Kitchen Hunt: Recipe Search by Ingredients you have in your Kitchen

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Abstract— **Cooking has become very popular all over the world at present. There are many foods made worldwide which are associated to different cultures, traditions and countries. Day by day, many new recipes and dishes emerge as people tend to try out new recipes and make new foods by combining ingredients and aspects of different cuisine styles. However, many people face problems when it comes to precisely searching the recipes which contain only the particular ingredients available. This paper discusses the project "Kitchen Hunt" which is a web based application designed to address this problem. It provides the best searching capabilities to search recipes online. Once the ingredients available are entered, users can easily find the recipes which can be made using those ingredients. This saves the time spent on referring lengthy recipe books and cook books. Kitchen Hunt also acts as a platform to connect people who are interested in different cuisine styles and allow them to share their knowledge with others as well.**

Keywords—recipes; ingredients; searching; application; user; platform

I. Introduction

At present, cuisine has become very popular all over the world. A vast number of styles of cooking exists, characterized by distinctive ingredients, techniques and dishes, which are associated with different cultures, traditions and countries worldwide. Day by day, many new recipes and dishes emerge as a result of fusion cuisine which combines elements of different culinary traditions. Many people tend to try out cooking with the ingredients which they already have in their pantries. However, a majority faces problems when it comes to searching recipes which contains particular ingredients, recipes of certain meal types and cuisine styles. It is difficult to precisely search the recipes which contain only the particular ingredients available. It takes a lot of time and effort to find the exact recipe that contains the ingredients available.

At present, there are many websites from which users can get recipe details. However, most of them have simple searching capabilities. Kitchen Hunt was developed in order to address these problems discussed and provide best searching capabilities to search recipes.

Kitchen Hunt is a web based application which provides the best searching capabilities to search recipes online. Once the ingredients available are entered, users can easily find the recipes which can be made using those ingredients. Users can easily customize the search so as to suit their preferences of certain types of foods and they can also explore recipes of different cuisines, cultures and countries. This saves the time spent on referring lengthy recipe books and cook books. Furthermore, Kitchen Hunt acts as a platform to connect people all over the world who are interested in different cuisine styles and allow them to share their knowledge with others as well. Users can also create their own My Kitchen account and post new recipes, save recipes to refer, request for recipes, rate recipes and comment on recipes.

This paper describes how Kitchen Hunt application was designed and developed. Section II surveys related work in building applications for finding recipes online. Section III provides an overview of the system. System models, design, implementation and testing of the application are described in sections III, IV, V, VI and VII. Final section of the paper describes conclusion and future work of Kitchen Hunt application.

II. Literature Review

This section provides an overview of some existing applications and websites that are available to find recipes online. "Super Cook" [1] is a top rated website from which users can search recipes online. User can add multiple ingredients and search recipes which contain at least one of the provided ingredients. Users can add restrictions and specify the meal type. It also allows users to create a free account. Super Cook searches recipes from other websites.

"My Fridge Food" [2] is a very popular web application that allows users to add ingredients of interest and search recipes. Results contain all the recipes which include at least one of the provided ingredients. The results are not ordered accordingly as to which ingredient is included in the recipe. Users can bookmark the recipes they want by logging in to their account.

When researching about recipe search algorithms, following SQL implementation became significant as it handles the search function using a query. It is a PostgreSQL realization, using sub-queries and intarray type. Figure 1 shows the SQL query to search recipes for the example ingredient set 129, 99, 56, 180. [3]

```
SELECT recipe_id, recipe_ingrs,
icount('{129,99,56,180}'::int[] - recipe_ingrs)
as shortage, icount(recipe_ingrs -
'{129,99,56,180}'::int[]) as excess

   FROM (

     SELECT id as recipe_id, array(select
ingridient_id from r2i where r2i.recipe_id =
recipes.id)::int[] as recipe_ingrs

     FROM recipes WHERE recipes.id IN (select
distinct recipe_id from r2i where ingridient_id
IN (129,99,56,180))

   ) as t

   ORDER BY excess ASC, shortage ASC;
```

Fig. 1. Sample SQL query for recipe search

When considering the above implementation, it was hard to order the recipes according to the percentage an ingredient contains within as it will make the query more complex.

When researching above systems, it was found that some features available in certain systems are not available in other systems. When taken as a whole, none of these systems contain all the options such as searching recipes, posting recipes, commenting on recipes, rating recipes and request for recipes within a single system.

III. Overview of the System and Process Followed

Rational Unified Process was used as the process model, which was based on four main phases; inception (the phase where majority of the identification and planning work was done), elaboration (the phase where majority of the design work was done), construction (the phase where the real implementation was taken place) and transition (the phase where deployment and maintenance work were carried out).

The business model and the requirements of the project were specified during the inception phase. Key use cases, database schema, system architecture and major interfaces were identified and designed during the elaboration phase. Implementation of the features in accordance with the system architecture with proper testing were carried out during the construction phase. Refactoring of the code, system testing and deployment were carried out during the transition phase.

IV. System Models

A. System Requirement Specification

This section describes the system requirement specification, which was launched at the inception phase of the project.

The functional requirements of Kitchen Hunt system are based on the main interfaces and the administrator portal. The key feature of Kitchen Hunt is the recipe searching functionality. There are two methods available for searching recipes. They are the general recipe search and ingredient and category based recipe search. The general recipe search searches recipes according to the recipe name. When a user types the name of a recipe, the system will provide suggestions out of the available recipes in the Kitchen Hunt database.

The ingredient and category based recipe search allows the user to search recipes which contains a particular ingredient, exclude an ingredient, and the user can also specify the meal type, cuisine type and health categories. When an ingredient is specified, the user can order the results according to the alphabetical order of the recipe names or according to the descending order of the percentage of the amount of the ingredient included.

Users can create a My Kitchen account by entering their details. After the account has been created, an email will be sent to the specified email address, informing the user that the account was successfully created. After successful creation of the account, the user can log in by entering the email address and password.

Once a user has created a My Kitchen account, he/she can post recipes, request for recipes, comment on recipes and rate recipes. Once a user has rated a recipe or posted a comment on a recipe, the author of the relevant recipe will be notified about the rating or the comment. Users can view the recipes they have posted, recipes they have added and ingredients of interest via the My Kitchen Dashboard. Administrators can log in to the web portal and publish posted recipes after moderating them. Administrators can also manage categories and registered users.

Recipe search feature is made prominent and the results are displayed in an attractive thumbnail view. High priority is given to user security. Security measures have been taken to ensure My Kitchen account security. Coding standards will be maintained so that it will be easy to implement new functions in future.

B. Use Case Diagram

The main actors which have been identified are general user, registered user and administrator.

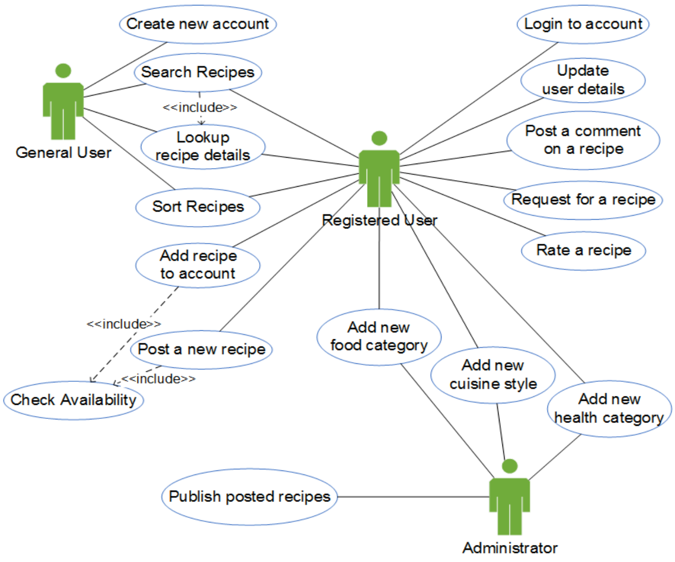


Fig. 2. Use case diagram of Kitchen Hunt

Figure 2 shows the use case diagram of Kitchen Hunt system. The three main actors, general user, registered user and administrator are shown with their relevant use cases.

General users can create their own My Kitchen account and log in to the system. General users and registered users can search for recipes on Kitchen Hunt using the general recipe search option as well as the ingredient and category based recipe search option. A set of results will be returned from the ingredient and category based search. Once the results are returned, users can sort the recipes according to any provided option. Once the user has sorted the results, they can view the recipe details.

Registered users can add recipes to their My Kitchen account for future reference. They can also post their own recipes, post a comment on a recipe, rate a recipe and request for a recipe. They can also update their account details via the My Kitchen Dashboard. When posting recipes, registered users may come across scenarios that they may have to add certain new categories for meal type, cuisine style and health category. In such scenarios, they can add categories as well.

Before publishing a recipe, an administrator has to read the recipe details and check whether the content is acceptable. If the content is not acceptable, the administrator can moderate the recipe up to s certain extent. After moderation, if the content is still not acceptable, the administrator can remove the recipe. Administrator can manage categories as well.

V. System Design

A. *Architecture of the System*

Kitchen Hunt web application has been developed using the three-tier architecture. The layering model of the web application has been based on assigning each layer with a particular responsibility. The three layers included are as follows.

1) View layer

This layer consists of the user interfaces. All the forms and interface classes (JSPs) belongs to the view layer.

2) Application logic layer

This layer consists of the servlets to perform the application functions. Application logic classes such as general search, ingredient and category based search and sorting also belong to the application logic layer.

3) Data access layer

This layer consists of the database access classes (Pool Manager) and object mapping classes such as, recipe, ingredient, rating, comment and user.

Having a layered architecture as mentioned provides many advantages. Each layer exposes an interface to the layers next to it. This type of layered architecture increases the abstraction of levels and provides a standardization of layer interfaces for libraries, frameworks and design patterns used.

All the recipe and ingredient data is accessed from the database via the Data Access layer only securing the backend. All the logic relevant to recipe search is handled within the Application Logic layer and the results are made visible to the View layer, securing all the application specific logic. The View layer can cache requests minimizing the network utilization, and the load is reduced on the application and database. Figure 3 depicts the three-tier architecture used in Kitchen Hunt.

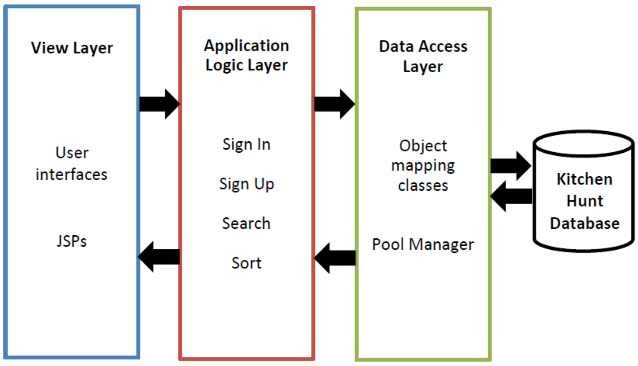


Fig. 3. Three-tier architecture used in Kitchen Hunt

B. *Logical View*

The class diagram for Recipe Search functionality is shown in Figure 4 below.

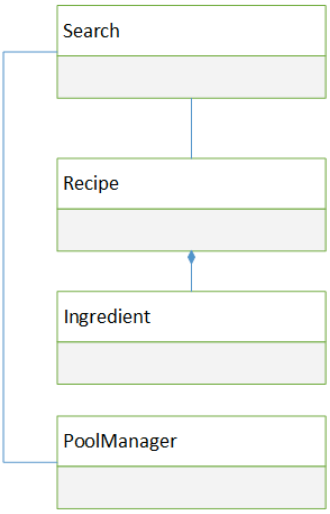


Fig. 4. Class diagram for Recipe Search functionality in Kitchen Hunt

The logic and algorithm which corresponds to the recipe search can be found in the Search class. PoolManager class will access the database and retrieve recipe details. From the results obtained, the recipes will be searched and those matching the criteria specified will be loaded.

C. *Process View*

The sequence diagram for Recipe Search functionality is shown in Figure 5. This specifies object interactions arranged in time sequence.

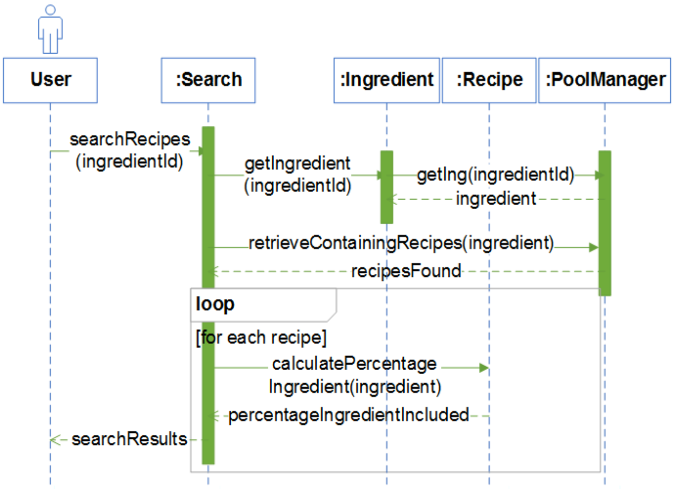

User
:Search
:Ingredient
:Recipe
:PoolManager
searchRecipes (ingredientId)
getIngredient (ingredientId)
getIng(ingredientId)
ingredient
retrieveContainingRecipes(ingredient)
recipesFound
loop
[for each recipe]
calculatePercentage Ingredient(ingredient)
percentageIngredientIncluded
searchResults

Fig. 5. Sequence diagram for Recipe Search functionality

Once the user enters the ingredient to include, the ingredients are searched from the ID. Then the recipes containing the particular ingredient are returned. For each recipe, the percentage of the ingredient included is calculated. Then the details and the search results are returned.

D. Data View

The Kitchen Hunt web application mainly functions upon the data stored in the database. The web application mainly stores details about recipes, ingredients, users, ratings, comments and user notifications.

The database schema for Kitchen Hunt is based on the data that is required to be stored for proper functioning of the system. The tables created can be basically divided into two categories as tables for user management and tables for recipe management. Basic details about the user and their interactions are stored in the tables for user management. Details about recipes related material and references are stored in the tables for recipe management. Foreign key constraints have been used to refer one table using the primary key of another table. In the case of deleting records, tables with foreign keys have been enabled for the cascade on delete option so that foreign key constraints will not cause any problems during updates and deletions.

VI. System Implementation

A. Implementation Procedure

Java programming language was used to develop this web application. Java language was selected due to many reasons. The Java / J2EE architecture is robust and reasonably elegant. It makes it possible to architect well-built applications. The free tools available for Java development such as Apache, Maven and Gradle are enterprise ready. Excellent support for developers is provided as there is a huge user base and rich community. There is also a good availability of third-party and open-source libraries for the Java programming language.

MySQL database was used as the back-end data storage. MySQL was selected because the database is free and open source, it provides strong support for specialized web functions like fast full text searches and provides security features for data protection. Since it is free, it is usually available on shared hosting packages and can be easily set up in a Linux, Unix or Windows environment.

Hibernate object-relational mapping framework [4] was used to generate the database mapping classes within the application. Hibernate ORM was selected because using Hibernate, it is easy to write applications whose data outlives the application process. Hibernate can be easily used in any environment supporting JPA including Java SE applications and Java EE application servers.

NetBeans was used as the IDE for development. It has many built-in plugins such as database connectors for MySQL and testing frameworks such as JUnit. It is easy to use and code using it. NetBeans provides excellent support for the latest Java EE 6 and 7 features. It natively supports build managers such as Ant and Maven as well as it has excellent integration with GlassFish application server. GlassFish will be used as the application server. The main reason to use GlassFish server is that it is specially designed for managing Java EE applications (servlets/JSP). It comes bundled by default with the Java EE SDK download from Oracle.

The project was created as a Java web application. First the basic web pages were developed. Java Server Pages were used to develop web pages as they allow to write Java code with HTML. Then styles for components were added using Bootstrap CSS framework. Then the servlets for actions were developed along with the application logic classes. Components for each functional requirement were developed and tested before integrating to the main system. After completing development of the system, the web application file (WAR) file was generated.

Hosting space was purchased from Digital Ocean [5] hosting service provider. A virtual machine was created with the provided IP address. Then Ubuntu was installed in the server. Java, MySQL and GlassFish were installed. The WAR file generated was uploaded to GlassFish application server and deployed.

B. Algorithm

The most important algorithm of the system is the recipe search algorithm. Algorithms were researched [6] [3] and an efficient algorithm was developed. To find the recipes containing the ingredient, "like" queries were used. Figure 6 below shows the pseudo codes for ingredient and category based recipe search. The application gets the values for categories specified from the user inputs. It adds the restrictions to the search and gets the list of relevant recipes.

For each recipe, it gets the weight of the included ingredient, calculate the total weight of ingredients and calculate the amount of included ingredient as a percentage of the total weight of ingredients. It saves the percentage value corresponding to each recipe in the list. Then the recipe list is sorted according to the descending order of the percentage of included ingredient. The resulting list is sent back to the results page. Figure. 6. Shows the pseudocode for ingredient and category based recipe search.

```
Start
Input include_ingredients
Input exclude_ingredients
Input meal_type, cuisine_style,
health_category

for each recipe in database
   if (meal_type, cuisine_style,
health_category matches to the recipe’s
values)
      set recipe_is_relevant = true

      for each inc_ing in include_ingredients
         if inc_ing is not present in recipe
            set recipe_is_relevant = false
            break
         else
            continue
         endif
      endfor

      for each exc_ing in exclude_ingredient
         if exc_ing is present in recipe
            set recipe_is_relevant = false
            break
         else
            continue
         endif
      endfor

      if recipe_is_relevant
        add recipe to recipe_list
      endif

   endif
endfor

for each recipe in recipe_list
   calculate the total weight of ingredients
in the recipe.
   get the weight of the first
include_ingredient
   percentage = include_ingredient_weight /
total_recipe_ingreident_weigth * 100
   add percentage to the list with the
relevant recipe
endfor

Sort the recipe_list according to the
descending order of percentage of the first
included_ingredient available for the recipe
Send the recipe_list to search results page
End
```

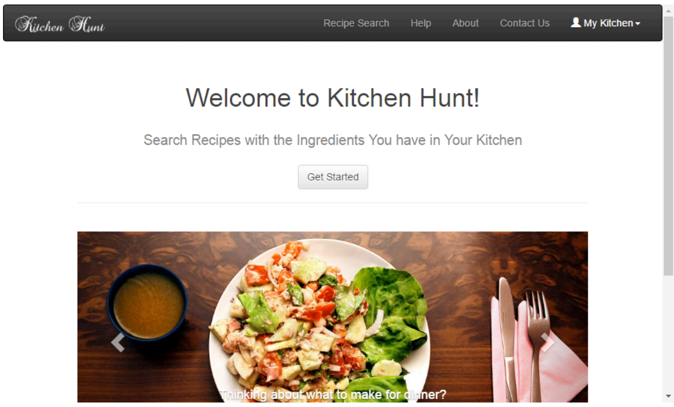
Fig. 6. Recipe search pseudocode

C. *Main Interfaces*

Interfaces were mainly designed using HTML, CSS and JavaScript. Bootstrap framework [7] was used to enhance the look and feel of the interfaces.

Figure 7 shows the home page of Kitchen Hunt. The “Get Started” button directs the user to the recipe search page. Figure 8 shows the recipe search page. On the side bar, first appears the general search, by which the user can search recipes by entering the recipe name. Next, the ingredient and category based search can be seen. The user can specify an ingredient to include, an ingredient to exclude. According to the categories selected, Kitchen Hunt will return the results to results page.

Figure 9 shows the returned results in an attractive thumbnail view. Each thumbnail consists of a small image of the food, the recipe name, author name, meal type, cuisine style and health category. The user can click on the “View Recipe” button to view the full recipe details.

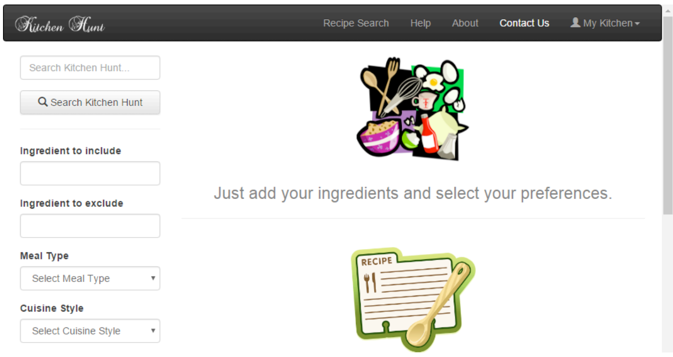


Welcome to Kitchen Hunt!

Search Recipes with the Ingredients You have in Your Kitchen

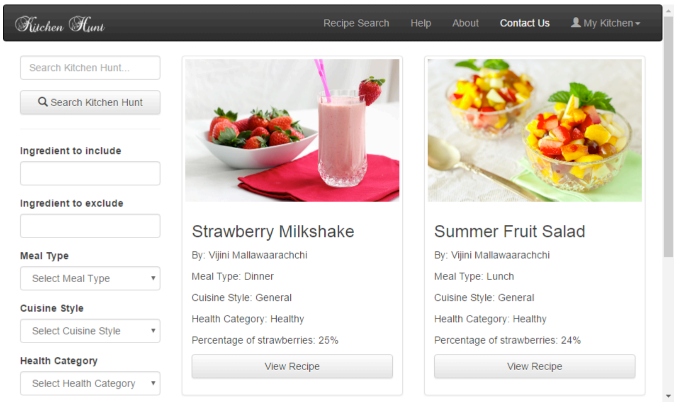
Thinking about what to make for dinner?

Fig. 7. Home Page



Just add your ingredients and select your preferences.

Fig. 8. Recipe Search Page



Strawberry Milkshake

By: Vijini Mallawaarachchi

Meal Type: Dinner

Cuisine Style: General

Health Category: Healthy

Percentage of strawberries: 25%

Summer Fruit Salad

By: Vijini Mallawaarachchi

Meal Type: Lunch

Cuisine Style: General

Health Category: Healthy

Percentage of strawberries: 24%

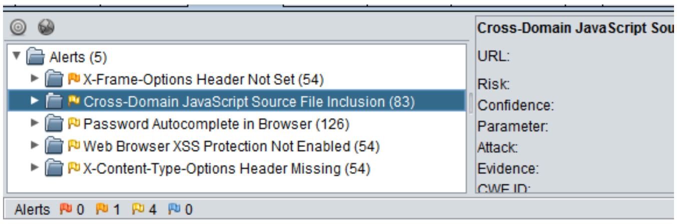
Fig. 9. Recipe Results Page

VII. System Testing and Analysis

When considered in a higher abstract level, Kitchen Hunt application consists of two subsystems, the main Kitchen Hunt application and administrator portal.

All the components in above two subsystems were verified and validated in order to ensure proper functioning of the system. The test items that were identified as targets for testing were Kitchen Hunt database, user interfaces, main Kitchen Hunt application functionality, administrator portal functionality, Kitchen Hunt server capabilities, and security model

Manual test approaches as well as automated test approaches were employed during the testing process. Test cases were automated by using JUnit testing framework [8] which is specially designed for Java language and Selenium framework [9] which is a portable software testing framework for web applications. Load testing of the server was carried out using Apache JMeter framework [10] to determine the behaviour of Kitchen Hunt system under normal anticipated workload and anticipated worst-case workload. Zed Attack Proxy penetration testing tool [11] was used to perform penetration testing to ensure security of the application. Certain vulnerabilities such as cross-domain JavaScript source file inclusion and password autocomplete and web browser XSS protection issues were discovered and they were fixed. Figure 10 depicts results of penetration testing.



Alerts (5)
- X-Frame-Options Header Not Set (54)
- Cross-Domain JavaScript Source File Inclusion (83)
- Password Autocomplete in Browser (126)
- Web Browser XSS Protection Not Enabled (54)
- X-Content-Type-Options Header Missing (54)

Cross-Domain JavaScript Sou
URL:
Risk:
Confidence:
Parameter:
Attack:
Evidence:
CWE ID:

Alerts 0 1 4 0

Fig. 10. Results of penetration testing.

VIII. Conclusion and Future Work

Kitchen Hunt provides the ability for the user to enter the ingredients and select different search criteria available such as, recipes based on meal types and different cuisine styles. It allows the ability for the user to specify certain ingredients to be excluded in the recipe due to certain preferences and dietary conditions. It provides the matching list of recipes according to the search criteria specified by the user, from which they can chose and view the recipes separately.

A majority of people faces problems when it comes to searching recipes which contains particular ingredients, recipes of certain meal types and cuisine styles. They cannot precisely search the recipes which contains only the particular ingredients they have. It takes a lot of time and effort to find the exact recipe that contains the ingredients available. Kitchen Hunt will save the users from all these problems and saves time spent on searching for recipes.

While testing with real world users, they were impressed with the searching feature and the My Kitchen account features. My Kitchen account allows the users to interact with other users and share their knowledge as well. Users were very impressed with the idea of the Kitchen Hunt community where users can share their ideas and connect users with similar interests in cooking and cuisine.

In the future, the ingredient and category based search functionality will be developed so that the users can include more than one ingredient and search for recipes which include the specified recipes. Furthermore, Kitchen Hunt will collaborate with local supermarkets so that the supermarkets can advertise their products along with the ingredients for each recipe. The supermarkets where the ingredients are available will be displayed and based on the user's location, the nearest supermarkets where the users can buy these ingredients will be displayed. The price of ingredients in each supermarket will be available for the user and the total cost for each recipe will be calculated and displayed so that the user can compare the options available and chose. Further, this will provide advertising opportunities for supermarkets.

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