Kingdom of Saudi Arabia
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HUMAN COMPUTER INTERACTION PROJECT

Smart kitchen System

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GROUP 2

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Abstract

People do daily life activities during their day routine, but most of their daytime is spent in the kitchen. How about smart technologies and assistance that facilitate cooking process along other additional features. Since kitchen is the main place for people's routine, we decided in this paper to develop a Smart Kitchen system to take advantage of technology to facilitate user's life, including beginners, elderly, housewife, and disabled. Smart Kitchen aims to facilitate cooking activities, ease their cooking experience and enhance their independency.

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1. INTRODUCTION

Nowadays many technologies were created that assist people during their various daily activities and one of these assists is helping people in the kitchen depending on their needs whether to overcome some difficulties during the cooking or to enhance their abilities. The kitchen is considered the center of daily life at home so the need to design a solution that overcomes the difficulties requires a clear understanding of people's needs that reside at home which eventually leads to producing a useful and usable product. In this paper, we try to understand the user's goals in the kitchen and determine which technology can be implemented in their kitchen to achieve these goals by producing one persona for each user. The information about our personas was collected by searching online about what difficulties they face during cooking meals and do the brainstorming to elicit the users' requirements that lead us to design a smart kitchen that uses various, advance and interconnected devices that enhance the quality of life in the kitchen. These enhancements may extend to cover different areas such as energy-saving and physical activity.

2. DEFINED THE PROBLEM

Making life easier is one of the most important things that people wish to have even inside our kitchens! Many people such as the elderly, disable and even normal people face some problems while they do their kitchen works. One of the most common problems is spending a lot of time to think about what to cook during the week. Many people want to eat a diverse list of food in order to avoid the problem of a lack of vitamins in their bodies. Another problem is monitoring each kitchen's devices to check its work is boring and time consuming for people especially if they want to do something else out of the kitchen. Furthermore, memorizing the date for each food when it will expire is impossible which led to getting rid of food before eating it. Also, some people face problems in controlling the kitchen furniture especially for disable people such as when they want to take something at the top, etc.

3. ASSUMPTIONS AND CLAIMS

3.1 Saving Time and Effort:

One of the advantages of a smart kitchen is saving time and effort by setting alternative solutions that excuse people from doing them. One of the most common things that happen to people is forgetting what they want from the Super Market or because they think that this product exists and there is no need to buy it. When placing a camera inside the refrigerator, this feature makes it easy to see what is inside and to know what is not there, without having to go to the kitchen.

3.2 Kitchen Controlling:

This feature serves all people, especially the handicapped and the elderly, due to the difficulty of moving quickly from around the house to the kitchen, or because of forgetfulness, especially the elderly. These will make it easy to control kitchen appliances such as starting or turning off the oven, controlling the drawers of the kitchen by opening or closing them, and controlling the kitchen lighting in terms of raising it or reducing it to the required level or turning it off in addition to controlling the kitchen conditioning by changing the temperature.

3.3 Kitchen Safety:

One of the ideas for protecting children is storing knives and all dangerous sharp tools in a dedicated drawer that can only be opened through the mobile app, this idea is more protection for the child than locking the drawer with the key, because the housewife may forget to close it with the key in case she was outside the home. Therefore, a drawer controlled by the application provides more protection for children and is easy to control outside or inside the home.

4. FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

4.1 Requirements Gathering

Today's information technology has helped in the development of our lives and made it simpler and easier, as well as solving some problems through various and different applications, and we know that every application targets a certain category of people and some serve everyone, the application also contains functional and non-functional requirements and in our application, the smart kitchen has a certain class served by this application.

	Code A Cake	Smart Kitchen	Cookin
Ease of use	Although its look is simple, beginners needs a more expert user in cooking to help in following the recipes	It does not need user effort to used to the system.	Cookin is easy to start.
effectiveness	It is very effective and help users to achieve their goals	It is very effective in term of tracking the cooking process and recognize the food	It improves the assistance during cooking.
Engagement	It motivates users to learn.	It motivates users to cook properly since it guides the step by step.	It encourages users to use it since it makes cooking process easier.
User Interface	It has a very attractive and simple interface	Its interface described as interactive	It has a very clear and simple appearance.
Internet based	It depends on Internet	It is not Internet based.	It based on Internet connection
Notifications	It advises users to follow steps properly	It notifies the user when moves to next steps.	It notifies the user once finished the recipe steps.
Communication	User can communicate with the system by clicking buttons.	Users can communicate with system using voice.	Cookin enables the user to communicate using voice, poses.
Navigations	It depends on user clicks to move to another step	It navigates between steps by user movement.	It navigates between steps by speech, pose, and movement.

4.1.1 Functional Requirements:

This application serves four main categories, which are beginners, adults, the elderly, and disabled people.

here is a detailed explanation of functional requirements:

1. **Create an account**

   This function allows the people to create an account that contains a username, password, and it belongs to any category.

2. **Log in**

   This function provides the customer with the service of logging into his own account, which he can use to remotely control the devices or search for a specific recipe and other functions.

3. **Control of kitchen appliances**

   In this function, the user can control the kitchen appliances remotely by turning them on or off, such as: turning on or turning off the oven and setting the temperature.

4. **Control of kitchen furniture**

   This job serves the disabled and the elderly, and through this process, a person can lower the kitchen furniture and lift it, as some elderly and disabled people find it difficult to get to something and take it.

5. **Writing main meals for the day**

   This function helps adults write main meals from the beginning of the day so that it is easy for them to apply and diversify each day with different recipes.

6. **Find the recipe**

   In this function, the user can search for any food recipe and know the ingredients of the recipe and how to prepare it in an easy and enjoyable way.

7. **Scan the barcode**

   This function allows the user to scan codes for food ingredients and then store them and send notification of names of materials that will expire soon, so he must use it before it expires or the materials that have been carried out and must be purchased.

8. **Shopping basket**

   In this function when the barcode is scanned and information is stored, and after a period the system places the materials that have been implemented to be purchased.

9.**Sign out**

After any user has finished using the system, they can log out to make their account more secure.

4.1.2 Non-Functional Requirements:

- **Usability**

1- Easy to remember how to use

The application contains clear steps and pictures so that they are easy to remember.

2- Easy to learn

This application is easy to learn and use because it contains simple and understandable words for everyone, also this application is divided and organized so that the user can access the required thing quickly.

3- Consistency

The user can perform his duties efficiently, because the layout is efficient enough so that the users can quickly find the items.

- **User experience**

1- Satisfying

The system serves many different users at their levels, as it contains different functions suitable for each category.

2- Engaging

This app contains features that motivate the user to use it, as the layout and images attract it to the system experience.

3- Helpful

This application helps to facilitate control of the kitchen through many features such as choosing the appropriate recipes and controlling the devices remotely.

5. PERSONAS

5.1 Housewife chef

Emily "Housewife chef"

Emily is a wife of 3 children. She is 33 years old. Cooking is her hobby and she is keen to join cooking courses.

Emily is a busy woman and had cluttered schedule. So, she is looking for efficient help that saves time.

How Smart Kitchen system helps :

- Provides home appliances that are efficient to use and allows her to do other thing in same time.
- Helps to vary in recipes and schedule her kids' favorites.
- Gives fun experience as it facilitates cooking process.

5.2 Beginner chef

Taylor "Beginner chef"

Taylor is 18 years old. She is new to cooking world and excited to expand her knowledge in cooking. She wishes to cook tasty dishes.

Taylor needs a guider to teach her how to cook and make delicious meals.

How Smart Kitchen system helps :

- Benefits her in guidance system that teach her to put ingredients correctly.
- Makes all recipes accessible to her, so she does not need to look repeatedly on the magazines or cooking books.
- Observes her progress in learning process and suggests her courses to enjoy.

5.3 Elderly chef

Liza "Elderly chef"

Liza is 75 years old and lives with her daughters. She is proficient and knowledgeable about recipes.

She always likes to try new and complex dishes, but she wants appliances that help her while cooking delicious meals.

How Smart Kitchen system helps :

- Provides appliances as a guider that helps in cooking process .
- Assists in cooking process with audio and graphics. Assistance integrated into devices and speakers.

5.4 Disabled chef

Monica "Disabled chef"

Monica is 35 years old. She is fairly skilled and cooks everyday. Monica has a midsize kitchen that equipped with sufficient appliances to do cooking process.

She lives independent life and takes advantage of any assists that would makes her everyday life skills better.

How Smart Kitchen system helps :

- Improves life independency.
- Facilitate cooking experience.
- Support her with interactive technology to get a high-standard living.

Figure1: Smart kitchen personas

6. SCENARIO

6.1 Beginner scenario:

Taylor was planning to do her 18th birthday in the house and inviting her relatives and close friends. So, she decided to prepare the place and make her birthday cake. She went to the kitchen, specifically to Echo Show as shown in figure2, to ask it for the best birthday cake. Echo Show displayed the top-rated birthday cakes and displayed the ingredients for each. She has selected one and started to prepare the ingredients. Echo Show reads the recipe for Taylor and guided her to put the correct ingredients. Once the cake became ready for baking, she set a timer and place it inside the oven. At 3 pm, she put small candles on its top and fired them. After her silent wishes and blowing out the candles, Taylor's parents cut the cake into pieces and distributed the slices. The family enjoyed and thanked Taylor for her delicious and wonderful cake.

Figure2: Echo Show

6.2 Housewife chef

One day, Emily's oldest son (Max) asked her mother to make chicken soup. Emily should cook vegetable soup as planned in the calendar, but chicken soup is a new dish. To not get bored, she accepted the challenge to do it, so she needed to check the ingredients. Emily directly went to the generated shopping list and found that tomatoes and onions are not available. The shopping list has already sent to Emily's husband (David) to pass by grocery and buy them. Once he came back, she started to prepare the meal. After finishing the preparation, she called her husband and children to gather for lunch. From the first sip, they showed their satisfaction and enjoyment. Finally, Emily decided to add the chicken soup to the plan list.

6.3 Elderly chef

As Liza was cooking for many years, she has cooked different meals, even traditional food. However, due to her age, she became interested in healthy food. With the help of the Echo Show, she was planning weekly what to cook. She started to suffer from memory loss and has affected daily life activities. What she did is, she got into using a guiding system in the kitchen, that instructs her during cooking time. This feature makes her feel comfortable and satisfied.

6.4 Disabled chef

Monica has an independent life, especially in the kitchen. Cooking is fun for her. She does not face difficulties while cooking, because her kitchen is prepared for her. Whenever she needs to get things are placed on the highest shelf of cabinets, only what she can do is pressing a button to lower the level of the cabinets. What is more functional is that she can lower the counter level and sink. All of these interactive technologies improved Monica's life and facilitate her cooking experience.

7. USE CASE DIAGRAM

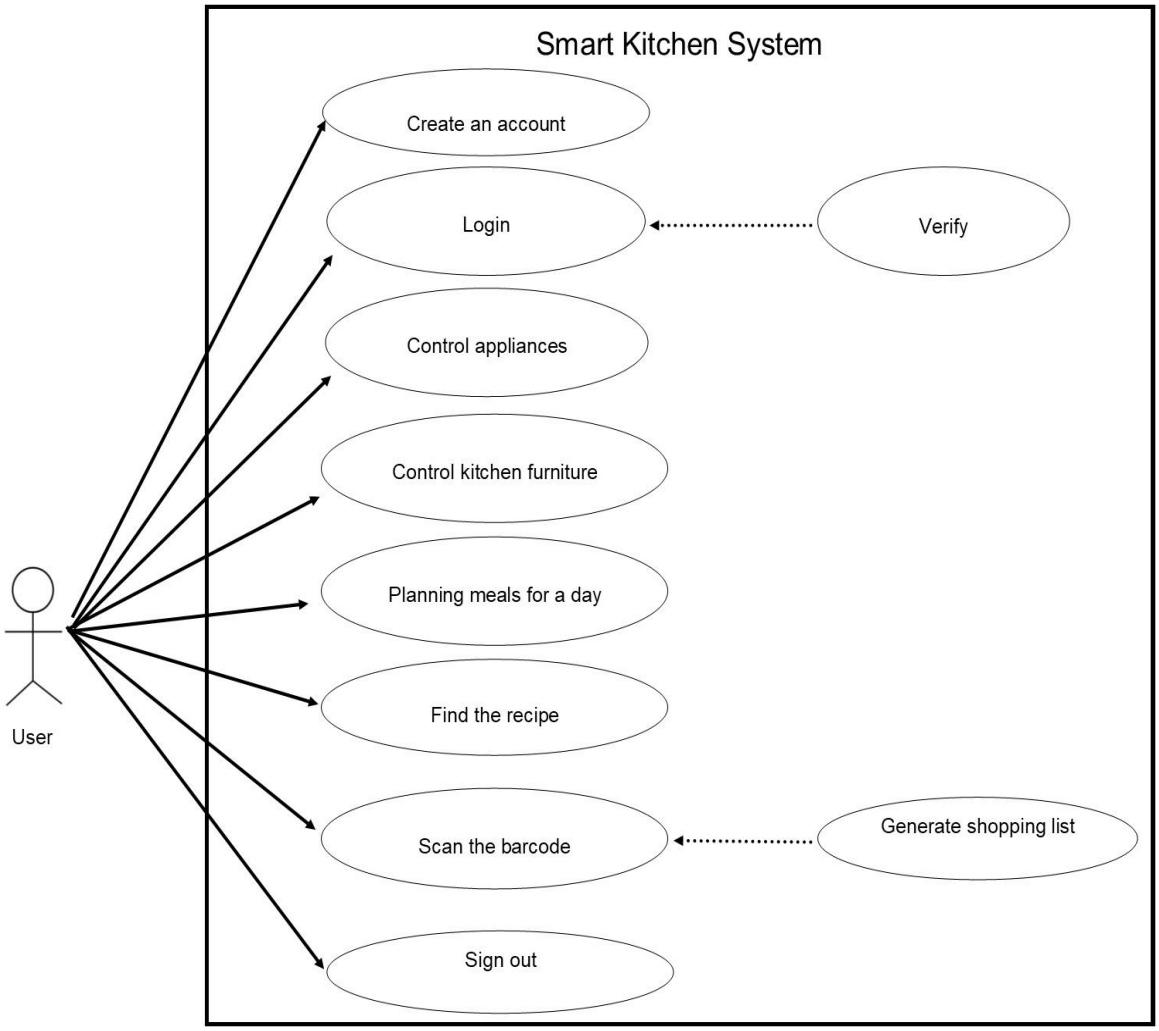


Figure3: Use case diagram

8. Design alternative

8.1: Low-fedelity prototyping

8.1.1: Storyboards

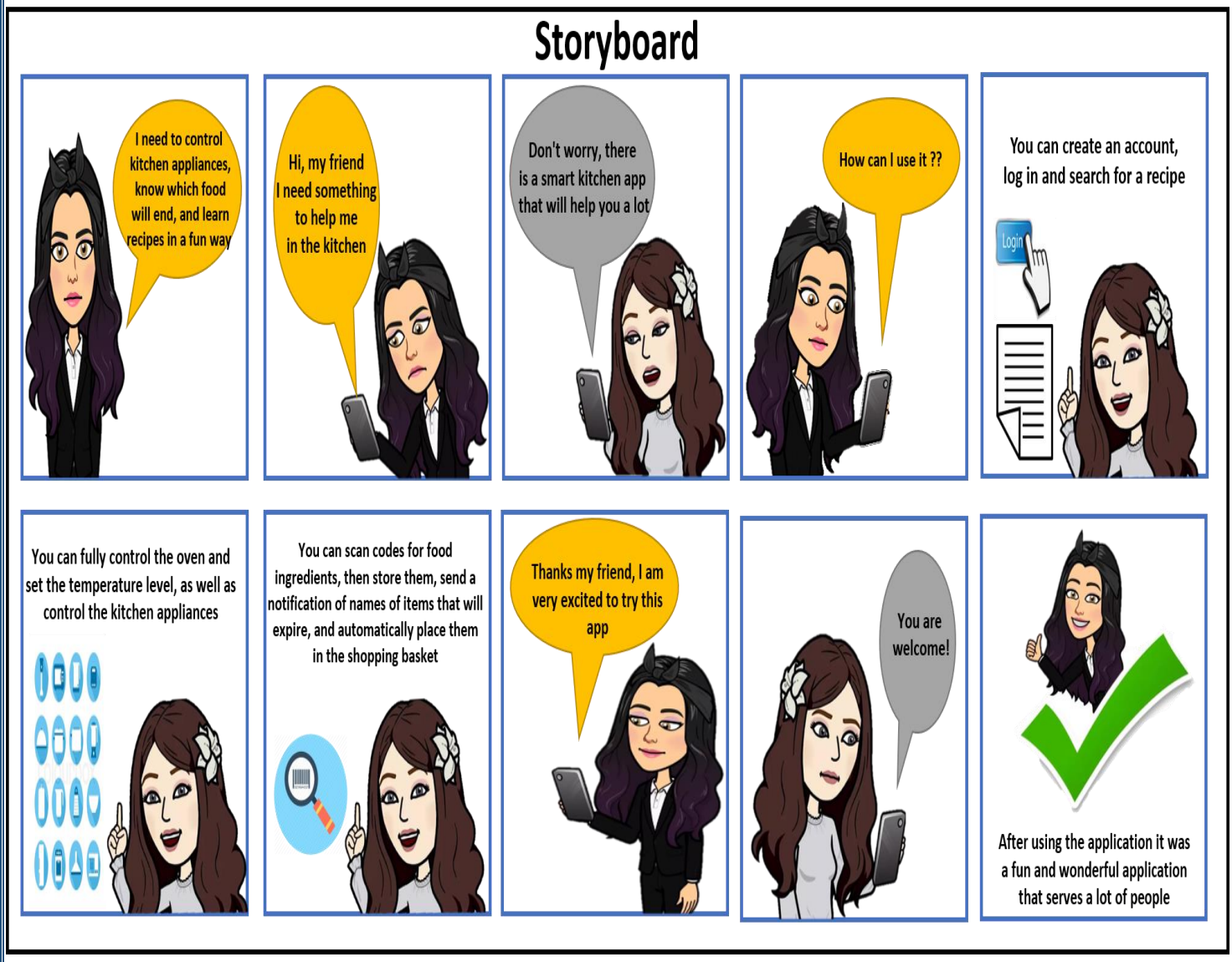


Figure4: Storyboards explain how smart kitchen app work.

Strengths	Weakness
1- The user can understand the system in a fun and easier way than a long paragraph. 2- 1- The user knows what functions the application provides. 3- It helps to create better visual images for the user. 4- It performs trying to design effectively with storytelling.	1- The scenario may be unclear. 2- If the person did it by hand, drawing on it can be difficult. 3- This design does not explain in detail what is going on inside the app. 4- It doesn't always look good. 5- The design may sometimes be restricted.

8.1.2: Sketching

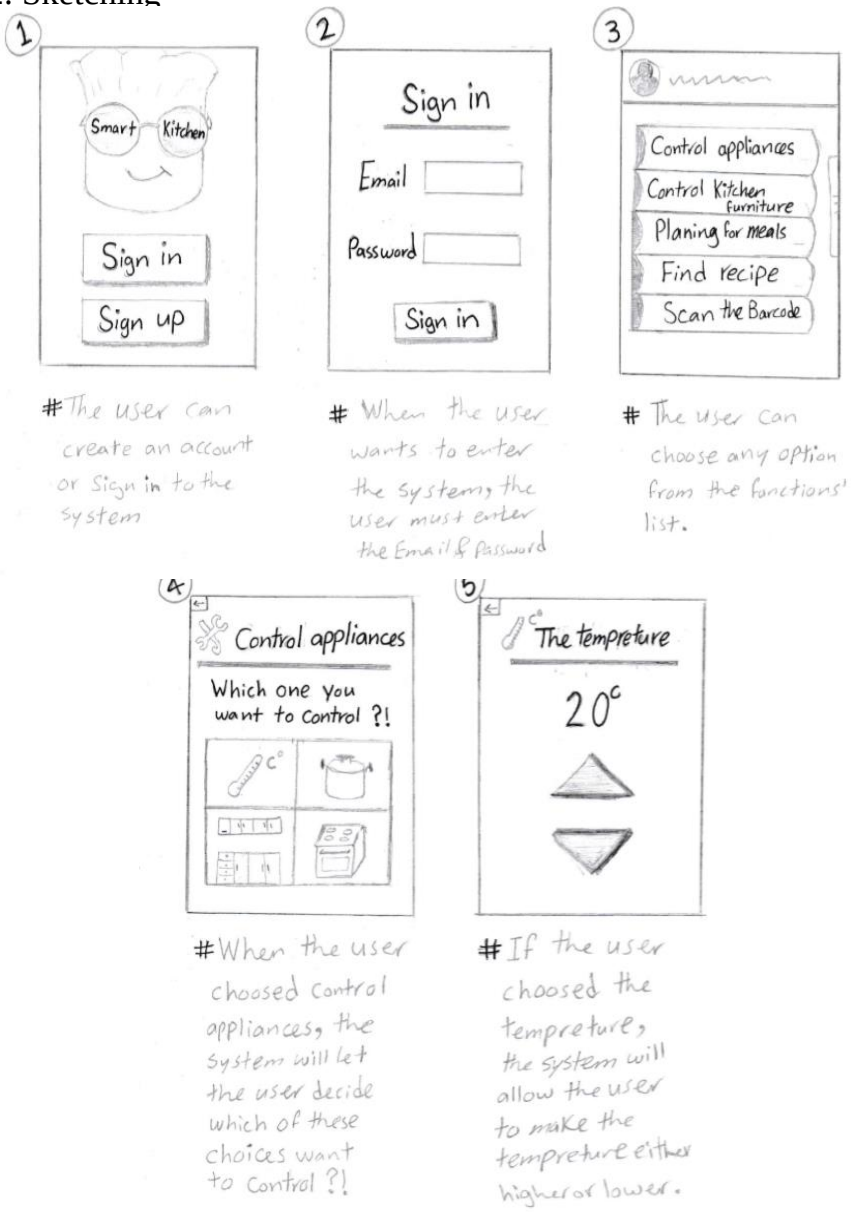


Figure5: Sketching

Strengths	Weaknesses
• Sketching is the easiest way to make a prototype. • It just needs simple tools such as pencil and paper. • It is cheaper than any other type of prototyping.	• It is less attractive. • The clarity of the prototype needs talented hands. • Some transactions between the pages of the system cannot be understood by sketching.

8.2 UX journey (The wheel)

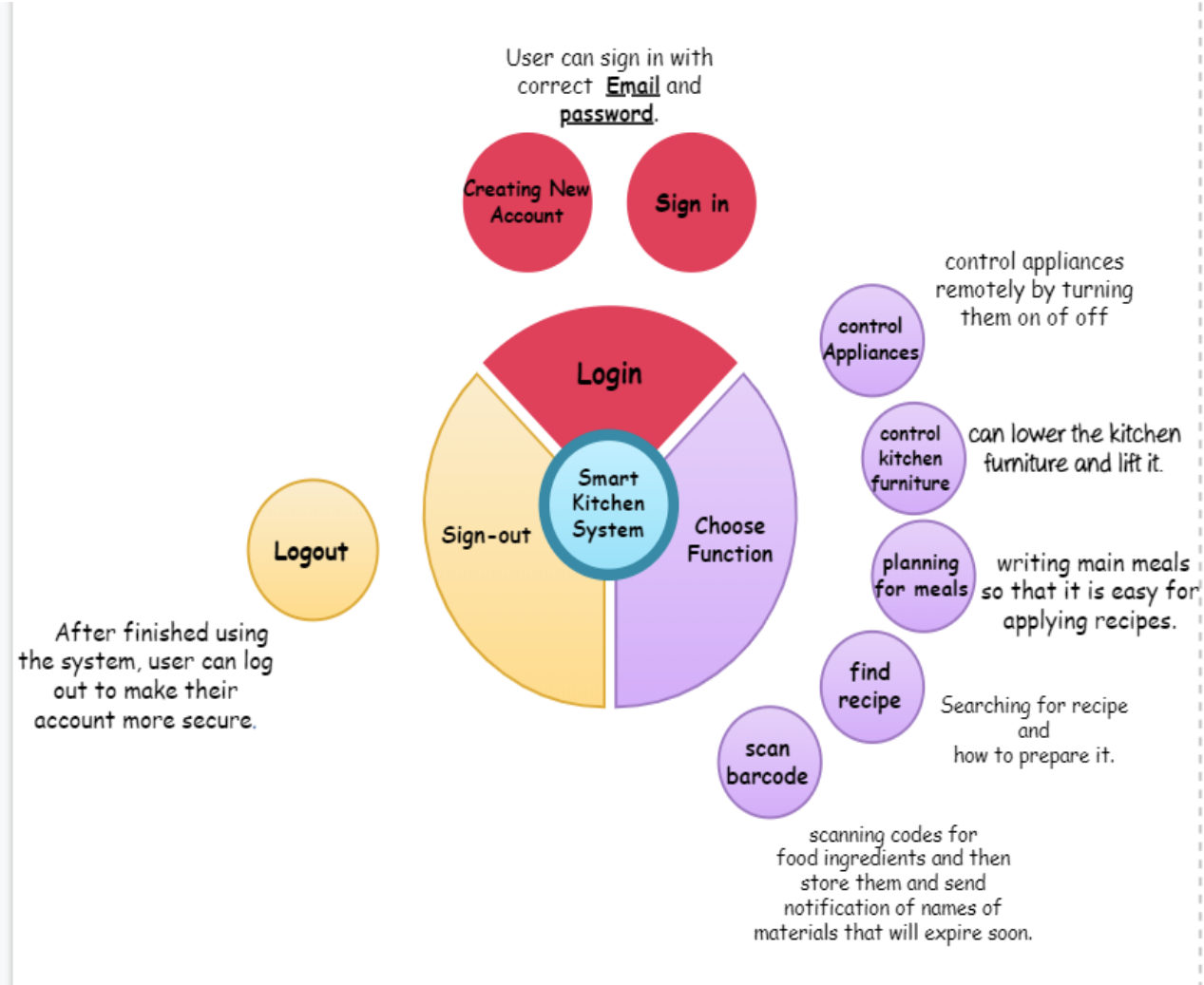


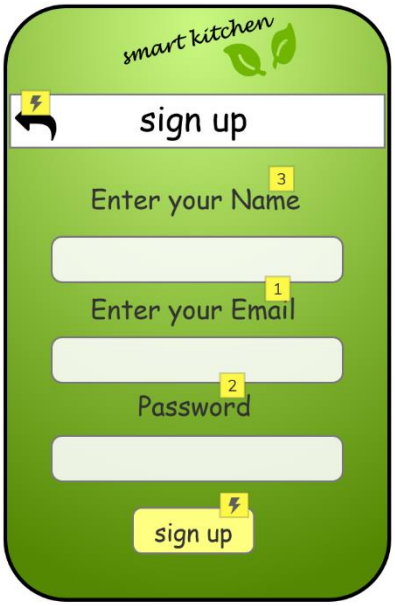
Figure 6: The wheel UX journey

8.3 High-fidelity prototyping

The high-fidelity prototype is designed to overcome the weakness in the two previous prototypes and combine the good aspects of them by making the app more colorful and showing a clear picture of how the app's pages will appear when the user navigates through it. Also, the high-fidelity prototype gives the user the ability to explore and understand the app's functionality.

#The interface of the smart kitchen App, where the user chooses to sign up if he a new user or sign-in of he a regular user.

#The regular user enters their name and password to login into the App.



#The new user enters their name, email and password to login to the App.

#After the login the user will able to use the app functionality.

#If the user chooses "+ Add an Appliances" the user will add a new appliance by connected it through the WiFi, then it will be added to the list. Also, at the same interface, the user can choose one of the Appliances in the list to control it.

#If the user chooses the "Control Oven" option, the user will be able to set the time and temperature of the oven. The icon " ← "enables the user to return back to the main function list.

The users will be able to control the kitchen furniture, where the users can choose either control the Kitchen's doors or control kitchen shelves. The icon " ← "enables the user to return back to the main function. list.

The users will be able to scan the product barcode and enter the quantity and save the result.

#if the user does not scan the barcode properly, the error message will appear to prompt the user to try again.

#After clicking in the save button the users will be able to view the list of products along with their quantities. Also, the screen provides an option to generate the shopping list .

The shopping list will be viewable to the user after clicking the "yes " button that contains the list of products that user need to get them from the supermarket

Figure7: High-fidelity prototyping

9.Evaluation

9.1 Aim of study

For many people, the kitchen is the center of the home and we aim to evaluate our application, to see the susceptibility of the system to users and their satisfaction with it, and has the system achieved efficiency, flexibility, ease of use and many advantages ...? Also, the application has achieved targeted goals or not?

For example: Does the smart kitchen app help people control kitchen appliances remotely with ease and comfort and reduce the time you need to spend watching food while cooking it?

9.2 Goals and Questions

These goals are set according to the standards of designing the user interfaces.

- Providing easy and alternative ways for the user to perform tasks in the kitchen.
- Reducing the possibility of errors in the system.
- Increased ease of reading application interfaces.
- Increased user ability to develop proposals to amend the system.
- Reducing information that requires the user to remember it.
- Get instructions to achieve more results.
- Increase clarity of tasks and functions using understandable and well-known icons and labels.

9.3 Tasks

Principle	Beginner chef 0	1	2	3	Comment
1.Visibility of system status		✓			Difficult to your status, such as whether user logged in or enter correct username and password successfully. Consider adding more feedback Messages since beginners need a clear guidance.
2.User control and freedom				✓	It is an excellent feature as it allows user with an appropriate control. Once user clicks buttons by mistake, he is allowed to cancel the undesired state.
3.Consistency and standards				✓	The design is very consistent especially for novice. Names and labels conventions consistent throughout the application.
4.Error prevention		✓			I would recommend to include warnings when finishes a process (e.g. Are you sure you want to delete this appliance)
5.Recognition rather than calling			✓		The way of presenting the icons is powerful. Beginners can guess what some buttons are performed by looking at icons. Thus, they do not need to memorize the steps
6.Provides users with context			✓		It provides users with a clear app and purpose, and provides visual clues. However, will better if the app shows number of steps of a recipe while the user is cooking.
7.Help user recognize, recover from errors				✓	Plain error messages are very helpful, so it is clear for the user what should do next (e.g. the code is not scanned properly..please try again!!)
8.Minimize Unnecessary complexity				✓	Smart Kitchen application is very simple to use. It breaks down complex steps into different small steps

Elderly chef

Principle	0	1	2	3	Comment
1.Help users recognize, diagnose, and recover from errors		✓			For elderly people, It would be useful to provide solutions for problems they face during using the app.
2. Visibility of system status				✓	I suggest to develop this feature. Elderly people need to receive feedback on Reasonable time.
3.Clarity				✓	Smart kitchen provides simple language that is understood by users. Moreover, The is designed with simple and meaningful labels, texts, icons.
4.Error prevention				✓	The system eliminates the error-prone conditions or check for them and present confirmation messages before doing an action
5.match between system and the real world				✓	This feature is very beneficial, especially for this community. Smart kitchen uses a natural language that is understandable and familiar
6.Promote a pleasurable user experience			✓		It is pleasurable since it meets user requirements and needs.
7.Minimize Unnecessary Complexity				✓	I agree that this system break down complex tasks into simple easy tasks
8. Help and documentation			✓		Every element is placed in its right place. For example, menu items are placed next to each other which help users to find what they need faster.

Housewife chef

Principle	0	1	2	3	Comment
1.Visibility of system status		✓			It would be hard for the user to identify whether the functions are done Successfully (e.g. adding appliances, sign in, sign up). Also, there is not a current-status icon to be indicated.
2.User control and freedom			✓		Smart kitchen supports undo and redo. It allows users to leave unwanted events(e.g pressing Scan The Barcode function by mistake)
3.Clarity				✓	I believe that users will be satisfied with this feature. The application provides meaningful labels, and avoids using technical language
4.Error prevention		✓			I think it would be more useful if you enhance the app and enable it to check for conditions before occurring .
5.match between system and the real world				✓	The app is designed perfectly in terms of interpretation. It assumes that different kinds people are using it. It uses a natural language that is familiar and logical.
6.Promote a pleasurable user experience		✓			The app is pleasurable, efficient, and fun. But, I suggest to enhance the app to meet users' needs. For example, feedback messages, Icons indicate currents status.
7.Minimize Unnecessary complexity			✓		Smart Kitchen provides an important feature which is simplicity. Simple tasks are desired by most users.

Disabled chef

Principle	0	1	2	3	Comment
1.Visibility of system status			✓		I would recommend to add feed-back messages, so user can know what the system status is (e.g. sys-tem is loading)
2. Recognition rather than recall			✓		The best thing is that user does not need to memorize the steps as Smart Kitchen supports simplicity from the interface to the functions.
3.Minimize unnecessary complexity				✓	It is a very satisfied feature. It provides a simple interface without visual cluttering. It enables users to find what they need.
4.Error prevention			✓		It provides instructions to eliminate error occurrence and show error message, such as " Please try again, the code is not scanned properly."
5.Promote a pleasurable user experience		✓			I think the interface is very attractive and meaningful. But, I suggest to add more accessibility feature, such as providing a tool to convert text to speech for blind people.
6.Provide users with context			✓		The purpose of the app is very clear. And it is better to enhance the way of navigation (e.g. highlight the current vis-ited tab).

9.4 Apparatus

- At this step, our used tools are numbers of guidelines that were chosen and arranged in a questionnaire that has the rating numbers (0-3) to rate whether a specific criterion is met or not and provide a part for the comments for each criterion.
- A meeting room is necessary to invite the 4 expertise to evaluate the prototype the beginners, home chef, elderly and disables.
- iPhone to let the experts use the prototype.

9.5 Procedures

- 4 expertise were invited to attend the evaluation session.
- The prototype of the system is provided to the 4 expertise and gives them a few minutes to explore it.
- Providing a list of tasks (functions) that the system preform and asking them to try each task one by one.
- After they are finishing all the tasks, we are giving them a questionnaire to rate (from 0-3) and comment on each function based upon the stated criteria and expected user as appears in the appendix.

9.6 Results

We distributed 4 questionnaires among 4 experts to evaluate Smart Kitchen prototype as follows:

- Expert A tests whether the application is useful for the beginner chef.
- Expert B tests whether the application is useful for the elderly chef.
- Expert C tests whether the application is useful for the Home chef.
- Expert D tests whether the application is useful for the disabled chef.

Expert A agreed that the system is consistent, simple and contains meaningful icons and labels. It provides beginners with simple tasks and visual clues to facilitate using the application. He suggested to include warnings for confirmation, and feedback messages to know what the system status is. Similarly, Expert B stated that Smart Kitchen is pleasurable, meets users need and uses natural and familiar language to make useful for elderly chefs. However, she recommended to include a solution for problems that are likely elderly chefs face. Expert C believes that the app would be desired by many users as it is simple, clear, and uses simple language. He mentioned that system needs some enhancement to meet users' requirements. He thinks it will be helpful to include indicators for icons to show the current system's status and eliminates errors before occurring by checking conditions. Finally, expert D agreed that the system does not memorize the steps. Moreover, she stated that Smart Kitchen has a simple interface without visually cluttered to facilitate users to find what they need. She recommended including advanced tools for disabled people to get benefits from the app. For example, a tool that converts texts to speech which benefits blind people.

9.7 Discussion

After the analysis of the result, we have seen that the application is useful and easy to use by housewives, beginners chefs, elderly and disabled people to help them in many ways. The user can control the kitchen appliances remotely. This will be very useful for the disabled and the elderly. the user can lower the kitchen furniture and lift it. Also, the app will help adults write main meals from the beginning of the day so that it is easy for applying recipes and searching for a recipe and how to prepare it. besides, the app provides the ability to scan codes for food ingredients and then store them and send notification of names of materials that will expire soon. that the application provides the user needs. Although some of the results found that, there are some weaknesses but it still a small percentage. In the future, we will work to keep all application mistakes to meet user satisfaction and happiness.

9.8 Conclusion

By working on building this application, we were able to achieve the main objective of producing a smart kitchen organizing and controlling the kitchen furniture in several ways, available to the user as he/she convenient to deal with.

In this project, we explained our idea for Smart Kitchen System. In the problem statement, we explained the problem that people facing and the solution for these problems be solved in our app, we discussed apps that similar to our app and analyzed them based on criteria we made it. Also, we identified the functional and non-functional requirements that will be in the app, and we have made 4 persona scenarios to make our requirement clear, then we designed a use case diagram for the functional requirements. Also, we made two low fidelity prototypes for our app Sketching and Storyboards, and after analysis, we designed the high-fidelity prototype for it and did interaction for the high-fidelity prototype. Finally, we did the Heuristic evaluation. It is a usability engineering method for finding usability problems in a user interface design, through making them addressable and solvable as part of an iterative design process. It involves a small set of expert evaluators who examine the interface and assess its compliance with “heuristics,” or recognized usability principles. these processes help prevent failure post-release.

Appendix

Beginner chef

Principle	0	1	2	3	Comment
1.Visibility of system status					
2.User control and freedom					
3.Consistency and standards					
4.Error prevention					
5.Recognition rather than calling					
6.Provides users with context					
7.Help user recognize, recover from errors					
8.Minimize Unnecessary complexity					

Housewife chef

Principle	0	1	2	3	Comment
1.Visibility of system status					
2.User control and freedom					
3.Clarity					
4.Error prevention					
5.match between system and the real world					
6.Promote a pleasurable user experience					
7.Minimize Unnecessary complexity					

Elderly chef

Principle	0	1	2	3	Comment
1.Help users recognize, diagnose, and recover from errors					
2. Visibility of system status					
3.Clarity					
4.Error prevention					
5.match between system and the real world					
6.Promote a pleasurable user experience					
7.Minimize Unnecessary Complexity					
8. Help and documentation					

Disabled chef

Principle	0	1	2	3	Comment
1.Visibility of system status					
2. Recognition rather than recall					
3.Minimize unnecessary complexity					
4.Error prevention					
5.Promote a pleasurable user experience					
6.Provide users with context					

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