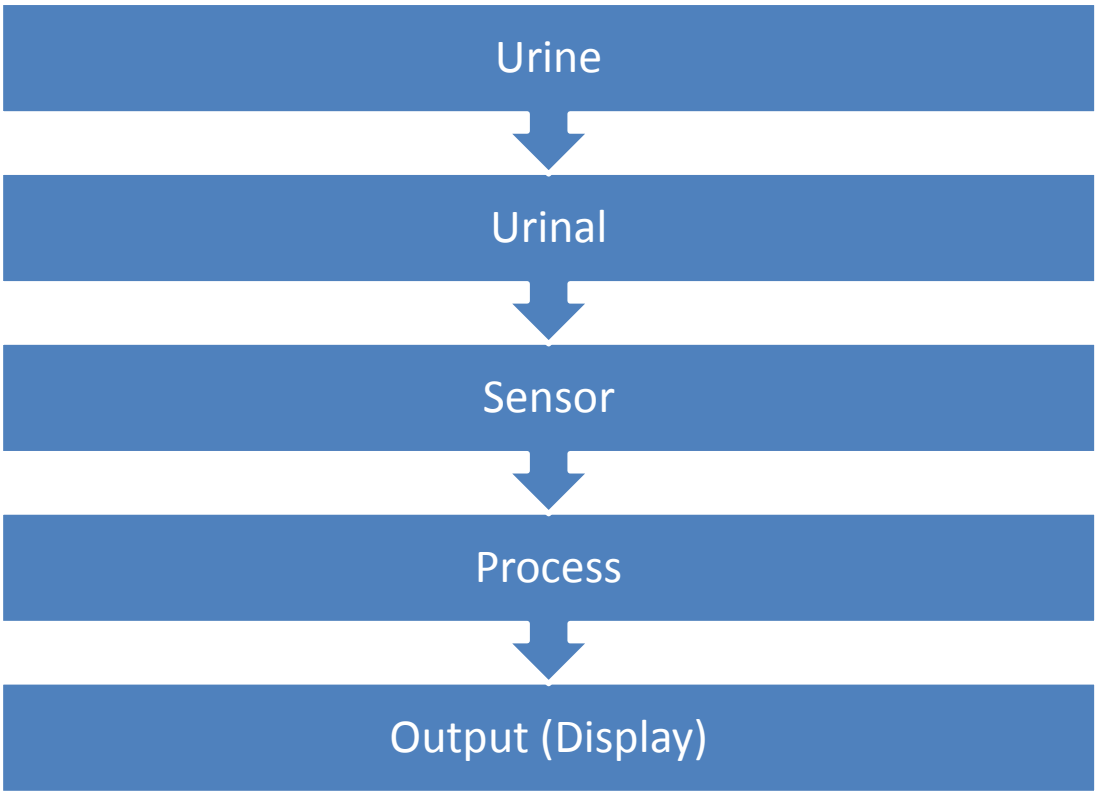
Gantt chart for Semester 2



Week	1	2	3	4	5	6	7	8	10	11	12	13	14	15
Parametric Design i) Analysis of critical part ii) Analysis of product														
Detail Design i) Drawing (CAD) ii) Assembly														
Prototyping i) Analysis of materials ii) Identify objects and actions														
Prototyping i) Fabricate														
Prototyping i) Testing of prototype														

APPENDIX B

Urinal Design Flow System



APPENDIX C

Example of Survey

UNIVERSITY TECHNICAL MALAYSIA, MELAKA
FACULTY OF MECHANICAL ENGINEERING
FINAL YEAR PROJECT 2011/2012
DESIGN OF URINAL HEALTH CHECKING SYSTEM

SURVEY ON KNOWLEDGE, FEEDBACK AND OPINION REGARDING CURRENT URINAL

This survey questionnaire is designed to gather information regarding people"s opinion about the current urinal. This information will contribute in developing the current urinal into a health checking urinal. This urinal could function as a preliminary test to indicate the health condition of a person. Please tick in the box according to your opinion.

Thank you in advance for your support and feedback in assisting the development of urinal health checking system. If there is any further inquiries or feedback, contact are as follow.

Yours sincerely,

_____

ADI ALIF BIN AZIM NG
4TH AND FINAL YEAR STUDENT
UNIVERSITY TECHNICAL MALAYSIA MELAKA
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B040810233@student.utem.edu.my

SECTION A

Preference between urinal and toilet bowl

Please tick X in which best describe your preference.

Preference	*Toilet bowl*	*Either*	*Urinal*
1. *Preference of using*			
2. *User friendly*			
3. *Comfort*			
4. *Hygienic / Cleanliness*			
5. *Privacy*			
6. *Ease to use*			

Regarding your preferences, please state any other reasons for your choice

_____

_____

_____

_____

SECTION B

Opinion / experience regarding current urinal

Based on your experience and knowledge in using current urinal, please choose that will best describe your opinion.

Please use this 5 point scale as a reference:

①	②	③	④	⑤
Unacceptable	*Dissatisfied*	*Neither*	*Satisfied*	*Outstanding*

Please mark ⊗ on the rating that best describe your answer.

In average, how often do you urinate daily?

1 ( ) 2 ( ) 3 ( ) 4 ( ) More than 5 ( )

	Unacceptable	Dissatisfied	Neither	Satisfied	Outstanding
1. *Current urinal is comfortable*	①	②	③	④	⑤
2. *Current urinal is user-friendly*	①	②	③	④	⑤
3. *Current urinal offers adequate privacy*	①	②	③	④	⑤
4. *Current urinal is hygienic / cleanliness*	①	②	③	④	⑤
5. *Current urinal automatic flushing sensor*	①	②	③	④	⑤
6. *Current urinal flushing system effectiveness*	①	②	③	④	⑤
7. *Atmosphere when using current urinal*	①	②	③	④	⑤
8. *Height of the urinal*	①	②	③	④	⑤

SECTION C

Health related routine (Medical Check-up)

1. How often do you visit the hospital for medical check-up?

   Weekly ( ) Monthly ( ) Yearly ( ) Once per >1 year ( )

2. What are the reasons to do a medical check-up?

   Compulsory routine ( ) Feeling a hint of unwell ( ) Feeling unwell ( )

   Experience pain ( )

	Unacceptable	Dissatisfied	Neither	Satisfied	Outstanding
1. *Travelling for medical check-up*	1	2	3	4	5
2. *Parking availability at hospital / clinic*	1	2	3	4	5
3. *Services by hospital / clinic*	1	2	3	4	5
4. *Waiting room comfort*	1	2	3	4	5
5. *Waiting time during queue for medical check-up*	1	2	3	4	5
6. *Knowledge gained regarding own health after medical check-up*	1	2	3	4	5
7. *Knowledge on urine*	1	2	3	4	5
8. *Awareness regarding urine testing*	1	2	3	4	5

SECTION D

Urine testing

Information obtained through urine testing

Color / Specific Gravity of Urine: Water intake of a person.
Clarity: May indicate bacteria / parasite infection.
pH level: High alkaline may cause by kidney disease or urinary tract infection. High acid may indicate lung disease or uncontrolled diabetes.
Odor: A sweet, fruity odor may be caused by uncontrolled diabetes. Bad odor may also cause by urinary tract infection (UTI).
Protein: Existence in urine may indicate kidney damage or infection.
Glucose: Existence in urine may indicate diabetes.

From the information above, which information regarding urine is preferable to be update daily or weekly?
Color/Specific Gravity ( ) Clarity ( ) pH level ( ) Odor ( ) Protein ( ) Glucose ( )

PERSONAL INFORMATION

Age:

◯ 13-18 years old ◯ 18-25 years old ◯ 26-40 years old

◯ 40-50 years old ◯ > 50 years old

Occupation: ◯ Student ◯ Professional Others _____

Gender: ◯ Male ◯ Female