MOBILE FOOD PLANNING AND CONSERVATION SYSTEM

(Food Planning and Demand Forecasting Control)

By

Benson Law

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION SYSTEMS (HONS)

BUSINESS INFORMATION SYSTEMS

Faculty of Information and Communication Technology

(Perak Campus)

JAN 2014

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DECLARATION OF ORIGINALITY

I declare that this report entitled "**MOBILE FOOD PLANNING AND CONSERVATION SYSTEM (FOOD PLANNING AND DEMAND FORECASTING CONTROL)"** is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : _____

Name : _____

Date : _____

ACKNOWLEDGEMENTS

To accomplish the degree course for Bachelor of Business Information Systems at Universiti Tunku Abdul Rahman, students are required to complete a Final Year Project in their degree course. The objective of this project is to provide an opportunity for students to apply the knowledge that they gained in these years of university life to the work or job they have done.

As I wrote this report, words could not express what a pride and privilege for me to complete my Final Year Project. The process for completing this report is an opportunity for me to apply all the knowledge and skills that I had learned in university. Hence, I take this opportunity to express my appreciation and gratefulness to those who contributed to the success of my endeavor.

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Lastly, I would like to thanks to my parents for their love, support and continuous encouragement throughout the studies in my bachelor degree.

ABSTRACTS

This project presents one of the modules of the project "Mobile Food Planning and Conservation System" which is defined as "Food Planning and Demand Forecasting Control". The purpose of this project is to plan daily meals with adequate nutritious value for the family and also control the inventory level of food by using food reordering formula, and forecasting technique to facilitate decision making. Besides that, this project's intention is to promote reduction of food wastage and the conservation of food through food inventory control, demand forecasting models and food sharing which includes aspects such as calculating reordering point, tracking expiry dates, predicting food demand, and sharing food through social networks.

This project targets to develop part of a mobile phone application which will include several unique modules. The first function is food reordering which is done by using the reordering formula proposed by Murphy and Wood (2012) to make sure household have enough foods to eat which also taken uncertainties into consideration. Besides, a demand forecasting model called Weighted Moving Average (WMA) proposed by Murphy and Wood (2012) is used to calculate the future demand of foods needed by the household. In addition to that, this projects also help to reduce carbon footprint by encouraging the users to purchase foods from nearby stores. This action can reduce the environment impact created by gases released during food disposal. Lastly, this project also supports uploading photos or information about foods to share among social networks in order to reduce food wastage.

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LIST OF ABBREVIATIONS

AUP	Agile Unified Process
MFPCS	Mobile Food Planning and Conservation System
SMA	Simple Moving Average
UI	User Interface
WMA	Weighted Moving Average
WP	Windows Phone

CHAPTER 1: INTRODUCTION

Food are the essential part in our life, it can sustain our life by providing nutrient and energy needed to complete our daily routine. Due to globalization, many aspect of our daily life has been digitalized such as the use of technology to automate food ordering process. The creation of smartphone with user friendly touch screen has greatly increased the interaction between machine and human. Application for mobile phone has been created to raise awareness of environment impact of food wastage among the citizens all around the globe in different countries with variety of cultures. Devices, applications and software are readily built to prevent food wastage, tracking food expiry date and even automated food ordering. With the help of information technology, stock management has become easier than before (Riley 2005), different types of information can now be gathered in a more convenient manner. (Lao 2010) In this chapter, we are going to discuss about how food planning is important to us and why it should be applied in our daily life.

1.1 MOTIVATION AND PROBLEM STATEMENT

Adequate food planning and controlling is crucial to ensure the foods are enough to satisfy the family member's nutritional requirements, so as to control the spending in grocery and also bonding the relationship within the family by enjoying the moment of having meals together. Dinner is the moment where most of the family members share their daily happenings and usually this is the only precious moment they enjoy being together after coming back from workplace and schools.

But using traditional methods to plan food manually by searching through the recipe books or calling friends to ask for the directions are ineffective and sometimes inconvenient. With

the help of technology such as mobile application in smartphone, they can plan more effectively and easier because information can reach to them faster with built-in functionalities. When foods are well planned in advance with the help of information technology, folks can enjoy healthy and low cost foods with faster decision making and a better control on food spending behavior. Besides, planning will utilize the food discount coupons, purchasing on sale items, and planning to conserve the leftover food.

One of the causes of food wastage can be the inadequate forecasting of food to be purchased. Without appropriate information technology and technique, one can hardly decide the amount of food to be bought and only can based on self-assumption or intuitive. Uncertainties in life can be a minor factor contributing to food wastage in the household such as sudden call out for a party at home.

According to Malaysia Today, Malaysians are either overeating or wasting food in their daily life, up to 930 tons of unconsumed food are thrown away. This is equivalent to us tossing away 93,000 unit 10kg bags of rice each day. (Aruna 2011) Most families do not plan well in their everyday meals and also do not worry about wasting the foods and they just throw the left over or expired foods into the dustbin after all. One day it can lead to food shortage, starvation and poverty if these issues are not taken care properly.

The Food Agriculture Organization (FAO) says that many foods are lost in the early stage of the food supply chain due to many reasons such as pest attacks, ineffective garnering techniques, poor storage facilities and poor transportation. On the other hand, food are lost at later phases of the food supply chain in a developed country. Li et al. (2009) says that at the food manufacturing and wholesaler levels, wasteful production practices, over fancy towards appearance of food instead of quality and misunderstanding over the expiry date

tags are the main causes of food wastage. At the customer side, over-buying, incorrect storage methods and over-cooking are the reasons of food wastage. (Li et al. 2009)

Furthermore, one do not keep track the inventory and expiry date of food items in the house when they do the grocery at the end expired food are being thrown away because they are not consumed until they are found expired. In addition, foods in the household are usually not categorized according to food types or nutritious information.

Although many application has been developed to improve food planning and prevent food wastage, it is still not widely used by household because the system is not usable for adults that are computer illiterate. In addition, computer are not handy to facilitate the ease of cooking when using those system, it must be done before that. Therefore, a Mobile Food Planning and Conservation System is implemented to solve the problems.

1.2 BACKGROUND INFORMATION

In this project, we are going to discuss about how food planning should be done with mobile application. Besides, with proper reordering of food and controlling of food expiry date, food conservation can be achieved and this leads to reducing food wastage that can impact the environment. Besides, another interactive way of conserving foods it to share them on the social networks to give to the people those needs them.

We are planning to develop a mobile application which emphasize on food reordering where calculation of reorder point can be applied to determine when to order food to store at home and what kind of stock we have in the storage. Furthermore, we will discussed about which demand forecasting technique be used to predict the amount of food needed on the next purchase. An example of the calculation technique will be weighted moving

average which is done by totaling up the multiplication of demand with a weight value across different time periods and then divide by the total of weight values.

Li et al. (2009) proposed a special analysis technique are used to classify items into three categories called ABC analysis, this analysis has been used widely in logistic industry and also in most of the supply chain management. In addition, this analysis technique is quite similar to Pareto Principle which stated that 80% of the consumption value comes from the 20% of the total items.

Besides, not only we are raising awareness of environment impact by food wastage but also encouraging users of our application to buy local foods from local stores or nearby markets because buying local foods can reduce the carbon dioxide emission to the atmosphere because foods are delivered by trucks to the supermarket and they will release carbon dioxide gases to the environment and pollute the air eventually. To save the environment, we hope to reduce the carbon footprints produced by transportation of foods and other food production process using technological means.

In addition, user's shopping planning behavior also been studied to discover various situation when they plan to purchase foods. Studies shown that there are some constraints when they planning the shopping list and this constraint can affect their food planning behavior indirectly.

1.3 OBJECTIVES

The main objectives of this project is to develop a mobile applications that help user to manage their food planning and conservation process with a user friendly and user interactive interface. The proposed application will provides user important features to plan

their meals daily and weekly. Besides, when users wants to share the foods to their friends, they can simple take a photo or post a status indicating this foods are giving our for free on the social networking sites.

In addition, we will implement an user friendly and interactive graphical user interface for the purpose of provide a better visualization experience, so that the user are comfortable when using the application.

The main objectives can be broken down into further sub-objectives. First, the food can be reorder by calculating the reorder point to prevent food shortage. Second, the information such as the expiry date can be embedded into the barcode as well or else user can enter the date by typing it manually. Lastly, with a forecasting technique users can forecast the amount of food needed to buy on the next shopping list.

1.4 IMPACT AND CONTRIBUTION

Global food manufacturing is the largest and the only factor of biodiversity loss and changing land usage which it occupies 25% of all habitable land, uses up 70% of fresh water intake, is responsible for 80% of deforestation and emits up to 30% of greenhouse gases. (Li 2013) Foods that are thrown in landfills spoilt and turns to a dangerous source of methane, an impactful greenhouse gas with twenty one times greater than the carbon dioxide that causes global warming. When food demand forecasting are accurate, there is a chance where food wastage can be prevented and thus can conserved the foods for the people in need around the globe. By reducing food wastage, Demery (2012) implies that the world would has enough food supply to feed the projected 870 million constantly

starving people in the world, excluding the increase food production and putting extra burden on global natural resources.

Using information technology such as mobile application can help reducing food waste through conservation can help to save up money and resources to minimize the environmental impacts and, the most significantly, making a world where everyone has enough food to live because with the help of electronic devices such as mobile phone and laptops information can be reach to the audience quickly and effectively.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this project we will discuss about how to manage the food planning in the house to reduce food wastage effectively. To achieve our objective, several review has been done in order to gain a more solid knowledge behind food planning and conservation. In supply chain management, forecasting technique is used to predict the future demand of the sales or amount of stock need to be reorder. Many researchers has done modifying the existing forecasting technique to produce a better result. The degree of complexity varies depends on the situation. We would like to apply the demand forecasting technique into our project to allow users to better predict the amount of foods need to be bought instead of spending long time to make a wise decision.

In addition, we also looking into reducing the carbon footprint when users buying the food. To do so, we are promoting local citizens to buy their foods in local stores nearby instead driving far away to supermarket. Studies found that different individuals have different shopping habits and some might be influenced by some specific factors around them. Users should be informed that when foods are going to expired and consumed them as soon as possible and also share them out to search for potential food lovers.

By combining all of the methodologies above into one platform, users can better manage their food at home with higher mobility and better understand the environment impact of food wastage or food loss.

2.2 FOOD LOSS AND FOOD WASTE

Food loss is the discarding of edible parts of food during the growing and processing stages of the food supply chain. Food waste typically happens during the distribution, sales and consumption phases. In the developing world, food loss is significant and food waste is minimal. In the developed world, with both more efficient production and more wasteful consumption, the opposite is the case (Reubold, 2014).

Food wasting can impact our society in three aspects: Economic, Social and Environment. In economic, wasting food means wasting our own money. In social, over wasting food can cause food shortage for our population. In environment, it can lead to greenhouse gases, limited natural resources such as water, nutrients and energy, and also pollution such as air, rivers, groundwater and soil.

2.3 FOOD PLANNING

Food is a consumable thing even when it is preserved and entails proper care and use. Appropriate planning of food storing will maximize nutritious value and optimizing food wastage. Food planning is the process that involves controlling and applying the knowledge of food, its nutrient condition and individual favorites to plan adequate and acceptable type of foods for the family. Food planning is a proficiency which improves with practice. One can learn to plan their daily, weekly or even monthly foods effectively. A complete food planning process involves identify the foods to be prepared, as well as the ingredients needed to be procured to cook them and store them in the inventory.

Food planning also covers how consumers plan their food storage at home. In other words, how much foods need to be stored at home. When storing food at home, one will consider

how much to purchase on the next shopping routine. To overcome this problem, some forecasting technology has been developed to help people to predict the adequate number items needed to be purchased. Inventory control in household is very important as it will contribute to the impact of food wastage if they are not taken care properly. When comes to a point where food is not enough to be served, it has reach a reorder point where food need to be replenished. Certain calculation and formulas existed to help consumers to better calculate with accurate information using various information system such as food reordering system proposed by. (Tanpure 2013)

2.4 FOOD CONSERVATION

Conserving food is to prevent people from wasting food whereby left over or expired foods are threw away after dinner or lunch daily. For instance, a pot of curry chicken can be save up for tomorrow's lunch when family cannot finish during dinner. In addition, if curry chicken powder was on sale, then it decreases the amount spent for it substantially. Besides, conserving food helps to save the environment by reducing food wastage and eventually less food to be purchased and finally less petrol being spent to transport the food from farm to the retailers. Since food is transported by trucks or other carbon dioxide emission vehicle, it can harm our globe and may cause certain level of air pollution if the transportation is in large scale.

2.5 DEMAND MANAGEMENT

In term of logistics, Murphy and Wood (2010) defined demand management as "the cross supply chain management and its marketplaces of a synchronized stream of demand".

2.5.1 DEMAND FORECASTING MODELS

The three fundamental forecasting models are judgmental, time series and cause and effect. First, judgmental forecasting includes applying own perspective or intuitive to forecast when there are partial or no past data, for example cooking a completely new type of meal where you never cook before.

In time-series forecasting, past demand is the key that maps out future demand. For comparison, if the sales of this year are 5 percent higher than last year, then the sales of next year should be the sales of this year and add a 5 percent higher.

Cause and effect states that multiple aspects are connected to the demand and it can be used to predict upcoming demand by using the relationship between cause and effect. (Murphy & Wood 2010) For instance, if the local price of the apples increased, the sales of the apples will dropped. Both judgmental and cause-and-effect forecasting methods are subjective and it depends on personal estimation.

2.5.1.1 SIMPLE MOVING AVERAGE

Simple moving average (SMA) is one of the time-series forecasting methods to predict the demands of certain items. Moving average is the unweight mean of previous *n* data. Because our project is quite novel, we try to use this simple methods and benchmark if there is any methods better to replace. The simple moving average is calculated by using

the number of time periods to divide the sum of the demand across different time periods. (Murphy & Wood 2010) The calculation of simple moving average is shown:

$$\text{Simple Moving Average Forecast} = \frac{\sum \text{demand in previous } n \text{ periods}}{n}$$

Where n is the number of periods in the moving average. Two month moving average means divide the sum of demand by two is preferred because the lower the number of moving average, the lower the average squared error.

For example the average squared error of three months moving average is $[4^2 + 5.7^2 + 1.7^2]/3 = 17.13$ while the average squared error of two months moving average is $[(-1.5)^2 + 4^2 + 5.5^2 + (-0.5)^2]/4 = 12.19$. Then it is known that the smaller the number of moving average, the lower the error is. The formula of average squared error is shown below:

$$\text{Average Squared Error} = \frac{\sum (\text{forecast} - \text{outcome})}{n}$$

Where n is the number of errors in the moving average.

2.5.1.2 WEIGHTED MOVING AVERAGE

Weighted moving average (WMA) is one of the time-series forecasting methods to predict the demands of certain items. The weighted moving average is calculated by summing the multiplication of demand with a weight across different time periods and then dividing by the total of weight. The calculation of weighted moving average is shown below:

$$\text{Weighted Moving Average Forecast} = \frac{\sum(\text{weight for period } n) \cdot (\text{demand in period } n)}{\sum \text{weights}}$$

Where *n* is the quantity of times in the moving average. The WMA focuses more on the most recent data. Therefore, the WMA reacts more quickly to the data changes than the regular SMA.

2.6 WHEN TO ORDER

An issue with respect to the inventory management includes when is the product should be ordered. In logistic, there are two types of order method: 1) fixed order quantity system and 2) fixed order interval system. In a fixed order quantity system, the size of the order remains constant while the time interval may change depending on situation. In contrast, fixed order interval system chose the time to be fixed but the quantity of the order varies. For example, one might go shopping for food every Sunday but the amount of food needed to purchases varies.

There is a reorder point for there to be an efficient fixed order quantity system. Reorder point (ROP) is relatively easy to calculate under conditions of certainty. An ROP is equal to the average daily demand (DD) in units times the length of the replenishment cycle (RC) in days:

$$\text{ROP} = \text{DD} \times \text{RC}$$

It is important to know that uncertainty might happens sometimes and the ROP can be modify to cater with the unexpected situation by just including the speculative stock factor in units:

$$ROP = DD \times RC + SS$$

According to Murphy & Wood (2010), the fixed order quantity system works best where there is a predetermined ROP signals that this system requires frequent monitoring of inventory levels. If sales start to increase, the inventory levels will reach the ROP more quickly. In contrast, most fixed order interval system is monitored less frequently often just before the scheduled time. For example, meat such as chicken and vegetables need to be restock frequently compare to rice because they cannot left for too many days whereas rice are able to store for long time. It is entirely possible for household to have inventory under fixed order quantity system and other inventory under fixed order interval system.

2.7 ABC ANALYSIS

In supply chain, Joffrey and Collignon (2012) say that ABC analysis is an inventory classification technique which classify things into three classes, A, B and C: A are most valuable items and C are the least valuable while B is in the middle between A and C. This technique is similar to the Pareto Principle which states that the 20% of overall items will determined 80% of the total consumption.

The ABC method says that, a company should weight each items from A to C when revising their inventory, based on the ratings with the following rules:

- **A-items** should have tighter inventory control and need to be reordered frequently, either in a daily or weekly manner. A-items should never stock-out but also cannot excess storage capacity. In household context, for example, dairy products, meats and vegetables are consumed frequently by many household so it should be reordered frequently in an adequate amount.

- **C-items** should be reordered less frequently. It is acceptable when the inventory stock out after each purchases by customer as the C-items are less demanded and possess a higher risk of undue inventory budgets. Example of C-item is rice. Rice should not be purchased frequently because it can be stored for a long time until it is reaching the reorder point.

- **B-items** stays between status of A and C. It should be monitored equally, not so towards A and also not towards C. For examples the can foods and spices such as salt and sugar in household can be purchases monthly or quarterly per year, depends on the amount of each purchases.

Through this classification, one can know the inventory status in real-time, and categorize them from the rest, particularly those which are frequent but not that lucrative.

2.8 SEASONALITY

In statistics, Vermorel (2011) says the demand for a certain products tends to display seasonality when the time periods undergoes a foreseeable cyclic discrepancy which is dependable on the months within a year. Seasonality method is a most often used statistical method to provide an accurate demand forecasts. For example, retailers in Western countries will undergoes peak sales during Christmas.

2.9 THE SHELF LIFE OF FOOD

Types of food / Condition	**Poultry**	**Beef, Pork, Lamb, Veal**	**Sausage**	**Meat & Poultry**	**Eggs**	**Canned Meat, Poultry & Fish**	**Bread**	**Fruits & Veggies**	**Dairy Products**
Raw, unopened	1-2 days	-	1-2 days	1-2 days	3-5 weeks	2 -5 years	-	Few days to couple weeks	Sour then throw, smell or taste a little
Cooked	3-4 days	3-5 days	3-4 days	3-4 days	-	-	-	-	
Precooked, after opening	3-4 days	-	3-4 days	-	-	3 - 4 days	2-3 days	-	

Table 2.1 Shell life of types of food. *Source: greatest.com*

From the table above, most raw and unopened foods such as poultry, sausage and ground meat can last for couple of days only while canned food can last from two to five long years. Besides, various fruits and veggies usually have a short shelf life and they are suggested to be consumed as soon as possible.

Moreover, precooked, foods after opening and cooked foods are normally last for 3 to 4 days since they will spoiled if left uneaten for too long even though they are stored inside a fridge.

Lastly, the shelf life of dairy products is easier to differentiate by just smelling or tasting them, if it is sour then it is spoiled. So, dairy products are not suitable to store for long a time and need to be consumed within a week after bought.

2.10 FOOD SHARING

When some of the foods in your kitchen or fridge are going to expired or spoiled, very often that you did not noticed or dispense them when you found that they cannot be consumed. Why not at the sharing it out before it is too late? You can share by posting to social media informing your relatives and friends that you have some foods that you would like to share with them because either you cannot finish or it is not the kind of food that your family members would like to eat. If this feature is implemented together with the existing food planning application, it would solve the problem of wasting food and also wasting a lots of money on buying too much foods that cannot be finished.

2.11 DOMESTIC FOOD SHOPPING PLANNING

Shopping is a critical activity for food getting into the home and while shopping happens mainly at the grocery stores or supermarket nearby, often the planning already starts at the home. Ganglbauer et al. (2012) interviewed some participants of a survey and reported a list of strategies around shopping planning: some strategies that support the planning and therefore to some extent avoid food waste, but also constraints that may hinder or influence shopping planning to be less organized.

1. *Preparing shopping list*

Some will buy more than what are listed in the shopping list as they suddenly though of what are needed but not in the list.

2. *Temporal constraints*

Participants that are busy with work will have no time to plan for a list and preferred to go shopping after work when they could without checking the details inside the fridge.

3. *Domestic storage constraints*

Food storage space at home was another issue for the participants in terms of how often they needed to go shopping and how easy it was for them to remember what they had at home. In addition, how the planning was conducted often depends on how much space they had in the fridge for food to occupy.

4. *Access and transportation constraints*

Another factor was the distance with the food stores. Those who live in rural areas often go for shopping by car or walk to the nearby stores to buy food. Also, the mean of transportation often decides how much things they could buy for example, they cannot buy too much foods if they travelled to the stores by bike or bicycle as it is too heavy and insufficient space to bring the foods back.

5. *Constraints of unpredictability*

Planning however did not always turn out as expected or result in less waste for many participants and a key factor in this was the unpredictability of their lives. Some may go out for dinner in just a call from a friend or a sudden meeting late after work. The factor of unpredictability had an important effect on the shopping planning for food or the impossibility of it.

6. *Social constraints of food choices*

They also found that food planning can be influence by the society around them. For instance one doesn't really know how to cook meat because they stay together with a vegetarian for too long or someone is visiting today and he/she likes to eat certain food but end up wasting the unfinished foods.

2.12 WINDOWS PHONE 8 DESIGN GUIDELINE

2.12.1 TYPOGRAPHY

Typography is the sentiment of Microsoft design language. Every Microsoft design principles strengthens the significance of typography. The UI framework that windows phone 8 follows is the Segoe UI. Segoe UI was announced in the Windows Vista or Office 2007 timeframe. It is a sans serif design drawn in the tradition of signage and way-finding typefaces. (MSDN n.d.) In short, Segoe UI not only utilized within all range of Microsoft's operating systems, apps, and devices, but also logos, branding, advertising, and packaging.

Figure 2.1 Windows Phone 8 Start Screen using Segoe UI

2.13 WINDOWS PHONE 8 API

The windows phone 8 API provides developer with a variety of built-in functionalities that can be used for customizing the application. Some of the functions provided are multi-tasking, long list selector control and the capability of supporting multiple resolutions. This will increase the flexibility and performance of the development process.

2.13.1 MULTI-TASKING

Windows phone 8 provides multi-tasking capability in order to allow application to be running at the foreground and at the same time running at the background. Multi-tasking property has been closely linked with the application lifecycle where pausing, returning and reactivate of application is allowed without crashing the application. When the application is running, for example, multi-tasking allows user to jump to the homepage and then jump back into the page where user left and perform any other action such as playing a music or browsing the gallery concurrently.

2.13.2 LONG LIST SELECTOR CONTROL

Yordan (2013) says that the new Windows Phone 8 SDK provides the LongListSelector which implements a jump-list style of UI as seen in the address book of the windows phone. To display a long lists of data normally it uses this type of UI. The control supports complete UI and data virtualization and is actually suggested even for displaying simple lists of data.

2.13.3 MULTIPLE RESOLUTIONS

Windows Phone 8 supports WVGA, WXGA, and 720p resolutions, while Windows Phone 7 only supports WVGA. The table shows the Windows Phone 7 and Windows Phone 8 supporting resolutions, aspect ratio and other attributes:

	Resolution	Aspect ratio	Scale	Scaled resolution	Phone Type
WVGA	480 x 800	15:9	1x scale	480 x 800	WP7, WP8
WXGA	768 x 1280	15:9	1.6x scale	480 x 800	WP8
720p	720 x 1280	16:9	1.5x scale, 80 pixels taller	480 x 853	WP8

Table 2.2 Resolution and aspect ratios supported in WP7 and WP8

Resolution that has the highest quality is WXGA and it automatically scale down to other resolutions so it is preferable to stay with this resolution during development. Ratio difference between 720p and other resolutions cause that there might be some cases when a customized image for 720p resolution is wanted, for example for a page background.

2.14 APPLICATION LIFECYCLE

To let mobile application developers to build an applications that the act and feel is same like multitasking, WP uses a method that allows applications to be paused, made dormant, and suspended without having to alert the user that the application is being paused. This five phase lifecycle introduced by Votano (2004) is called the tomb-stoning. (Votano et al. 2004)

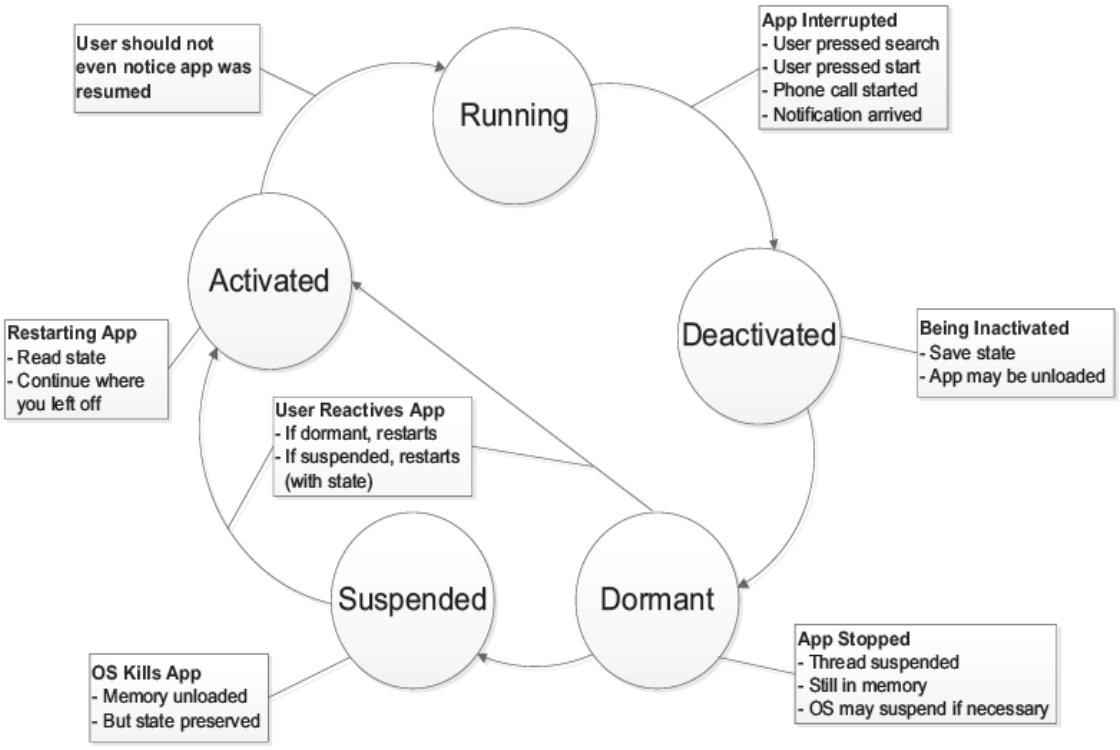


Figure 2.2 Application lifecycle (tomb-stoning)

2.15 REVIEW OF EXISTING APPLICATIONS

There are many existing application on the app store today to manage meal planning, but less of them are to prevent food wastage. For example, Food Planner, Meal Board, Food On The Table, eMealz, Calorific and Food Saver. Generally, these applications are helping users to manage their daily meal plans and also record the expiry date of the items in their pantry.

There are three main features that these applications provided so far. The first one to be discusses here is meal planning or food planning. The types of meals a family having everyday are different from breakfast to dinner or even supper. So these meal planning features are to plan out what are the foods or meals that going to be prepared in a day or even in a week. Besides, most of the family will go to the grocery stores or supermarkets to buy the ingredients required to prepare their food, which is going to be discussed in the next paragraph.

To plan a meal, what you will need are ingredients in order to prepare your meals. Information of these ingredients is necessary to be recorded so that you can know which items are insufficient or need to restock when you prepare your meals. You can generate a shopping list when you need to buy only items that you need next time. With this feature, there is no need to worry about missing or lacking of ingredients when you are preparing you meals for the family members. Most of these applications provided those features mentioned above, another feature such as tracking of the expiry date and food sharing are the done by different applications independently.

Table 2.3 shows the summary and overview of the comparison between existing features and functionality provided.

✓ Indicates features provided; × indicates features not provided

Features / Applications	Meal planning	Recipe	Shopping list	Bar code	Inventory	Expiry date tracking	Food Sharing
Food Planner	✓	✓	✓	✓	✓	×	✓
Food Manager	✓	✓	✓	×	✓	✓	×
eMealz	✓	✓	✓	×	✓	×	✓
Meal Board	✓	✓	✓	×	✓	×	×
Food On The Table	✓	✓	✓	×	×	×	×
Love Food Hate Waste	✓	✓	✓	×	×	×	×
Food Saver	×	×	×	×	✓	✓	✓
Calorific	✓	✓	×	×	×	×	×

Table 2.3 Comparison of existing application

Based on the table above, most existing applications being reviewed have these three common features that are meal planning, import recipe from various recipe website or add by your own and generating a shopping list. Other applications even provide sharing of shopping list among your friends and relatives or sharing of recipe online.

Meal planning is to plan out what food should be prepared in a day or in a week, one can have breakfast in the morning, lunch in the afternoon, tea time in the evening, dinner in the night and even supper in the late night of a day. However, mostly people had a hard time to plan out what should be prepared, and sometimes they cook too much and at the end cannot finish it but to throw them away. For example, eMeals only let user to plan what's for dinner only. You can select simple dishes to make up well-balanced meals. If you know that you will be pressed for time, plan to prepare a simple one-dish meal.

Shopping list tells you what you should buy when u do the grocery, including the price, amount and description of each items. Shopping list can be generated automatically when you start using the application by adding items in your inventory. This can save a lot of valuable time thinking what to buy and how much to buy the items. Apart from that, this can prevent food from being wasted because you are told to buy items that are sufficient for each weeks.

Inventory is responsible to track down what items you have bought, added or used before in your recipe. It has two functions, add and reduce the quantity of each items. When you add a meal in your meal plans, whatever ingredients you used in your recipe will be added into the inventory to that next time you can find what you had used to cook what meals in the future. Using items in the inventory, a shopping list can be generated and inform users

what to buy as discussed earlier. In short, inventory feature helps you to organize your items, foods or ingredients in an organized manner.

Expiry date tracking is keeping alert of which foods are going to be expired soon. A message will be sent out to notify users about which foods are going to be expired soon and advise them to cook or consume them as soon as possible before spoiled. However, this features do not provided as a sub-feature by common food planning applications but it is a single standalone application.

Other features such as food sharing and the sourcing of food by telling you where is the nearest store that you can buy your foods helps to improve the planning and conservation of food in a typical household. However, these features are not taking planning and conservation of food seriously by the applications mentioned earlier. Most of the applications provides excellent meal planning and recipe features but none of them consider the sharing of food and least of them taking care of the food expiry date.

2.16 COMPARISON AMONG EXISTING APPLICATIONS

Compare to other food planning applications, Food Planner covers all the essential features such as meal planning, recipe importing, shopping list, inventory, bar code scanning and food sharing. The flow of using the application is flexible because user can either start by plan out the three meals of the day or adding items into the inventory first or even importing the recipes so that meal planning made easy.

Food Planner is the best existing application among the other. However, it is not complete because it did not consider food expiry feature and the sources of food. Furthermore, the bar code scanning features often not functioning well because of the sensitivity of the scanner or the types of bar codes used. Some functions need to be improved although it has lots of functions such as the ability to add already-bought grocery items to the inventory list, that feature is too hard to be managed. If the navigation was easier it will be better, without going back to the Weekly view just to reach the Grocery or Inventory list.

In terms of User Interface (UI), different user will have different perspective on how usable an application would be. Some prefer a simple and clean yet easy to use interface, but some might like to have everything in their eyes in one glance. It is not easy to create a perfect application, whether in terms of features or interfaces. As long as it is usable, everyone would give it a try and maybe even suggest some possible improvements. For example, interface Food Planner is more complex and Food Manager is simpler and cleaner. There are some screenshots of existing food planning application below:

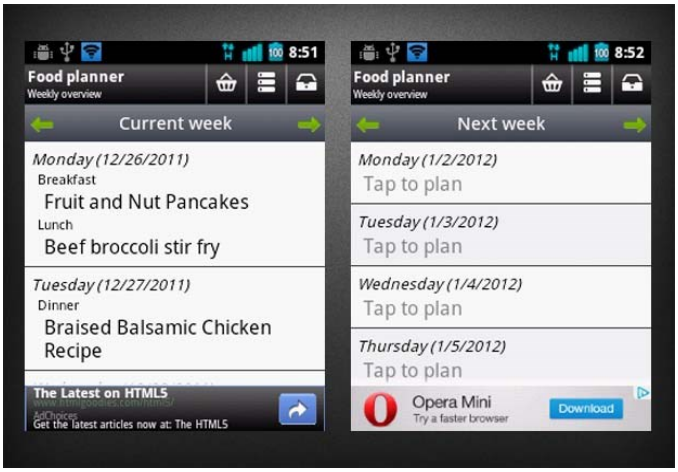


Figure 2.3 Food Planner

Figure 2.4 Food Manager

Figure 2.5 Love Food Hate Waste

CHAPTER 3: METHODOLOGY AND TOOLS

3.1 AGILE UNIFIED PROCESS (AUP)

Agile methods is a rather novel approach to software development, becoming well known recently. Some principles from "Agile Manifesto" includes individuals and interactions are more significant than processes and tools, working software is more treasured than complete documentation, customer relationship is more preferred than negotiation of contract, and flexibility is appreciated higher than creating and following a plan (Alliance 2001). Agile method focusing on eliminating much of the modeling and documentation overhead and time spent and also emphasizing simple, iterative application development. Agile Unified Process (AUP) is adopted as a methodology of this project. There are four phase in the AUP: Inception, Elaboration, Construction and Transition.

3.1.1 INCEPTION

During this phase is where the initial scope of the entire project is identified. Based on the analysis such as literature review, we determined the motivations, contributions, limitations and the initial requirements of the new MFPCS. In this phase we gathered information from various resources such as journals, seniors' and supervisor's perspectives to decide which module this system should have especially which type of forecasting technique should we apply in this system to predict the food demand of the household inventory. During the identification of suitable forecasting technique, we consulted one of the lecturer in UTAR Mr Tan Ding Wen, which he is more familiar with this field and he had suggested several techniques that we can apply into the system.

3.1.2 ELABORATION

Elaboration phase consists of proving the potential architecture design of the system such as the detailed functional requirements and database design. After we decided all the requirements and chosen a suitable forecasting technique which is WMA, we are focusing on analysis and design such as design page organization, page navigation, database design and the system architecture. Use case diagrams and sequence diagrams are drawn to explain about each module in detailed to provide a clearer picture of the entire system. Besides, screen shots are captured to illustrate the whole process when using the system. Lastly, we identified all the requirements gathered prior to construction phase and were used to create the architectural baseline for the new system. This became the bases for the construction phase. The system architecture is shown in section 3.2.1 which will be explained in depth later.

3.1.3 CONSTRUCTION

During this phase where we start coding to build a working application on a regular, incremental basis based on the architectural baseline defined in the previous phase. We constantly update each other and monitor about the development process to stay on the right track. In this phase the system will be develop incrementally and iteratively until all the user requirements are met. Before that we will set up the database using SQLite prior to the development so that testing will be easier. Each of the module are implemented as a part and tested iteratively to uncover any bugs and logic errors and fix them as soon as possible. After all the modules are implemented and verified, we will move on to the last phase which combined all the modules into one complete system.

3.1.4 TRANSITION

Transition includes validation for quality assurance and deployment of the application. After each cycle, user requirements are added into consideration and each newly added requirements are reprioritized and changes are made in the technical design for instance the coding of the application. For example, when we found out simple moving average forecasting technique is not suitable, we quickly made changes and update the module to avoid any delay on development process. Last but not least, the documents of the designs are modified as well when any changes made to the system. In addition, test plan are conducted as well using the data gathered from various sources to verify the chosen forecasting technique.

Figure 3.1 Agile Unified Process

3.2 PROPOSED SYSTEM ARCHITECTURE

3.2.1 MFPCS ARCHITECTURE

The system architecture of MFPCS depicted in Figure 3.2 covers both online and offline access. When users are online, they can share the excessive food or goings-to-expired but not consuming food on the social websites. Besides, users can search for food recipe to prepare delicious meals for their families and friends. In other hand, when users are offline they can plan their meals routinely, manage their inventory including calculate the reorder point and expiry date and also create an instant shopping list when foods are needed.

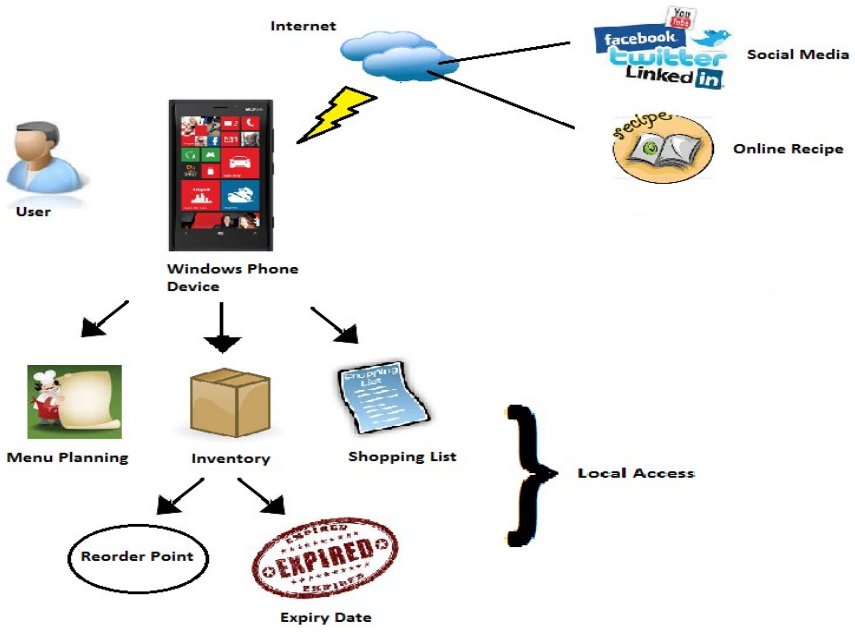


Figure 3.2 The system architecture of MFPCS with both online and offline access

3.3 IMPLEMENTATION ISSUES AND CHALLENGES

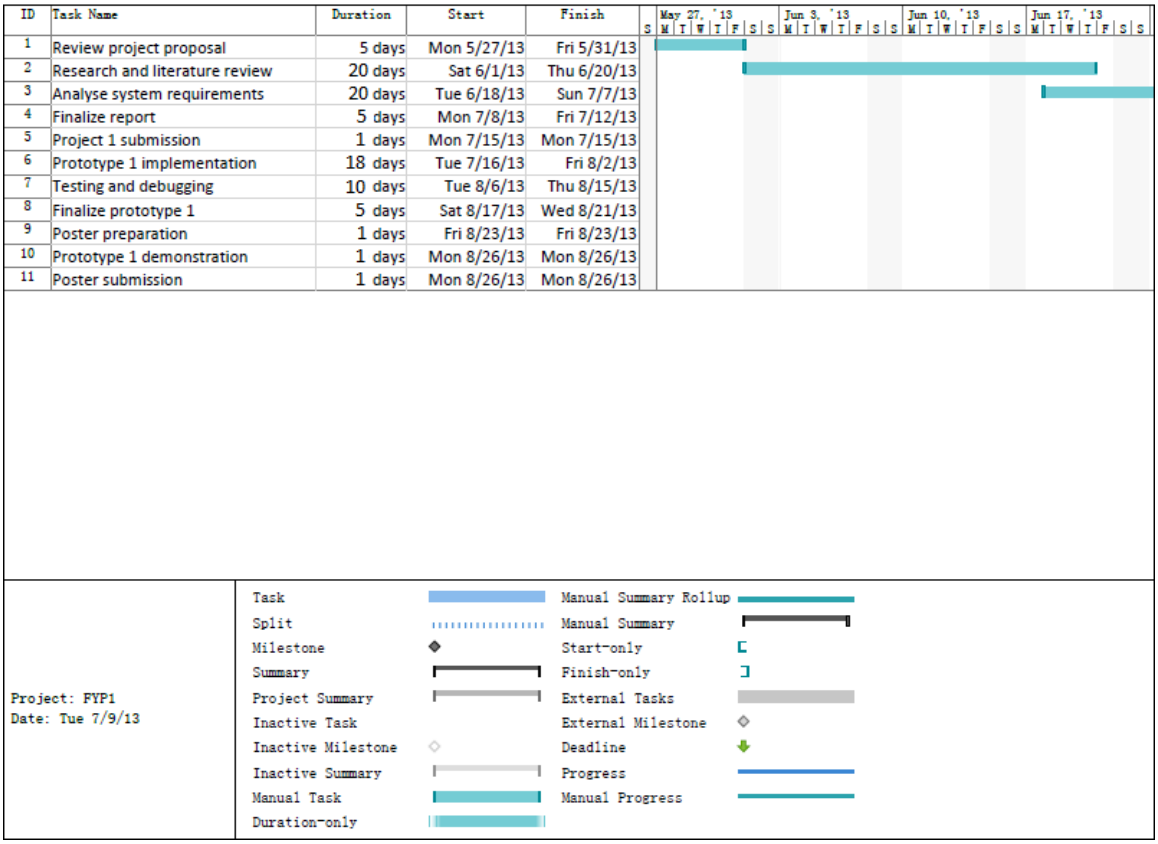
The windows phone's application developer account registration process is very lengthy and requires several verification steps and causes inconvenience during implementation of the project. We waited for several weeks for the reply from Microsoft and has no clue how to test the application on the real phone before that. Besides, it is risky when choosing which framework to use because once decided it has no turning back or else the entire project's code is going to retype all over again.

The major challenges of this project is the different programming style, language, syntax and framework used in the development because our course structure does not covers this domain knowledge and Microsoft does not provides any training for us about Windows Phone development. We have to start from scratch with online reference and senior's guidance. In addition, another challenge is when deciding which typography to use when designing the interface of the application. Each typography has its own set of properties and it spent me some times to design the interfaces.

3.4 TIMELINE

Project 1 will take seven weeks to complete and hand it to supervisor on week 8 Monday. After submitting the report, prototyping process will begin to develop a partially function prototype system and demonstrate it at the end of semester. Two milestones will be set to make sure the deliverables are passed up on time. The first milestone will be the submission of project 1 report and the second milestone will be the demonstration of prototype. The end product deliverable of current semester will be the partially function prototype system and the poster for our project. For the next semester onwards will be focusing on implementing the fully functional system by following a proper methodology with careful planning and sufficient resources. Before a full system is developed, three prototypes will be built, tested and debugged vigorously to find out any critical problems that can harm the full system and correct them as many as possible. The full system will be presented and submitted at the end of the last semester of year 3.

3.4.1 PROJECT 1 TIMELINE



ID	Task Name	Duration	Start	Finish
1	Review project proposal	5 days	Mon 5/27/13	Fri 5/31/13
2	Research and literature review	20 days	Sat 6/1/13	Thu 6/20/13
3	Analyse system requirements	20 days	Tue 6/18/13	Sun 7/7/13
4	Finalize report	5 days	Mon 7/8/13	Fri 7/12/13
5	Project 1 submission	1 days	Mon 7/15/13	Mon 7/15/13
6	Prototype 1 implementation	18 days	Tue 7/16/13	Fri 8/2/13
7	Testing and debugging	10 days	Tue 8/6/13	Thu 8/15/13
8	Finalize prototype 1	5 days	Sat 8/17/13	Wed 8/21/13
9	Poster preparation	1 days	Fri 8/23/13	Fri 8/23/13
10	Prototype 1 demonstration	1 days	Mon 8/26/13	Mon 8/26/13
11	Poster submission	1 days	Mon 8/26/13	Mon 8/26/13

Figure 3.3 Timeline of project 1

3.4.2 PROJECT 2 TIMELINE

ID	Task Name	Duration	Start	Finish
1	Review Project 1 report	5 days	Mon 1/13/14	Fri 1/17/14
2	Design prototype 2 system architecture	3 days	Sat 1/18/14	Mon 1/20/14
3	Prototype 2 development	11 days	Tue 1/21/14	Fri 1/31/14
4	Testing and debugging	5 days	Sat 2/1/14	Wed 2/5/14
5	Review prototype 2	3 days	Wed 2/5/14	Fri 2/7/14
6	Design final prototype with all functionality	5 days	Sat 2/8/14	Wed 2/12/14
7	Final prototype development	13 days	Thu 2/13/14	Tue 2/25/14
8	Testing and debugging	4 days	Wed 2/26/14	Sat 3/1/14
9	Full system development	22 days	Sun 3/2/14	Sun 3/23/14
10	Testing and debugging	5 days	Mon 3/24/14	Fri 3/28/14
11	Benchmark and evaluation system's performance	3 days	Sat 3/29/14	Mon 3/31/14
12	Finalize report	13 days	Tue 4/1/14	Sun 4/13/14
13	Project submission and presentation	5 days	Mon 4/14/14	Fri 4/18/14

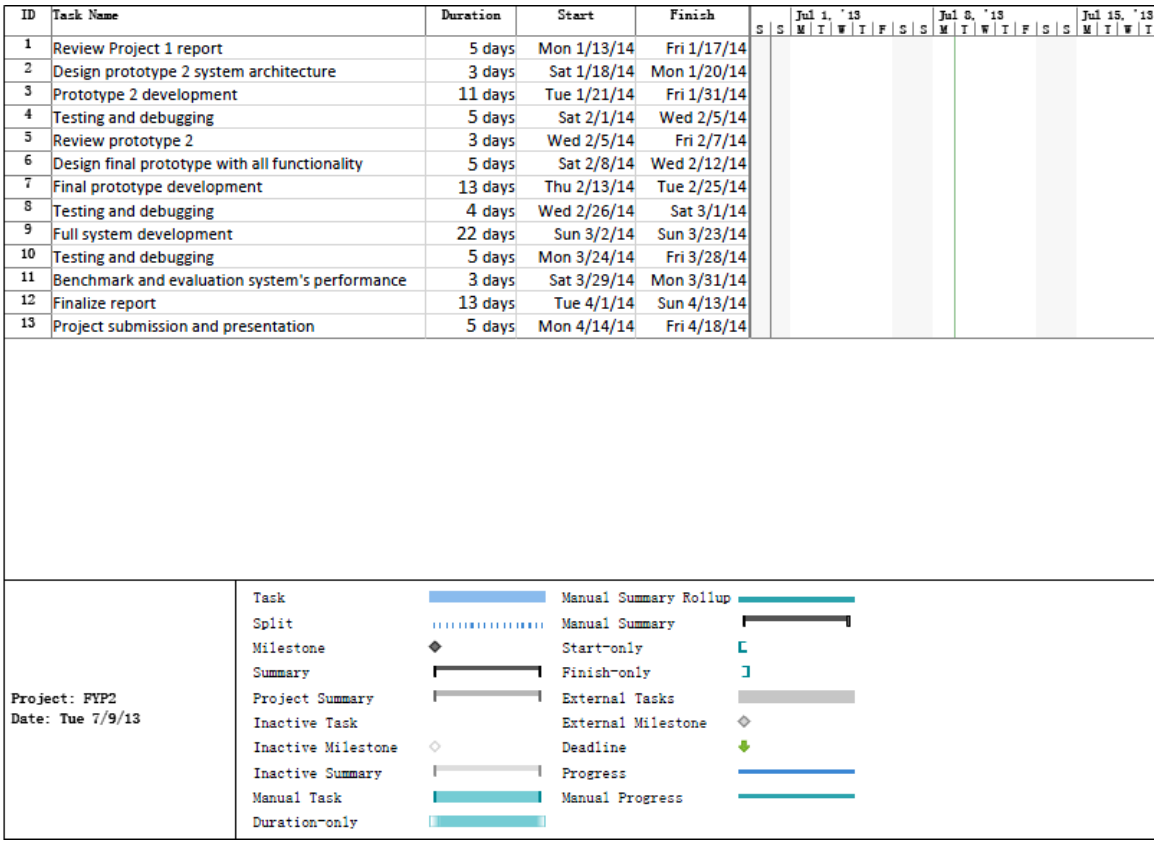


Figure 3.4 Timeline of project 2

CHAPTER 4: DESIGN AND VERIFICATION PLAN

4.1 USER INTERFACE DESIGN

1. Main Menu

Figure 4.1 Main Menu of MFPCS

The main menu consists of six icons which includes Planned Meals, Recipes, Inventory, Shopping List, Forecasting and Share. Each of this icon will navigate to respective page when tapped.

2. Planned Meals

Figure 4.2 Planned meals menu

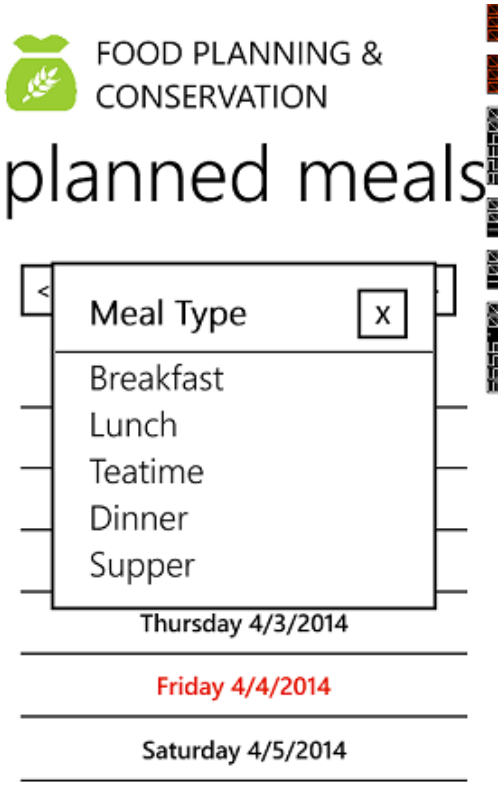


Figure 4.3 Context menu of planned meals

This page shows the weekly calendar of the phone which today's date is highlighted. User can tapped on each date and start planning their meals in the future. There are six type of meals where user can choose from such as breakfast, lunch, teatime, dinner and supper.

Figure 4.4 Meal list in planned meals

After selected the date and meal type, user can add the meal by tapping the "+" icon and type in the name of the meal. For deleting the meal, just tap the rubbish bin icon on the application bar and tap on the name of meal to be deleted.

3. Online Recipe Search

Figure 4.5 Search recipes menu

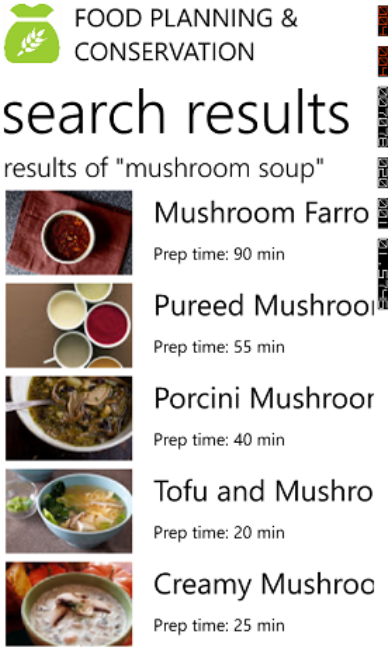


Figure 4.6 List of search results

This page will require user to enter the name of recipe to search online, user can also specify their allergies or diet habit. The result queried will be displayed as a list together with estimated preparation time.

Figure 4.7 Recipe details

Figure 4.8 Ingredients of recipe

When tapped, recipe's details such as rating, number of servings and preparation steps will be shown. Besides, user can swipe horizontally to view the ingredients needed to prepare the meal.

4. Inventory

Figure 4.9 Expiry date list

Figure 4.10 Set amount menu

User can set the amount of item by tapping on the number on the right of the item.

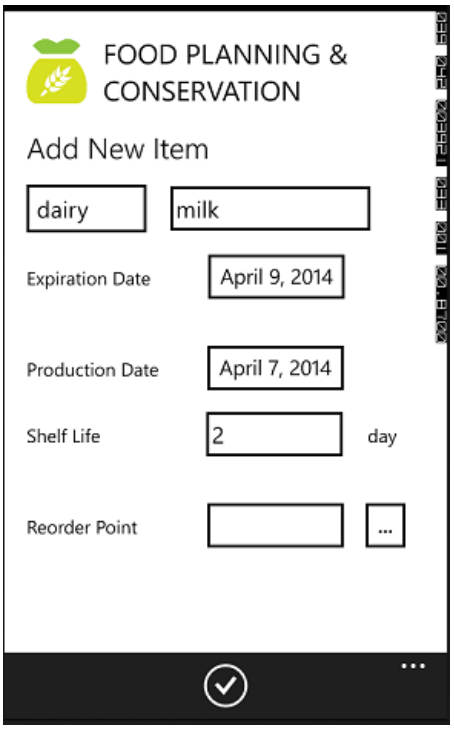


Figure 4.11 Add New Items

Figure 4.12 Delete items

User can add item by tapping "+" icon and enter its name, expiration date, production date and reorder point. To delete, tap the rubbish bin icon and tap on the item.

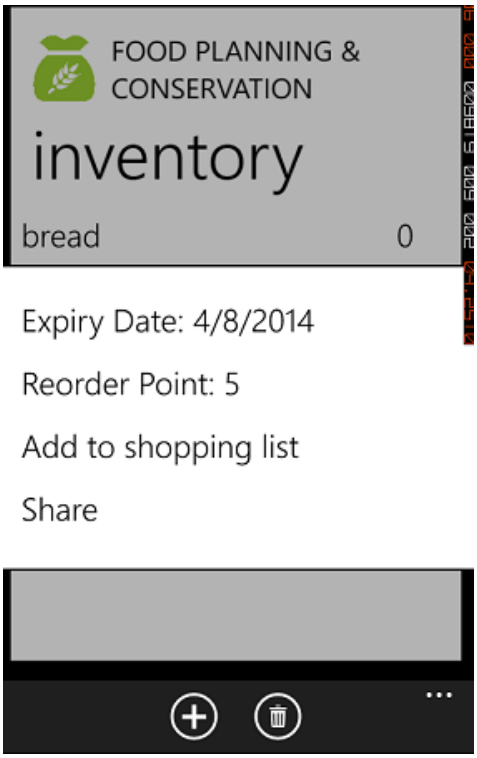


Figure 4.13 Context menu of inventory

Figure 4.14 Set expiry date menu

When user long click an item, a context menu will be displayed for user to set expiry date, reorder point, add to shopping and share it out.

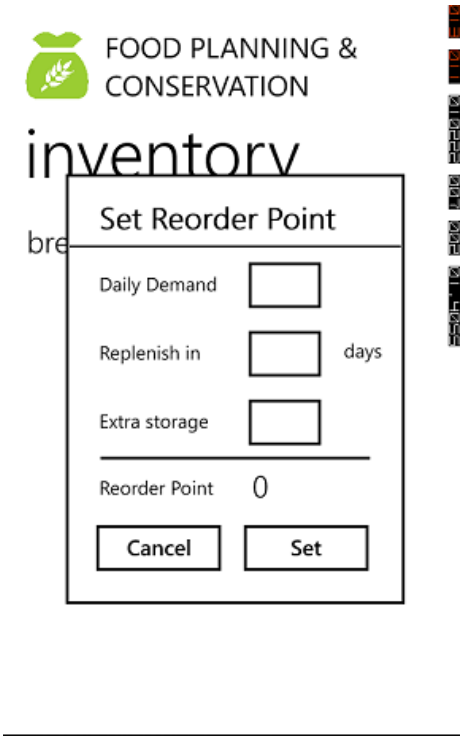


Figure 4.15 Set reorder point menu

Figure 4.16 Expiry date reminder

When user set the expiry date of an item, a reminder will prompt user to check their inventory if the item's expiry date is near.

5. Shopping List

Figure 4.17 Shopping list menu

Figure 4.18 Add new item into shopping list

When user add items to the shopping list from the inventory, they will show up in this page. Besides, user can also add new item into the shopping list without select them from the inventory. When the new item is bought, they will be added into the inventory.

6. Forecasting

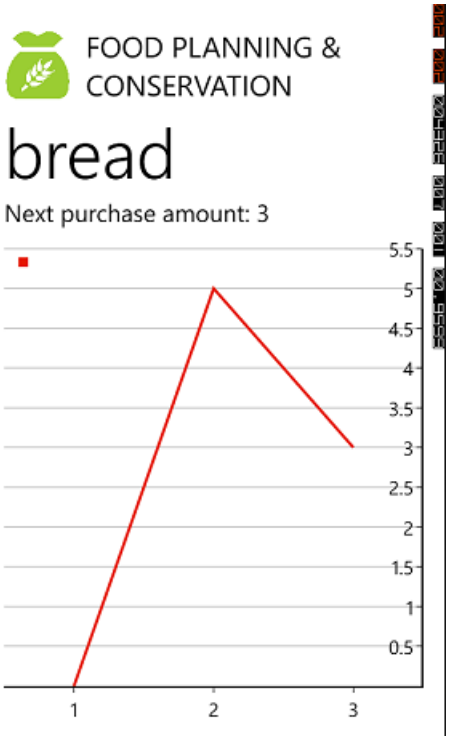


Figure 4.19 Forecasting menu

Figure 4.20 Graph of predicted amount

Items in the inventory list will be populated here, to forecast the amount of items should be bought next time. A graph is used to show the forecasting result. User can update the amount (reorder point) each time they refilled the item in the inventory. The amount will be recorded and use to predict the next purchase.

Figure 4.21 Summary (warning)

Figure 4.22 Summary (critical)

Besides, items will also be grouped together according to the situation such as warning and critical.

7. Share

Figure 4.23 Food sharing menu

Figure 4.24 Sharing via SMS

To share foods among friends and relatives, users can tick several foods at once to share it out via SMS or post it as a status at social sites such as Facebook or Twitter. The foods displayed here is populated from the inventory. Prior sharing to social sites, users have to configure their phone to have Facebook or Twitter account. Same case to share via SMS where user must have contacts number in their phone first.

4.2 VERIFICATION PLAN

To proof that the demand forecasting model applied to this project are valid, a test plan is developed with careful planning and accurate strategy. The participant of this testing plan is one of the vendors of Block C Cafeteria in UTAR Perak campus. First, the amount of the food bought by the vendor is recorded every month in the duration of 4 months. Then, the demand forecasting technique proposed in this project will be applied to predict the amount of food will be purchased in the fourth month. Lastly, the predicted amount will be compared to the actual amount of food bought by the vendor.

Example: The demand for goods across three months is shown in Table 4.2. The forecasted demand for month 4 is done by weighting the past three months as follows: last month (3), two months ago (2), three months ago (1).

Period	**Weight**
Last Month	3
Two Months Ago	2
Three Months Ago	1
Sum of Weights	**6**

Table 4.1 Period of the demand

Month	**Demand**	**Calculation**	**Forecast**
1	1500		
2	2200		
3	2700		
4	2300	$\frac{(1500 \cdot 1) + (2200 \cdot 2) + (2700 \cdot 3)}{6} \approx 2333$	2333

Table 4.2 Demand calculation for forth month

4.3 USE CASE DIAGRAM

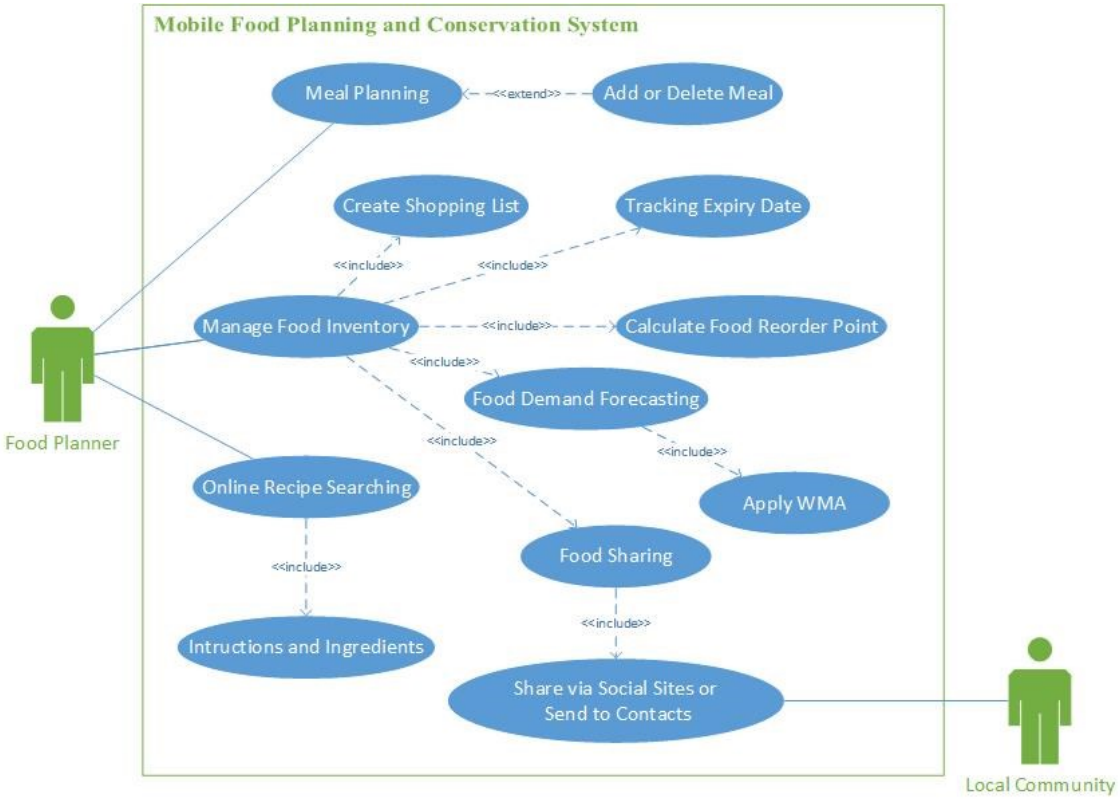


Figure 4.25 Use Case diagram of MFPCS

In the use case above, the food planner can access to three functions of the MFPCS which includes Menu Planning, Manage Food Inventory, Calculate Food Reorder Point and Online Recipe Searching. In Food Inventory, food planner can track the expiry date, perform food demand forecasting, calculate food reorder point and sharing the food. While food demand forecasting are applying WMA to predict the future food demand. Besides, food planner can choose to generate a shopping list using items from the inventory or enter a new items to be bought manually.

4.4 SEQUENCE DIAGRAM

4.4.1 Food Inventory

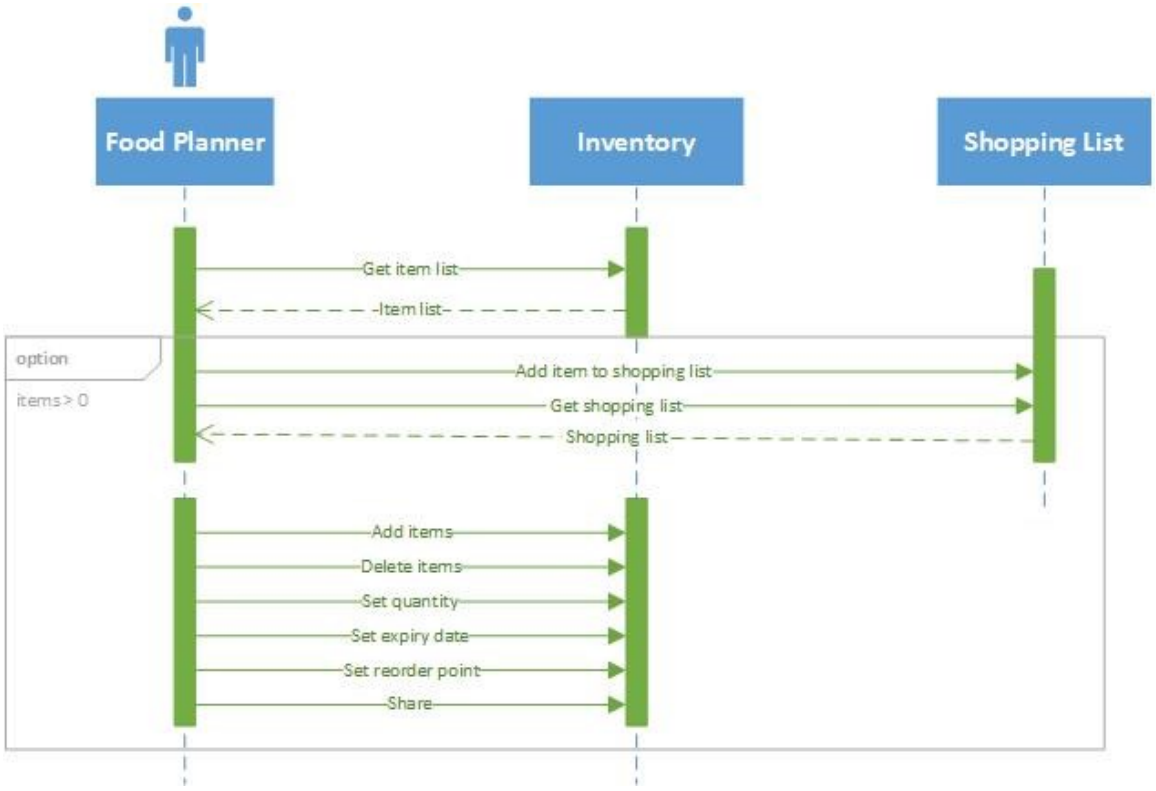


Figure 4.26 Sequence diagram of Food Inventory use case

Food planner will get a list of items from the inventory. When there is more than one items, food planner get to choose to perform several tasks: 1) Add items to shopping list 2) Delete unwanted items from the inventory 3) Set the quantity of each items 4) Set the expiry date of each items 5) Set the reorder point of each items and 6) Share them via messaging or social networks.

4.4.2 Meal Planning

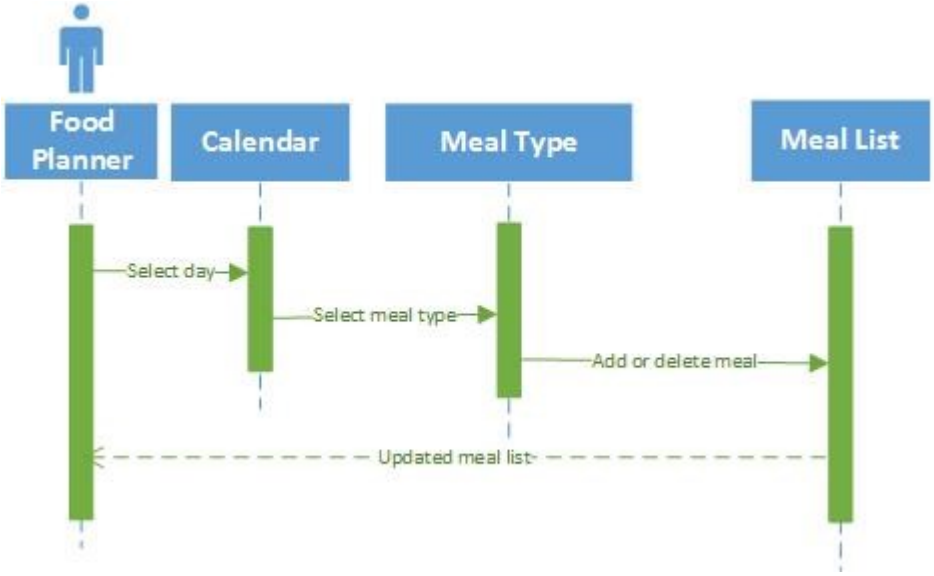


Figure 4.27 Sequence diagram of Meal Planning use case

Food planner will first select the date from the menu, then select the meal type such as breakfast, lunch or dinner. Then, food planner is prompt to enter meal's name. Besides, when he change his mind, he can delete the meal respectively. After that, an updated meal list will be display to food planner.

4.4.3 Online Recipe Searching

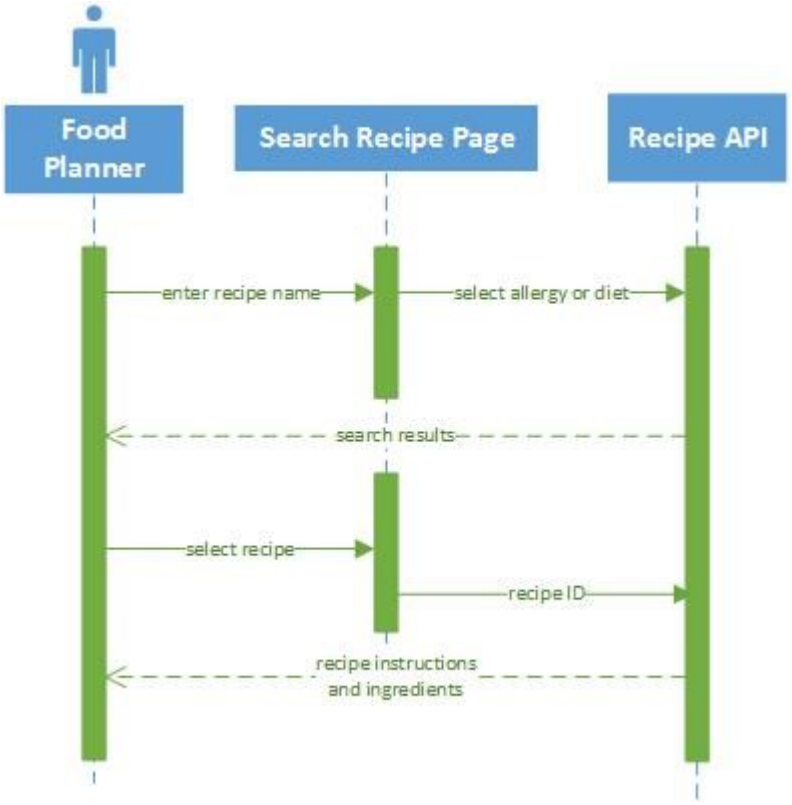


Figure 4.28 Sequence diagram of Online Recipe Searching use case

Food planner will first enter recipe name for searching, he have the options to select allergy or diet to filter unnecessary results. After that, a list of search results will be displayed with a picture, recipe name and estimated preparation time. Food planner can then select the desire recipe and view the details such as instructions and ingredients needed.

4.4.4 Food Sharing

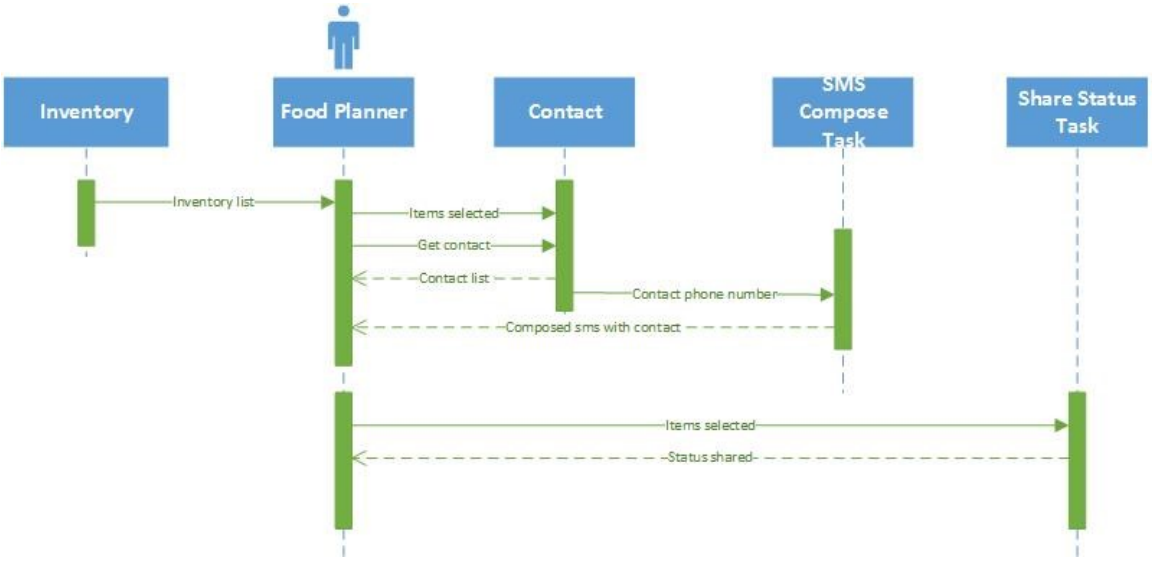


Figure 4.29 Sequence diagram of Food Sharing use case

Food planner can select one or more items from the list, they can choose to send via messaging or social networks. When decided to share through message, he will need to select the name of person from his contact list in the phone. Then, a message is composed that contains items need to be share and send to the person. When food planner decided to share through social networks, the items selected are posted as a status to their social sites to acknowledge their friends.

4.5 ENTITY RELATIONSHIP DIAGRAM

Figure 4.30 ERD diagram of MFPCS

The four tables consist of Food Inventory, Shopping List, Meal Plan and Food Record. Each table has a primary key named “Id” and required attributes. Shopping List table is part of Food Inventory table because items from the shopping list are derived from the Food Inventory table. When user update the amount of an item, it will be recorded in Food Record table.

4.6 USE CASE TESTING

Use Case ID	1
Title	Meal Planning
Pre-Condition	Click on "Planned Meals" on main menu
Test Steps	1. Select date 2. Select meal type
Expected Results	A list of meals of selected meal type is displayed
Results	Pass

Use Case ID	2
Title	Add or Delete Meal
Pre-Condition	Select date and then meal type
Test Steps	1. If "Add", enter meal's name 2. If "Delete", click on meal's name on the list 3. Click "done"
Expected Results	Meal is added or delete from the list
Results	Pass

Use Case ID	3
Title	Manage Food Inventory
Pre-Condition	Open the application, main menu is shown
Test Steps	1. Click on “Planned Meals” 2. Click on “Recipes” 3. Click on “Inventory” 4. Click on “Shopping List” 5. Click on “Forecasting” 6. Click on “Share”
Expected Results	Respecting page will be displayed to user
Results	Pass

Use Case ID	4
Title	Create Shopping List
Pre-Condition	Click on “Shopping List” on main menu
Test Steps	1. Click “Add” from the application bar 2. Select items from inventory or add new item 3. If add new item, enter item’s name
Expected Results	A list of shopping list’s items will be displayed
Results	Pass

Use Case ID	5
Title	Tracking Expiry date
Pre-Condition	Go to “Inventory” page
Test Steps	1. Long-press an item on the list 2. A list of context menu will be shown 3. Select “Set expiry date” from the context menu 4. Select and confirm date 5. Click “Ok”
Expected Results	The item’s expiry date is set, user can long press on the item again to check the expiry date
Results	Pass

Use Case ID	6
Title	Calculate Food Reorder Point
Pre-Condition	Click on “Inventory” on main menu
Test Steps	1. Long-press an item on the list 2. A list of context menu will be shown 3. Select “Set reorder point” from the context menu 4. Enter daily demand 5. Enter replenishment period 6. Enter safety stock (optional)

	7. Click “Set” and reorder point will be calculated 8. Click “Ok”
Expected Results	The item’s reorder point is set, user can long press on the item again to check the reorder point
Results	Pass

Use Case ID	7
Title	Food Demand Forecasting
Pre-Condition	-
Test Steps	1. Click on “Forecasting” on main menu
Expected Results	1. Predicted results will be shown to user
Results	Pass

Use Case ID	8
Title	Apply WMA
Pre-Condition	Go to “Inventory” page
Test Steps	1. Update the amount for a particular item every time user replenishes the item
Expected Results	1. A line graph plotting the amount of a particular items and the predicted amount will be shown
Results	Pass

Use Case ID	9
Title	Food Sharing
Pre-Condition	Open the application, main menu is shown
Test Steps	1. Click on “Share” on main menu
Expected Results	A list of inventory items will be displayed
Results	Pass

Use Case ID	10
Title	Share via Social Sites or Send to Contacts
Pre-Condition	Select items to be shared from the inventory list
Test Steps	1. Click “Send” or “Share” on the application bar 2. If “Send”, user need to select the contact name and a message will be generated to that contact 3. If “Share”, a status will be posted to their social networking sites
Expected Results	A message is sent to selected contact or a status is posted on social networking sites
Results	Pass

Use Case ID	11
Title	Online Recipe Searching
Pre-Condition	Click on "Recipes" on the main menu
Test Steps	1. Enter recipe name 2. Select search condition such as allergy or vegetarian (optional) 3. Click "search" on the application bar
Expected Results	A list of search results will be displayed to user
Results	Pass

Use Case ID	12
Title	Instructions and Ingredients
Pre-Condition	User select a particular recipe item
Test Steps	1. Click on one item on the result list 2. To look for recipe's instructions, click on the "Preparation steps" hyperlink on the "recipe" pivot page 3. To view the ingredients, swipe left or right to reach "ingredients" pivot page
Expected Results	1. If user clicked on the hyperlink, a web browser will be opened showing respective instructions of the recipe

	2. Recipe's information such as picture, rating, preparation time and number of servings will be displayed 3. If user wants to view ingredients, a list of ingredients with specific quantity will be shown on "ingredients" pivot page
Results	Pass

4.7 OUTCOME ANAYSIS

		Normal Purchase	After Weighted Moving Average (WMA) Prediction
2014	**January**	50	
	February	55	
	March	40	
	April	45	47
	May	50	45
	June	40	47
	July	45	44
	August	50	44
	September	45	47
	October	55	47
	November	60	51
	December		**56**

Table 4.3 Comparison between results of normal purchase and after WMA prediction

According to Table 4.3, the amount predicted for December is 56. This prediction method is using 3-months weighted moving average to smoothen the data of prediction. That is why the first three months of prediction is blank.

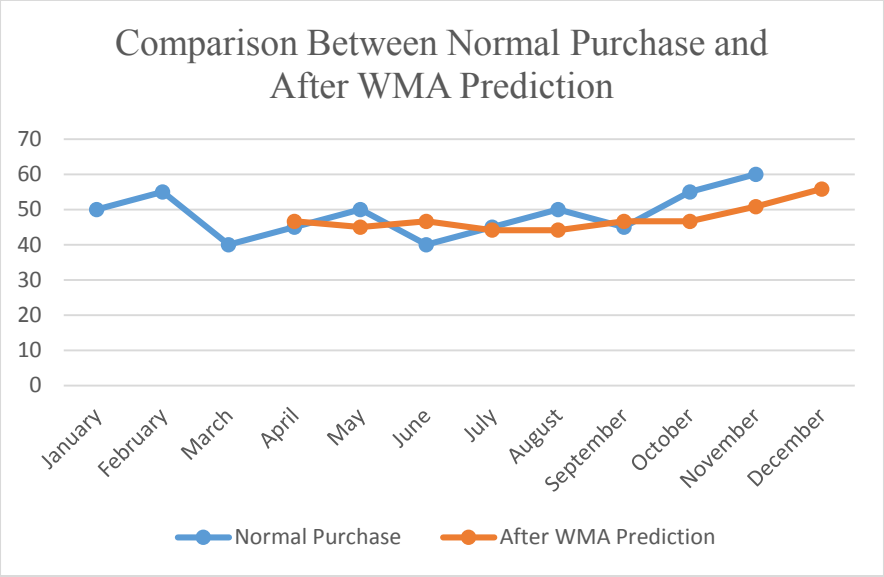


Figure 4.31 Graph of comparison between normal purchase and after WMA prediction

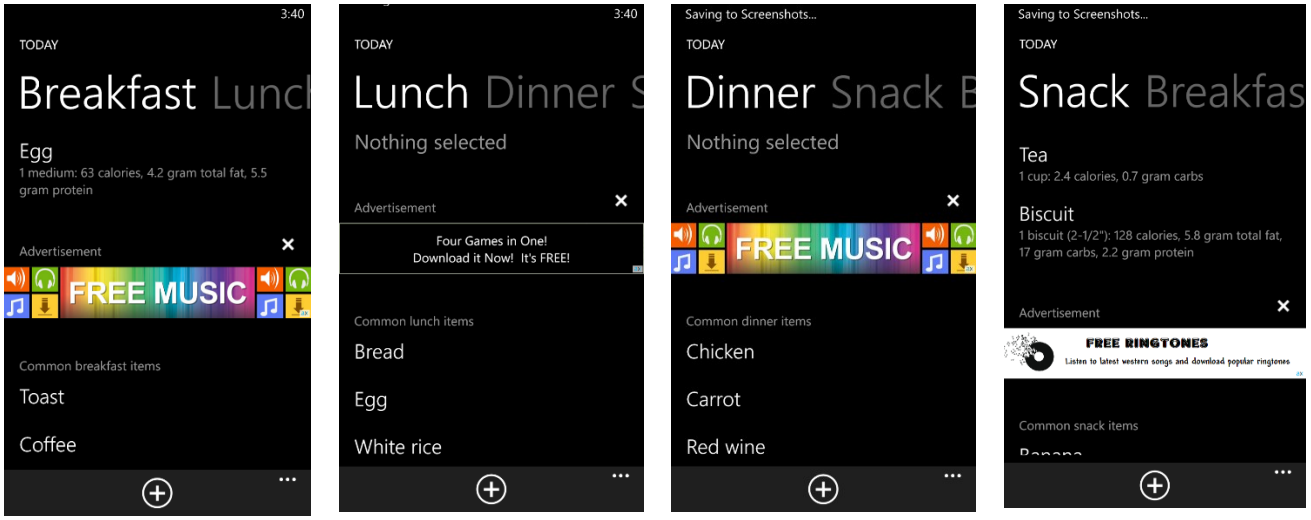
From the graph above, it is known that each predicted amount of items to be purchased is slightly lesser than the actual amount bought so by using this technique food can be conserved and thus food wastage can be reduced gradually.

4.7.1 COMPARISON OF IMPLEMENTED FEATURES AGAINST EXISTING APPLICATIONS

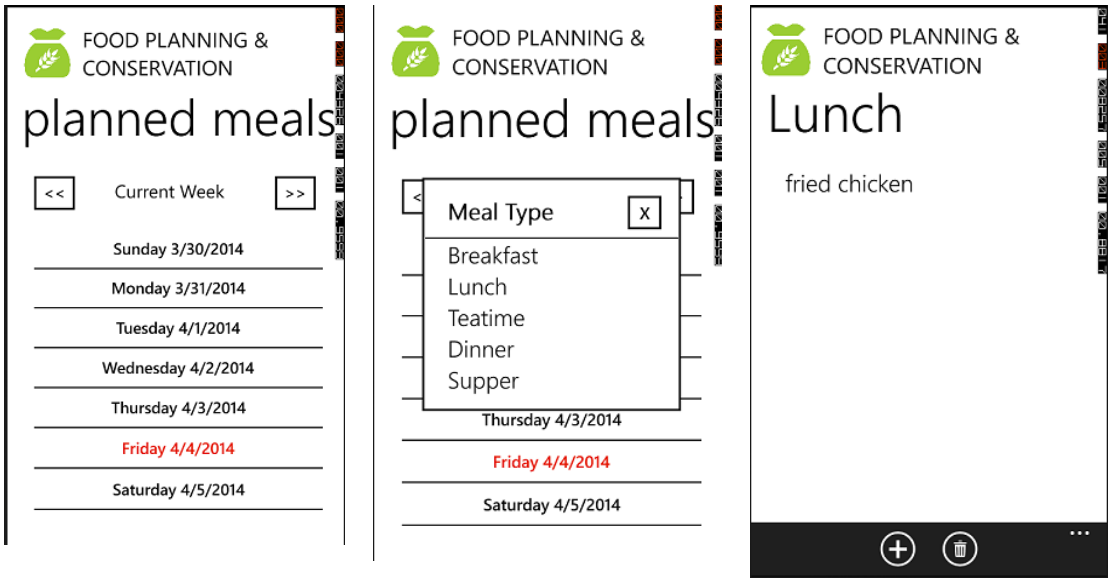
There are a few applications in the Windows Phone 8's Windows Store that are similar to this project, among them are myFridgeFriend and Food Diary. Below is the comparison of this project over the other applications.

MEAL PLANNING

Application: Food Diary



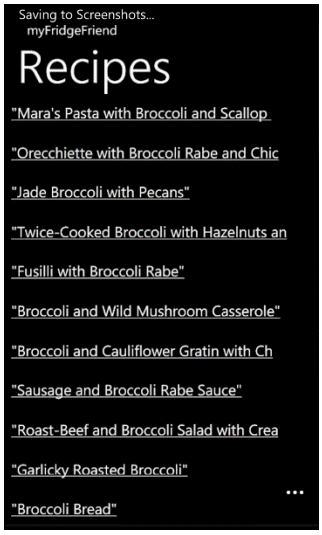
Food Diary uses pivotal arrangement of meal type and it has a limited common list of meals that are available for users to select. In addition, this application also has in-app advertisement which is uses to generate profit. However, this will obscure the interaction between user and the application as the advertisement is located in the middle of the page. Although each meal has a description below it, the font is not easy to view because it is too small.



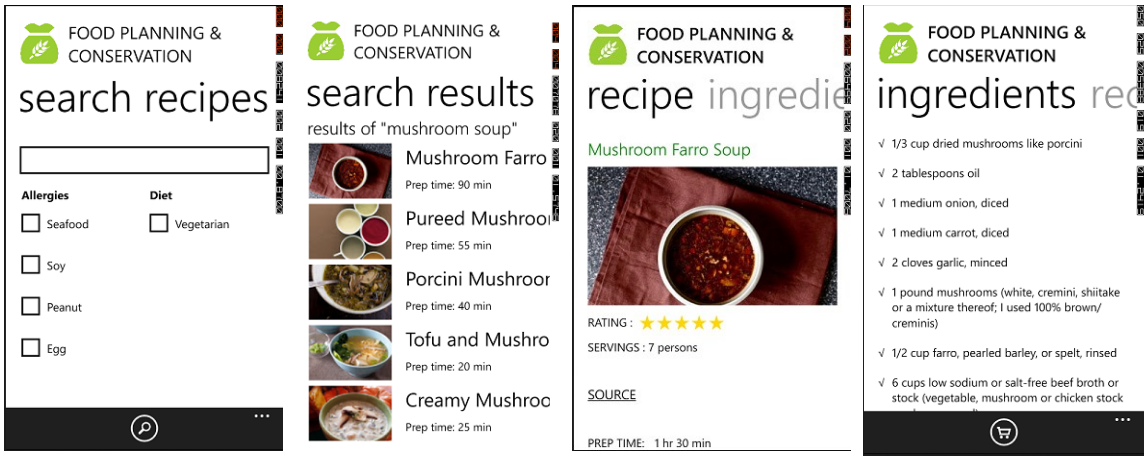
Compare to this project, this application has a proper listing of date and week to allow users to identify which day of the week they want to plan their meals. Besides, the meal type is easy to view and select since all the meal types is fit in one screen. This has reduces user interaction to search for desire meal type to plan their meals. Moreover, this project does not put advertisement inside the application so that to provide better user experience and usability.

RECIPES SEARCHING

Application: myFridgeFriend



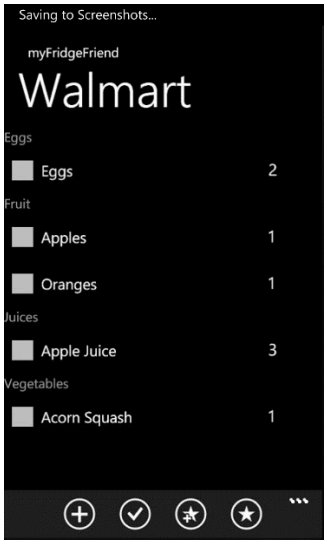
myFridgeFriend has a very simple interface and the design for recipe list is rather not appropriate because the recipe name is too long and it uses hyperlink button instead of providing pictures and using larger fonts. It allows user to add favorite recipes for easy searching later. In addition, the application also do not has a proper margin for list of items as shown in the screen shots although the basic functions such as adding and deleting items are there. In conclusion, myFridgeFriend has a cumbersome user interface and limited functionality.

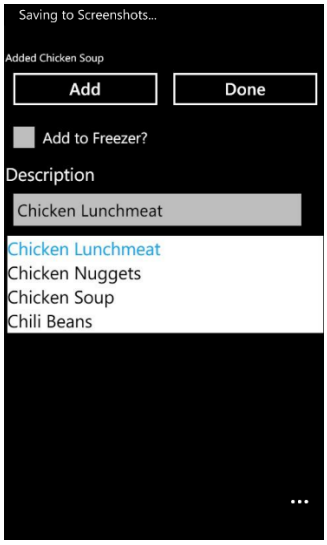


Compare to this project, this application has a better recipe searching function. First, allergies and diet preference is provided as a filter to search recipe. It provides more flexibility and safety while searching for recipes. Second, the recipe results are identified by picture of the meal and estimated preparation time is shown to user. Third, it provides details about the meal in a clearer way so to increase usability. Lastly, the ingredients are stated in a scrollable list, they can be added to the shopping list just in case user wanted to cook this meal.

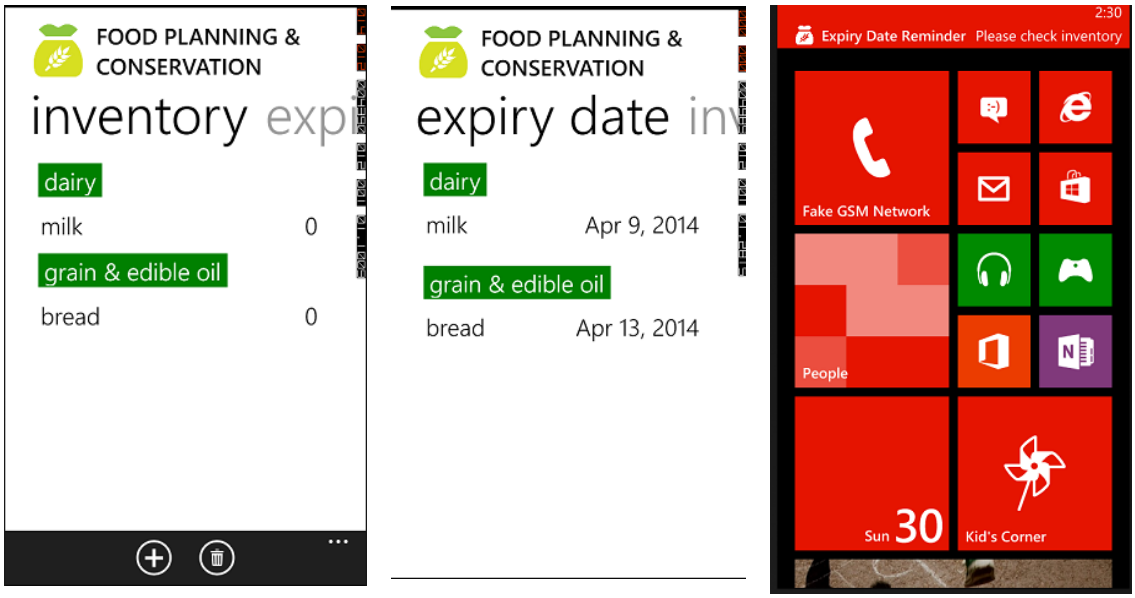
INVENTORY

Application: myFridgeFriend



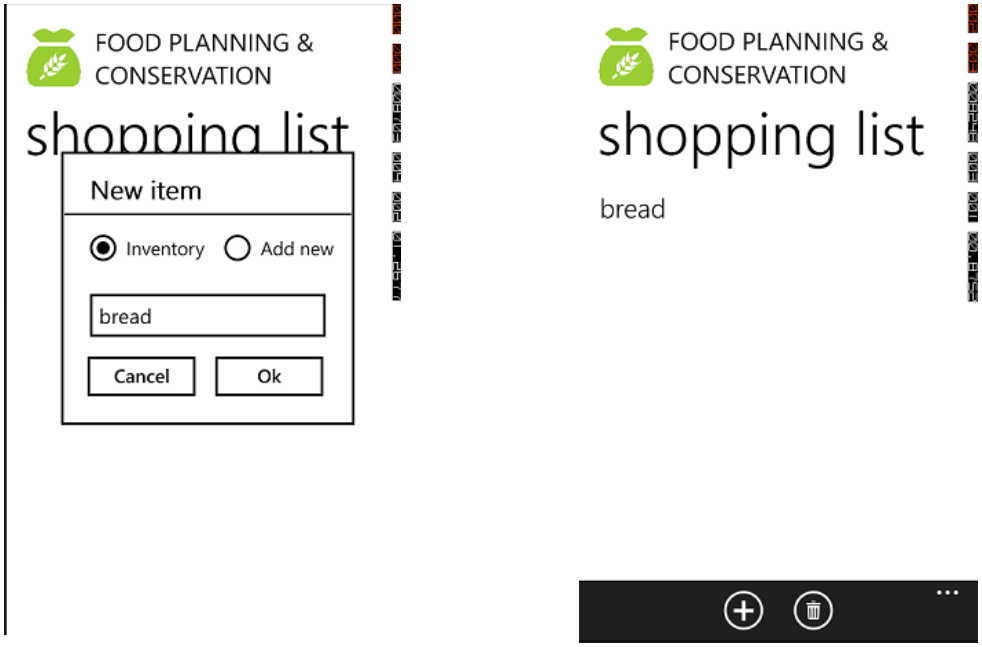


myFridgeFriend has a categorized inventory list using checkboxes to select multiple items at once. Besides, it can search for items and add them into a compartment called freezer similar to the freezer in the refrigerator.



In this project, this application allows user to add items by scanning bar code or entering it manually. It will also show a list of items with their respective expiry date so user can keep track of the expiry date. Besides, a toast notification will notify users about foods are expiring soon and encourage users to finish them before they spoiled.

SHOPPING LIST

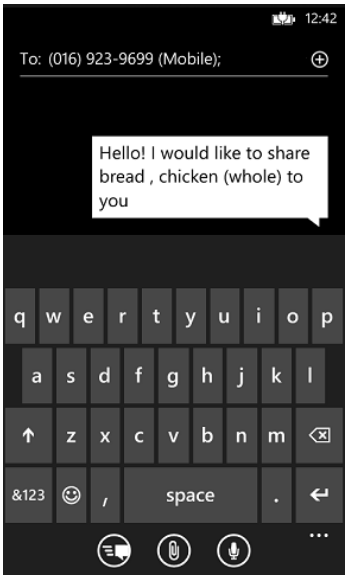


In this project, the application allows users to add items into the shopping list either from the inventory or entering a new one. The way adding and deleting items are similar to the inventory but it has an additionally feature that allows users to add all recipe's ingredients into the shopping list automatically. So far there are no similar applications that provide this shopping list functionality because most of them are just solely recipes searching or meal planning which do not support this function.

FORECASTING

This project provides demand forecasting function which none of the application in the Windows Store support this feature. It predicts the next purchase amount of a particular item using forecasting technique from the business industry. It is based on the purchase period and the amount users bought of an item and draws the graph accordingly. Besides, it also has a summary page which shows the status of inventory items. The two status are warning and critical, warning means that the item are approaching critical status and critical means that the item need to be replenish as soon as possible to avoid food insecurity.

FOOD SHARING



This project also supports food sharing which means users can select the foods they cannot finish but do not want to waste it and share them among their friends and relatives. After selection users can select the contacts in their windows phone and send them a message to notify them. Besides, it also can share it as a status in the social sites such as Facebook and Twitter to notify friends about foods users wanted to share. This feature is aimed to reduce food wastage based on the inventory of household.

CHAPTER 5: CONCLUSION

In a nutshell, proper food planning and adequate replenishment of food will benefits in many aspects such as environment and society. As the amount of food wastage is increasing quicker than food production, this situation has to be taken seriously to prevent food shortage which will eventually lead to food insecurity in many places. When food is being conserved, more food will be available to the needy and will reduce the impact to the environment caused by food wastage for example the release of greenhouse gases to the globe. With demand forecasting technique, chances of wasting food will be low because one does not buy too much but enough amount of food based on the result of the forecast. When sharing food, one also can conserve food by acquire the required food from local community instead of buying them from supermarket.

When people start to buy food locally, the amount of air pollution caused by the transportation of food will be decreased. Thus, saving the environment. Furthermore, the treatment of food waste in Malaysia is rather limited, so reducing food wastage is better and more efficient than treating it. Abdul Hamid, et al. (2012) says that the implementation of the food waste management in Malaysia is rather difficult. Hence, we can consider this system to achieve current and long term benefits.

By deploying this Mobile Food Planning and Conservation System, food wastage will be reduced by planning the food in advance, forecasting adequate amount of food demand and using up expiring food before expired. Hence, the objectives of our project are achieved.

5.1 PROJECT CONSTRAINTS

This project is suitable for household usage only because the application is not able to process and categorize large amount of data. Besides, the meal plans and shopping list cannot be shared via the social networks. Only the items in the inventory can be shared. Testing this application could be challenging because most of the household in Kampar did not manage their inventory in a systematic manner. They only rely on their memory and situation such as events, happenings or celebrations to decide the items to be purchased from the grocery. Additionally, they are also not aware on the consequences of food wastage. Moreover, users are highly advised to apply the dark theme only because this application is not compatible to the light theme of windows phone.

5.2 PROJECT EVALUATION

This project is strong in helping household to control food usage and prevent food wastage. The impact is significant in terms of money spent on foods when this application is used in a long run. Besides, one become more organized when planning food and also becoming more aware about the consequences of food wastage.

Due to the application is solely focus on household level, it is hard to apply it in industry wide level because the methods used to predict the food demand is less significant. Moreover, it might not be usable if one does not has a regularly habit on planning or organized food usage in the household.

Furthermore, this project can be uploaded to the windows store since there is no similar application in the store for now. It can reaches a wide range of audience if this application is made free initially.

5.3 PROBLEMS ENCOUNTERED

During the development of this project, several problems are slowing down our progress. First, the test data are hard to collect since most of the households did not record their inventory purchasing history. As a result, the prediction is solely based on the current test data I have gathered from vendors in the campus. Second, the emulator of the Microsoft Windows Phone SDK 8 sometimes failed to boot and need to repair the SDK in order to start the emulator again which is very time consuming, repairing the SDK takes approximately 2 hours to complete which is greatly impeding the progress. Finally, the design of the application are time consuming because the default theme is dark and the project is developed using that theme. When switching to light theme, some icons and colors of the page are distorted.

5.4 FUTURE ENHANCEMENT

There are few modules which can be improved in the future. First, the meal planning module. The list of meals entered earlier can be more visible to users that they do not need to check manually day by day. Besides, the meal plans can also be shared instead of read only. Second, the ingredients listed in the recipe page can be linked with the inventory so that users will know what ingredients they need to purchase in order to cook the food based on the recipe. Third, the inventory can be grouped into categories either predefined or defined by the users. If inventory is categorized, searching for items in the inventory could be much easier. Next, the design of the application could be further improved to increase the usability and attractiveness. Finally, the reorder point module could be related to the forecasting methods to better predict the future demand of items.

BIBLIOGRAPHY

Abdul Hamid, A., Ahmad, A., Ibrahim, M. H. and Nik Abdul Rahman, N. N. 2012. Food Waste Management in Malaysia-Current situation and future management options. *Journal of Industrial Research & Technology*, 2 (1), pp. 36--39.

Alliance, A. 2001, *Manifesto for Agile Software Development,* Available from: <http://agilemanifesto.org>. [25 November 2012].

Ambler, S. W. & Lines, M. 2005, *Disciplined Agile Delivery (DAD): A Practitioner's Guide to Agile Software Delivery in the Enterprise,* IBM Press.

American Public Media, 15 Ways to Reduce Your Carbon Footprint | Consumed | Sustainability Coverage From American Public Media. Available at: http://sustainability.publicradio.org/consumed/tips.html [Accessed June 11, 2013].

Arrand, M., 2008. Reorder point (ROP) control.

Aruna, P. 2011, Malaysia Today, Available from: <http://www.malaysia-today.net/mtcolumns/newscommentaries/41024-930-tonnes-of-food-being-thrown-away-every-day>. [23 November 2012].

Demery, P., Web-only - IRCE 2012 Report: Consumers explain how they shop online - Internet Retailer. Available at: http://www.internetretailer.com/2012/06/07/irce-2012-report-consumers-explain-how-they-shop-online.

FAO, 2013. FAO Statistical Year Book 2012 Europe and Central Asia Food and Agriculture. , p.12.

Ganglbauer, E., Fitzpatrick, G. & Molzer, G., 2012. Creating Visibility : Understanding the Design Space for Food Waste. , pp.0–9.

Li L., Chen N., Wang W., Baty J., 2009. LocalBuy : A System for Serving Communities with Local Food. , pp.2823–2828.

Joffrey Collignon, J.V., 2012. ABC analysis (Inventory) Definition. Available at: http://www.lokad.com/abc-analysis-(inventory)-definition [Accessed June 26, 2013].

Kulkarni, H., Dascalu, S. & Harris, F., Software Development Aspects of a Mobile Food Ordering System. , pp.67–72.

Lao, S.I. et al., 2010. An Integrative Food Handling System for Managing Inventory Information in Food Warehouses.

MSDN, Guidelines for typography (Windows). Available at: http://msdn.microsoft.com/en-us/library/windows/apps/jj553415.aspx [Accessed July 5, 2013].

Murphy, P. & Wood, D., 2010. *Contemporary Logistics*, 10th edn. Prentice Hall, New Jersey.

Nada, R. & Larry, P., 2004. Integrating judgmental and quantitative forecasts : methodologies for pooling marketing and operation information. *International Journal of Operations & Production Management*, 24(5/6), pp.514 – 526.

Reubold, T. 2014. The Rotten World of Food Waste. [online] Available at: http://ensia.com/infographics/the-rotten-world-of-food-waste/?utm_content=buffer5b4a2&utm_source=buffer&utm_medium=twitter&utm_campaign=Buffer [Accessed: 17 Jan 2014].

Riley, M., "Food and beverage management a review of change", International Journal of Contemporary Hospitality, 17(1), pp88-93, 2005.

Saeed, M. O., Hassan, M.N., and Mujeebu, M. A. (2009) Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. Waste Management, 29, 2209-2213.

Shakman, A. 2009, Redefining Foodservice Waste Management: What's Next, *Foodservice Equipment & Supplies,* vol. 62, no. 13, pp. 15-n/a.

Tanpure, S.S., 2013. Automated Food Ordering System with Real-Time Customer Feedback. , 3(2), pp.220–225.

The Star Online, 2013. Wasteful ways of Malaysian gluttons - Nation | The Star Online. Available at: http://www.thestar.com.my/News/Nation/2013/06/05/Wasteful-ways-of-Malaysian-gluttons-15000-tonnes-of-food-enough-to-feed-75-million-people-thrown-a.aspx [Accessed July 1, 2013].

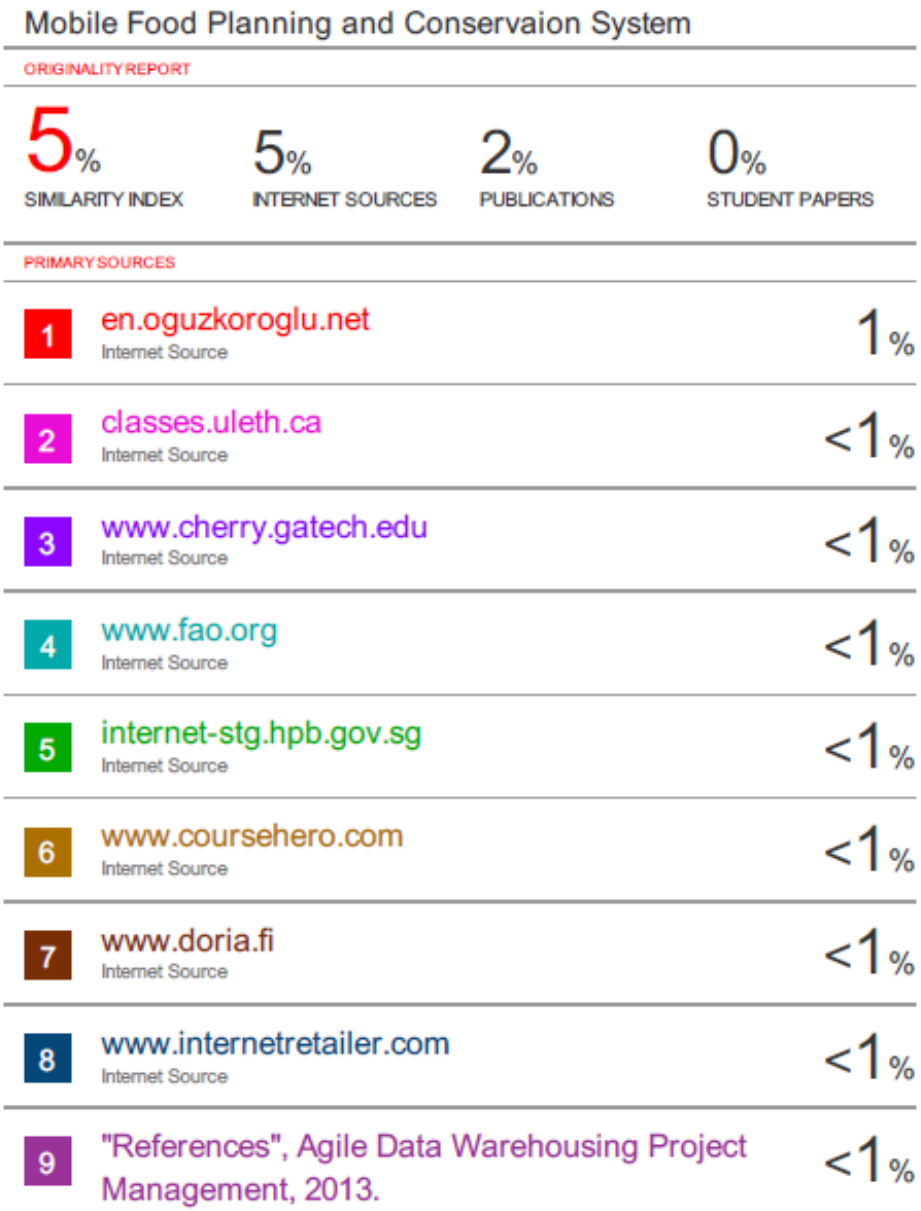
Vermorel, J., 2011. Definition of Seasonality. Available at: http://www.lokad.com/definition-seasonality [Accessed June 26, 2013].

Votano, J., Parham, M. & Hall, L., 2004. Essential Windows Phone 7.5. *Chemistry & ….* Available at: http://onlinelibrary.wiley.com/doi/10.1002/cbdv.200490137/abstract [Accessed June 19, 2013].

Yordan P., 2013. Windows Phone 8 SDK. *The FEBS journal*, 280(14), pp.3482–3. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23826866.

Zhi, J. & Gao, J., 2009. Carbon Emission of Food Consumption: An Empirical Analysis of China's Residents. *2009 International Conference on Environmental Science and Information Application Technology*, pp.148–151. Available at: http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=5199857 [Accessed June 9, 2013].

APPENDIX A: TURNITIN RESULT



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