Smart Brokering for Household Items

By

Lee Jia Zhen

16016

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
32610 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Information and Communication Programme
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Approved by,

_____

(Dr Izzatdin Abdul Aziz)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SRI ISKANDAR,
32610, TRONOH, PERAK
MAY 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not undertaken or done by unspecified sources or persons.

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LEE JIA ZHEN

ABSTRACT

Households will normally feel very annoyed when they want to buy a product but the budget is limited. Thus, a wise consumer will carry out product price survey before purchasing so that he or she is able to buy the desired product within the required budget.

This project proposes the development of a Smart Brokering System for product price survey activity so that to ease consumers in their daily routine in selecting the household products. In this project, a price comparison system for household products will be developed to display all possible product prices from several grocery stores based on the budget preferences set by the consumers. In particular, the proposed system will be developed by using a full-text search library, which the data is already been populated in the database to implement the data retrieval process. This system is written in C# and ASP .Net. Apart from that, system testing is carried out by the author to test the algorithm so that the functions are working smoothly and perfectly. Acceptance tests has been done by the potential consumers to make sure the end product meet the users' requirement.

As a result, the expected outcome of this research is to improve the easiness of shopping and the efficiency of price surveying activity by the consumers.

ACKNOWLEDGEMENT

Greatest pleasure goes to acknowledge the efforts of many people who directly or indirectly gave their support, guidance, motivation, cooperation, understanding and friendship toward the accomplishment of this final year project. Without their support, completing this project would be difficult.

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Last but not least, greatest recognition poured to my dearest family members, team members who are under the supervision of Dr Izzatdin and fellow friends for being all the while supportive, understanding and helpful. I truly appreciate the useful advices they gave to me when I faced obstacles.

Thank you.

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ABBREVIATIONS

ASP.NET	Active Server Pages .NET
B2C	Business to Consumer
C#	C-Sharp
CSA	Comparison Shopping Agent
DSS	Decision Support System
E-commerce	Electronic Commerce
FYP	Final Year Project
GUI	Graphical User Interface
LINQ	Language-Integrated Query
MS	Microsoft
OS	Operating System
PCS	Price Comparison System
SDLC	System Development Life Cycle
Shopbots	Shopping Bots
UAT	User Acceptance Testing

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

In today's society, business-to-consumer via electronic commerce (B2C e-commerce) is gaining popularity due to the rapid growth of the Internet [1, 2]. This statement was explained by Vachon through a survey carried out by the Vertical Web Media in 2010. The survey states that there are 60% of consumers from the United State of America shopped online quarterly each year [1].

Indeed, shopping has become one of the favourite activity of the people from younger generation. This activity has become a hobby in today's trend and will be carried out by the people at least once a week. However, shopping can be an infuriating experience if the budgets are limited. It is not easy for consumers to buy the product from the right store with prices that matches the consumers' budget [3]. Thus, a wise consumer will carry out a simple research before purchasing products to avoid regretting of purchase wrong products.

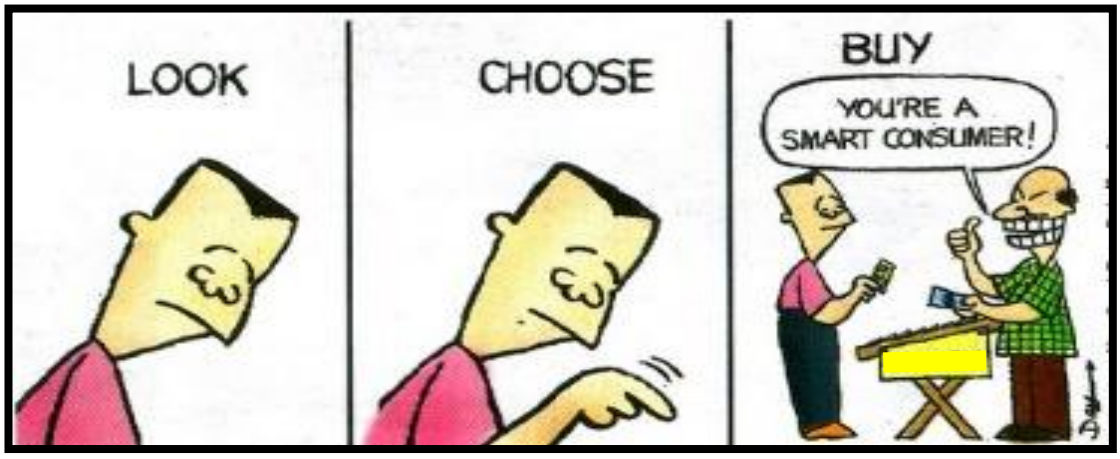

***Figure 1*: How to be a wise consumer?**

Figure 1 illustrates three simple steps to become a smart consumer, including look, choose, and buy. Firstly, the consumer search for a desired product that match with his budget. Then, compare the product price with the other product which is from different brands or stores. Finally, the consumer purchases the product which is offered with the lowest price.

The daily products such as the grocery and gourmet are a must for everyone in their daily life. Given an example, mothers or housewives will usually do their shopping weekly or monthly to refill the goods and some raw material for cooking daily meals. Not to deny that housewives are the sagacious consumers as they will compare the price of an item before purchasing it.

According to the researcher, a Decision Support Systems (DSS) was developed to apply a cognitive approach in solving a problem, however, the DSS is now turned to help the consumers in their online buying decision process [1]. Therefore, the author decided to create a Smart Brokering System so that it can assist the consumers to improve the process of their buying decision.

The "Smart Brokering for Household Items" is an intelligence brokering system that helps the users to compare the price of the daily products from several grocery stores without looking at a few set of brochures. It acts as an agent to filter and provide the lowest price of a best matching product upon the users' requirements and then display the searching results on the webpage to the users for price referencing. In brief, the aim of this system is to help the users to make suitable buying decision through price comparison.

As a result, the Smart Brokering System is the intermediary between the consumers and the stores that convey the pricing information of the household items to the consumers. This intelligent broker allows the consumers to make decision on their shopping carts with the best matching budget according to the users' budget capacity. It can also boost up the consumers' buying decision process indirectly by saving the time of the consumers to compare the prices manually from the brochures. This can be proven by the statement from Shopping.com where *"In today's cluttered online world, smart consumers demand simple and easy comparison features that take the stress out of online shopping, help inform the right purchasing decision and lead them straight to the products they're seeking, while saving time and money [4]."*

1.2 PROBLEM STATEMENT

There are a lot of grocery stores at a residential area that sells similar household items at different prices even for identical item and brands. In order to buy a certain product that best matches the buyer's requirement, a buyer has to compare the prices from different brands and different stores before purchasing the product. However, it is troublesome for the consumer to compare the prices of a daily product manually from the brochures of different grocery stores. This is because not all of the grocery stores print brochures weekly. However, if they do so, the brochure might not contains the products that the consumer wants. Therefore, in order to ease the price survey processes of the consumers, there is a need to develop a platform to register the prices of household products online, so that it allows consumers the ability to check the desired products within their budget easily.

1.3 OBJECTIVES

- **To study the existing smart brokering systems and provide analysis**

  A study will be conducted to understand the intention of the Smart Brokering Systems that are available in the market. Besides that, the functions of the existing brokering systems will be analyzed in this research for enhancement.

- **To design and develop a smart brokering system to improve the buying decision of a consumer**

  An algorithm will be developed to perform best matching of a buyer's requirement when compared to the registered household items with the broker. The algorithm will be tested on a web-based application that acts as a platform to show the price comparison of a product between different grocery stores in helping the users to make suitable buying decision. This application will also enable the consumers to get the best deal according to the buyer's budget requirement.

1.4 SCOPE OF STUDY

The scope of this research is to focus on finding the most accurate way to filter the price list of different products from different grocery stores. In particular, this brokering system will be developed by using a full-text search library, which the data is already being populated in the database to implement the data retrieval. This system is written in C# and ASP .Net.

The concept behind the system is simple. It is assumed that the participating retailers (grocery stores) register their products with the smart broker. In specific, the representatives of each retailers are allowed to manage the products, such as add new or delete existing product information in the brokering system. The representatives of each retailers are required to register an account before they are allowing to manage the products.

The Brokering System will execute the searching after the users enter a product name/keywords at the search box. Furthermore, the users are able to set the product price ranges according to the budget to execute the searching process. Search results is displayed to the users after the execution.

As a result, the expected outcome of this research is to improve the easiness of shopping and the efficiency of price surveying activity of the consumers with accurate filtering mechanism.

1.5 FEASIBILITIES OF THE PROJECT

- Technical Feasibility

  This project requires knowledge and programming skills in C#. The search algorithm and the web-based application are developed using this programming language exploiting the .Net Framework. The search algorithm can be extracted from the tutorials on YouTube or ASP .Net website that is available on the Internet.

- Economic Feasibility

  No extra cost is needed to fund the project because the algorithm and web-based application is developed using a personal computer workstation and Microsoft Visual Studio Express 2013 that is free of charge for academic research.

- Schedule Feasibility

  An efficient system development requires more investigation work and system architecting work to be done. Therefore, author has put a lot of effort and fully utilized FYP timeline by doing research and seeking advice from the superior in order to make this project a success.

CHAPTER 2

LITERATURE REVIEW

2.1 WHAT IS PRICE COMPARISON SYSTEMS (PCS)?

A lot of price comparison sites from different industry can be found in the e-commerce market today and the sites are widely used by the shoppers. Gregoriadis, an E-consultancy analyst said *"More and more consumers are using comparison sites to research products and services so they can find the best value products and services."* This can be proven based on the 30% growing rate of the amount of traffic to the price comparison sites every year [5].

For example, Trivago is one of the world's largest hotel searching platform that provide hotel information across the countries from different booking sites. It compares over 800 thousands of hotels worldwide from 270 booking sites so that potential travelers are able to find and rent the ideal hotel at the lowest rates [6]. In brief, the price comparison websites bring convenience to the people as they can search and compare prices of a certain product within their budget in just a few mouse clicks.

2.2 THE ROLE OF PRICE COMPARISON SYSTEM

Sometimes, the Price Comparison Systems are also known as Shopping Bots (Shopbots), Comparison Shopping Agents (CSA) or Comparison Shopping Engines (CSE) by some other researchers in certain context [1, 7, 8]. It is a web-based application that provide the consumers with opportunities to acquire wider range of information on various products through online [7].

Basically, the price comparison system collects product information such as the price from participating retailers and then display the information on a webpage in response

to the buyers' query [8]. In this way, buyers are able to compare the product's price from different retailers and choose the merchant that offers the best value.

The researcher explained that a price comparison system integrates the search engine and comparison tools of a website [1]. He also agreed with the explanation made by other scholars [9] where the price comparison system acts as the 'middleman' that search for a particular product among several websites and then execute the comparison between competitors' offerings.

In brief, the "Smart Brokering for Household Items" is a price comparison system that facilitates comparison of the products' price among the grocery stores. Moreover, it is intelligence enough to select alternatives goods for the consumers based on the price preferences and other attributes such as brand, and current promotion.

2.3 THE EXISTING PRICE SURVEY TECHNIQUES USED

There are a few techniques available used by the consumers to compare the price of the products from several stores. In this project, the author has selected three common techniques that are used frequently by households, which are:

a. Consumers get the pricing information from friends and family (through Word-of-Mouth).
b. Consumers carry out the price survey physically by visiting to the grocery stores.
c. Consumers carry out the price survey via online catalogues from different websites.

Table 1: Comparison of the Existing Price Survey Techniques Used

Features / Characteristics of the Techniques	Technique A: Word-of-Mouth	Technique B: Visit the stores Physically	Technique C: Online Catalogues
Accurate Price Matching	Medium	High	High
Accurate Product Matching	Low	High	Medium
Easiness of Shopping	Low	Low	High
Time Saving for Shopping	Low	Low	High

Table 1 above shows the comparative study of the existing price survey techniques used by the consumers.

Three most common techniques were selected by the author as follows. Technique A: Word-of-Mouth and Technique B: Visit to the stores physically are the conventional methods used by most of the households from older generation such as Generation X and before. On the other hand, Technique C: Referring to the Online Catalogues is the latest trend where it was used by the consumers who are the frequent online shoppers.

When the consumers apply Techniques B and C for the price surveying activity, there are higher chances where the consumers are able to get an accurate price match for a certain product. This is because consumers are able to check the product price on the spot when they visit the store or checking through online catalogues. However, Technique A is less accurate and unreliable because people tend to make mistakes when they deliver information.

Besides that, consumers visit to the grocery stores physically can get hundred percent accurate matching of a product in term of the quality and some other attributes such as the brand, color, weight and so on. This is because consumers can check out the product tangibly by touching or smelling it. However, it is a bit challenging for the consumers to compare the product quality through imagination. Thus, Techniques A and C are less reliable at this points compared to Technique B.

Consumers need to spend longer time when they carry out the price surveying activity via the conventional Techniques A and B. Thus, when it comes to the easiness of shopping, it is no doubt that Technique C is the best among the three techniques. It brings the convenience to the consumers when they are referring to the online catalogues for price survey. This is because they do not need to compare the product price manually by looking at a few set of brochures. On the other hand, it also save the travelling time of the consumers as they know where to buy the products after the decision is made.

As a result, Technique C is more efficient and reliable for the consumers who want to carry out product price surveying activity.

2.4 THE EXISTING PRICE COMPARISON SYSTEMS (PCS) IN THE MARKET

From table 1 in section 2.3, we can conclude that there are a lot of gaps that need to be fulfilled, thus, another comparison is carried out in this research to reduce the gaps. In this research, author has selected three potential price comparison systems that are available in the market, which are:

a. PriceMe smarter shopping <www.priceme.com.my>
b. Shoppy Guide to Malaysian online shops <www.shoppy.com.my>
c. Shopping.com <www.shopping.com>

Table 2: Comparison of the Existing PCS in the Market [4, 10, 11]

Features of PCS	PriceMe	Shoppy	Shopping.com	**Smart Brokering**
Provide Household Items	Yes	Yes	Yes	**Yes**
Provide Grocery & Gourmet	No	No	Yes	**Yes**
Usability Friendly	Yes	No	Yes	**Yes**
Available in Malaysia	Yes	Yes	No	**Yes**

Table 2 shows the comparative study of the existing shopping comparison engines in the market and the proposed Smart Brokering System in this project.

In table 2, we knew that the websites are providing the price comparison for the household items such as cooking utensils, containers, and some electronic stuffs. However, only Shopping.com is providing the price comparison for grocery items and gourmet whereas PriceMe and Shoppy do not include this service.

Next, based on the Graphical User Interface (GUI) design of the websites above, PriceMe and Shopping.com are more user friendly as compared to Shoppy, as the users are able to easily understand how to use the websites. Besides, the search result provided by PriceMe and Shopping.com are clearer than Shoppy. The price lists of the similar products in different brands will be displayed, thus, it helps the users to make up their mind easily. However, the search result provided by Shoppy confuses the users when the system execute a list of useful websites upon the search result instead of displaying the result of the price lists directly to the users. It brings trouble to the users as they need to choose the third party websites to check the price of only one product.

Last but not least, Shopping.com is a well-known price comparison engine that belongs to eBay Commerce Network. It is pioneered online price comparison engine that is still remain as one of the leading shopping sites in the market today [4]. Consumers were giving their support to Shopping.com because it was helping a lot of consumers to make informed purchasing decisions over a decade. It is no doubt that the reputation of Shopping.com is far better than PriceMe and Shoppy. Unfortunately, Shopping.com is not available in the market in Malaysia yet. It is too bad as the consumers in Malaysia are not able to fully utilize Shopping.com although it has a better reputation and advanced features as compared to the other price comparison sites such as PriceMe and Shoppy.

As a result, in order to fulfill the lacking features of PriceMe, Shoppy, and Shopping.com, the "Smart Brokering for Household Items" is implemented in order to narrow the gaps of the problems faced by the consumers.

2.5 SUMMARY OF THE COMPARATIVE STUDIES

From the first comparative study on the existing price survey techniques used by the consumers which has been analysed and discussed in Section 2.3, it can be concluded that Technique C: Online Catalogues helps the consumers to carry out price surveying activity more efficient as compared to Technique A: Word-of-Mouth and Technique B: Visit to the stores physically.

From Table 1 in Section 2.3, Technique C provides high accuracy on the price matching of an item and medium accuracy on the product matching of an item. Consumers are able to get accurate price information of the product because the price lists are provided by the retailers. Besides, by referring to the online catalogues, consumers are able to view the pictures or to read the description of a product but could not touch it, hence, the accuracy of product matching is medium. The easiness of shopping as well as time saving for shopping is high when consumers check the price via online catalogues. Online catalogues bring convenience to the consumers because they do not need to waste time on checking the product price manually from the brochures. Furthermore, they can check the product price by just a few mouse clicks on desktop anytime.

As a result, Technique C: Online Catalogues is strongly recommended to the consumers when they want to carry out price surveying activity.

From the second comparative study on the existing price comparison system in the market which has been analysed and discussed in Section 2.4, Smart Brokering System is designed and developed to fulfil the lacking features of the existing price comparison sites as been mentioned in Table 2.

In Section 2.4, three potential price comparison systems were selected, which are PriceMe, Shoppy, and Shopping.com. The features among the price comparison systems such as PriceMe, Shoppy, Shopping.com as well as the Smart Brokering System were compared in Table 2.

From Table 2, all price comparison sites provide the price comparison for household items such as personal care products and personal hygiene products. However, PriceMe and Shoppy do not provide the price comparison for grocery and gourmet. Thus, Smart Brokering System is designed to help the households so that they have a platform to do price survey on grocery and gourmet. In addition, the search result is displayed in a table form in the Smart Brokering System, hence, it is usability friendly as it helps the households to compare the product prices easily. Moreover, although Shopping.com has advanced features as compared to PriceMe and Shoppy, unfortunately, it is not available in the local market, so consumers are not able to utilize the services provided by Shopping.com. As a result, Smart Brokering System is implemented to reduce the cons of PriceMe, Shoppy and Shopping.com.

2.6 MATCHING ENGINE

2.6.1 Why the Application is written in C#?

C# programming language was chosen to implement the Smart Brokering System because syntax of C# is simple and easy to learn. The author believes that she can master C# with the basic knowledge of C++ and Java which she learned before in lectures.

Besides, C# is designed to be a type-safe object oriented language which allows the programmers to build secure and robust applications that run on the .Net Framework [12].

The advantages of C# are as follows [13]:

- ✓ C# establishes better event management using delegates
- ✓ C# supports conditional compilation
- ✓ C# supports cross-language interoperability with any .Net languages

2.6.2 Why the Application is written in ASP.NET?

ASP.NET was chosen to implement the Smart Brokering System because it is the easiest entry point for people who does not have broad programming experience.

ASP.NET stands for Active Server Pages .NET, it allows the developers to build dynamic, rich web sites and web applications by using compiled languages such as Visual Basic and C# [14]. Besides, ASP.NET Web Pages is specifically designed to be a lightweight framework, and targets developers who want a simple web development story [15].

Some of the benefits provided by ASP.NET are as follows [14]:

- ✓ ASP.NET reduces the amount of code required to build large applications.
- ✓ ASP.NET framework is complemented by a rich toolbox and designer in the Visual Studio integrated development environment. For example,

WYSIWYG editing, drag-and-drop server controls, and automatic deployment.

- ✓ The source code and HTML are together therefore ASP.NET pages are easy to write and maintain.

2.6.3 Why SQL Server Express LocalDB is used?

SQL Server Express LocalDB is chosen to implement the Smart Brokering System because it runs in user mode and has a fast, zero-configuration installation that has a short list of installation prerequisites [15].

SQL Server Express LocalDB is a lightweight version of SQL Server that has many programmability features of SQL Server database. In addition, it is free of charge and can be used to run relatively small production database with less than 10GB of data.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 RESEARCH METHOD AND ACTIVITIES

Applied research method was used through the project. The applied research is a method that is conducted to find a solution by developing a new product or technology [16]. Thus, the reason for choosing this method was to ensure the user requirements will be met.

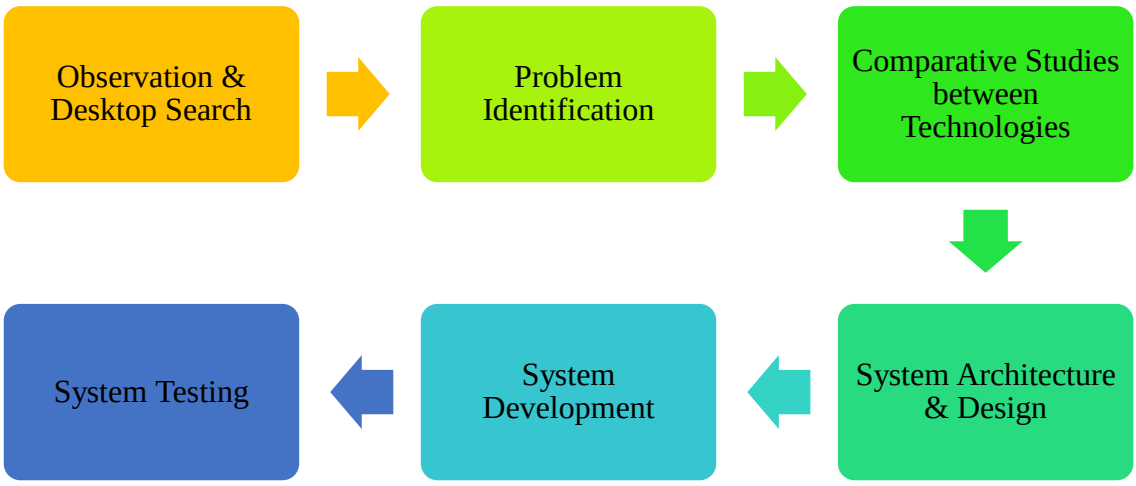

***Figure 2*: Research Model of Smart Brokering System**

Figure 2 shows the research model of the Smart Brokering System. The project development was separated into six stages. Observation and desktop search was carried out in the early stage to find the topic of the project. Once the topic is decided, the author started to identify the problem and set the objectives. Next, comparative studies between the technologies have been done to find the research gaps. In the 4th

stages, system architecture and flow diagrams were designed as the foundation of the project development. The system development is started after important information was gathered. Upon testing, feedbacks and critics are taken into consideration to ensure the project functions effectively and improvements are made immediately.

3.1.1 Observation and Desktop Search

It was found that there was very limited usage of online catalogues for the household items in Malaysia. The consumers from developed countries such as the United States has widely adopted the use of online catalogues in helping them to compare the prices of the household products especially the grocery and gourmet. As compared to Malaysia, online catalogue is still new and sparse.

It was also observed that not all retailers own an online catalogues in our nation to allow the consumers to compare the prices of the household products. The consumers in Malaysia tend to compare the prices of the grocery products by visiting to the stores physically.

3.1.2 Problem Identification

This phase is where problem of the study is defined to narrow down the scope of the project. The main focus of this project was to develop a Smart Brokering System to ease the consumers in price comparison for the household items from the registered retailers in the brokering system. Traditionally, the consumers need to visit to the grocery stores physically to check out the price of the grocery products. By using the Smart Brokering System, it can be considered as time saving and more efficient. This intelligence broker also provide alternative choices based on other attributes of the products.

3.1.3 Comparative Studies between Technologies

In this phase, two comparative studies were carried out in order to get an accurate idea for the system development. As been discussed in Chapter 2, the first comparative study was about the existing techniques used for price surveying by the consumers in Malaysia. This comparative study showed that Malaysians are not familiar in using the online catalogues.

Meanwhile, the second comparative study was about the existing price comparison systems in the market. From the comparison, the author found out the strengths and weaknesses of the existing price comparison systems and thus able to enhance the weaknesses in the Smart Brokering System.

3.1.4 System Architecture and Design

The system architecture of the Smart Brokering System involves a few parties including the end users, Graphical User Interface (GUI), Internet, a web server, some web applications and a database.

Basically, the end users are the people who use the Smart Brokering System with an Internet connection. The GUI is the web browser of the system at the clients' side. Meanwhile, the web server is a platform used to distribute information to the web browser. This brokering system is supported by a few main web applications such as C#, and ASP .Net. While these web applications will be connected to a pre-defined local database in Microsoft Visual Studio.

The system architecture and system flowchart were designed and further discussed in Chapter 4.

3.1.5 System Development

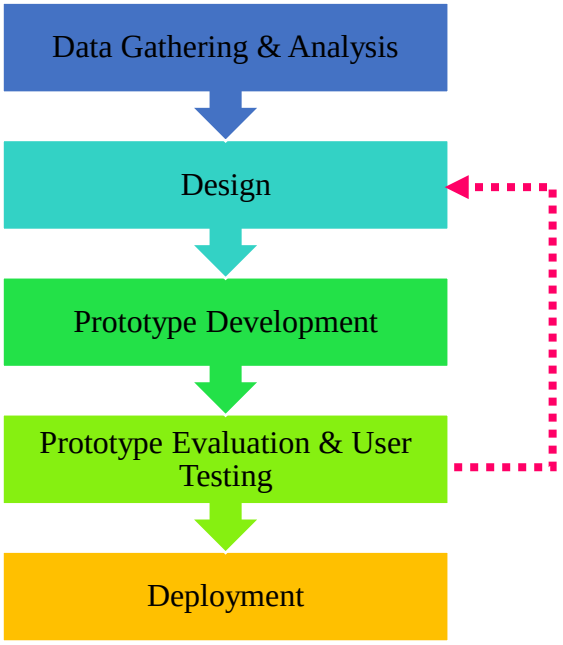

***Figure 3*: SDLC of Smart Brokering System**

The System Development Life Cycle (SDLC) of the Smart Brokering System is shown in Figure 3. It is adopted from the Rapid-Prototyping Model where the development is aligned according to the deadlines and testing is conducted once the prototype is ready. If the Brokering System encounters any problem through any stage, the system administrator can easily go back to the pervious stage to make necessary changes. This can ensure the system will meet the design capabilities.

Before the initial development of the system, necessary data needs to be gathered and analysed for better interpretation of the project. Hence, comparative study of several areas of this project had been made to help making a decision on creating the functionalities which are suitable for this brokering system. For instance, accurate matching and budget preferences of an item are the core functions of the brokering system.

The prototype development process starts after the system architecture and design of the brokering system done. The graphical user interface and the search algorithm were implemented using C# and ASP.NET. Besides, the author spent about 9 weeks on the prototype development and some major defects appeared. Fortunately, the obstacles had been solved immediately and the brokering system works perfectly.

Upon the prototype evaluation, system testing and user acceptance testing have been carried out to ensure the functionalities of the system conform the users' requirements before deployment.

3.1.6 System Testing

System testing was performed to evaluate the system's accuracy, stability and efficiency before deployment. Integration testing of the main functions was carried out by the author. While the acceptance testing is tested by a group of user that fits the target user demographic, which is the consumer. Consumers' response and interaction towards the system is closely monitored. Any feedbacks and critics are taken into accounts and improvements will be made immediately. Re-evaluation is required to ensure the Smart Brokering System satisfies the consumers need.

3.2 TOOLS AND EQUIPMENT

- Hardware

  Personal Laptop:

  - ✓ Dell Inspiron N4110
  - ✓ 4GD RAM
  - ✓ 2.3GHz Intel Core i5

- Software

  - ✓ Windows 7 with 64-bit OS
  - ✓ Microsoft Visual Studio Express 2013 for Web
  - ✓ SQL Server Express LocalDB

- Programming Languages
  - ✓ C-sharp
  - ✓ ASP.NET
  - ✓ SQL and LINQ

3.3 KEY MILESTONE & GANTT CHART

A Gantt chart (Appendix D) is prepared to guide the development of the project. Deliverables and key milestones (Appendix C) are attached together in the Gantt chart. Note that the timeline was merged for FYP I together with FYP II in order to make sure the project is able to deliver on time and tested with target users before release to the public.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 SYSTEM ARCHITECTURE

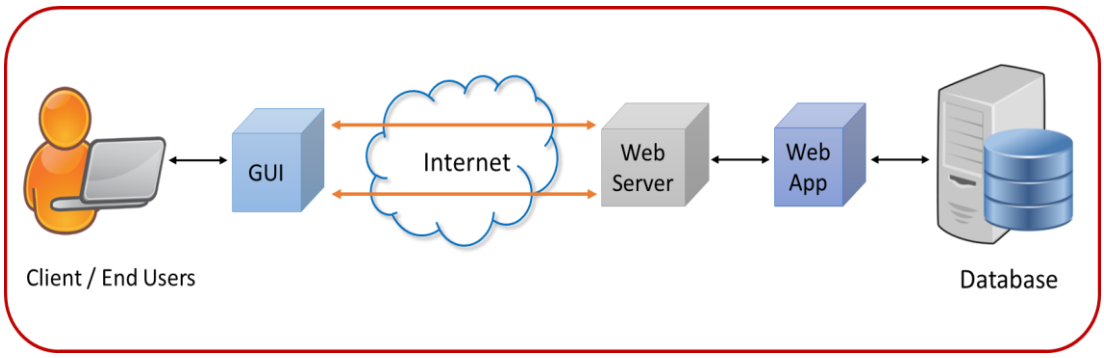

***Figure 4*: Architecture of Smart Brokering System**

Figure 4 shows the architecture design of the "Smart Brokering for Household Items". The system architecture involves the end users, GUI, Internet, a web server, some web applications and SQL server express local database.

The end users are the people who visit and use the Smart Brokering System with an Internet connection. In this case, the targeted users of the Smart Brokering System are the households who want to carry out product price research before purchasing.

Next, the Graphical User Interface is referring to the web browser of the Smart Brokering System at the clients' side, which is in HTML format. Meanwhile, the web server is a platform used to distribute information to the web browser. Apart from that, this brokering system is supported by a few main web applications such as C#, and ASP .Net. These web applications will be connected to a local database in Visual Studio that is being populated by the retailers.

In general, Smart Brokering System is implemented a comparison system through the search engine. While the search engine of the Smart Brokering System is developed by information (data) searching.

During the information searching process, the brokering system will start to execute after the users insert the search criteria such as a product name or set the budget range. The database query will look for the matching item in the local database. Then, the search result will be displayed in table form for users' references.

4.2 SYSTEM FLOW

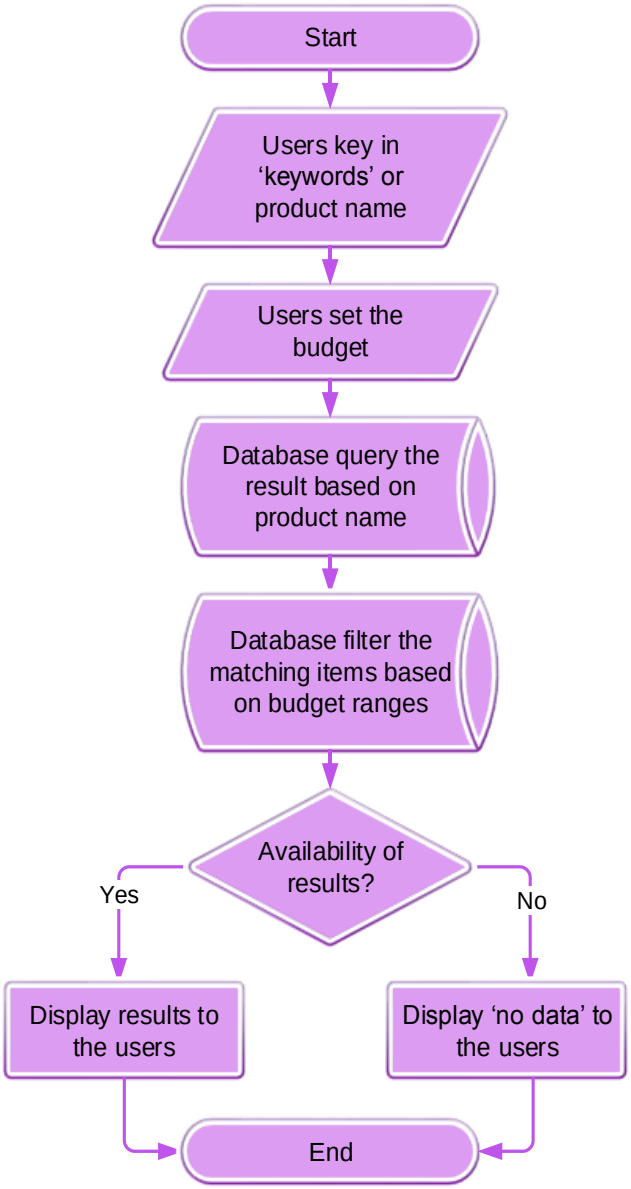

***Figure 5*: Flow Diagram of Smart Brokering System**

The proposed system flow diagram of Smart Brokering System is shown in Figure 4. The diagram explains how the overall system works.

As been mentioned before, the items of the household products are pre-populated by the retailers and stored in the database beforehand. This is because data crawling cannot be carried out as most of the grocery stores do not own a websites, hence, data crawling is unable to apply in this case.

The brokering system starts to execute after the users insert the search criteria (e.g. product name) in the search bar, they are able to set the budget range from the dropdown lists under the search bar too if they have fixed their budget. The search only takes one click, after the users clicked on the search button, the database query starts to execute the matching items inside the local database. Firstly, the database query the result based on the product name. Then, it filters the matching items based on the budget ranges.

When the process is done, the list of the prices from several stores are presented on the webpage to the users for their decision making. If the items are available in the database, results will be displayed else empty data text will be displayed to inform the users that the product is not found. Users may repeat the process by inserting another search criteria if the result is not found in the previous try.

4.3 GRAPHICAL USER INTERFACE (GUI) DESIGN OF THE SMART BROKERING SYSTEM

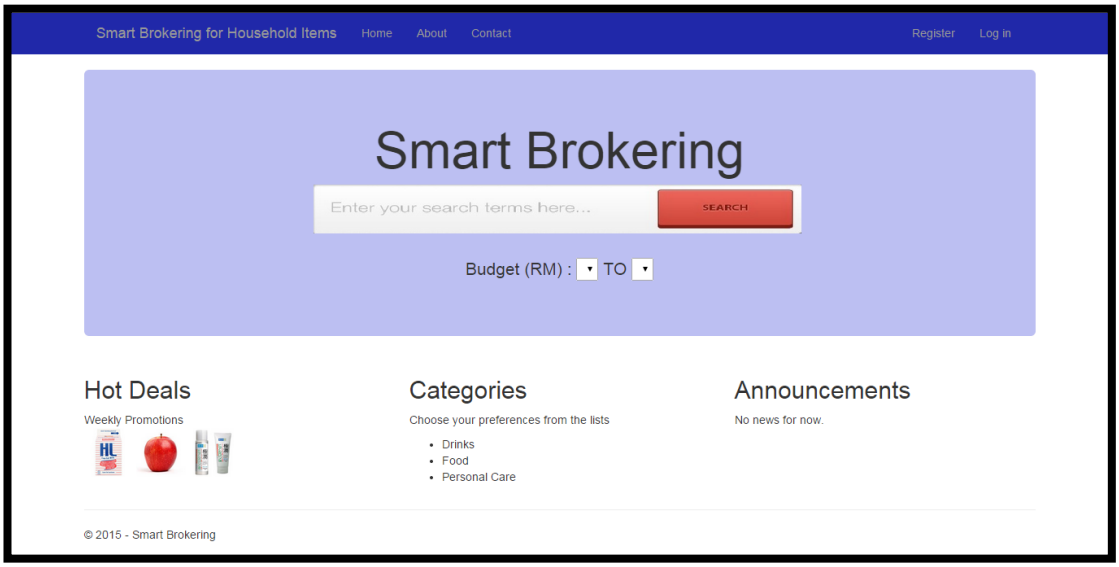

***Figure 6*: Initial design of the homepage of Smart Brokering System**

Figure 6 shows the initial interface design of the Smart Brokering System. The design was being changed because the links to different pages could not be seen at the top navigation bar.

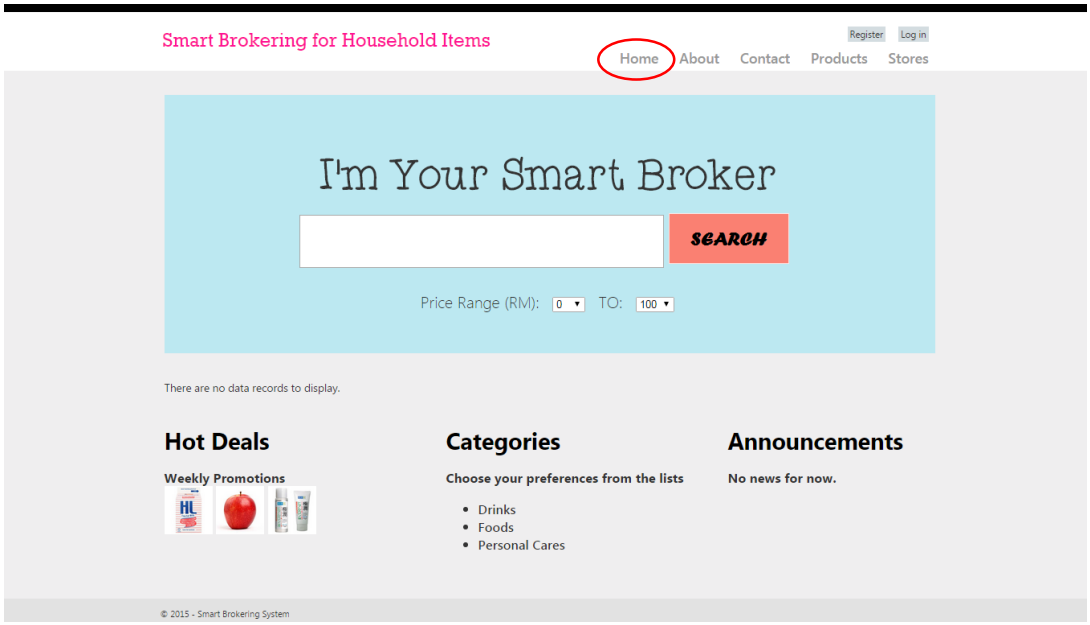

***Figure 7*: Final design of the homepage of Smart Brokering System**

Figure 7 shows the final interface design of the Smart Brokering System.

At the homepage, users are required to insert the search criteria such as a product name in the search bar in order to perform the search query. Besides that, users are able to set their budget range from the dropdown list under the search bar if they want to, else the budget range on system default is from RM0 to RM100.

On the other hand, if the users have no idea on what to buy, they can refer to the product items under 'Hot Deals' to look for the weekly promotions. Furthermore, they can also check the prices of a particular product by browsing through 'Categories'. The household products have been categorized into three different categories, which are Drinks, Foods and Personal Cares. *Please refer to Figure 12.*

The 'Announcements' column is designed to display important news or notices to the users.

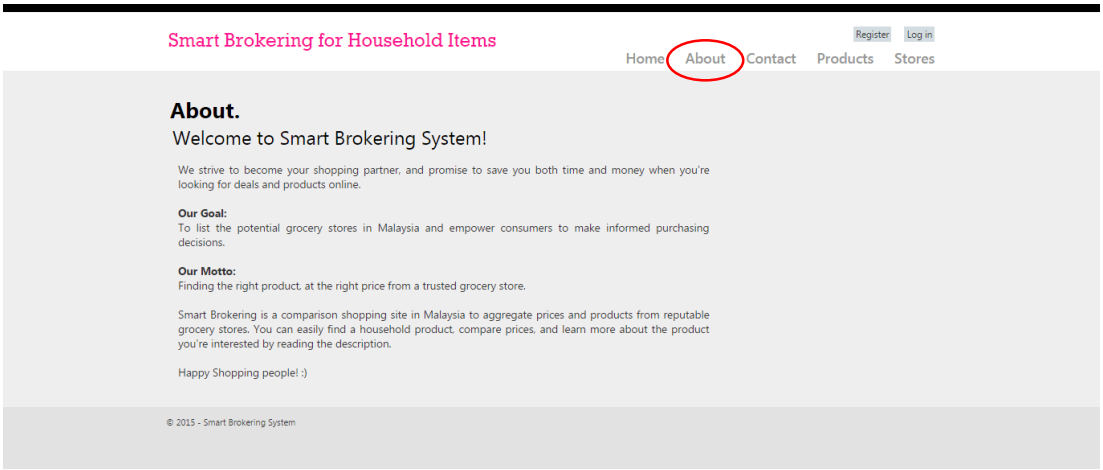

***Figure 8*: About page of Smart Brokering System**

Figure 8 shows the information of the Smart Brokering System including the purpose, goal and mission of the establishment of the system.

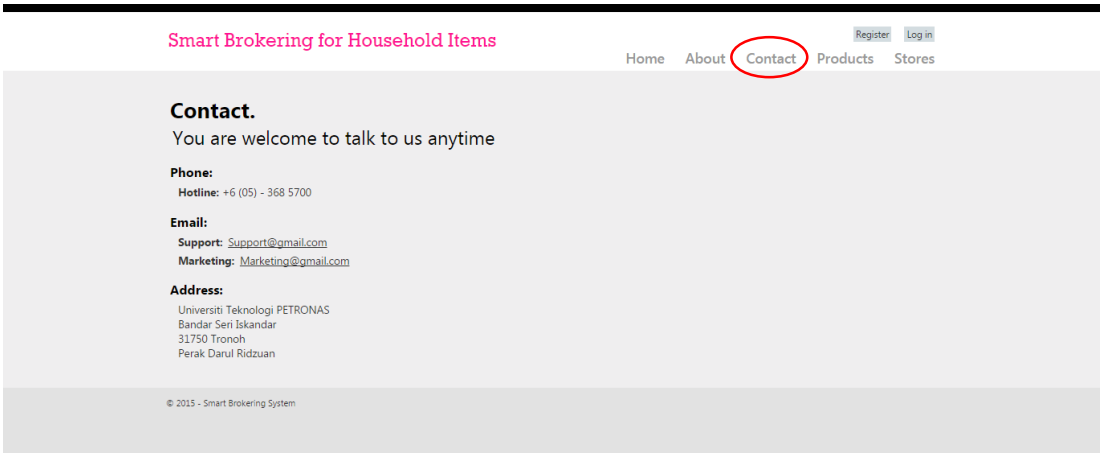

***Figure 9*: Contact page of Smart Brokering System**

Figure 9 shows the contact information of the developer. Users are welcomed to provide any feedback or complains through the given contacts.

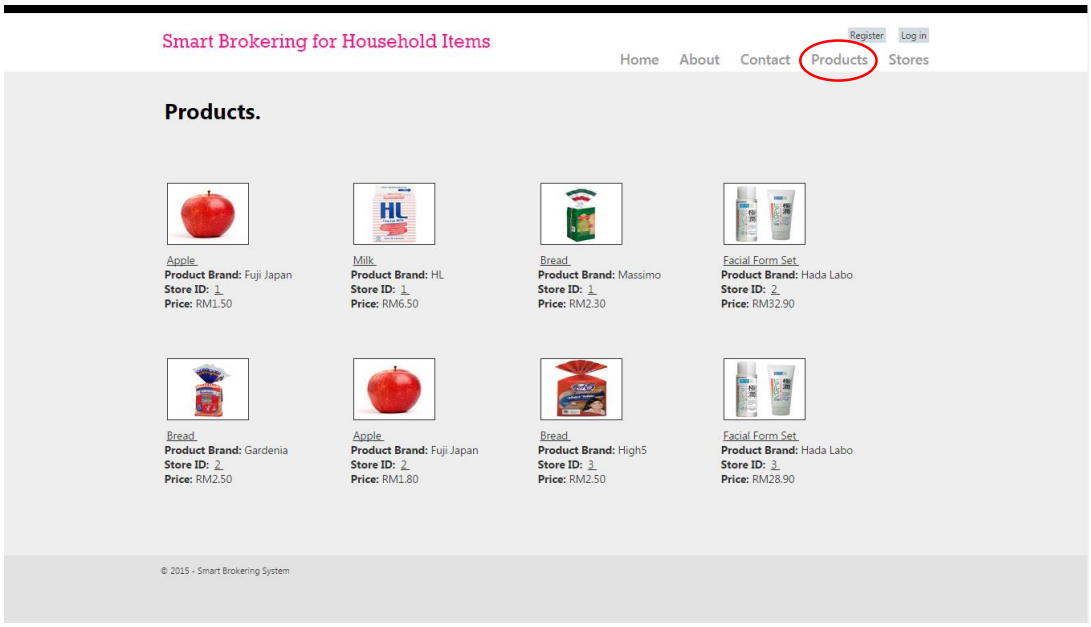

***Figure 10*: Products page of Smart Brokering System**

Figure 10 lists all the registered household products for users' references. More product information is shown under the picture of the item including the brand, store and price of the item.

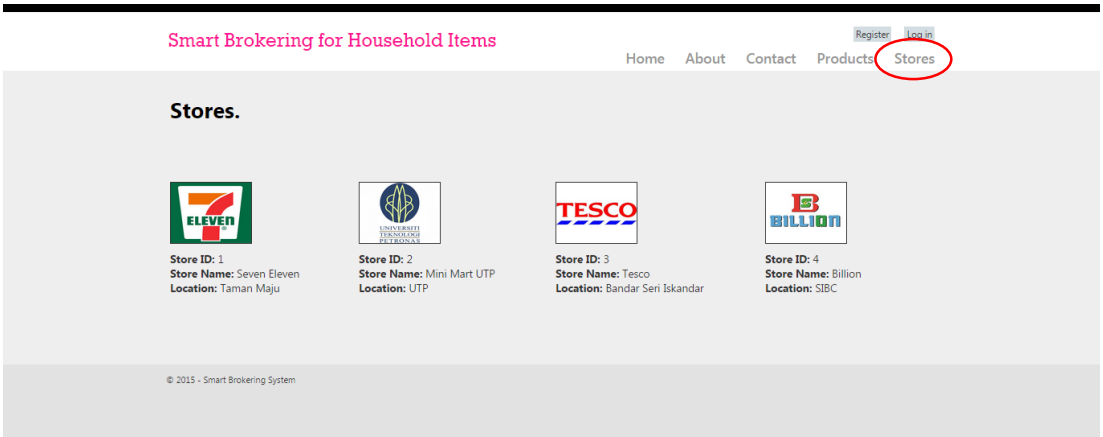

***Figure 11*: Stores page of Smart Brokering System**

Figure 11 lists all the participated stores and their information such as store name and store location for users' references.

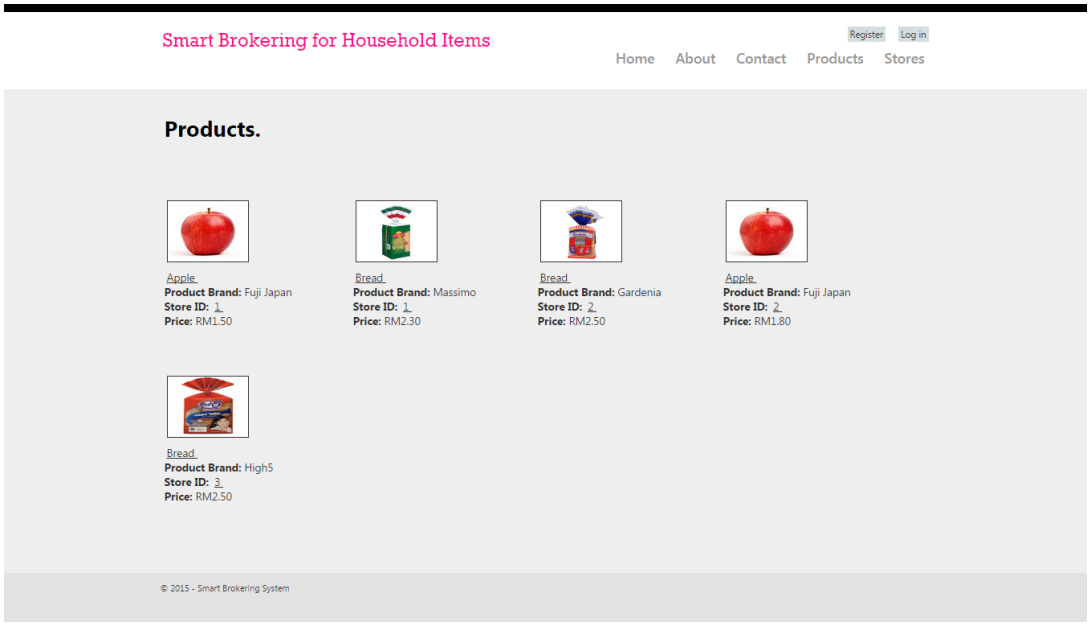

***Figure 12*: Products page categorized by Foods**

When users clicked on the link button of 'Foods' under Categories column at the homepage, all the Foods that are registered in the system is displayed as shown in Figure 12.

While if the users clicked on the link button of 'Drinks' or 'Personal Care' under Categories column, all drinks or personal care products that are registered in the system will be displayed.

Please refer to Figure 7 for the link buttons under the 'Categories' column.

4.3.1 Role of Users

Basically, there are 3 types of role who will be using the Smart Brokering System, which are system administrator, store administrators and end users.

System administrator, which is the author of this project is responsible to manage the system such as to carry out some enhancement works of the system, and to manage the store administrators in the database.

While the store administrators are the person in-charge from the participated retailers. They are responsible to update the price list of the products from time to time. The stores administrators are able to add new products or to delete the old products information from the system.

Lastly, the end users are the people who use the system to carry out price surveying activity.

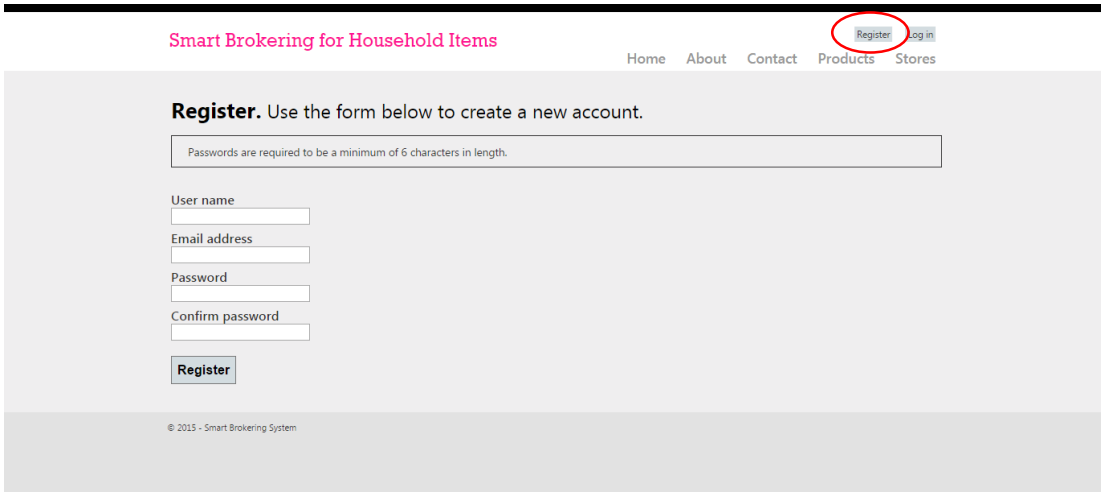

***Figure 13*: Register New Account page of Smart Brokering System**

'Register New Account' page as shown in Figure 13 is used to register a new account. End users do not need to register an account, only the participated stores' administrators are required to register an account for the purpose of authentication to manage the products information.

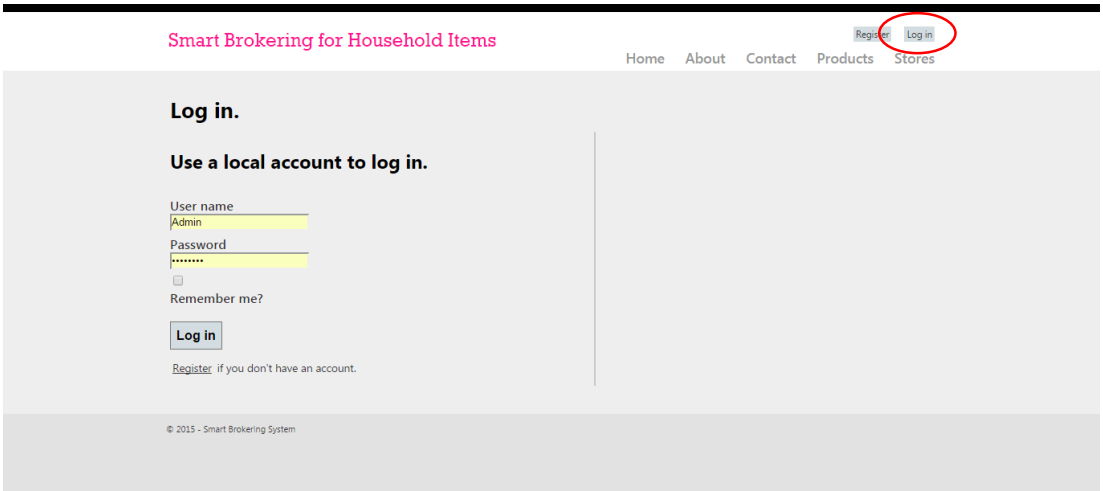

***Figure 14*: Account Login page of Smart Brokering System**

'Account Login' page as shown in Figure 14 is designed for the stores' administrators to log in to the system in order to update the products information.

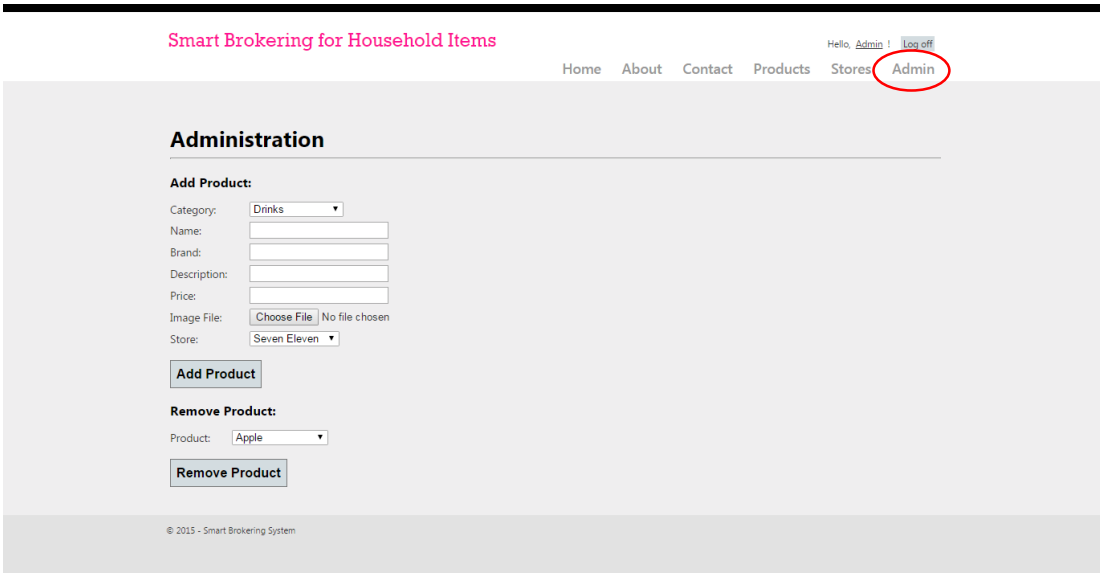

***Figure 15*: Admin page of the Smart Brokering System**

Figure 15 shows the Admin page that is designed for the store administrators to manage the price lists of the products either to add new product or to remove an existing product. To add a new product, the store administrators have to insert all the details required and then click on the 'Add Product' button to update the database. While to remove an existing product, the store administrators have to choose the products from the dropdown list and click on the 'Remove Product' button to delete the old product information from the database.

Note that after the store administrator logged in to the system, the 'Admin' link is appear on the navigation bar.

4.3.2 How to Perform the Search Query?

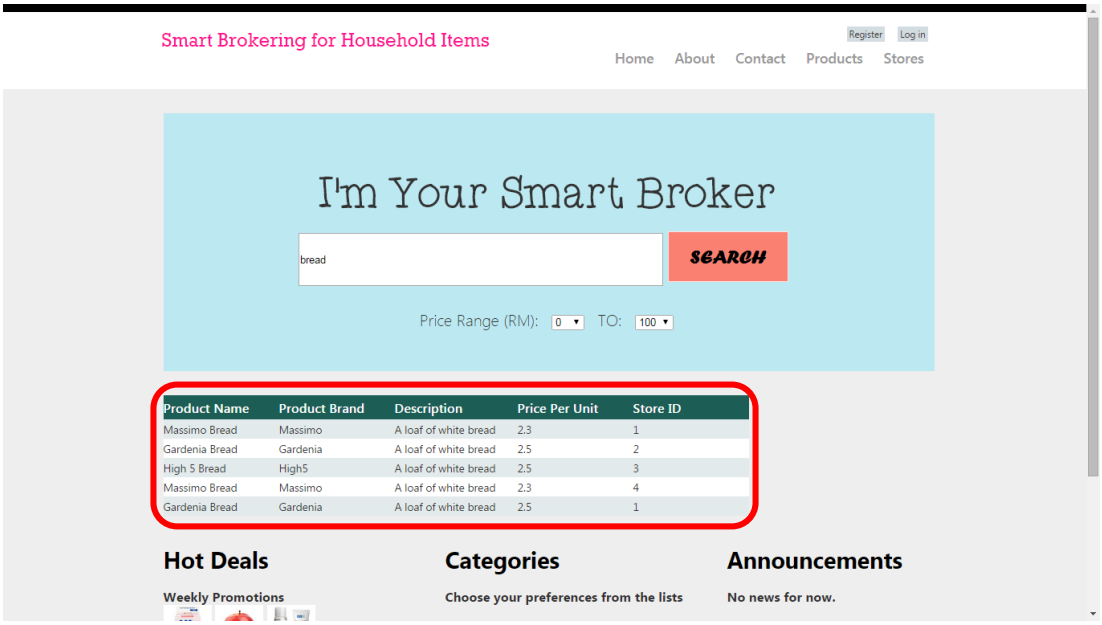

***Figure 16*: Search Result in Table form**

As been mentioned before, users are required to insert the search criteria (E.g.: bread) in the search bar in order to perform the search query. Besides, users are able to set their budget range from the dropdown list under the search bar if they want to, else the budget range on system default is from RM0 to RM100. After that, click on the 'Search' button beside the search bar and wait for the search result to be displayed.

Figure 16 shows the search result which is the price lists of the bread are displayed in table form so that it allows the users to compare the prices easily. In addition, some important information of the products also displayed in the table such as brand, description, and store.

4.4 THE SEARCH ALGORITHM

```
<asp:SqlDataSource ID="SqlDataSource1" runat="server"
    ConnectionString="<%$ ConnectionStrings:ConnectionString %>"
    SelectCommand="SELECT [ProductName], [ProductBrand],
    [PDescription], [ProductPrice], [StoreID]
    FROM [Products]
    WHERE (([ProductName] LIKE '%' + @ProductName + '%') AND
    ([ProductPrice] &gt;= @ProductPrice) AND ([ProductPrice] &lt;= @ProductPrice2))">
    <SelectParameters>
        <asp:ControlParameter ControlID="SearchTextBox" Name="ProductName"
            PropertyName="Text" Type="String" />
        <asp:ControlParameter ControlID="DropDownFrom" Name="ProductPrice"
            PropertyName="SelectedValue" Type="Double" />
        <asp:ControlParameter ControlID="DropDownTo" Name="ProductPrice2"
            PropertyName="SelectedValue" Type="Double" />
    </SelectParameters>
</asp:SqlDataSource>
```

***Figure 17*: The Search Algorithm**

Figure 17 shows the pseudocode of the search and matching algorithm.

The concept of the search and matching algorithm is easy to understand. It starts from the database connection which is written in Line 2, ConnectionString = "<%$ ConnectionStrings:ConnectionString %>", the database ConnectionString was being connected to the ConnectionStrings.

At Line 3: SelectCommand = "SELECT [ProductName], [ProductBrand], [PDescription], [ProductPrice], [StoreID] FROM [Products] This part is to select some commands from the table of [Products] in the local database. The commands [ProductName] and [ProductPrice] will be used to match with the search criteria inserted by the users.

At Line 6: WHERE (([ProductName] LIKE '%' + @ProductName + '%') AND ([ProductPrice] >= @ProductPrice) AND ([ProductPrice] <= @ProductPrice2)) This part is use to set some requirements so that matching process can be done accurately when query from the database. Two things need to be checked when doing the search query, which are the search criteria in the search bar and budget ranges from the dropdown lists.

i. ([ProductName] LIKE '%' + @ProductName + '%')

   The LIKE operator here is used to search for a specified pattern in a column. Hence, [ProductName] from the database must be matched with the criteria given by the users @ProductName which is from the Search Text Box.

ii. ([ProductPrice] >= @ProductPrice)

The >= operator is used to compare the price lists in the database which is greater than the price set by the users. Hence, [ProductPrice] from the database must be greater than @ProductPrice in the first dropdown list.

iii. ([ProductPrice] <= @ProductPrice2)

The <= operator is used to compare the price lists in the database which is lesser than the price set by the users. Hence, [ProductPrice] from the database must be lesser than @ProductPrice2 in the second dropdown list.

4.5 SYSTEM TEST RESULTS

System testing is carried out to test the accuracy, stability and efficiency of the Smart Brokering System before deployment. The objective of the system testing is to ensure that the Smart Brokering System will satisfy the consumers need, which is to filter a desired product's prices from different brand and several stores based upon the budget requirements.

Three integration tests have been done to test the stability and accuracy of the Smart Brokering System. Each test was carried out 40 times (10 trials for every 30, 40, 50 and 60 data size). The data size means the total number of items stored in the database.

4.5.1 Test Case One

Test case one is used to measure the time taken to retrieve the data. In this experiment, the responding time of the searching result to be displayed on the webpage was measured using a stop watch with the increment of the data size inside the database.

Table 3: Time Taken to Retrieve the Data

Data Size (Items)	Response Time (s)
30	0.20
40	0.21
50	0.23
60	0.25

The response time given is satisfied as it is around 0.22s in average.

4.5.2 Test Case Two

Test case two is used to test the accuracy of the searching result without setting the price range. In this experiment, the searching result displayed on the screen was compared with the item stored inside the database.

Table 4: Accuracy of the Search Result without setting the Price Range

Data Size (Items)	Accuracy (Yes/No)
30	Yes
40	Yes
50	Yes
60	Yes

Accurate results were generated in this test.

4.5.3 Test Case Three

Test case two is used to test the accuracy of the searching result without setting the price range. In this experiment, the searching result displayed on the screen was compared with the item stored inside the database.

Table 5: Accuracy of the Search Result by setting the Price Range

Data Size (Items)	Accuracy (Yes/No)
30	Yes
40	Yes
50	Yes
60	Yes

Accurate results were generated in this test.

4.5.4 User Acceptance Testing (UAT)

Besides, user acceptance testing was also conducted to evaluate whether the Brokering System is effective and meet the user requirements. The target user in this research is the consumer who want to carry out price surveying activity. The user evaluation of the system will assist in analyzing the effectiveness of the Smart Brokering System in suggesting the best matching household products for the consumers based on their product and budget preferences.

The author personally guided and showed 10 of the respondents from UTP how to use this system during Sedex. Respondents had been informed that this system is newly created by the author herself. Although this system is similar to the other price comparison system that is available in the market but the objective of this system is to act as a platform to embed the algorithm in order to prove the research hypothesis.

Below are the set of questions that were asked to 10 respondents.

Question 1: Is the Smart Brokering System user friendly?

Question 2: Are you able to understand the information displayed in the system?

Question 3: Is the interface of Smart Brokering System attractive?

Question 4: As a consumer, do you agree that this system is effective and improve your shopping experience?

Question 5: In your opinion, what is the best way to carry out price surveying activity?

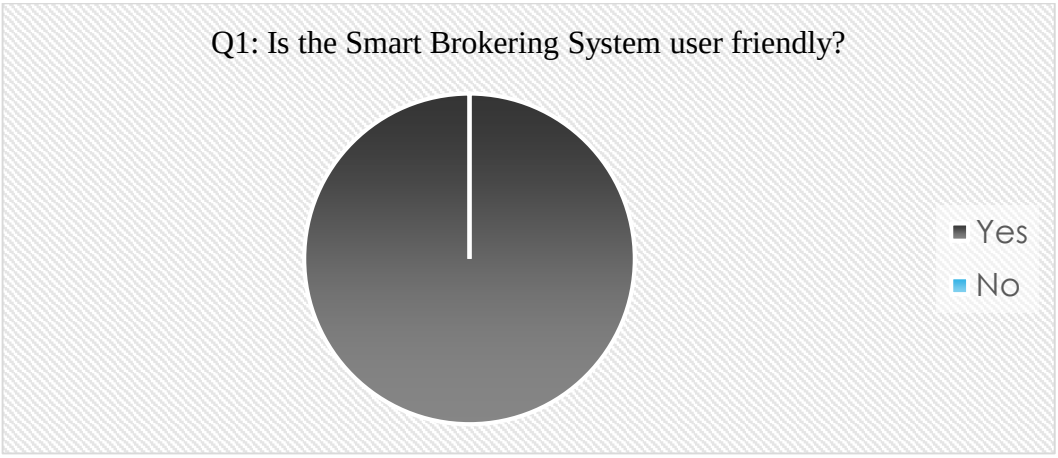

***Figure 18*: UAT Result for Question 1**

From Figure 18, author can conclude that the respondents positively accepted the Smart Brokering System. All respondents agreed that Smart Brokering System is user friendly. This is because it is very simple to use to carry out price surveying activity as it only needs a few mouse clicks to search for the products.

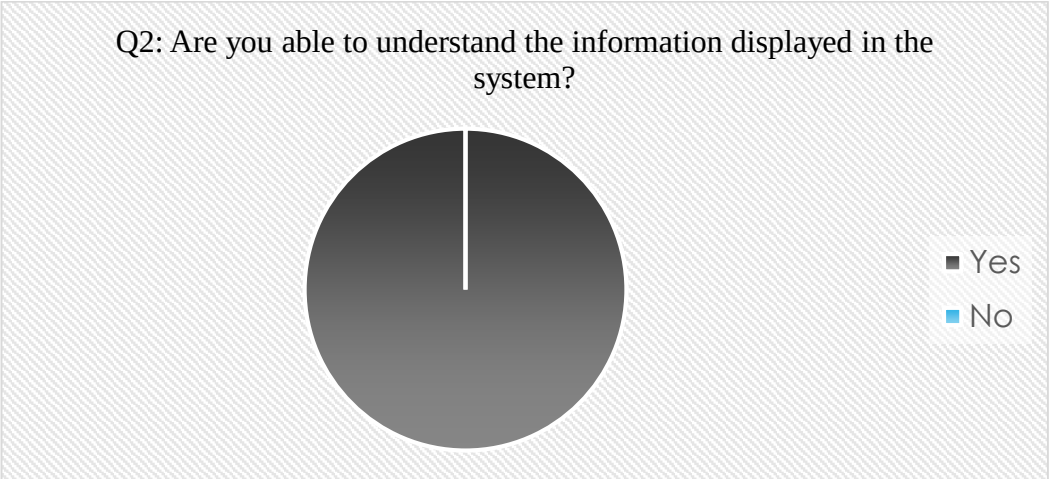

***Figure 19*: UAT Result for Question 2**

Besides, all respondents are able to understand the information displayed in the system. They are agreed that the searching result is displayed in a table form with some important information such as product name, price, and store being attached together in the table.

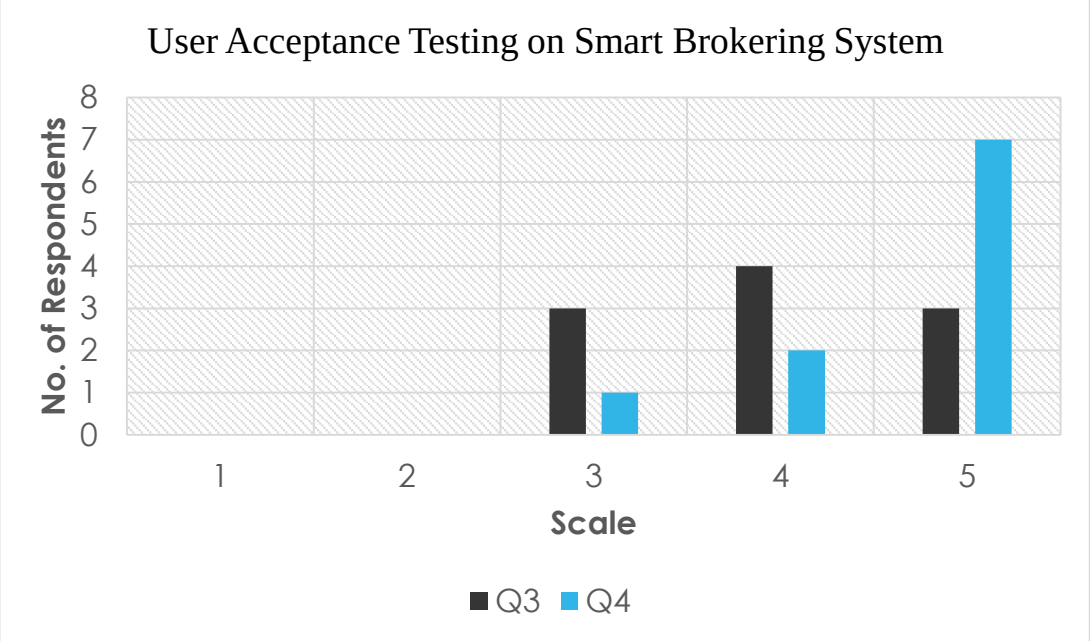

***Figure 20*: UAT Result for Question 3 and 4**

In addition, Likert Scale was used to measure Question 3 and Question 4 where scale 1 is strongly disagree and scale 5 is strongly agree.

From Figure 20, most of the respondents were not satisfy with the current interface design of the system. They found out that the interface was very dull and boring due to the color scheme.

However, seven of them do strongly agree that Smart Brokering System is effective and they also believe with the help of Smart Brokering System, their shopping experience will be improved too. They believed that they could save a lot of money and time, if they use the system to check on the pricing information before purchasing.

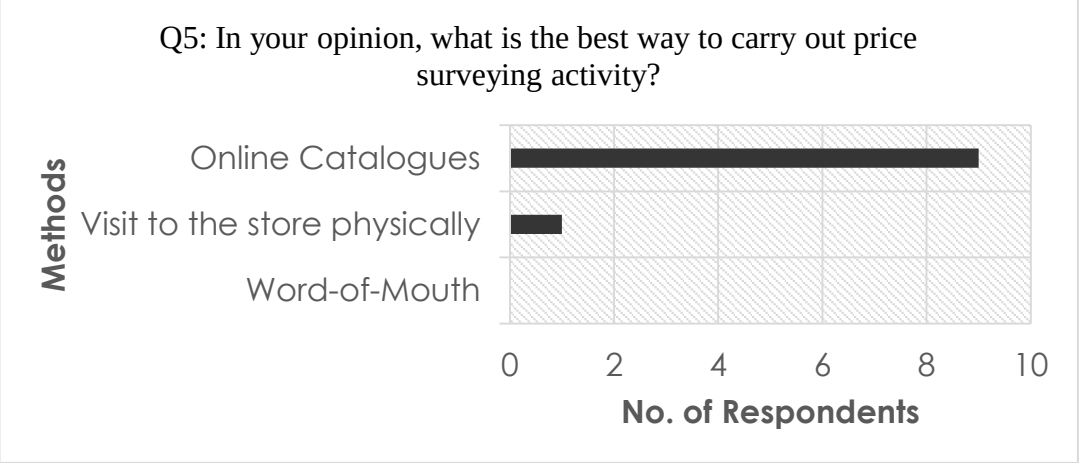

Figure 21: UAT Result for Question 5

Lastly, from Figure 21, nine respondents are believed that online catalogues is the best way to carry out price surveying activity, while only one respondent prefers to visit to the store physically.

In overall, based on the user acceptance results, the author is happy to conclude that the respondents are very positive and supportive. They had showed their support by giving useful feedback and comments to the author in order to further improve the system. Thus, Smart Brokering System is effective and meet the user requirements.

4.6 PROBLEMS FACED DURING SYSTEM DEVELOPMENT

There are some defects appeared during the development stages.

i. Wrong database name caused the failure of connection.

Due to the wrong database name was used during the initialization of the database connection, the author failed to connect the database to the server. Author had tried plenty of times to initialize the connection with a wrong database name, hence, it caused failure to the connection. Fortunately, this critical problem has been solve in two days where the mistake was figured as shown below:

'SmartBroker' is used instead of the correct database name of 'DBSmartBroker' in ProductContext.cs

ii. Images could not be viewed on the webpage.

Due to the wrong image path had been assigned in the database, the images could not be viewed on the webpage. Fortunately, author found out the root of the problem within a few minutes after re-reading the code. The mistake was figured as shown below:

'Apple.jpg' is assigned instead of '/Images/Apple.jpg'.

The missing of folder name caused the failure of displaying the pictures.

CHAPTER 5

CONCLUSIONS

5.1 CONCLUSIONS

The conventional price comparison engines that are frequently used in the market today provide only basic browsing through keyword and classification where the search result given is not 100% accurate [17].

This project presents a price comparison system that will show all possible prices of the household products from different stores based on the consumers' product and budget preferences using data searching method.

By applying the data searching method in the Smart Brokering System, the searching results will be processed in shorter time which is approximately 0.22s in average and the results displayed are 100% accurate. This is proven in the test cases in Section 4.5.

As a result, the objectives of the Smart Brokering System is achieved which is to help the consumers to carry out a simple research on the price of a product efficiently with accurate filtering mechanism.

5.2 FUTURE WORK AND RECOMMENDATIONS

The author strongly suggested this Smart Brokering System can be continued to develop into a mobile application. This is because in today's society, most of the consumers own a smartphone. Hence, with the mobile apps, it will ease the buyers or consumers to check the price list of a product at anywhere anytime. It cut down the limitation of the smart brokering system on web which is only allow people with laptop to carry out the price survey.

Besides, the interface design of the system is recommended to be re-designed by most of the respondents during User Acceptance Testing. For example, the color of the homepage may change to a brighter color in order to attract users' attention.

On the other hand, the distance of the participated stores and the house of a user can be calculated in order to cut down the time taken and transportation cost to reach the stores. With this function added to the system, Smart Brokering for Household Items will be a perfect solution for the users as it helps to improve the buying decision of a consumer as well as to save the time and transportation cost of the users.

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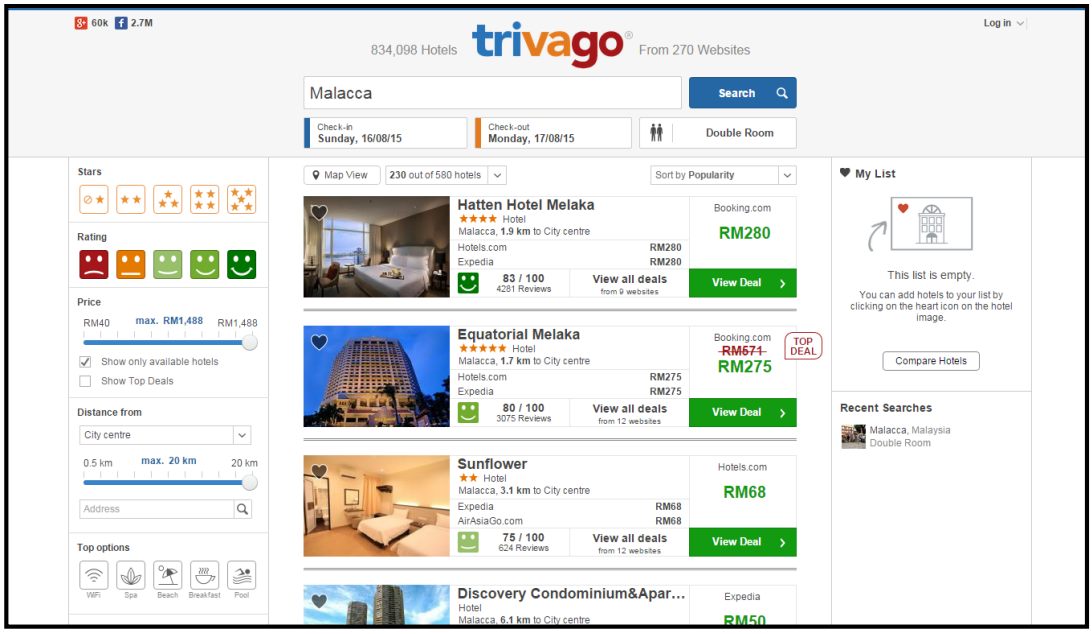
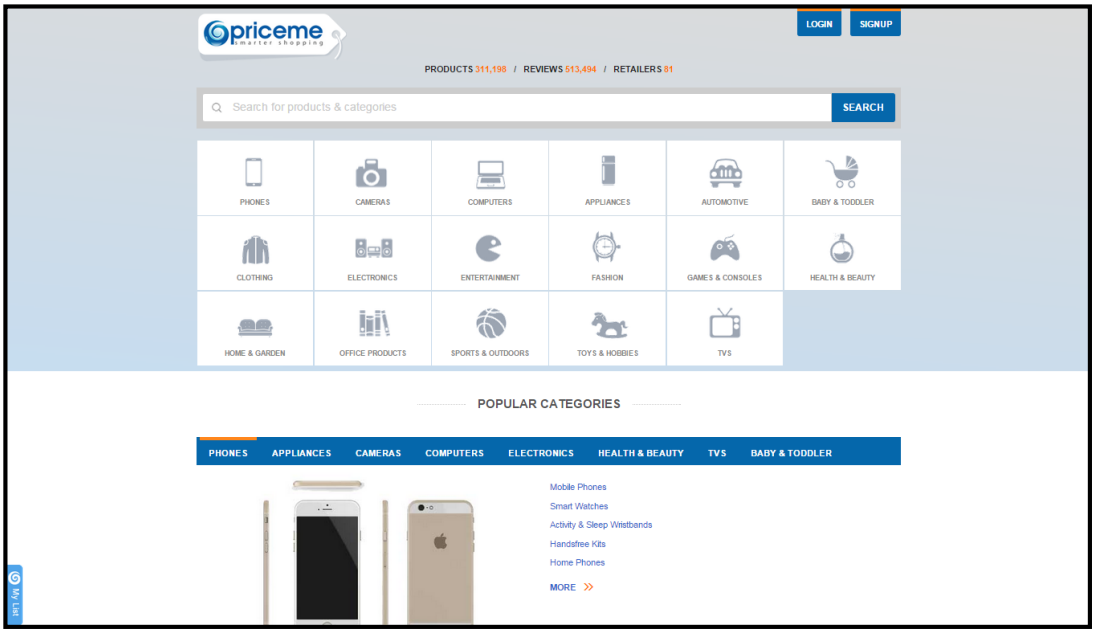
APPENDICES

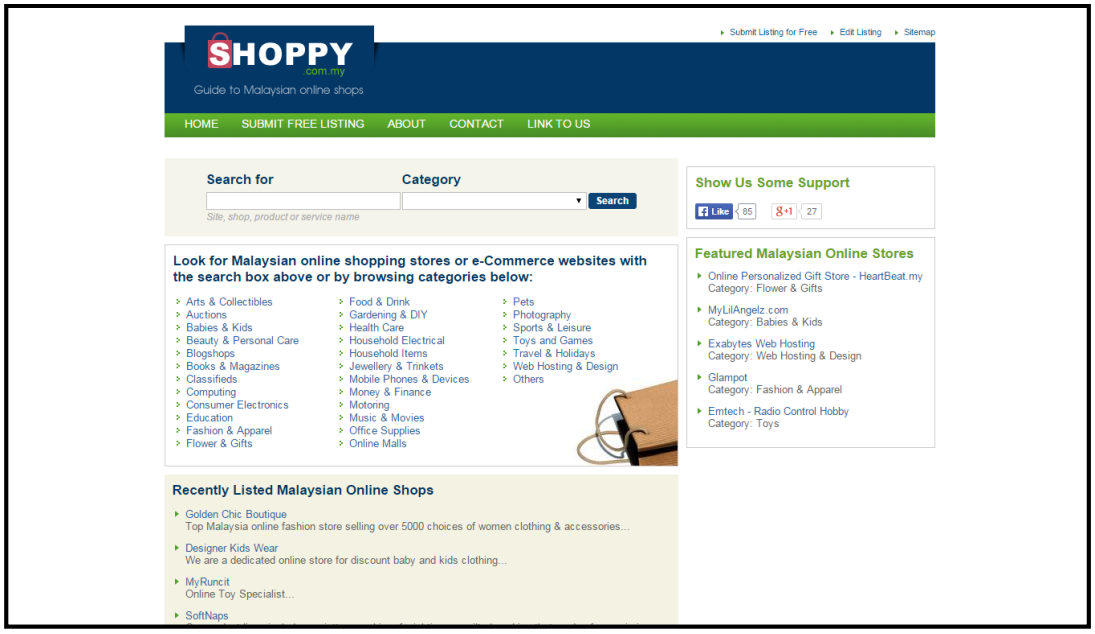
Appendix A



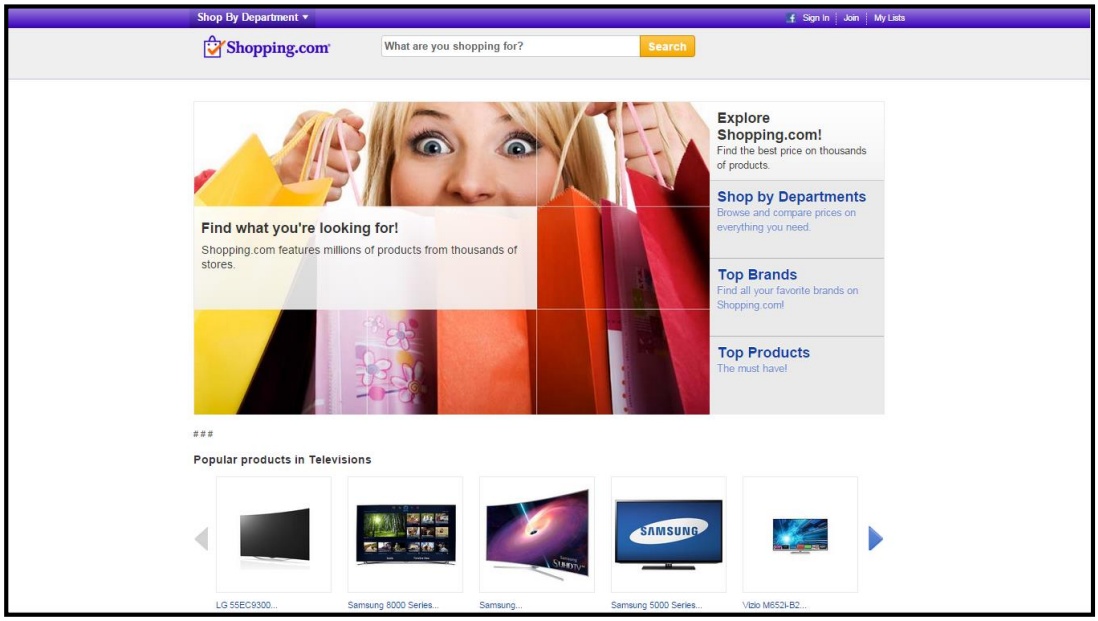
www.trivago.com.my



www.priceme.com.my



www.shoppy.com.my



www.shopping.com

Appendix B

Group photo with our supervisor and internal examiner, Dr. Nordin during Research Proposal Defense

Group photo with our awesome supervisor during Pre-Sedex

Sharing my excitement with my Supervisor after being awarded Bronze Medalist in Sedex 35th

Group Photo with Mr. Ikhwan, Dr. Bob, and Dr. Izzatdin during VIVA

Appendix C

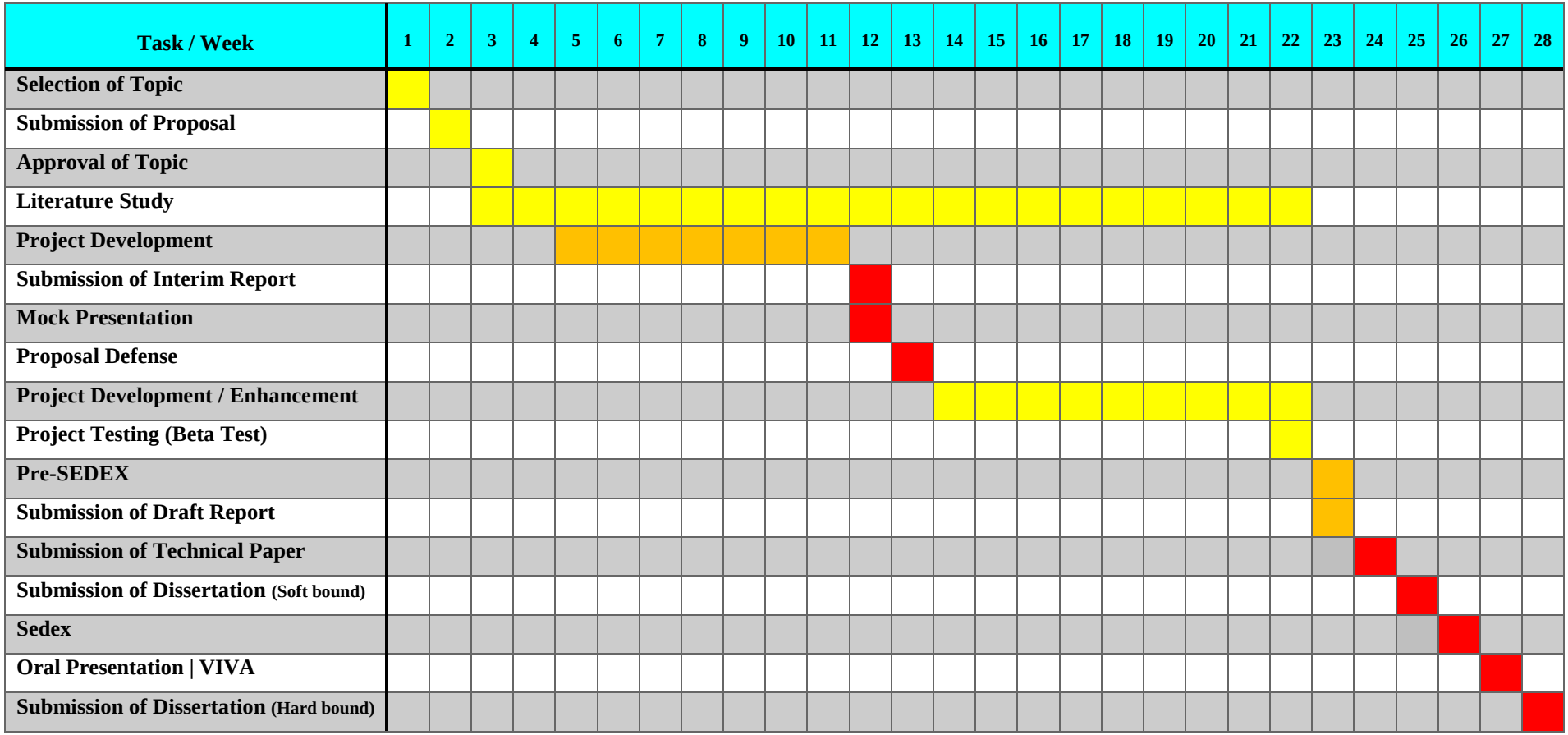
No.	Week	FYP I Milestone	Date
1	1	FYP I Briefing	14 January 2015
2	1	Selection of Project Topic	14 January 2015
3	2	Submission of Proposal	21 January 2015
4	3	Confirmation of Topic and Supervisor	28 January 2015
5	5	Project Development starts	9 February 2015
6	9	Briefing on Plagiarism	11 March 2015
7	12	Submission of Interim Report	31 March 2015
8	12	Mock Presentation	3 April 2015
9	13	Proposal Defense and Progress Evaluation	9 April 2015

Key Milestones for FYP I

No.	Week	FYP II Milestone	Date
1	2	FYP II Briefing	27 May 2015
2	8	System Testing	8 July 2015
3	9	Mock Presentation	12 July 2015
4	9	Poster Presentation | Pre-Sedex	13 July 2015
5	10	Technical Paper Submission	24 July 2015
6	11	Dissertation Submission	29 July 2015
7	12	Sedex	4 August 2015
8	14	VIVA	19 August 2015
9	15	Submission of Hardbound	4 September 2015

Key Milestones for FYP II

Appendix D



Gantt chart for FYP I and FYP II

Appendix E

Technical Report

Smart Brokering for Household Items

Lee Jia Zhen, Dr. Izzatdin Bin Abdul Aziz, Nazleeni Samiha Haron

Computer and Information Science Department, Universiti Teknologi PETRONAS

Bandar Seri Iskandar, 32610 Tronoh, Perak Darul Ridzuan

E-Mail: jiazhen0323@gmail.com, izztdin@gmail.com, nazleeniharon@gmail.com

ABSTRACT

This research paper proposes the development of a Smart Brokering System for product price survey activity so that to ease consumers in their daily routine in selecting the household products. In this paper, a price comparison system for household products will be developed to display all possible product prices from several grocery stores based on the budget preferences set by the consumers. In particular, the proposed system will be developed by using a full-text search library, which the data is already been populated in the database to implement the data retrieval process. This system is written in C# and ASP.NET. In brief, the expected outcome of this research is to improve the easiness of shopping and the efficiency of price surveying activity by the consumers.

Keywords: search, comparison, price

1. INTRODUCTION

In today's society, business-to-consumer via electronic commerce (B2C e-commerce) is gaining popularity due to the rapid growth of the Internet (Liu & You, 2003; Vachon, 2011). This statement was explained by Vachon through a survey carried out by Vertical Web Media in year 2010. The survey states that there are 60% of consumers from the United State of America shopped online quarterly each year (Vachon, 2011).

Indeed, shopping has become one of the favourite activity of the people from younger generation. This activity has become a hobby in today's trend and will be carried out by the people at least once a week. However, shopping can be an infuriating experience if the budgets are limited. It is not easy for consumers to buy the product from the right store with prices that matches the consumers' budget (Deeb, 2014). Thus, a wise consumer will carry out a simple research before purchasing products to avoid regretting of purchase wrong products.

According to the researcher, a Decision Support Systems (DSS) was developed to apply a cognitive approach in solving a problem, however, the DSS is now turned to help the consumers in their online buying decision process (Vachon, 2011). Therefore, the author decided to create a Smart Brokering System so that it can assist the consumers to improve the process of their buying decision.

The "Smart Brokering for Household Items" is an intelligence brokering system that helps the users to compare the price of the daily products from several grocery stores without looking at a few set of brochures. It acts as an agent to filter and provide the lowest price of a best matching product upon the users' requirements and then display the searching results on the webpage to the users for the price referencing. In brief, the aim of this system is to help the users to make suitable buying decision through price comparison.

As a result, the Smart Brokering System is the intermediary between the consumers and the stores that convey the pricing information of the household items to the consumers. This intelligent broker allows the consumers to make decision on their shopping carts with the best matching budget according to the users' budget capacity. It can also boost up the consumers' buying decision process indirectly by saving the time of the consumers to compare the prices manually from the brochures. This can be proven by the statement from Shopping.com where *"In today's cluttered online world, smart consumers demand simple and easy comparison features that take the stress out of online shopping, help inform the right purchasing decision and lead them straight to the products they're seeking, while saving time and money. ("Shopping.com," 2000)"*

The objectives of this research is to perform a study on the existing smart brokering systems and provide analysis and to design and develop a smart brokering system to improve the buying decision of a consumer.

The scope of this research is to focus on finding the most accurate way to filter the price list of different products from different grocery stores. In particular, this brokering systems will be developed by using a full-text search library, which the data is already being populated in the database to implement the data retrieval. This systems is written in C# and ASP.NET. The concept behind the system is simple. It is assumed that the participating retailers register their products with the smart broker.

In specific, the representatives of each retailers are allowed to manage the products, such as add new or delete existing product information in the system. The representatives of each retailers are required to register an account before they are allowing to manage the products. The Brokering System will execute the searching after the users enter a product name at the search box. Furthermore, the users are able to set the product price ranges according to the budget to execute the searching process. Search results is displayed to the users after the execution. As a result, the expected outcome of this research is to improve the easiness of shopping and the efficiency of price surveying activity of the consumers with accurate filtering mechanism.

2. LITERATURE REVIEW

2.1 What is Price Comparison Systems (PCS)?

A lot of price comparison sites from different industry can be found in the e-commerce market today and the sites are widely used by the shoppers. Gregoriadis, an E-consultancy analyst said *"More and more consumers are using comparison sites to research products and services so they can find the best value products and services."* This can be proven based on the 30% growing rate of the amount of traffic to the price comparison sites every year (Gregoriadis & Lake, 2006).

For example, Trivago is one of the world's largest hotel searching platform that provide hotel information across the countries from different booking sites. It compares over 800 thousands of hotels worldwide from 270 booking sites so that potential travelers are able to find and rent the ideal hotel at the lowest rates ("Trivago," 2015). In brief, the price comparison websites bring convenience to the people as they can search and compare prices of a certain product within their budget in just a few mouse clicks.

2.2 The Role of Price Comparison System

Sometimes, the Price Comparison Systems are also known as Shopping Bots (Shopbots), Comparison Shopping Agents (CSA) or Comparison Shopping Engines (CSE) by some other researchers in certain context (Hayes, 2012; Kim & Ha, 2014; Vachon, 2011). It is a web-based application that provide the consumers with opportunities to acquire wider range of information on various products through online (Kim & Ha, 2014).

Basically, the price comparison system collects product information such as the price from participating retailers and then display the information on a webpage in response to the buyers' query (Hayes, 2012). In this way, buyers are able to compare the product's price from different retailers and choose the merchant that offers the best value.

The researcher explained that a price comparison system integrates the search engine and comparison tools of a website (Vachon, 2011). He also agreed with the explanation made by other scholars (Serenko A., 2010) where the price comparison system acts as the 'middle man' that search for a particular product among several websites and then execute the comparison between competitors' offerings.

In brief, the "Smart Brokering for Household Items" is a price comparison system that facilitates comparison of the products' price among the grocery stores. Moreover, it is intelligence enough to select alternatives goods for the consumers based on the price preferences and other attributes such as brand, and current promotion.

2.3 The Existing Price Survey Techniques Used

There are a few techniques available used by the consumers to compare the price of the products from several stores. In this research, the author had selected three common techniques that are used frequently by households, which are:

a. Consumers get the pricing information from friends and family (through Word-of-Mouth).
b. Consumers carry out the price survey physically by visiting to the grocery stores.
c. Consumers carry out the price survey via online catalogues from different websites.

Table-1. Comparison of the Existing Price Survey Techniques Used

Features / Characteristics of the Techniques	Technique A: Word-of-Mouth	Technique B: Visit the stores Physically	Technique C: Online Catalogues
Accurate Price Matching	Medium	High	High
Accurate Product Matching	Low	High	Medium
Easiness of Shopping	Low	Low	High

Time Saving for Shopping	Low	Low	High

Table 1 shows the comparative study of the existing price survey techniques used by the consumers.

Three most common techniques were selected by the author as follows. Technique A: Word-of-Mouth and Technique B: Visit to the stores physically are the conventional methods used by most of the households from older generation such as Generation X and before. On the other hand, Technique C: Referring to the Online Catalogues is the latest trend where it was used by the consumers who are the frequent online shoppers.

When the consumers apply Technique B and C for the price surveying activity, there are higher chances where the consumers are able to get an accurate price match for a certain product. This is because consumers are able to check the product price on the spot when they visit the store or checking through online catalogues. However, Technique A is less accurate and unreliable because people tend to make mistakes when they deliver information.

Besides that, consumers visit to the grocery stores physically can always get hundred percent accurate matching of a product in term of the quality and some other attributes such as brand, color, weight and so on. This is because consumers can check out the product tangibly by touching or smelling it. However, it is a bit challenging for the consumers to compare the product quality through imagination. Thus, Techniques A and C are less reliable at this points compared to Technique B.

Consumers need to spend longer time when they carry out the price surveying activity via the conventional Techniques A and B. Thus, when it comes to the easiness of shopping, it is no doubt that Technique C is the best among the three techniques. It brings the convenience to the consumers when they are referring to the online catalogues for price survey. This is because they do not need to compare the product price manually by looking at a few set of brochures. On the other hand, it also save the travelling time of the consumers as they know where to buy the products after the decision is made.

As a result, Technique C is more efficient and reliable for the consumers who want to carry out product price surveying activity.

2.4 The Existing Price Comparison Systems in the Market

From Table 1, we can conclude that there are a lot of gaps that need to be fulfilled, thus, another comparison is carried out in this research to reduce the gaps. In this research, author had selected three potential price comparison systems that are available in the market, which are:

a. PriceMe smarter shopping <www.priceme.com.my>
b. Shoppy Guide to Malaysian online shops <www.shoppy.com.my>
c. Shopping.com <www.shopping.com>

Table-2. Comparison of the Existing PCS in the Market ("PriceMe smarter shopping," 2007; "Shopping.com," 2000; "Shoppy Guide to Malaysian online shops," 2014)

Features of PCS	PriceMe	Shoppy	Shopping.com	Smart Brokering
Provide Household Items	Yes	Yes	Yes	Yes
Provide Grocery & Gourmet	No	No	Yes	Yes
Usability Friendly	Yes	No	Yes	Yes
Available in Malaysia	Yes	Yes	No	Yes

Table 2 shows the comparative study of the existing shopping comparison engines in the market and the proposed Smart Brokering System in this research.

In table 2, we knew that the websites are providing the price comparison for the household items such as the cooking utensils, containers, and some electronic stuffs. However, only Shopping.com is providing the price comparison for grocery items and gourmet whereas PriceMe and Shoppy do not include this service.

Next, based on the Graphical User Interface (GUI) design of the websites above, PriceMe and Shopping.com are more user friendly as compared to Shoppy, as the users are able to easily understand how to use the websites. Besides, the search result provided by PriceMe and Shopping.com are clearer than Shoppy. The price lists of the similar products in different brands will

be displayed, thus, this helps the users to make up their mind easily. However, the search result provided by Shoppy confuses the users when the system execute a list of useful websites upon the search result instead of displaying the result of the price lists directly to the users. It brings trouble to the users as they need to choose the third party websites to check the price of only one product.

Last but not least, Shopping.com is a well-known price comparison engine that belongs to eBay Commerce Network. It is pioneered online price comparison engine that is still remain as one of the leading shopping sites in the market today ("Shopping.com," 2000). Consumers were giving their support to Shopping.com because it was helping a lot of consumers to make informed purchasing decisions over a decade. It is no doubt that the reputation of Shopping.com is so far better than PriceMe and Shoppy. Unfortunately, Shopping.com is not available in the market in Malaysia yet. It is too bad as the consumers in Malaysia are not able to fully utilize Shopping.com although it has better reputation and advanced features as compared to the other price comparison sites such as PriceMe and Shoppy.

As a result, in order to fulfill the lacking features of PriceMe, Shoppy, and Shopping.com, the "Smart Brokering for Household Items" is implemented in order to narrow the gaps of the problems faced by the consumers.

3.0 RESULTS AND DISCUSSIONS

3.1 System Architecture

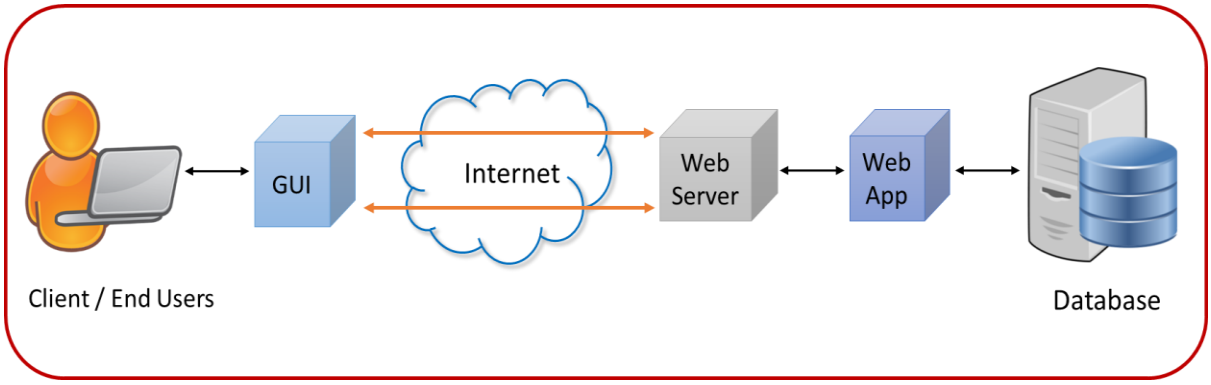


Figure-1. Architecture of Smart Brokering System

Figure 1 shows the architecture design of the "Smart Brokering for Household Items". The system architecture involves the end users, GUI, Internet, a web server, some web applications and SQL server express local database.

The end users are the people who visit and use the Smart Brokering System with an Internet connection. In this case, the targeted users of the Smart Brokering System are the households who want to carry out product price research before purchasing.

Next, the Graphical User Interface is referring to the web browser of the Smart Brokering System at the clients' side, which is in HTML format. Meanwhile, the web server is a platform used to distribute information to the web browser. Apart from that, this brokering system is supported by a few main web applications such as C#, and ASP.Net. These web applications will be connected to a local database in Visual Studio that is being populated by the retailers.

In general, Smart Brokering System is implemented a comparison system through the search engine. While the search engine of the Smart Brokering System is developed by information (data) searching.

During the information searching process, the brokering system will start to execute after the users insert the search criteria such as a product name or set the budget range. The database query will look for the matching item in the local database. Then, the search result will be displayed in table form for users' references.

3.2 System Flow

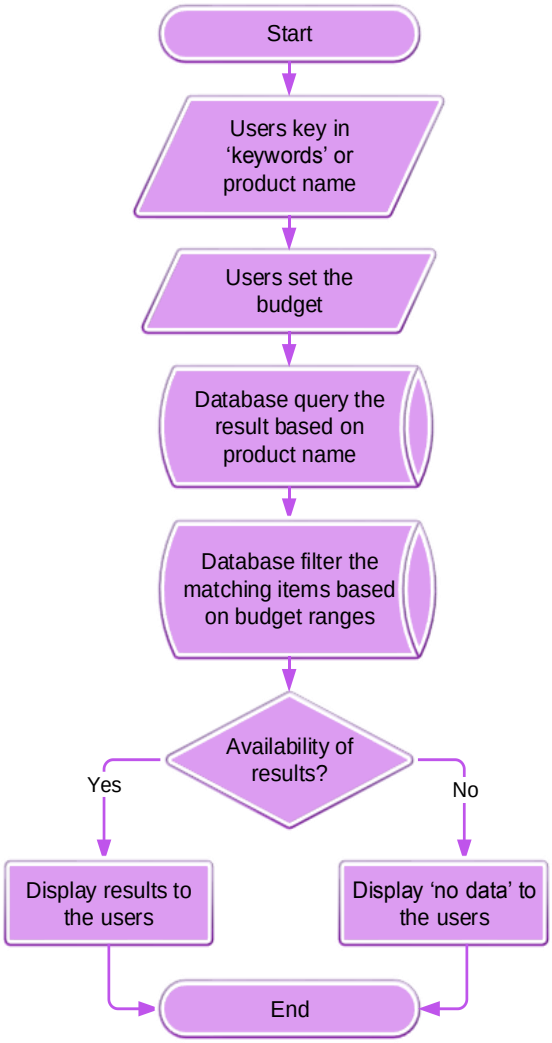


Figure-2. Flow Diagram of Smart Brokering System

The proposed system flow diagram of Smart Brokering System is shown in Figure 2. This diagram explains how the overall system works.

As been mentioned before, the items of the household products are pre-populated by the retailers and stored in the database beforehand. This is because data crawling cannot be carried out as most of the grocery stores do not own a websites, hence, data crawling is unable to apply in this case.

The brokering system starts to execute after the users insert the search criteria (e.g. product name) in the search bar, they are able to set the budget range from the dropdown lists under the search bar too if they have fixed their budget. The search only takes one click, after the users clicked on the search button, the database query starts to execute to look for the matching items inside the build-in database.

When the process is done, the list of the prices from several stores are presented on the webpage to the users for their decision making. If the items are available in the database, results will be displayed else empty data text will be displayed to inform the users that the product is not found. Users may repeat the process by inserting another search criteria if the result is not found in the previous try.

3.3 Graphical User Interface (GUI) Design of the Smart Brokering System

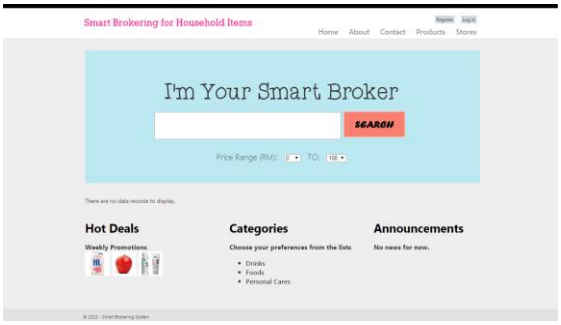


Figure-3. Homepage design of Smart Brokering System

Figure 3 shows the interface design of the Smart Brokering System.

At the homepage, users are required to insert the search criteria such as a product name in the search bar in order to perform the search query. Besides that, users are able to set their budget range from the dropdown list under the search bar if they want to, else the budget range on system default is from RM0 to RM100.

On the other hand, if the users have no idea on what to buy, they can refer to the product items under 'Hot Deals' to look for the weekly promotions. Furthermore, they can also check the prices of a particular product by browsing through 'Categories'. The household products have been categorized into three different categories, which are Drinks, Foods and Personal Cares.

The 'Announcements' column is designed to display important news or notices to the users.

3.3.1 Role of Users

There are 3 types of role who will be using the Smart Brokering System, which are system administrator, store administrators and end users.

System administrator, which is the author of this research is responsible to manage the system such as to carry out some enhancement works of the system, and to manage the store administrators in the database.

While the store administrators are the person in-charge from the participated retailers. They are responsible to update the price list of the products from time to time. The stores administrators are able to add new products or to delete the old products information from the system.

Lastly, the end users are the people who use the system to carry out price surveying activity.

3.3.2 How to Perform the Search Query?

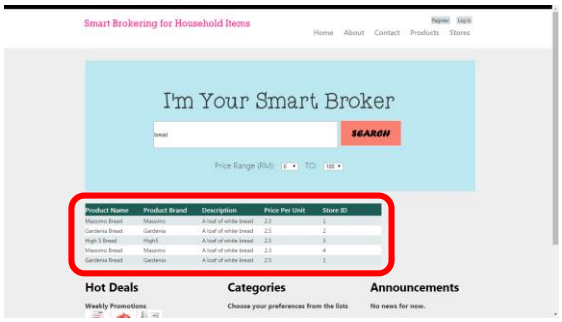


Figure-4. Search Result

As been mentioned before, users are required to insert the search criteria (E.g.: bread) in the search bar in order to perform the search query. Besides, users are able to set their budget range from the dropdown list under the search bar if they want to, else the budget range on system default is from RM0 to RM100. After that, click on the 'Search' button beside the search bar and wait for the search result to be displayed.

Figure 4 shows the search result which is the price lists of the bread are displayed in table form so that it allows the users to compare the prices easily. In addition, some important information of the products also displayed in the table such as brand, description, and store.

3.4 The Search Algorithm

```
<asp:SqlDataSource ID="SqlDataSource1" runat="server"
    ConnectionString="<%$ ConnectionStrings:ConnectionString %>"
    SelectCommand="SELECT [ProductName], [ProductBrand],
    [PDescription], [ProductPrice], [StoreID]
    FROM [Products]
    WHERE (([ProductName] LIKE '%' + @ProductName + '%') AND
    ([ProductPrice] &gt;= @ProductPrice) AND ([ProductPrice] &lt;= @ProductPrice2))">
    <SelectParameters>
        <asp:ControlParameter ControlID="SearchTextBox" Name="ProductName"
            PropertyName="Text" Type="String" />
        <asp:ControlParameter ControlID="DropDownFrom" Name="ProductPrice"
            PropertyName="SelectedValue" Type="Double" />
        <asp:ControlParameter ControlID="DropDownTo" Name="ProductPrice2"
            PropertyName="SelectedValue" Type="Double" />
    </SelectParameters>
</asp:SqlDataSource>
```

Figure-5. The Search Algorithm

Figure 5 shows the pseudocode of the search and matching algorithm.

The concept of the search and matching algorithm is easy to understand. It starts from the database connection which is written in Line 2, ConnectionString = "<%$ ConnectionStrings:ConnectionString %>", the database ConnectionString was being connected to the ConnectionStrings.

At Line 3: SelectCommand = "SELECT [ProductName], [ProductBrand], [PDescription], [ProductPrice], [StoreID] FROM [Products] This part is to select some commands from the table of [Products] in the local database. The commands [ProductName] and [ProductPrice] will be used to match with the search criteria inserted by the users.

At Line 6: WHERE (([ProductName] LIKE '%' + @ProductName + '%') AND ([ProductPrice] >= @ProductPrice) AND ([ProductPrice] <= @ProductPrice2)) This part is use to set some requirements so that matching process can be done accurately when query from the database. Two things need to be checked when doing the search query, which are the search criteria in the search bar and budget ranges from the dropdown lists.

i. ([ProductName] LIKE '%' + @ProductName + '%')
   The LIKE operator here is used to search for a specified pattern in a column. Hence, [ProductName] from the database must be matched with the criteria given by the users

@ProductName which is from the Search Text Box.

ii. ([ProductPrice] >= @ProductPrice)
The >= operator is used to compare the price lists in the database which is greater than the price set by the users. Hence, [ProductPrice] from the database must be greater than @ProductPrice in the first dropdown list.

iii. ([ProductPrice] <= @ProductPrice2)
The <= operator is used to compare the price lists in the database which is lesser than the price set by the users. Hence, [ProductPrice] from the database must be lesser than @ProductPrice2 in the second dropdown list.

3.5 System Test Results

System testing is carried out to test the accuracy, stability and efficiency of the Smart Brokering System before deployment. The objective of the system testing is to ensure that the Smart Brokering System will satisfy the consumers need, which is to filter a desired product's prices from different brand and several stores based upon the budget requirements.

Three tests have been done to test the stability and accuracy of the Smart Brokering System. Each test was carried out 40 times (10 trials for every 30, 40, 50 and 60 data size). The data size means the total number of items stored in the database.

3.5.1 Test Case One

Test case one is used to measure the time taken to retrieve the data. In this experiment, the responding time of the searching result to be displayed on the webpage was measured using a stop watch with the increment of the data size inside the database.

Table-3. Time Taken to Retrieve the Data

Data Size (Items)	Response Time (s)
30	0.20
40	0.21
50	0.23
60	0.25

The response time given is satisfied as it is around 0.22s in average.

3.5.2 Test Case Two

Test case two is used to test the accuracy of the searching result without setting the price range. In this experiment, the searching result displayed on the screen was compared with the item stored inside the database.

Table-4. Accuracy of the Search Result without setting the Price Range

Data Size (Items)	Accuracy (Yes/No)
30	Yes
40	Yes
50	Yes
60	Yes

Accurate results were generated in this test.

3.5.3 Test Case Three

Test case two is used to test the accuracy of the searching result without setting the price range. In this experiment, the searching result displayed on the screen was compared with the item stored inside the database.

Table-5. Accuracy of the Search Result by setting the Price Range

Data Size (Items)	Accuracy (Yes/No)
30	Yes
40	Yes
50	Yes
60	Yes

Accurate results were generated in this test.

3.5.4 User Acceptance Testing (UAT)

Besides, user acceptance testing was also conducted to evaluate whether the Brokering System is effective and meet the user requirements. The target user in this research is the consumer who want to carry out price surveying activity. The user evaluation of the system will assist in analyzing the effectiveness of the Smart Brokering System in suggesting the best matching household products for the consumers based on their product and budget preferences.

The author personally guided and showed 10 of the respondents from UTP how to use this system during Sedex. Respondents had been informed that this system is newly created by the author herself. Although this system is similar to the other price comparison system that is available in the market but the objective of this system is to act as a platform to embed the algorithm in order to prove the research hypothesis.

Below are the set of questions that were asked to 10 respondents:

Question 1: Is the Smart Brokering System user friendly?

Question 2: Are you able to understand the information displayed in the system?

Question 3: Is the interface of Smart Brokering System attractive?

Question 4: As a consumer, do you agree that this system is effective and improve your shopping experience?

Question 5: In your opinion, what is the best way to carry out price surveying activity?

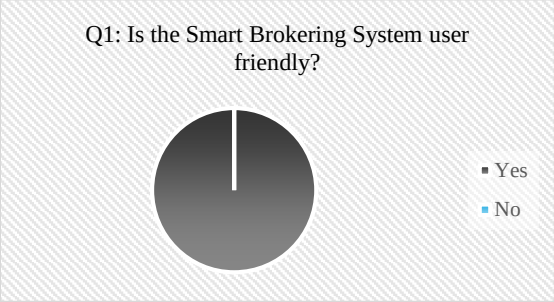


Figure-3. UAT Result for Question 1

From the figure above, author can conclude that the respondents positively accepted the Smart Brokering System. All respondents agreed that Smart Brokering System is user friendly. This is because it is very simple to use to carry out price surveying activity as it only needs a few mouse clicks to search for the products.

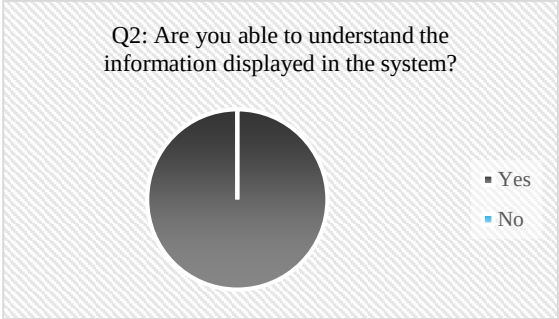


Figure-4. UAT Result for Question 2

Besides, all respondents are able to understand the information displayed in the system. They are agreed that the searching result is displayed in a table form with some important information such as product name, price, and store being attached together in the table.

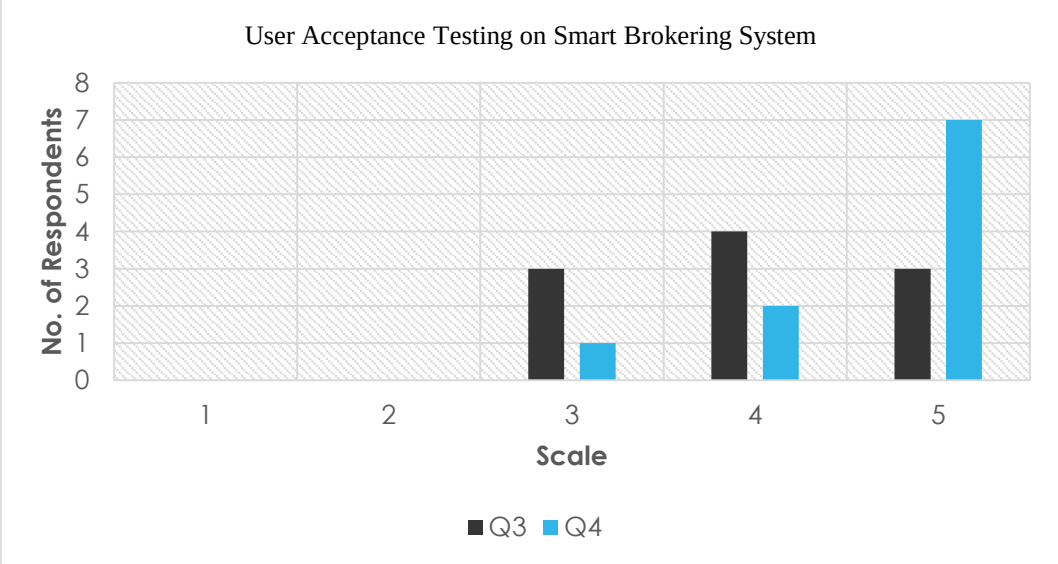


Figure -5. UAT Result for Question 3 and 5

In addition, Likert Scale was used to measure Question 3 and Question 4 where scale 1 is strongly disagree and scale 5 is strongly agree.

From Figure 5, most of the respondents were not satisfy with the current interface design of the system. They found out that the interface was very dull and boring due to the color scheme.

However, seven of them do strongly agree that Smart Brokering System is effective and they also believe with the help of Smart Brokering System, their shopping experience will be improved too. They believed that they could save a lot of money and time, if they use the system to check on the pricing information before purchasing.

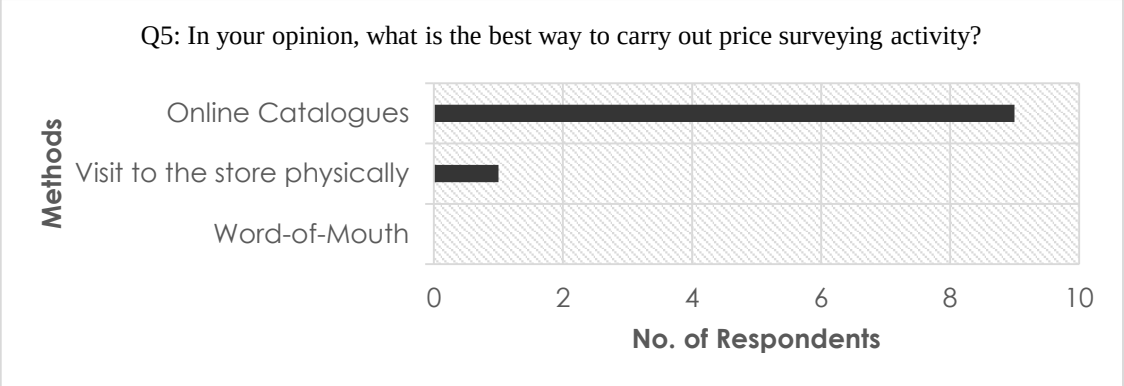


Figure -6. UAT Result for Question 5

Lastly, from Graph 4, nine respondents are believed that online catalogues is the best way to carry out price surveying activity, while only one respondent prefers to visit to the store physically.

In overall, based on the user acceptance results, the author is happy to conclude that the respondents are very positive and supportive. They had showed their support by giving useful feedback and comments to the author in order to further improve the system. Thus, Smart Brokering System is effective and meet the user requirements.

3.6 Problems Faced during System Development

There are some defects appeared during the development stages.

i. Wrong database name caused the failure of connection.
Due to the wrong database name was used during the initialization of the database connection, the author failed to connect the database to the server. Fortunately, this critical problem has been solve in two days where the mistake was figured as shown below:
'SmartBroker' is used instead of the correct database name of 'DBSmartBroker' in ProductContext.cs

ii. Images could not be viewed on the webpage.
Due to the wrong image path had been assigned in the database, the images could not be viewed on the webpage. Fortunately, author found out the root of the problem within a few minutes after re-reading the code. The mistake was figured as shown below:
'Apple.jpg' is assigned instead of '/Images/Apple.jpg'.
The missing of folder name had caused the failure of displaying the pictures.

4.0 CONCLUSION

4.1 Conclusions

The conventional price comparison engines that are frequently used in the market today provide only basic browsing through keyword and classification where the search result given is not 100% accurate (Chen & Huang, 2013).

This research presents a price comparison system that will show all possible prices of the household products from different stores based on the consumers' product and budget preferences using data searching method.

By applying the data searching method in the Smart Brokering System, the searching results will be processed in shorter time which is approximately 0.22s in average and the results displayed are 100% accurate. This is proven in the test cases in Section 3.5.

As a result, the objectives of the Smart Brokering System is achieved which is to help the consumers to carry out a simple research on the price of a product efficiently with accurate filtering mechanism.

4.2 Future Works and Recommendations

The author strongly suggested this Smart Brokering System can be continued to develop into a mobile application. This is because in today's society, most of the consumers own a smartphone. Hence, with the mobile apps, it will ease the buyers or consumers to check the price list of a product at anywhere anytime. It cut down the limitation of the smart brokering system on web which is only allow people with laptop to carry out the price survey.

On the other hand, the distance of the participated stores and the house of a user can be calculated in order to cut down the time taken and transportation cost to reach the stores. With this function added to the system, Smart Brokering for

Household Items will be a perfect solution for the users as it helps to improve the buying decision of a consumer as well as to save the time and transportation cost of the users.

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