



**Northumbria**  
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# **Tableside Ordering System for Dine-In Restaurants in India**

A dissertation submitted for the degree of Postgraduate Degree

**By**

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## **Abstract**

The Indian restaurant industry has witnessed a rapid growth in the past years, along with the diners. To meet the changing expectations and needs from the customers, the restaurant owners are trying to incorporate various technologies in their restaurants. One such pain point that emerges with the advent of COVID-19 is the need for a solution for fast and contactless dining experience to the customers. The ordering process in a restaurant is one of the areas in which direct contact with the multiple persons involves either directly or indirectly. Along with that, the errors caused by the traditional ordering system is also a pain point that owners try to solve. Although there are various technologies implemented in the restaurants for the ordering process, many of them does not meets the needs of the customers to enhance their dining experience. This research aims to design and develop a tableside ordering system for the dine in restaurants in India so as to provide a better experience to the customers and to make the work flow easier for the restaurant team. This study is qualitative research and collects data from various primary and secondary sources of data. Along with that, the study follows agile development methodology throughout the process. An organized review on literature is conducted for understanding the restaurant industry in India and the current technologies used in the ordering process. Furthermore, various literatures were reviewed to understand the working of tableside ordering system and other possible solutions to the problem.

As a result of the research conducted, a tableside ordering system was designed and developed for the dine-in restaurants in India. The system would enhance the dining experience of the diners by reducing the waiting time and improving contactless experience. Also, the restaurant could reduce the errors in ordering process and avoid additional costs that came with the traditional ordering process.

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Last, but not least, I would like to convey my acknowledgement towards Northumbria University, which allows me to conduct this study and gain knowledge in the latest technologies to conduct this study.

## **Declaration**

Hereby I declare that,

- The content included in this paper is the result of my work and has provided references for the authors, websites and so on where the source of information is collected in the study.
- The word count of this dissertation is 11369.
- This research is not been submitted previously for a degree at this or any other University/Institute.
- I acknowledge the purpose of this research is not to harm or insult anyone in any way. The purpose of this research will be for study only.
- I declare that this research follows the ethics and privacy policies of Northumbria University.

Jaise Padinjarekalayil Jose

12/01/2023

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# **1 Introduction**

## **1.1 Background Overview**

Food possesses a notable position in the lifestyle of Indian people and India is a country with rich in diverse foods based on the culture and heritage. With the effect of rapid modernization and urbanization, the country has witnessed huge growth in the food industry. According to the report released by the National Restaurant Association (NRAI) of India, 11% increase in CAGR is marked during the period of 2015 – 2016 and 2018 – 2019 (Vig & Agarwal, 2021). Although a huge growth was seen in the food industry during the past years, the advent of COVID-19 has negatively impacted the industry. About 50% - 70% decrease in the revenue were seen by the industry during the pandemic as per the CRISIL organization. But with the end of lockdowns and restrictions, more diners show inclination towards eat-out over takeaway when safety measures are provided. This has made many unfamiliar challenges to the small restaurant owners to meet the needs of customers and staffs. Although it is impossible for the restaurants to completely remove the human-contact in the premise, new solutions that reduce the risk of transmitting the virus is invited by the restaurant owners. One such area with the need of advancement with the technology is the ordering system in restaurants.

## **1.2 Research Motivation**

Although various food ordering solutions are existing in the Indian restaurants, a novel solution that enhance the dining experience as well as the safety concerns of the diners needs to be incorporated. In addition to that, a system that reduces the efforts required by the team to manage the work flow of the ordering process is also problem that needs to be solved. With the existing solutions, the diners wait for more time over the food preparation time which could be eliminated to enhance their experience. Furthermore, order errors made through the traditional ordering system not only reduces the positive experience of the customers as well as increases the additional costs of the restaurant as well. In addition to that, a system that reduces the human-contact in the ordering process of the restaurant is also inevitable.

### **1.3 Research Aim**

The dissertation aims at designing and developing a system that provides optimal dining experience to the customers by delivering fast and better customer service, and improve the efficiency of the restaurant order management process. Unlike existing ordering systems, the system enables diners to order themselves using their own smartphones without the need to have any application installed on their device. Also, the system aims to reduce the direct human contact between people in the restaurant during the ordering process.

Although many research papers covers various ordering system using different technologies, none of them have discussed specifically about the implementation of tableside ordering system in Indian restaurants.

### **1.4 Research Objectives**

In fulfilling the above aim, the following objectives are considered important to be achieved:

- Research on the Indian Restaurant Industry and the various technologies used to manage orders in restaurants in India.
- Evaluate the existing tableside ordering systems in the market.
- Identify the requirements for the system to be designed and developed.
- Propose a system design, meeting the identified requirements and implement the system along with its testing.
- Evaluate the system developed and identify its future scope and limitations.

### **1.5 Thesis Structure**

Chapter 1 of this paper establishes the aims and objectives of the research with a short overview about the topic. This chapter would lead the following chapter as it defines the main purpose of this study and the objectives to be achieved after this study.

Chapter 2 discusses the various literatures that were reviewed in the study. This chapter mainly focusses on understanding the Indian Restaurant Industry and identifying the limitations with the existing ordering systems. In addition to that, a critical review of different restaurant ordering solutions was also discussed. Furthermore, the chapter also briefly discusses about the various technologies that is to be used in the proposed system.

Chapter 3 of this paper defines the research methodology adopted in this chapter. It elaborates various research principles followed during data collection and data analysis stages of the study.

Chapter 4 discusses the various steps completed to design the proposed system. This chapter follows the UI/UX model proposed by Jesse James Garrett. The different planes in this model are discussed in detail in accordance with the proposed system.

Chapter 5 of this research focuses on the implementation of the proposed system. This includes the development of database, back-end and front-end of the application. This chapter also discusses the technical stack used for the implementation of the system.

Chapter 6 of this paper is the system testing chapter which discusses the strategies adopted for testing of the system. This section elaborates the various techniques used to test the system and illustrates the various test cases that were performed during the study.

And finally, chapter 7 is the conclusion part of the paper, where it discusses the overview of the study and the findings obtained with the study. This chapter also discusses the contributions made through this research to the community. And lastly, the limitations of the proposed system with its scope of improvement in the future is also discussed in the section.

## **2 Literature Review**

The background research of the project was conducted particularly on two relevant areas. Firstly, a deep study was conducted to understand the existing ordering systems in Indian restaurants. Along with that, the technologies used by restaurants in other countries to take orders with their customers is also researched in this area. Secondly, a study was conducted to understand various web and mobile development technologies that could be utilised for the development of the project.

### **2.1 Restaurant Industry in India**

The past decade has witnessed a growth in the restaurant industry due to fast modernization and urbanization. According to Vig & Agarwal, the factors that are linked with this growth are, the growth in women employment, increased number of elementary family, altering lifestyles and growth in the income. India is popular for its wide variety of food and food possess an exceptional position in the Indian culture and heritage. Food is considered as a means to remain attached and socialize with the friends and family. Furthermore, around the world, India has a notable millennial citizen, and these population are more career oriented with international exposure who have distinct food behaviour than older generations. This group of people are inclined to eating out and experience variety of foods and are ready to pay for the optimal experience (Vig & Agarwal, 2021).

The Indian Food Services Report (IFSR) 2019 for the National Restaurant Association (NRAI) of India highlights that the restaurant industry has witnessed an immense development in the past 3 years. Between the time period of 2015 – 2016 and 2018 – 2019, the CAGR has grown at 11%. In addition to that, this industry holds a notable share in the employment opportunities and during 2018-2019, almost 7.3 million were employed under this segment. From the surveys conducted by the Federation of Hotels and Restaurant Associations of India (FHRAI), there are almost 53000 hotels, 7 million organized restaurants and 23 million unorganized restaurants in India (Vig & Agarwal, 2021).

As shown in the below graph, it is estimated that, the Indian Food Industry would see a growth \$95.75 billion. Also, as per the latest report, the online food services would be grown twice in India which is almost valued up to \$13 billion (Roy, 2021).

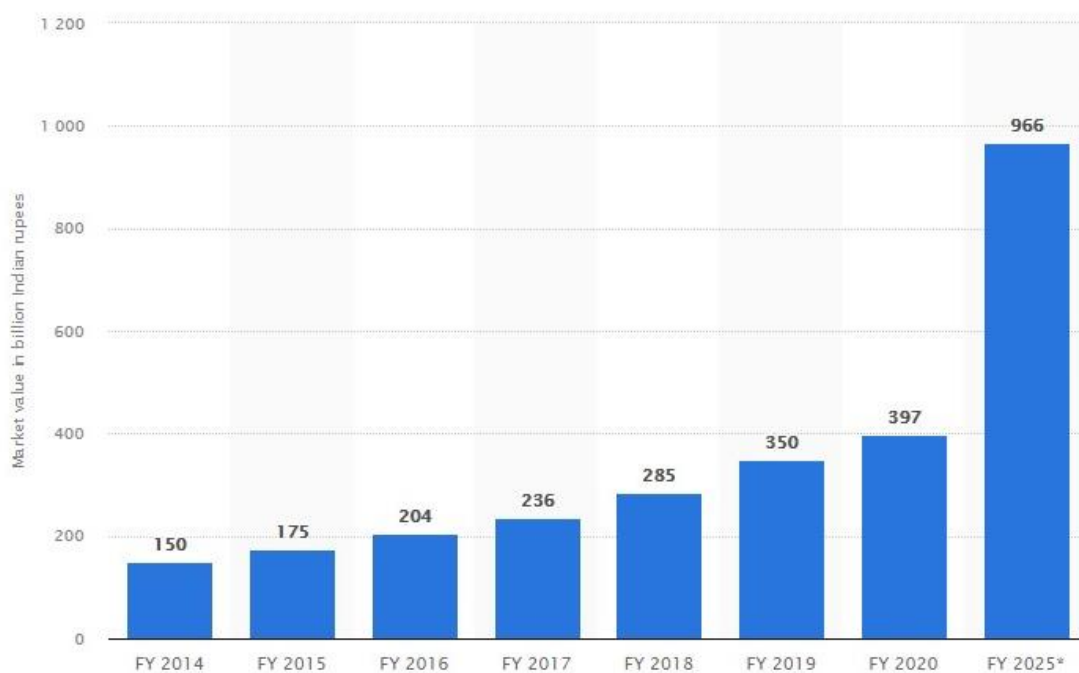


Figure 1 Predicted Food Service Market in India by 2025 (Roy, 2021)

## 2.2 The Restaurant Industry and COVID-19

As Vig & Agarwal says, the nation-wide lockdown during the COVID-19 pandemic has adversely impacted the Indian restaurant industry. Vital services were only permitted during those periods and no restaurants were under operations. Even after the lockdown was ceased, only takeaway orders were allowed and dine-in operations were still closed. After the 6 months of complete shutdown, relaxation in opening the businesses were introduced by the government and restaurants starts operating with minimal seating capacities and following social distance policies. As the diners were highly bothered about safety and hygiene and avoiding public gathering made restaurant owners to face serious ambiguity (Ozili & Arun, 2020). As home dining trend were popular during the time, a notable reduction of customers was observed by the restaurants. As per the rating organization CRISIL, almost 50% - 70% decline in income was witnessed in the restaurant industry with the interruption caused during the pandemic.

## 2.3 Dine-In Restaurants

The number of diners in India has been increased in the recent years (F. Rarh, 2022). The restaurants providing dine-in service offers most positive experience to the diners as they are able to give maximum service, ambience, and great food (Rewards Network, 2020). A study on “Changing Expectations of Restaurant Diners Owing to COVID-19 Pandemic” conducted

by an analytics firm Economix Consulting Group investigates various dining habits of respondents such as dine-in experience, safety concerns, restaurant type and so on. The study was conducted among the middle and upper-class segments particularly in the cities like Chennai, Bengaluru, Mumbai and few other cities in India. The result of the study shows that, although a notable diners preferred to take their orders by the servers at the table, the diners in the age group of Generation Y shows great interests in ordering food via QR codes or mobile applications. Also, the respondents aged above 40 shows high flexibility towards both traditional and mobile based ordering systems (Brand Equity, 2021). Furthermore, almost 72% of diners in Chennai preferred dining out at restaurants after COVID lockdown is ceased (Brand Equity, 2021). Similarly, almost 50% diners are inclined towards dine-out over takeaway in Bangalore City after the COVID lockdown is ceased. In terms of method of ordering food, 45% of diners in Mumbai preferred to place order food via apps or QR codes (Brand Equity, 2021). With this result, it could be concluded as, a many of diners in India prefer dine in at restaurants as similar or beyond takeaway.

As per discussed in Stocktalk (2020), an increasing trend towards eating out is visible across all types of economic classes. This trend is shown without the need for a special event, but as part of shopping or visiting out. Also, the millennial age group between 15-34 years of age show this trend strongly during 2019 fiscal year. The figure below shows the average frequency of population eating out and ordering-in in the 2019 fiscal year.

Age Group	Eating-out Frequency/ Month	Ordering-in Frequency/ Month	Average Spend per Outing (₹)	Average Spend per Order (₹)
15-24 yrs.	2.3	0.9	225	120
25-34 yrs.	1.9	0.7	220	115
> 35 yrs.	1.5	0.3	300	105

Figure 2 average eating-out and ordering-in frequency (Stocktalk, 2020)

## 2.4 Quick Service Restaurants (QSR)

The focus of these restaurants is to serve their customers quickly with minimal table service, but efficiently as possible. Although takeaway is more popular in QSR, dine-in facilities are also provided. The food in this type of restaurant is prepared in large quantity in prior and store

it by retaining its hotness. QSR's are commonly operating in urban and semi-urban areas, especially within the malls and so on (Shende et al., 2019).

## **2.5 Fine Dining Restaurants (FDR)**

According to Shende et al. (2019), fine dining restaurants are also referred as white tablecloth restaurants which are usually exclusive and expensive. In contrast with casual dining, family restaurants and cafes, fine-dining serves to higher end clientele and caters best quality food. These types of restaurants typically have formal ambience with dine-in facility and provides fancier menu than other categories of restaurants. As it provides high quality food and exotic services with well-trained and professional chefs and staffs, fine dining restaurants are expensive and exclusive.

## **2.6 Trends in Indian Restaurant Business**

According to Vig & Agarwal, COVID-19 pandemic has offered uncommon challenges to the small-scale restaurant owners and had enormous effects on their customers and staffs. But it has also introduced a space for research and innovation in the restaurant industry and some owners see this as an opportunity to implement new innovations in their restaurants. Although it is impossible to completely eliminate the human-contact in the restaurant, restaurant owners are finding new solution that lowers the human contact so as to reduce the risk of spreading virus. Also, COVID-19 has remarkably changed the nature of customers which led to present-day trends in the restaurant industry. The businesses are finding new ways to give safe dining to the diners and few of them are:

### **2.6.1 Contactless Experience**

As the spreading of COVID-19 virus takes places from the several infected areas, restaurant owners are trying a way to provide contactless-experience for their customers visiting their restaurant. They identified that digital technologies could be utilised for reducing the human contact in the restaurant operations. Human contact is being eliminated at various stages, such as introducing facilities for online reservations, and requesting diners to be seated at their booked spaces. Restaurants are using mobile applications to provide the facility of online reservations. In addition to that, the application is also utilised for pre-ordering the items, so that the diners can reduce their waiting time at restaurant. Few restaurants installed contactless tracking systems so as to check whether the diners are wearing face masks while they enter the restaurant. Also, some of the restaurants has started to change the physical menu to digital



menu using the QR Code, so that the diners could be able to view and order the food without touching the physical menu (Vig & Agarwal, 2021).

### **2.6.2 Digital Payments**

The restaurant owners came to identify the fact that the online payment solutions would possess a critical role in COVID-19 period, and they started accepting payments from digital platforms. Also, the government of India has also initiated many schemes and policies to encourage online payments, and has put a huge money into Indian digital payment sector with payment gateways and mobile applications. A lot of financial technology companies are attempting to enter this sector by providing several online payment systems. And the Reserve Bank of India, which is a top banking controller has provided permission in 2019 for 11 companies to start payment banks. Similarly, the Governments all over the world encourages online payment so that crowd at various places such ATM counters, billing points and so on would be reduced (Vig & Agarwal, 2021).

## **2.7 Existing Ordering Systems for Dine-In Restaurants**

The traditional way of ordering food in the Indian restaurants are through paper based menu cards. The servers or the waiters of the restaurants make use of pen and paper to note down the orders by the customers and all the records are also stored on papers. This system outcomes wastage in paper, money and time. Since all the menus are paper printed in this system, having an alteration in the details of menu demands the restaurant to print the menu again with the updated details and replace the older paper menus. And reprinting the menu regularly for small change in the menu is not reasonable for the restaurant supervision (Paul et al., 2020).

According to Paul et al (2020), PDAs are the wireless devices that has been introduced in the restaurant industry to replace the traditional way of taking orders of customers with pen and paper. With the PDA ordering system, the waiters of the restaurant direct the customers to the tables and offer them the traditional paper-based menu cards. During the time in which the customers go through the menu and decides the food they wish to order, the waiter would attend other customers in other tables or engage in other works of the restaurant. As the diners are ready to make order, the waiter will attend them and take orders through the PDA device. The order details would be transferred to the kitchen through the device and the food would be cooked accordingly. And the bills would be generated by checking the customer's order using PDA (Cheong et al., 2010).

Although PDAs are used by restaurants to take orders, there are some drawbacks with PDA-based food ordering system. For example, the paper-based menu cards would be still used in this system to display the food items and details to the customers. So that, any alteration required in the details of menu such as name, price or quantity details demands modification in the paper menu and needs to print new menus and replace the older menus. Along with that, the conventional paper-based menu could only provide limited amount details. So that, the waiters need to study the menu in detail in which they could help the customers with their queries. In addition to that, the diners don't have the option to view the list of items they order with the PDA based ordering system. Also, the staff taking orders should be well trained to use PDA for taking orders without error (Cheong et al., 2010).

According to Intal, G.L. et al. (2020), one of the usual errors that happens in restaurant is taking or serving food that the diner did not order. It is highlighted in the article titled "Most common restaurant complaints" that, out of 1003 users surveyed, the largest percentage of complaint category was on "Meals are not what you order". These errors in food ordering would generally slows down the serving process as well. Also, it could impact on the accuracy of the sales report, which in turn negatively affect the restaurant's accounts management. They also add that, waiters possess large role in the process of manual order management in a restaurant. In some situations, attending large number of customers would be difficult for the waiters and hence the ordering process can be delayed. Many of the time, waiters may attend the table that are near to them and have the chance to miss the customers waiting long. This could create unhappy customers and which could adversely affect the restaurants reputation. Also, it is pointed in the article "Ordering method and system for restaurants" that 30% costs for operating the restaurant goes with the labour cost. So that, the implementation of self-ordering technology in the food ordering process in the restaurant could reduce the labour cost.

Intal, G.L. et al (2020) also discusses about researches conducted with real examination to evaluate the existing restaurant ordering process. The restaurant business process starts with the entry of diners to the restaurant. If the dining area does have vacant seats, the waiter would guide the customers to the seats. If no seats are vacant at the time, the diners would need to wait until the seats become vacant. After the customers are being seated, the waiter would hand over the menu with the customers and requests them for the order. When the order is received from the customer, the waiter would share the order details with the kitchen and the cashier to initiate the customer's bill. Once the food is prepared by the kitchen team, the waiter will serve the food to the customers at their table. When the customer completed their order, they request

for the bill to the waiter and waiter will get it from the cashier. Lastly, the customer would pay the bill once they received the bill from the waiter.

A survey was also performed by the researchers to recognize the limitations of the ordering process and the experiences. As the survey is based on quality of service, SERVPERF Model tool was selected to assess the ordering process of the restaurants. The dimensions that the model comprises are: Tangibles, Reliability, Responsiveness, Assurance, and Empathy. These parameters benefited the researchers to identify the disappointing services that the staffs provided in the restaurant. The parameter Tangible assess the physical structure such as the provisions, materials, staffs. Reliability evaluates the capability of the restaurant to operate and act in accordance with the assurance they provided without error. The rapidness of services of staffs and the readiness to the serve the customers is evaluated in the Responsiveness parameter. And, knowledge and politeness of staffs are assessed using Assurance parameter. Lastly, the attentiveness provided by the staffs and their readiness to attend the customers is measured in Empathy parameter (Intal, G.L. et al. 2020).

The result depicts the areas for enhancement in the quality of service and the Responsiveness act as a critical parameter for the improvement. The below figures depict the points of failure in the current ordering process of restaurant.

Failure Points	Issue	Dimension
1. Wait for available seat	Customer sometimes has to wait before being seated	Responsiveness
2. Ask for Menu	Waiter is unable to respond promptly	Responsiveness
		Empathy
3. Delivery of order	Waiter sometimes is unable to deliver the correct order	Reliability
4. Ask for bill	Waiter is unable to respond promptly	Responsiveness
		Empathy
5. Wait for bill	Processing of bill takes time	Responsiveness
6. Receive receipt and change	Waiter is unable to give receipt and change right away	Responsiveness
	Processing of customer's payment takes time	

Figure 3 Failure Points of Restaurants Business Process (Intal, G.L. et al. 2020)

Summary of Average Service Time of Waiter's Activity	
Activity	Mins.
Assist customer to table	0.83
Give Menu to Customer	0.97
Get Customer's Order	4.42
Give Customer's Order to Kitchen Staff	2.04
Give Customer's Order to Cashier	0.96
Give Customer's Order	6.13
Get Customer's Bill from Cashier	1.56
Give Bill to Customer	1.04
Get Customer's Payment	2.16
Give Receipt to Customer	1.63
<b>TOTAL AVERAGE SERVICE TIME</b>	<b>21.73</b>

Figure 4 Service Time for Waiter's Activity (Intal, G.L. et al. 2020)

The paper "Implementation of Smart Restaurant with e-menu Card" by Mayur D. Jakhete et al. (2015) proposes that, to improve the dining experience many restaurants has started utilising technologies like mobile applications, PDA's, multi-touch screens and so on. The proposed system consists of a mobile phone or a tablet in each customer's table with an android

application which displays all menu details. The system utilises Wi-Fi to get connected with the customer's tablet and kitchen display system. The orders made through the customer tablet will be transferred to the kitchen system. The system limits the errors that could be caused by the humans and thereby improves the efficiency of the restaurant ordering system. Although the system is efficient and user-friendly, having a tablet in each table would be not practical for restaurants having many tables.

Parag Bhingre et al. (2015) proposed on the paper titled "Digital Dining System using Android" that the restaurant industry is impacted by the technology and has given rise to improve the conventional dining experience. Customers could order only order food online with the current systems. With the proposed system in the paper, the users could make use of an android application to order and reserve the table in the restaurant.

The paper "Automated Food Ordering System with Real-Time Customer Feedback" by Shweta Shashikant Tanpure et al. (2013) discusses some of the attempts made to implement technologies for the enhancement of restaurant industry. This paper researched about the implementation of digitalization of food ordering system in the restaurants so as to improve the dining experience of the users. The system implemented in this system comprises of a mobile application for customers which contains the list of food items. The orders placed by the customers would be sent to the database and would be updated in the kitchen and cashier systems. In addition to that, the manager could be altering the menu in the system hassle free. Overall, the system proposed in the paper eliminates the limitations of the conventional ordering food ordering systems.

## **2.8 Tableside Ordering System**

A tableside ordering can be defined as a system that allows diners to view menu, order foods and drinks with the aid of a server or by themselves using the smartphone with limited or zero contact method. Generally tableside ordering system comes up in two different ways. One is QR Code Ordering Platform and the other way is handheld POS systems. This system enables diners to make use of an ordering device that enhances their dining experience as well as the speed of service in restaurant (Toast, 2022).

### **2.8.1 Enhancement of Customer Experience**

It is highly valuable if a restaurant could enhance the customer experience over their dining. Tableside ordering system does this improvement in customer experience, as they have the complete control over how and what to order. Also, with the experiences from other services

like online payments, self-checkout facilities in grocery stores, customers are familiar to the tableside ordering concepts. The system itself could act as a promoter for the specials served in the restaurant and the menu could be altered based on the current trends and customer's tastes. So that the menu always go hand in hand with the taste of diners and situation. It is highly essential that, the user-interface of the system should be user-friendly and direct, so that it is ensured that the situations causing technology driven anxieties are limited and avoids the servers to be called frequently to assist for the technical support or the training. Along with that, more features could be integrated with the system such as implementation of entertaining activities for the diners like music, games and so on, so that the diners could use this for passing their time while they wait for the food to be served. The capability of providing complete control to ordering food as well as entertaining diners not only increases the customer retention, but also positively impacts on the brand of the restaurant (Talech, 2021).

### **2.8.2 Increased Order Accuracy**

Tableside ordering system not only improves the speed of service in the restaurant, but also increases the accuracy of the orders as well. Ordering items using tableside ordering system limits the probability of making errors. Many times, servers may miss out to note the special requests made by the diners or may only note it partially. This error not only negatively impact the experience of the customers, but also causes adverse impact on the kitchen by more food cost and waste (Davis, 2019).

### **2.8.3 Reduced Usage of Paper**

Davis (2019) also discusses that, many of the customers would not need a printed paper receipt regardless of the mode of payment they made, both cash or card. Except the cases of spending for business dinners, most of the printed receipts are thrown away once the payment is done. With the use of tableside ordering system, the restaurants could reduce the paper wastage and thereby save extra money.

### **2.8.4 Access to More Data**

Access to data, even if they are large or small data, business could improve value from these collected data. With the use of tableside ordering system, restaurants get more insights on diners eating behaviour. The reports such as which dish from the menu is more ordered by the customers, and how frequently they visit the restaurant lets the business understand more their customer's behaviour. Furthermore, this data could be used to enhance the loyalty programs and generate customized promotions to get more sales (Davis, 2019).

### **2.8.5 Tableside Ordering System in Nando's Restaurant – Case Study**

Nando's restaurant group has revealed that, they have transformed their diners ordering experience to digital system by an astonishing rate of 85% which was zero during pre-pandemic period. Partnering with the technology company Vita Mojo, Nando's has reopened their restaurants in more than 400 locations safely with the implementation of contactless ordering and dining experience for the customers. With the survey conducted among the customers, almost 92% of customers have welcomed the new digital ordering system with a "great" rating. During the post-pandemic period diners visiting Nando's restaurant will experience the new eat-in and digital ordering experience. The customers would scan a QR Code to enter the new digital queueing system so that customers have no waiting in the crowds of the people. As soon as the diners are seated, they can order the food and pay the bill from their table using their own smartphones with maintaining consistency in digital experience for Click and Collect orders and all other channels of Nando's including their customer retention platforms. All these provides a consistent brand experience for the employees and diners. "We launched Order at Table quickly and tested and iterated in short cycles to refine the experience at an incredible speed. It's remarkable that we were able to roll this out across all locations in such a short space of time without compromising on the quality of the experience", said by Reg Meyer, head of technology solutions at Nando's UK & Ireland (Seymour, A., 2021).

## **2.9 Technical Research**

This section discusses about the technical study conducted on this research. The proposed system utilises various technologies such as cross platform application development with real-time communication between each other.

### **2.9.1 Real Time Communication using Socket.IO**

The proposed system consists of multiple modules and each modules needs to be communicated each other for the real-time updates. This could be achieved using the concept of socket connection. Real-time WebSocket technology permits both clients and servers interact in both directions at full - duplex mode over a consistent, single-socket connection. This connection is initiated with a HTTP request or response. Socket.IO is a library made on top of WebSocket protocol that permits both clients and servers to communicate between each other with low latency. It also provides additional features such as automated reconnections, supporting broadcast messages and so on (Ably, 2022).

Events are the basis of working of Socket.IO. It uses event listeners on http server objects on the server side. It is also possible to initiate socket connection with other frameworks like Express. The client uses `/socket.io/socket.io.js` to serve with the HTTP server (Khachatryan, 2019). Socket.IO uses rooms which is a random channel that could be joined or leave by the sockets. This rooms could be utilised to send broadcast messages to a set of clients (SocketIO, 2022). Figure 5 shows the working of Socket.IO between client and server using rooms.

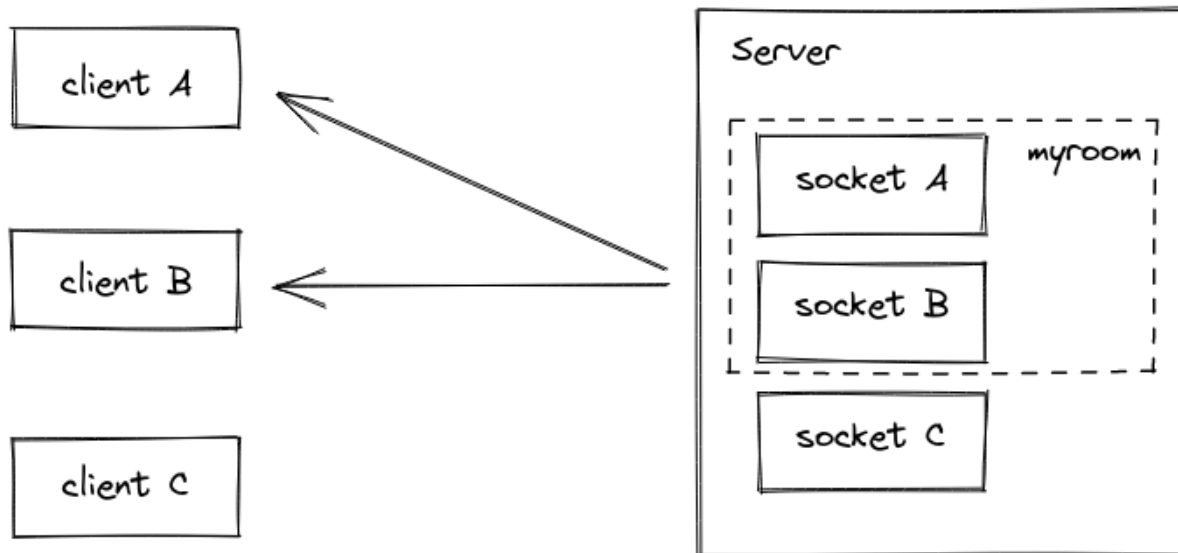


Figure 5 Working of Socket.IO (SocketIO, 2022)

## 2.9.2 Web & Mobile Development Technologies

### 2.9.2.1 React JS

React JS is a free and open-source JavaScript library released by Facebook on 2013. It is utilised for the development of user-interface and web application development with less code. An application built using React is made up of multiple components which could be reusable across the application. The components are independent set of interfaces which is then combined together to create the complete user interface of the application. React JS uses the single page application for developing websites. Only a single HTML file is loaded in the browser in single page application architecture during the initial request. Later, only the specific part of the website would be updated with the help of JavaScript which needs an update. This concept of updating the specific part of webpage without the need of complete reload of the application on the client side called Client-Side Routing. This provides better user experience and more performance (Herbert, 2022).

### **2.9.2.2 React Native**

React Native is framework based on React for building mobile applications for Android and iOS devices which runs natively on the respective devices. When React JS targets on browser, React Native targets on mobile devices. React Native uses JSX for writing code which is the combination of JavaScript and XML. With the uses of React Native bridges, native running APIs executed in Java for android and Objective-C for iOS applications. This would render the UI as native mobile views rather than web views. In addition to that, React Native has the ability to use the platform specific features like camera, location and so on (O'Reilly, 2022).



### 3 Methodology

#### 3.1 Research Process

This section discusses the various steps that were followed for the study of the topic and prepare this report. The first step of the study was the identification of the problem and defining the aims, and objectives of the study. Following that, various literatures associated with the topic were reviewed and defined the research questions. And decided the methods that is used to collect and analyse the data for the study. The next process of the study was to analyse the data, and describe the findings of the study. And finally, the research recommendations and the conclusions made on the study is described. Figure 6 illustrates an outline of the research process that is followed.

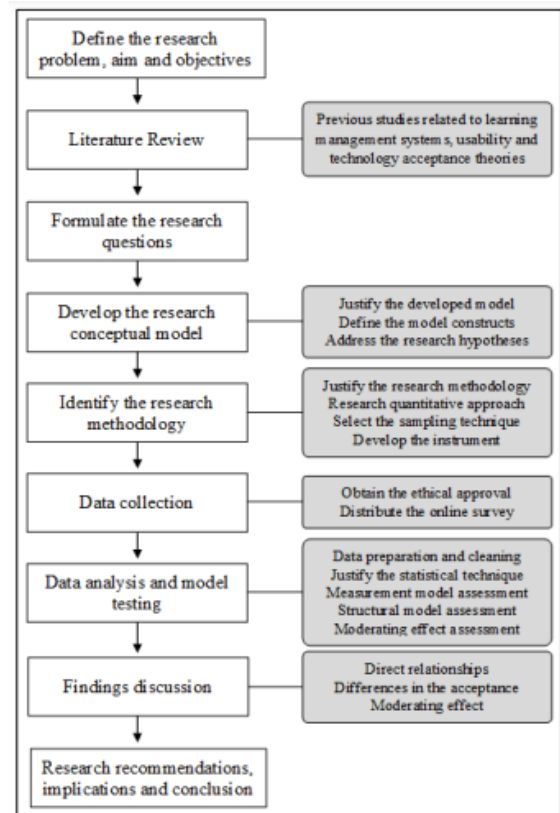


Figure 6 Research Process (Binyamin et al., 2019)

#### 3.2 Research Methodology

A research methodology is the key aspect of a research, that would direct the study of the topic. It is the structure of the processes, methods and approach used in the study for the gathering, and analysis of the data. For this study, various methods are utilised for the collection and analysis of data. The two major decisions made while considering the research methods are what data is to be collected and how to analyse those data. The various methods that were considered on collection of data were Qualitative or Quantitative approach, Primary or Secondary source, Descriptive or experimental data. And regarding the analysis of data, statistical analysis method could be utilised for quantitative data, and thematic analysis could be used for qualitative data.

#### 3.3 Data Collection Methods

As this research is a problem-solving based study, the type of data required is based on experiences and ideas, **Qualitative Data** collection method is adopted for this study. The study aims to solve the issues faced by the Indian restaurants with the present ordering system and

expects to receive descriptive data rather than statistical or numerical data. This method of data collection could be conducted with small sample groups and is flexible in nature. Regarding the source of data collection, the study adopts both **Primary and Secondary** sources of data. Primary sources of data give the exact knowledge about the research question which is to be answered, and secondary sources of data gives all the exiting knowledge about the topic. For this study to be successful, it is essential to understand the problems of the restaurant owners directly with the present ordering system implemented in their restaurants. Similarly, a review on various literatures and reports would give knowledge on the existing solutions and identify the gaps in the research. Furthermore, the study follows **Descriptive Research** method so as to gather information on the topic of the study and to know the characteristics of the user groups.

Research Method	Primary/Secondary	Analysis Method	Usage
<b>Literature Review</b>	Secondary	Qualitative	To know the existing solutions, identify research gaps
<b>Interview</b>	Primary	Qualitative	To know the problems faced by the restaurant owners, expectations of the diners.
<b>Observation</b>	Primary	Qualitative	Identify how the ordering process works
<b>Case Study</b>	Secondary	Qualitative	Understanding the implementation of tableside ordering system in other countries.

Figure 7 Data Collection Methods

### 3.4 Sampling

A population is the complete collection from which the data is gathered, and a sample is the particular category among the population. The population for the data collection of this study is the Indian restaurant owners and the Indian diners. As it is a large population and geographically dispersed, as well as it is difficult to connect with them from the place of study

is conducted, its essential to have a sample from the population. For concluding a valid result from the data collection, the selection of sample from the population is crucial to decide. Among the two sampling methods, Probability and Non-Probability methods, this study adopts the usage of **Non-Probability Sampling Method** due to factors such as convenience and other criteria. Although the conclusion made about the population is limited than probability sampling, this method is easy to access and are cheaper to conduct. Among the non-probability sampling, the study follows **Convenience Sampling** method, where the sample includes the people which was most easily accessible during the period of study.

From the knowledge gathered from reviewing various literatures, it is known that there are various categories of dine in restaurants in India, mainly Casual Dining and Fine Dining. One restaurant owner from each category of the restaurant and a restaurant manager were selected as the sample group of restaurant owners' population. And with the diner's population, four individuals in different age categories were selected.

### **3.5 Interview**

Interview is a method used in qualitative research process and it depends on the questions asked to gather the information. The study follows unstructured interview method so as to receive broad way of answers from the interviewee. This method of interview is more flexible and are open-ended.

The interviews of this study were conducted between November 7, 2022 to November 10, 2022. As the study is based on India, online platforms like Zoom and Google Meets were utilised to conduct the interviews. Each interview lasts for 15 – 20 minutes. The purpose of interviews was to collect data about the problems in existing ordering system in Indian restaurants and to get the expectations of the users.

### **3.6 Agile Methodology**

The study of the paper is based on a software development project and it was essential to adopt a modern software development methodology for the success of the project. Among many methodologies available, the study follows the Agile Methodology to manage the work flow of the project. Some of the factors that made to choose this methodology are, Agile is flexible for changes such that the changes could be incorporated throughout the lifecycle of the project. Also, this methodology focusses on people and their feedbacks and they received early stages of project rather than after the final deployment.

Among the various methodologies available in the Agile process, like scrum, lean, scaled agile frameworks and so on, the project follows Scrum methodology. In scrum methodology, a set of small tasks is completed and delivered in a short period. Throughout this project, a product backlog is maintained to understand the ideas, tasks, issues, deliverables, and so on.

The tool used for managing agile methodology is Jira software. All the product backlogs, user stories and sprints were managed using this software. The project follows 2 weeks sprint model where a set of tasks were completed in each sprint.

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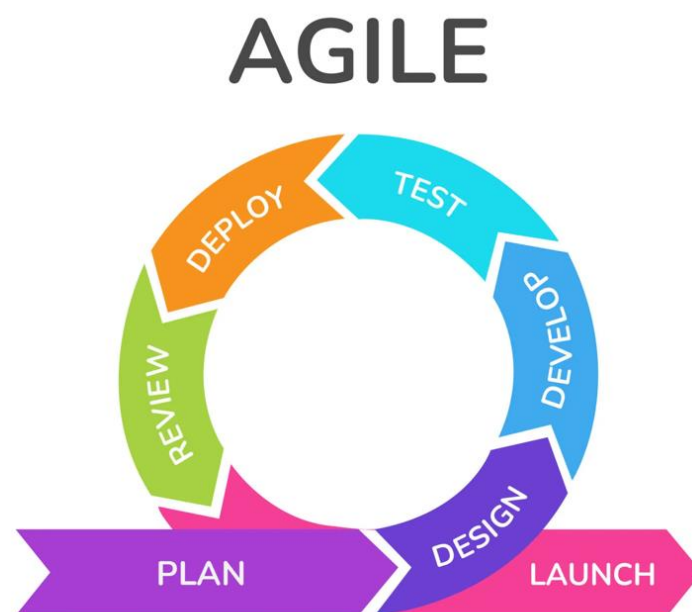


Figure 8 Agile Methodology (Amoros, 2022)

### 3.7 Legal and Ethical Considerations

The proposed study is complied with all necessary legal and ethical considerations. The academic policies and guidelines were strictly followed throughout the study which includes reviewing literatures, collecting data through various sources, data analysis and so on. It is ensured that, no harms are caused to anyone or anything legally, ethically or physically by any activities of the study conducted. The software implemented as part of the study follows the legal and ethical considerations to be made. All the software's, hardware's used in the research process is legal to be used and they follow the guidelines stated by the Government of United Kingdom. Some of the consideration made is the process of study are:

Honesty – All the individuals whom were contacted for the purpose of data collection as part of Interview were informed about the purpose of the study and clearly explains them how the data collected through them is utilised in the project.

Sensitivity – While interviews were conducted, it was ensured that no other persons were involved in the discussions.

Data Protection – As the study doesn't requires personal data to be collected, no sensitive details like contact numbers, email id's, date of birth and so on were collected. All the data collected is used only for the purpose of this study only.

## 4 System Design

This chapter discusses about the various stages adopted in designing the system using Garrett's Five Plane Model. This was published by Jesse James Garrett in 2002 on the book "The Elements of User Experience". The planes of the model consist of Strategy, Scope, Structure, Skeleton and Surface planes. Each plane is significant at each plane level and they are dependent on each other as a whole system (Chen, 2022).

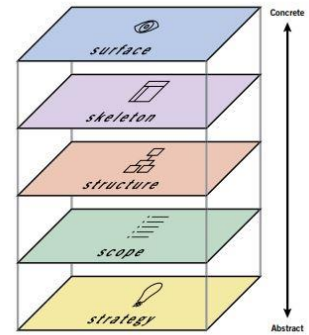


Figure 9 Five Plane Model (Garrett, 2011, p.22)

### 4.1 Strategy Plane – Product Objectives and User Needs

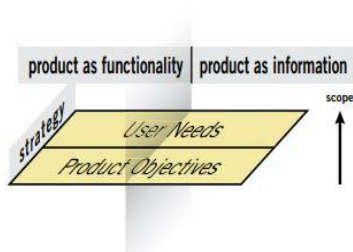


Figure 10 Strategy Plane (Garrett, 2011)

The Strategy plane is aimed to understand the product objectives and user needs of the system. This is a conceptual plane, where problems are evaluated and find the solutions to them (Nawaz Rizvi, 2022). For the proposed system, product objectives are defined by the restaurant owners and the user needs are established by the diners of the restaurants. Both of this combined together would form the foundation of making decision in each step of design process.

#### 4.1.1 Product Objectives

According to Garrett (2011), the establishment of the objectives of the system is the fundamental part of the design strategy. The various stakeholders of the proposed system, who are restaurant owners, restaurant staffs and diners define the objectives by answering questions in connection with the goals of the system.

##### 4.1.1.1 Business Goals

The business goals of the proposed tableside ordering system are:

- A tableside ordering system to enhance the user experience of the system.
- The system should simplify the work flow of the ordering process of the restaurant.
- The menu should be accessible through contactless mode.
- The system should work in real-time such that, updates on any part of the system should update the system as a whole.

- Waiter should be able to see the assigned orders for them and should have the feature to update the status when served.
- Kitchen team must be able to see all the orders and should have the feature to update the status of the order.

#### **4.1.1.2 Business Brand Identity**

- Make diners feel that the ordering process offered is easy, fast and error free.
- Make users feel that the waiting time is minimal with the system.
- Promote the customer service value of the restaurant.

#### **4.1.2 User Needs via Research**

As behaviour of the users of the system are distinct, understanding the requirements of the user is a complex task. To establish the needs of the system, it is significant to define the user groups and perform research on that groups (Garett, 2011).

##### **4.1.2.1 User Interviews**

According to Pernice (2018), one of the important processes in UX research strategy is the User Interviews, as it not only defines the expected goals of the users, but also establishes an understanding about their thought process on the system. For the design of the proposed system, user interviews were conducted with the restaurant owners, restaurant manager and diners of the restaurant.

Some of the profiles selected for the interview are:

**User Profile A:** Amal Antony Aloysius – Restaurant Owner

**User Profile B:** Jerin Sebastian – Restaurant Owner

**User Profile C:** Akash Antony – Restaurant Manager

**User Profile D:** Amal Babu – Customer

**User Profile E:** Rosily John - Customer

#### 4.1.2.2 User Interview Questionnaire for User A

User Interview Questionnaire – Tableside Ordering System		
<b>User Name: Amal Antony Aloysius</b> <b>User Role: Restaurant Owner</b>		
1.	Can you describe yourself briefly?	I'm a fine dine restaurant owner with 10 years of experience in the hospitality industry.
2.	Can you briefly explain the ordering process in your restaurant ?	Yes, as soon as the customer visits the restaurant, a staff would guide them to a vacant table. After few minutes, a menu card would be given to the customer. After some time, when the waiter is free, waiter would attend the customer to take the order. Order is noted in a tablet. Kitchen Order Ticket (KOT) is printed from the reception and transfer it to the kitchen. Once the food is ready, a staff from the kitchen would bring the food to the dining area. After looking the KOT's of the food placed in the dining area, waiter would serve the food to the table. If the customer needs additional items, they call the waiter again and order for the food. Finally, user pays the bill by cash or using card when the waiter give the card machine to the customer.
3.	What are the problems that you face in your existing ordering process ?	Some of the problems that we face in our existing ordering process are, many times we have collected wrong orders from the customers, especially the toppings, size, and some special requests to avoid some ingredients. Also, all our waiters may not have complete knowledge about the menu we serve, especially the ingredients. Along with that, few customers has shown less interest to use the menu card that are used by many people after the Covid period.
4.	<i>Explained about Tableside Ordering System.</i> What id thoughts on incorporating this system in your ordering process ?	Of course, this system would make the process easier and error free. But the concerns I have is that, the system should not demands user to install any applications and it should be easy to use. It would be difficult if the customer needs any technical support for ordering the food.
5.	Do you like to have any other features implemented in the system ?	Well, even though the waiting time for ordering process would be reduced with this system, the food preparation time can't be reduced. It would be great, if the system could engage the customer in any activities during the food preparation time so that they don't feel they are waiting too long. The activity can be any simple games, puzzles and so on.

Figure 11 User Interview Questionnaire for User A



#### 4.1.2.3 User Personas

According to Faller (2019), User Personas defines the objectives and behaviours of selected users from the defined user groups. It would provide support in finding solutions for the users to whom the system is developing. As result of interview conducted, some of the user personas are illustrated below.

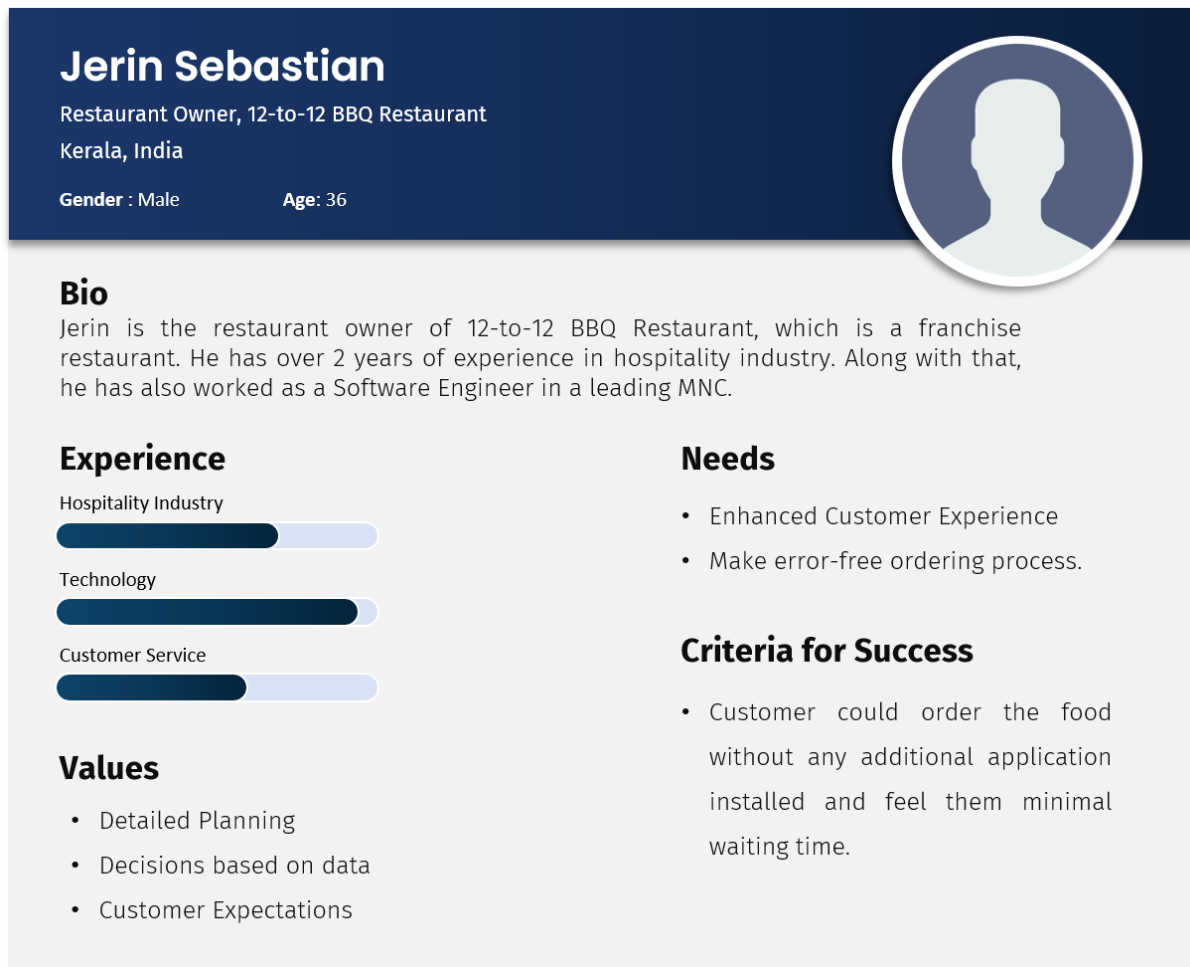


Figure 12 User Persona of User B

Figure 12 illustrates the user persona of User B, which is the representative user selected from the restaurant owner user group. This persona briefly describes the characteristics of the restaurant owner user group.

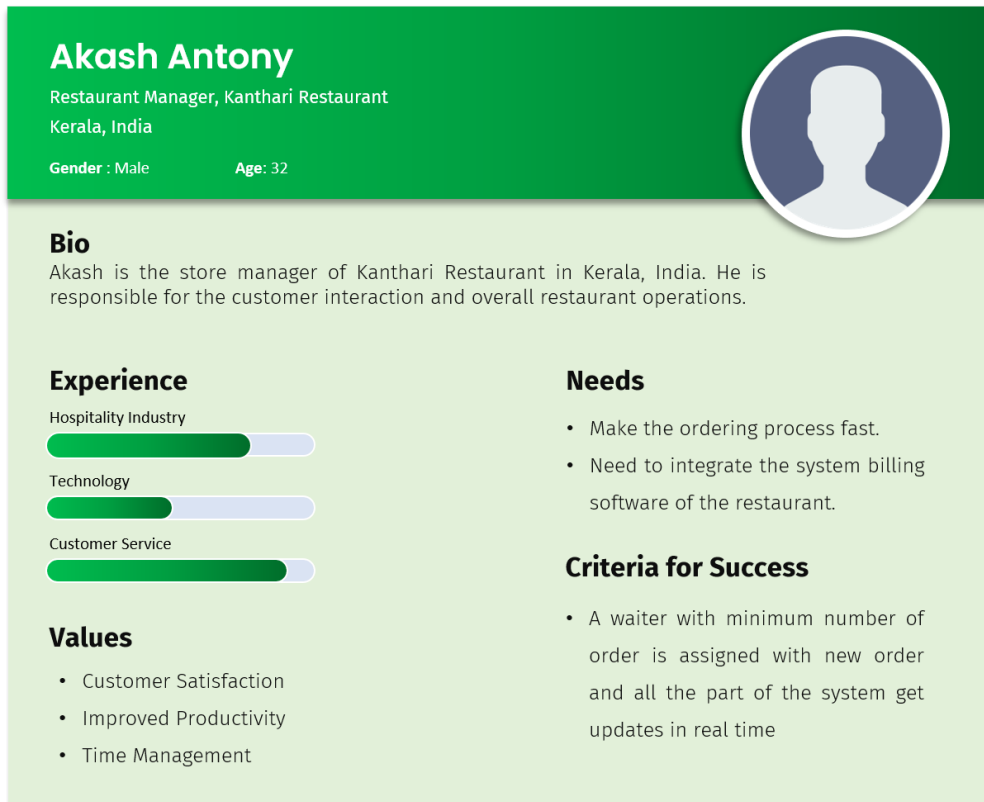


Figure 13 User Persona of User C

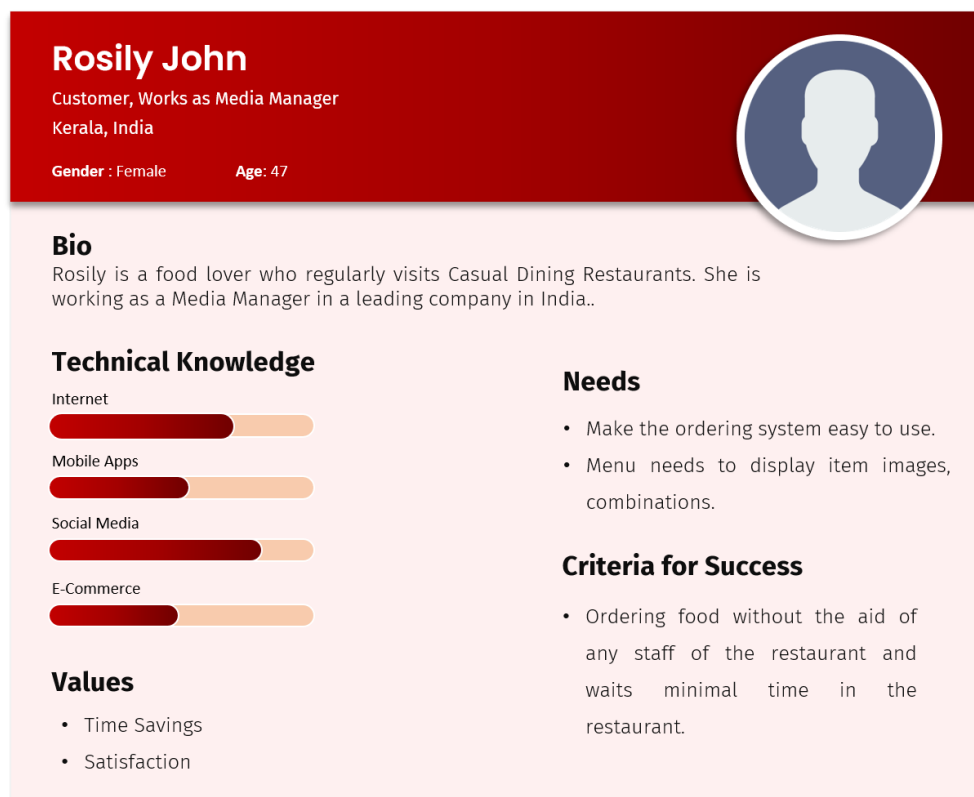


Figure 14 User Persona of User E

## 4.2 Scope Plane – Outline and Research

Establishment of requirements of the system from the result obtained from the strategy plane research is performed in Scope Plane. Functional Requirements and the Content Specifications are the point of interests in this plane. Functional Requirements would play as the formal document of reference comprising the

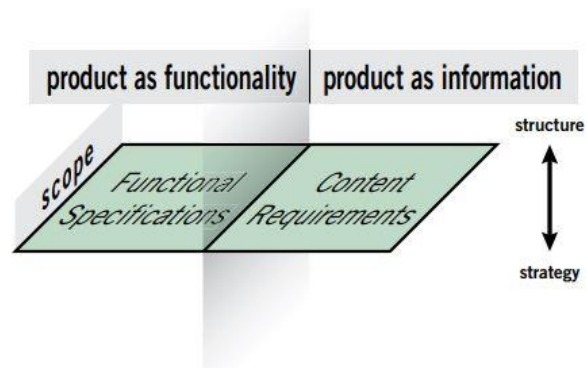


Figure 15 Strategy Plane (Garrett, 2011)

significant features of the system. And, the document that specifies the important contents to be included in the system is defined in the Content Requirements (Wesley Clover, 2022).

### 4.2.1 Business Requirements for Tableside Ordering System

Business Functional Requirements obtained with the analysis of Business Goals, and Brand Identity of the system is discussed further.

Business Requirements of Tableside Ordering System
A system that enables customers to make orders with their own device,
Customers should be able to pay their bills from their table via online payment modes.
Each successful order should be assigned to a waiter with least number of assigned orders.
Kitchen team should receive the order in real time.
Updates in any point of the system should be reflected throughout the system in real time.
Waiter should receive notification when an order assigns to him.
Kitchen system should receive notification when new order is placed.
Kitchen system should be able to update the status of the order.
Waiter should receive notification when the assigned order is made ready to server.
Waiter should be able to update status when the order is served.

Figure 16 Business Requirements

### 4.2.2 User Requirements

The interview conducted with the customer user groups defines the user requirements as illustrated in Figure 17.

User Requirements – Tableside Ordering System	
<b>User Name: Amal Babu</b> <b>User Role: Customer</b>	
User Needs	How It Helps Me
A simple to use menu website	So that I can order items easily
Should be accessible by contactless code	So that I reduce the risk of getting infected from viruses.
Display pictures of the food.	So that I can easily recognize the food.
Responsive design	So that I can use the website in all devices.
Display allergen information	So that I would be informed about the allergen details.
Engage in any activity	So that I could make the waiting time enjoyable.
Provide online payment facility	So that I could easily pay the bills from my table itself.

Figure 17 User Requirements

### 4.2.3 Context Diagram

Context diagram is significant to design to understand the external context of the system. This could be used to visually map the system environment as a whole. With the requirements collected from the users of the system, a context diagram for the proposed system is designed and is shown in Figure 18. The three actors of the system are Customers, Waiters and Kitchen Staff. And, the other end of the system is Restaurant Data centre, Payment Gateway System and the Table Access Point which is the QR Code on table. The three entities interact each other through the system for the ordering process. The main actions done by the customers are sending order details and payment details of the system. In the case of waiters, a waiter could update the order and receive orders assigned to him. And, for the Kitchen Staff, they interact

with the system sending order updates, and updating menu items. They also receive live orders from the system.

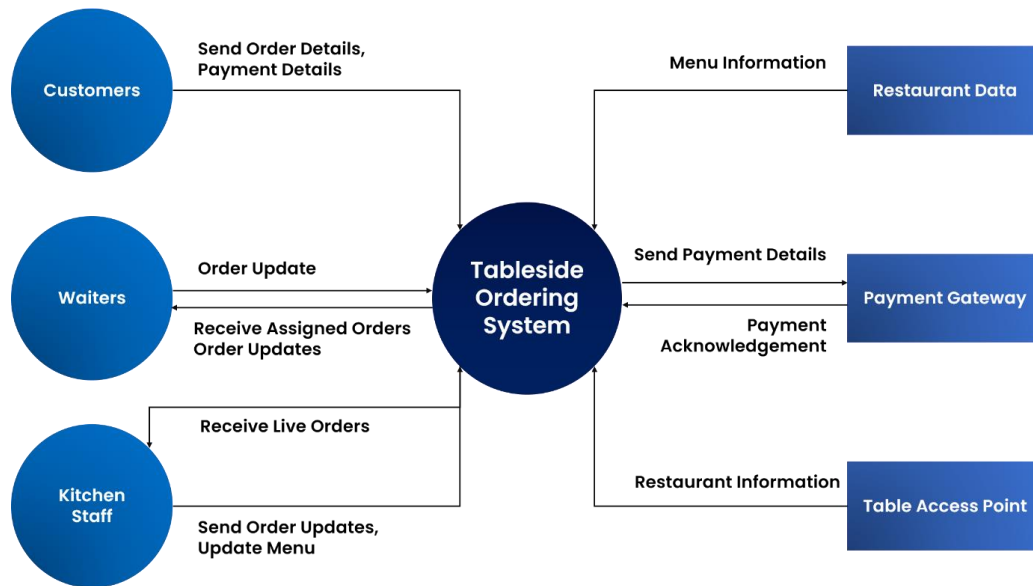


Figure 18 Context Diagram

#### 4.2.4 Use Case Diagram

Uses cases are concise, written sequential tales that depict how a user interacts with a technology. They help to connect user needs with development objectives. Based on the context created, use case diagrams are created for the different users of the system (Larman, 2005). Based on the different contexts identified, various use cases were created. Figure 19 shows the use case diagram of customer.

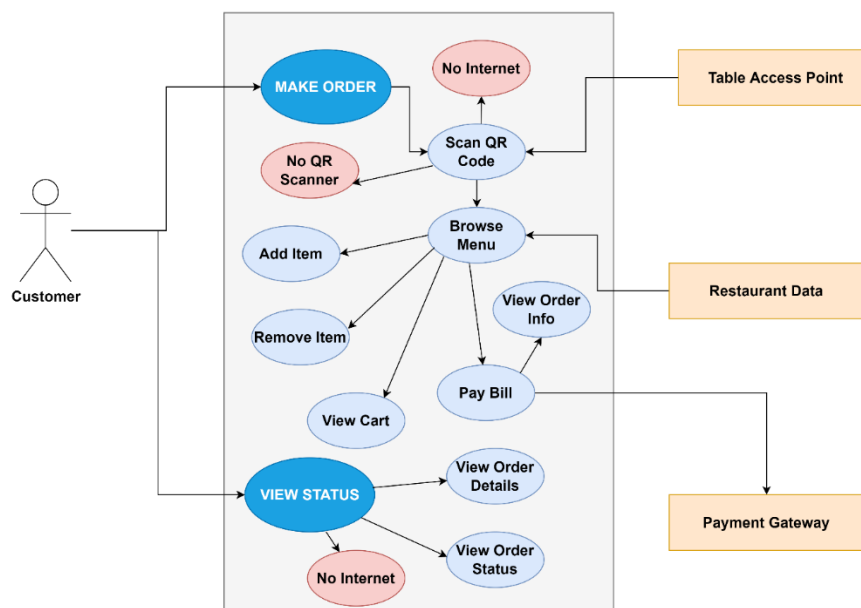


Figure 19 Use Case Diagram of Customer

### UC1 – Make Orders

1. User Scan QR Code
  - a. No Internet Connection – Failed
  - b. Can't Read the QR Code - Failed
2. User Browse Menu
  - a. User Could Add Item to Cart
  - b. User Could Edit Item in the Cart
  - c. User Could View Items in the Cart
3. User Could Pay Bills
  - a. User Could View Order Details
  - b. Payment Declined - Failed

### UC2 – View Status

1. User View Order Details
2. User View Order Status
  - a. No Internet - Failed

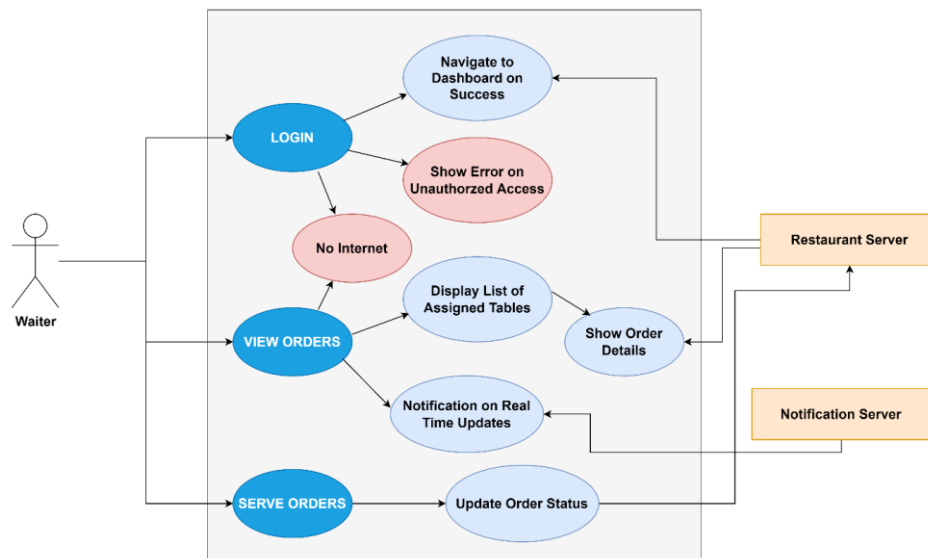


Figure 20 Use Case Diagram of Waiter

### UC1 - Login

1. User Enter Input
2. User Navigates to Dashboard on Success.
  - a. Unauthorized Access
  - b. No Internet

### UC2 - View Orders

1. User could view list of assigned tables.
  - a. Show Order Details
2. User gets real time notifications.

### UC3 – Serve Orders

1. Update Order Status

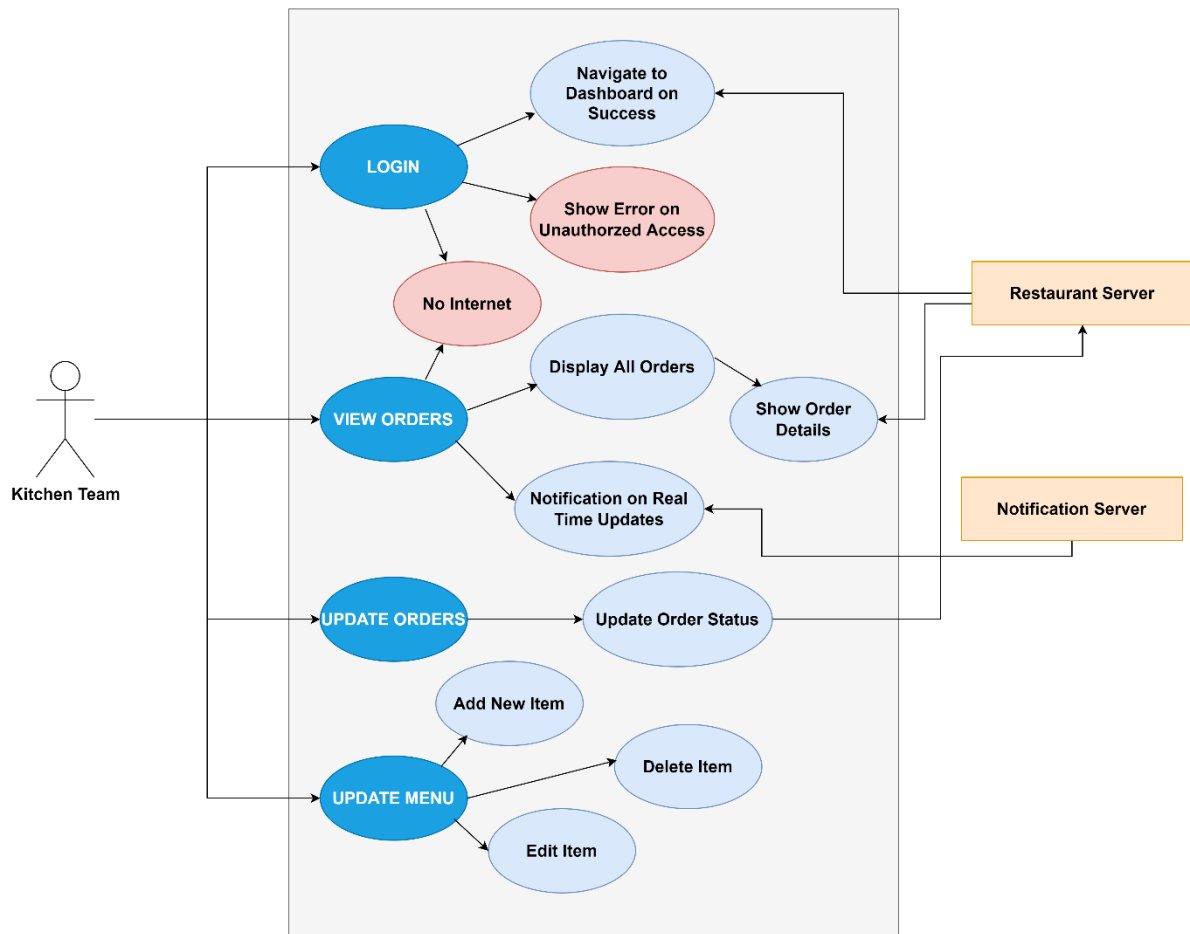


Figure 21 Use Case Diagram of Kitchen Team

#### 4.2.5 User Journeys

User Journey is an efficient tool for UX researchers to analyse how the system is being used by a user and it helps them to understand the system from the view of a user. Based on the user research conducted, User Journey maps of the proposed tableside ordering system is illustrated further.

### User Journey of a Customer - Make an Order

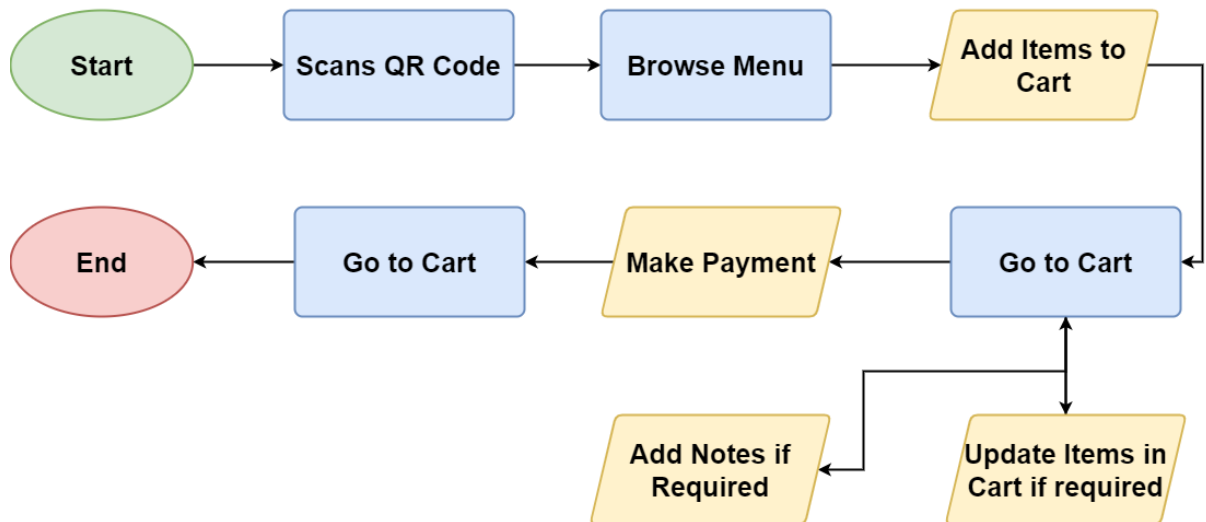


Figure 22 User Journey of a Customer to Place an Order

### User Journey of a Waiter / Kitchen Staff - Authorization

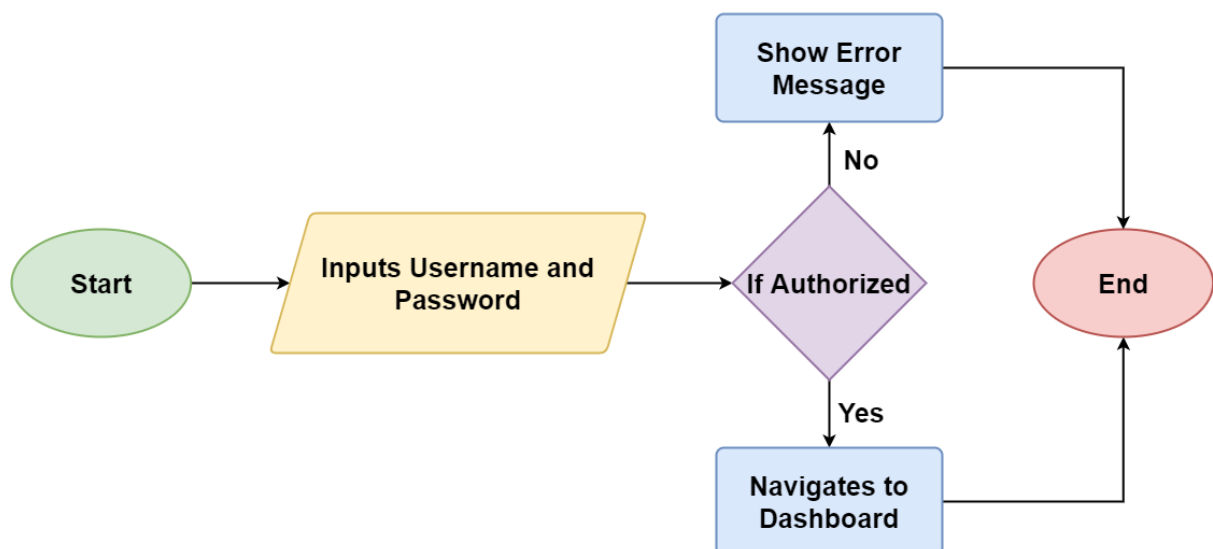


Figure 23 User Journey of a Staff for Authorization



### User Journey of a Waiter - Manage Assigned Orders

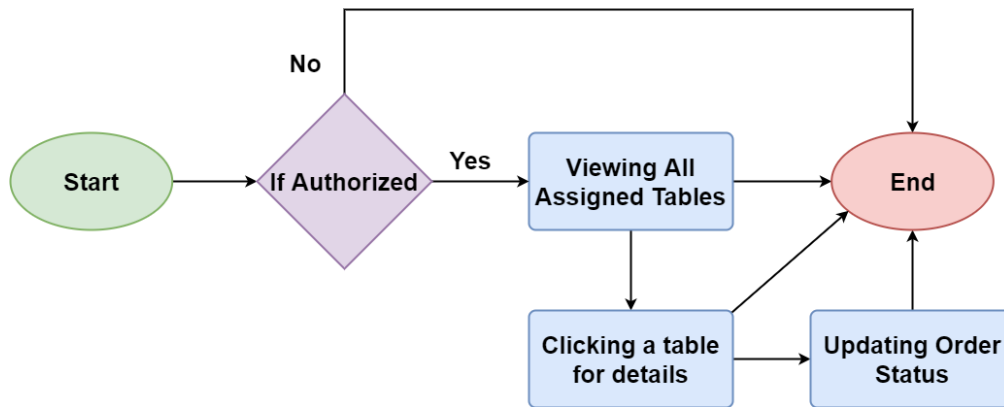


Figure 24 User Journey of a Waiter to Manage Orders

#### 4.2.6 MoSCoW Analysis

According to Gibbons (2021), The MoSCoW analysis developed by Dai Clegg is an analysis method which are followed by various agile frameworks which is used for grouping the requirements of the system into four different clusters such as – “Must Have”, “Should Have”, “Could Have” and “Won’t Have”. The MoSCoW analysis of the proposed system is shown in Figure 25

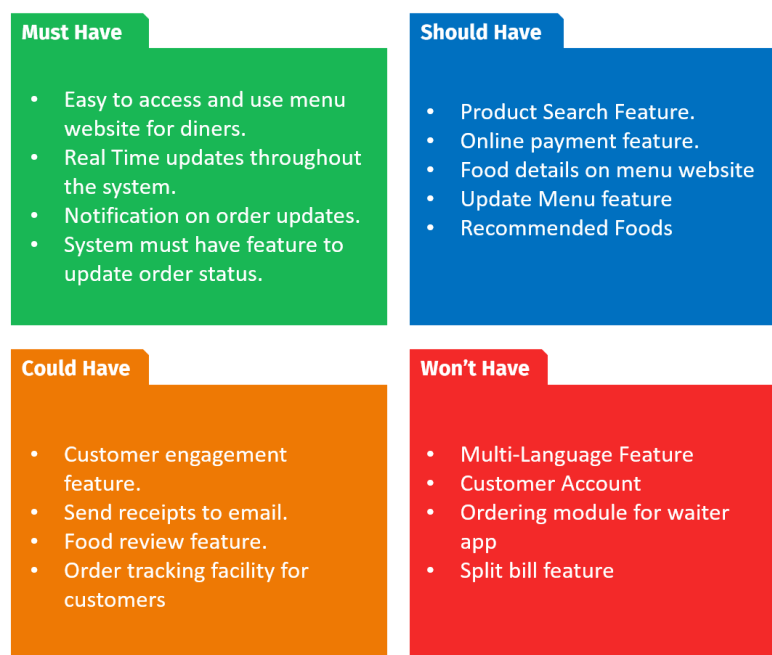


Figure 25 MoSCoW Analysis

### 4.3 Structure Plane

According to Qureshi (2020), Structure Plane establishes the structure of the contents and functionalities of the system as a whole. This analysis defines how a user of the system could access a particular content from the system and how they could navigate to next from the point.

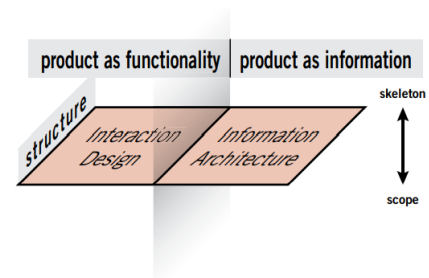


Figure 26 Structure Plane (Garrett, 2011)

#### 4.3.1 Content Planning

Figure 27 shows how the contents of menu website of tableside ordering system is arranged across multiple pages.

Content	Splash Screen	Home Page	Cart Page	Success Page
Restaurant Logo	✓	✓		
Table No		✓		✓
Categories		✓		
Products Details		✓		
Cart Total		✓	✓	
Order Number				✓
Waiter Name				✓

Figure 27 Content Planning of Tableside Ordering System

## 4.4 Skeleton Plane

With the process done through the above planes, the system working is established. Skeleton plane deals with presentation of the system to the users. The areas of interest in this plane are at micro level components and the connection between each of them (Garrett, 2011).

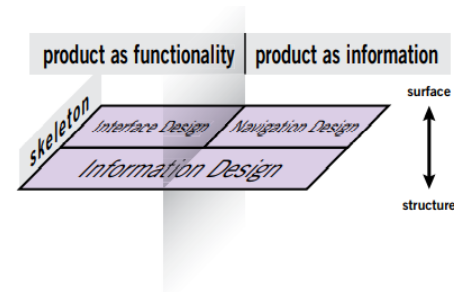


Figure 28 Skeleton Plane (Garret, 2011)

### 4.4.1 Wireframe

A wireframe could be defined as a two-dimensional illustration of a system that mainly considers about the significant contents, space allocation, and the functionalities and characteristics required for the system (Usability.gov, 2022).

#### 4.4.1.1 Low Fidelity Wireframe

This section illustrates the low fidelity wireframes of the proposed system which is derived from the various research strategies adopted from the previous planes.

##### 4.4.1.1.1 Menu Website for Customers

The customers are interacting with the menu website of the system mostly through their phones by scanning the QR Code. Following are the low fidelity wireframes of the same.

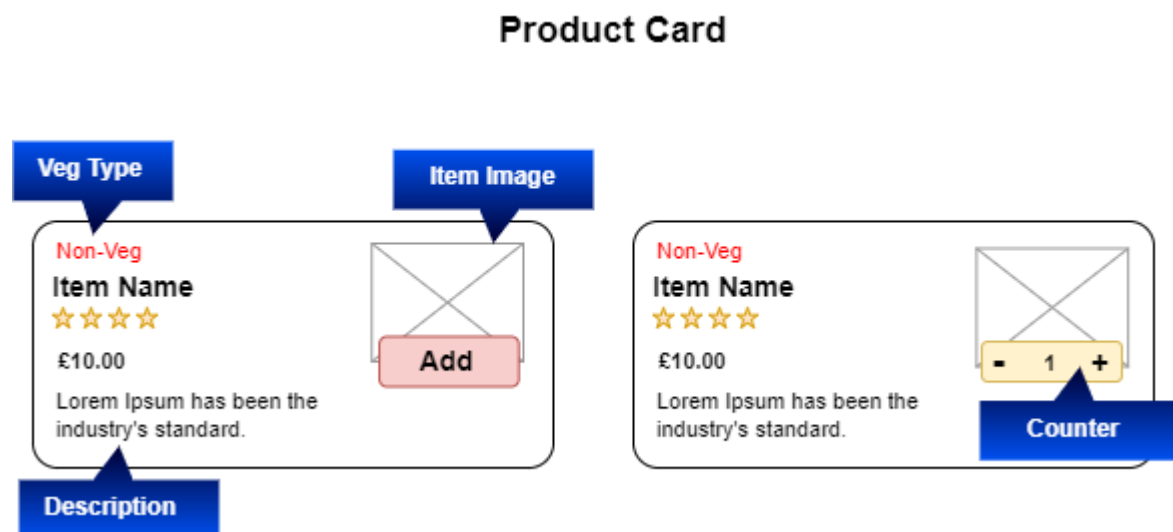
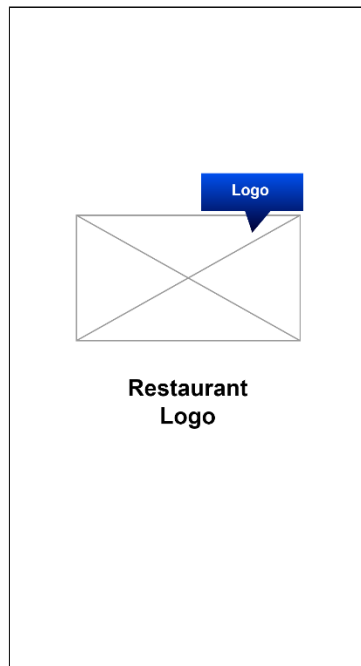


Figure 29 Low Fidelity Wireframe of Product Card

## Splash Screen



## Home Screen

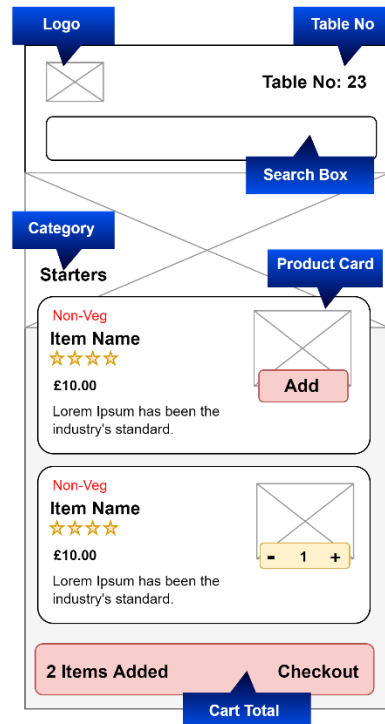
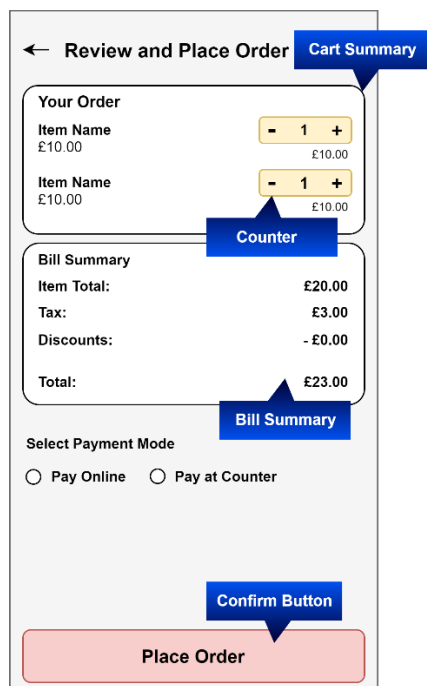


Figure 30 Low Fidelity Wireframe of Splash & Home Screen

## Checkout Screen



## Order Success Screen

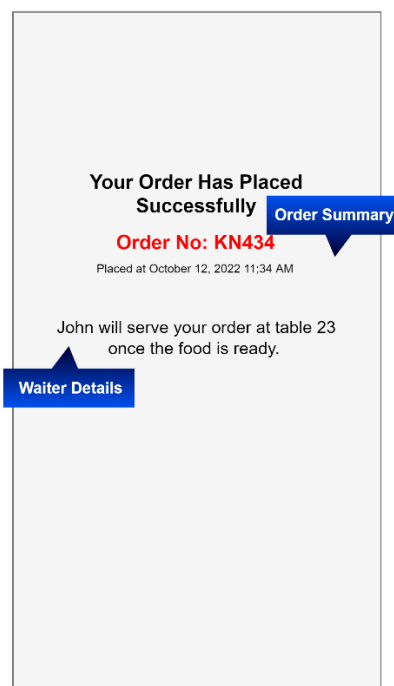


Figure 31 Low Fidelity Wireframe of Cart & Success Screen

#### 4.4.1.1.2 Waiter Mobile Application

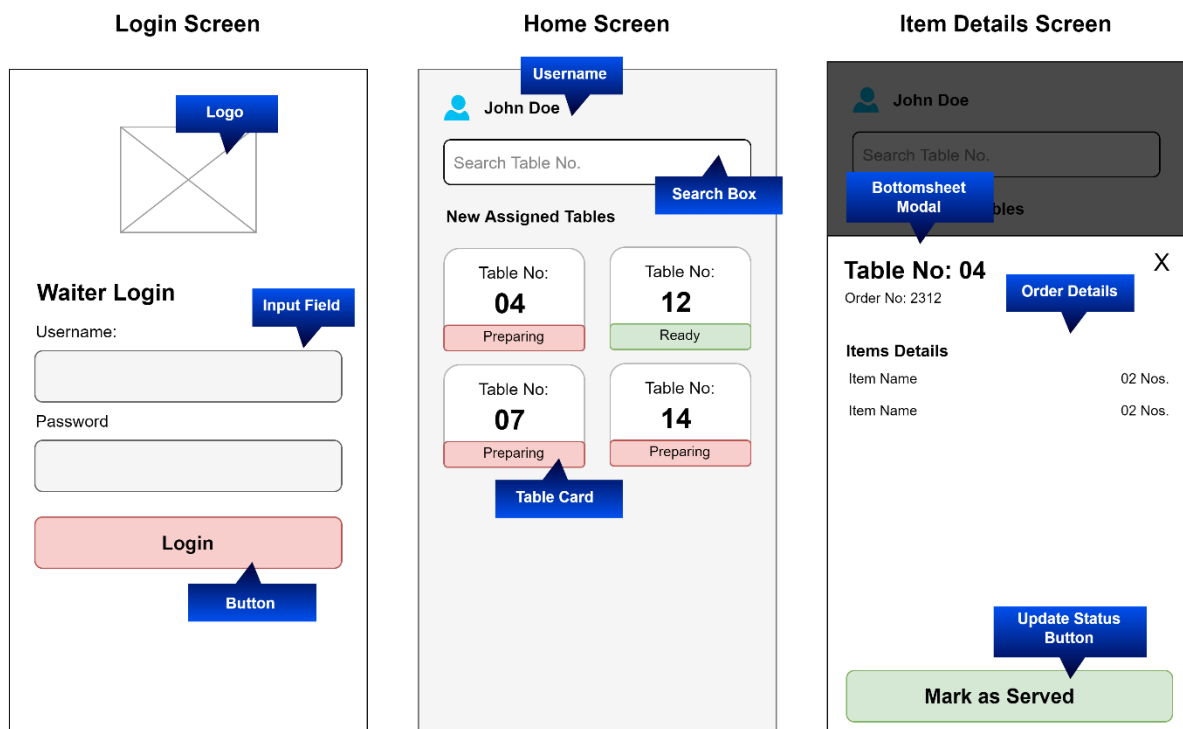


Figure 32 Low Fidelity Wireframes of Waiter Application

#### 4.4.1.1.3 Kitchen System

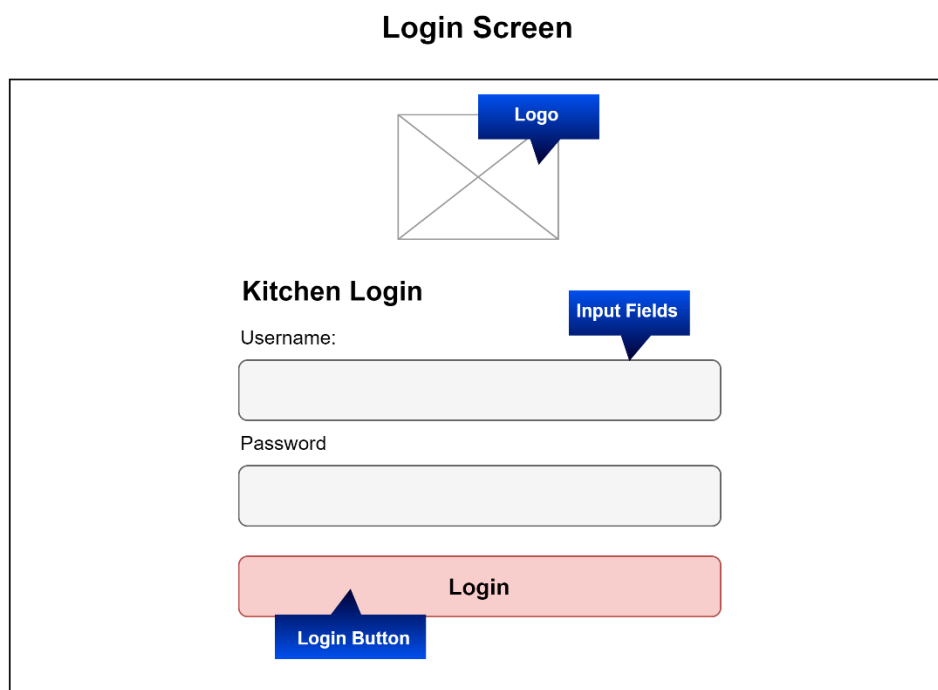


Figure 33 Low Fidelity Wireframe of Login Screen

## Order Dashboard

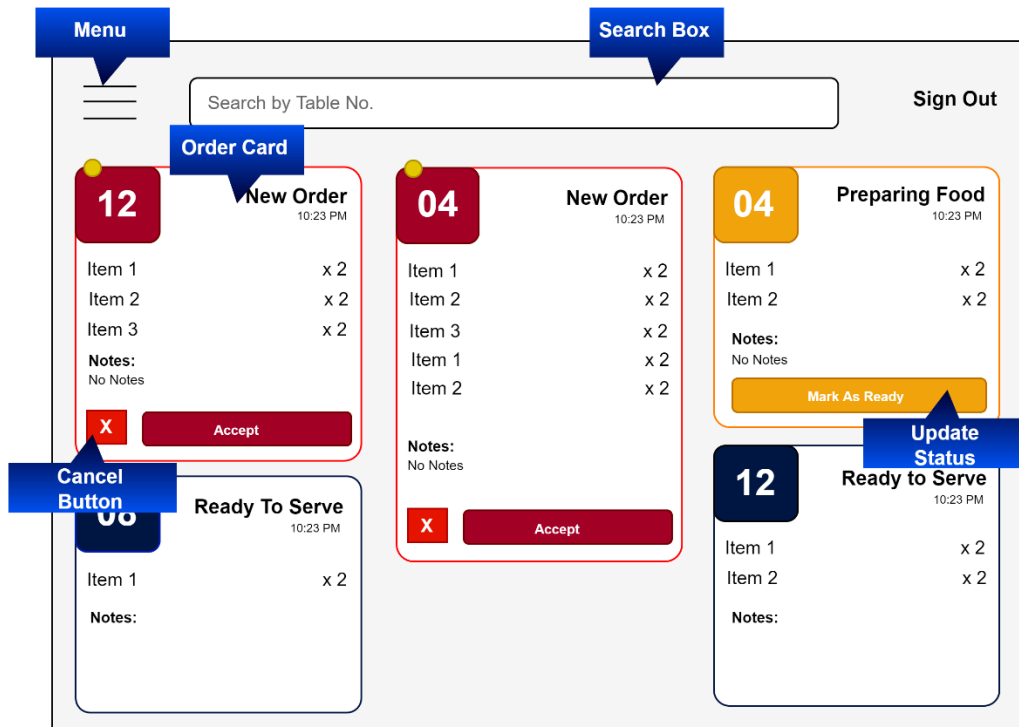


Figure 34 Low Fidelity Wireframe of Dashboard Screen

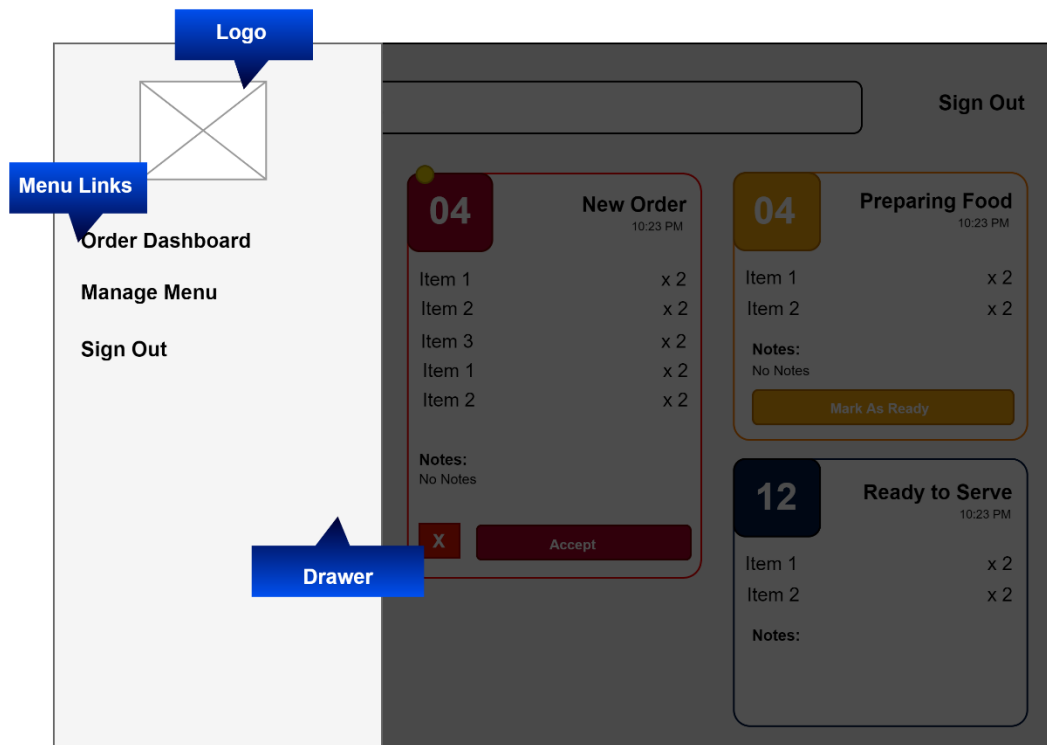


Figure 35 Low Fidelity Wireframe of Menu Drawer

#### 4.4.1.2 High Fidelity Wireframes

Based on the style guidelines and brand principles, the high-fidelity wireframes of the system are designed and are shown further.

##### 4.4.1.2.1 Mobile Friendly Menu Website

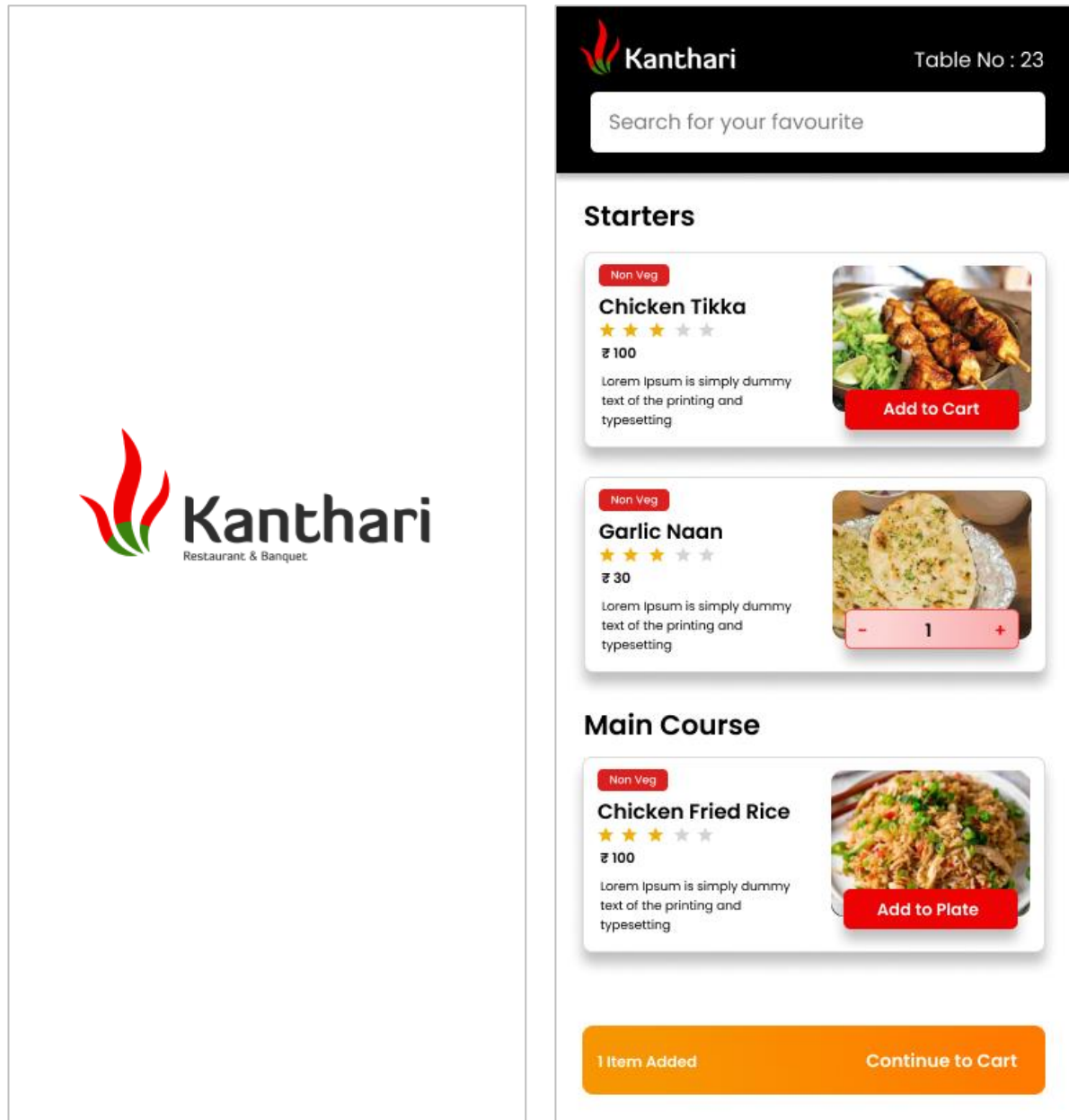


Figure 36 High Fidelity Wireframes of Splash & Home Screen

←

Review & Place Order

Item Details

Garlic Naan

₹ 30

-

1

+

Chicken Biryani

₹ 100

-

1

+

Billing Details

Item Total

₹ 130

Tax

₹ 20

Discounts

-₹ 0

Total

₹ 150

Select a Payment Mode

☐ Pay at Counter

☒ Pay Online

Confirm Order

Wow! Thanks for your order.

Order No: KN145

Sit Back & Relax While we Prepare your Order

John will serve your food at table number 23  
once the food is ready.

Figure 37 High Fidelity Wireframes of Cart & Success Screen

48



#### 4.4.1.2.2 Waiter Mobile Application

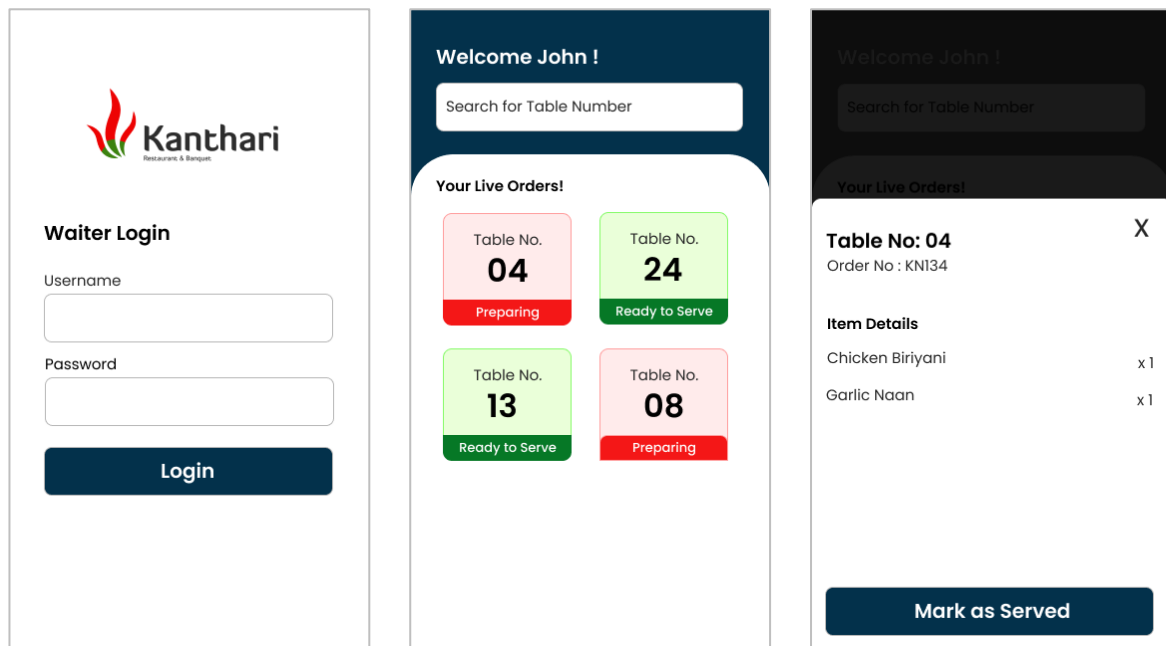


Figure 38 High Fidelity Wireframes of Waiter Application

#### 4.4.1.2.3 Kitchen System

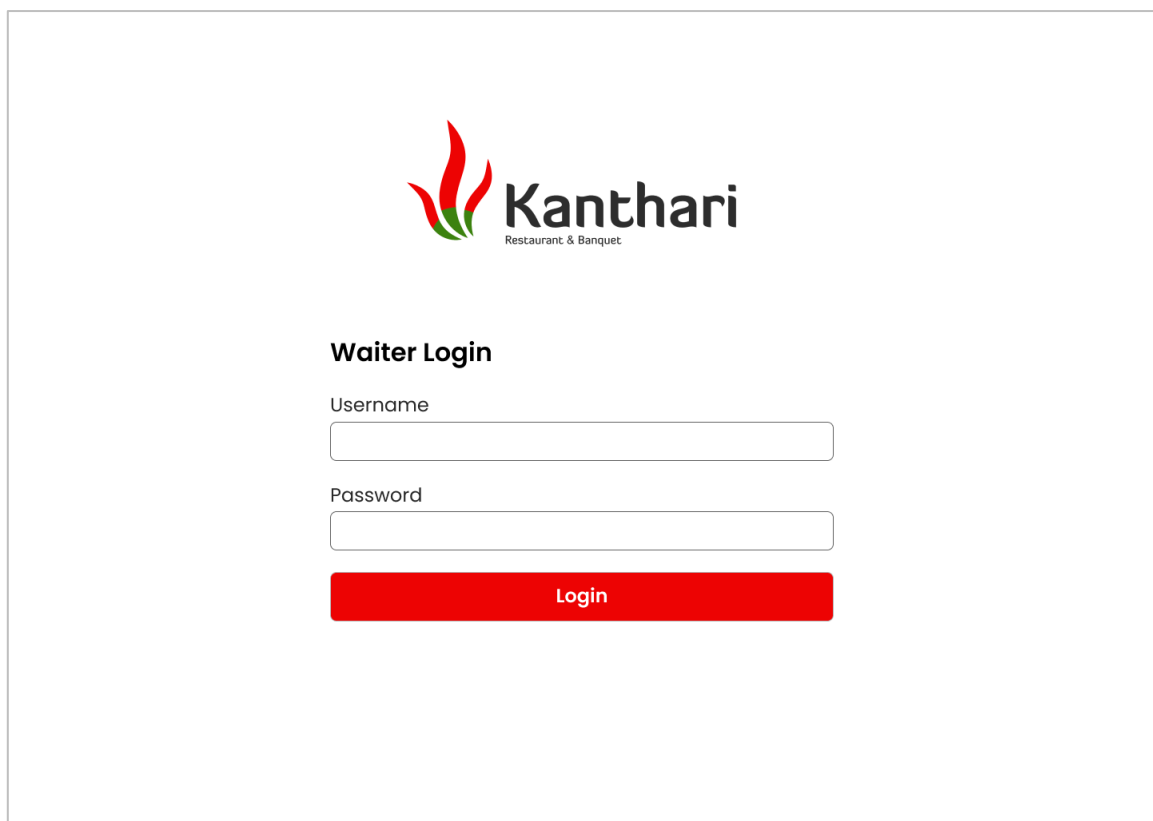


Figure 39 High Fidelity Wireframe of Kitchen Login Screen

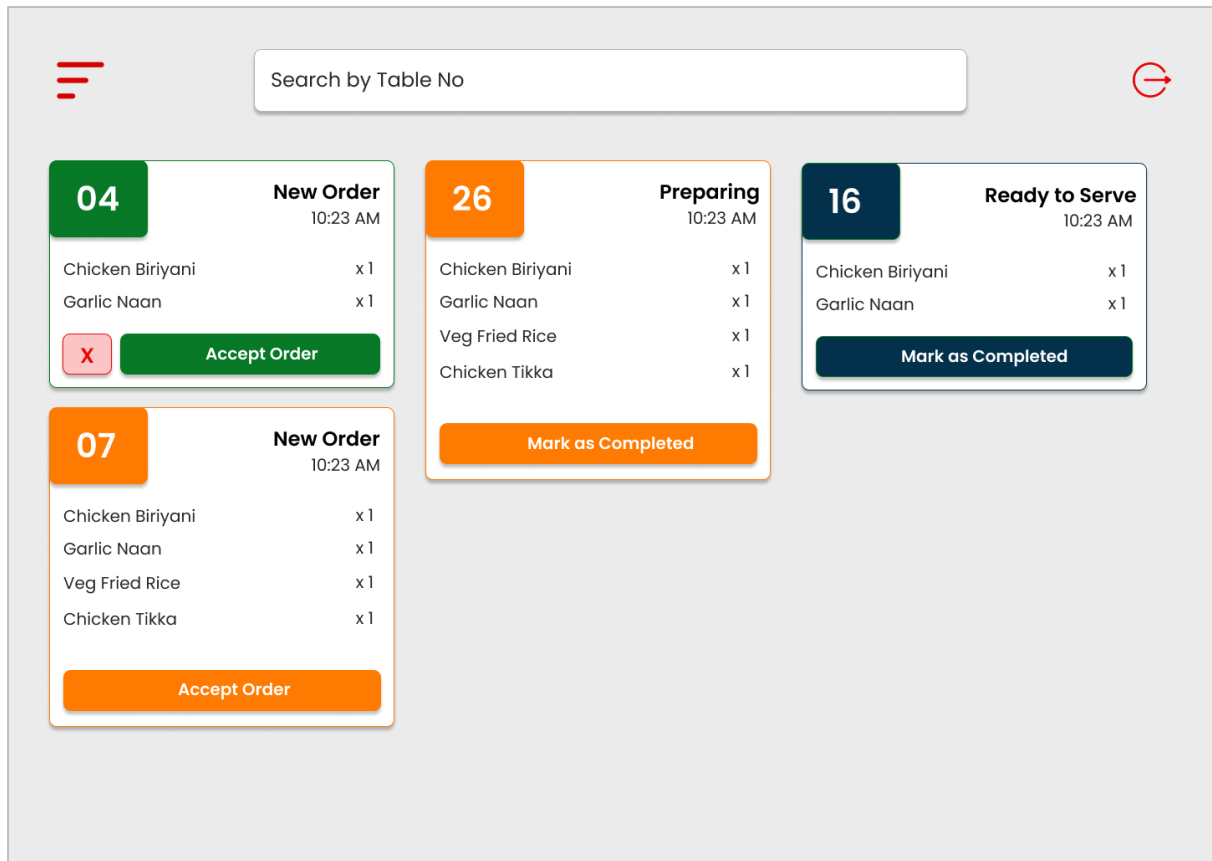


Figure 40 High Fidelity Wireframe of Kitchen Dashboard

## 4.5 Surface Plane

Surface plane mainly focuses on the visual representation of the system. The visual characteristics includes typography styles, colour combinations, and so on (Lauviahx,2022). The surface plane research for the tableside ordering system is conducted and is discussed further.

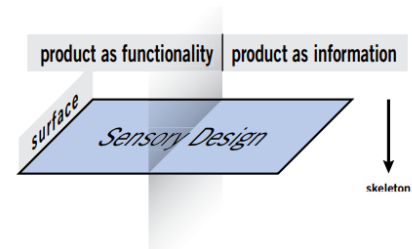


Figure 41 Surface Plane (Garret, 2011)

### 4.5.1 Colour Scheme

The prototype of the system is built for a restaurant in Kerala, India. The colour scheme used for the system is based on the logo of the restaurant selected.

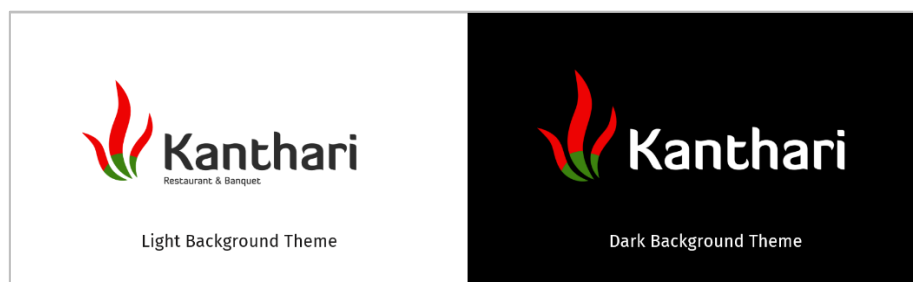


Figure 42 Restaurant Logo

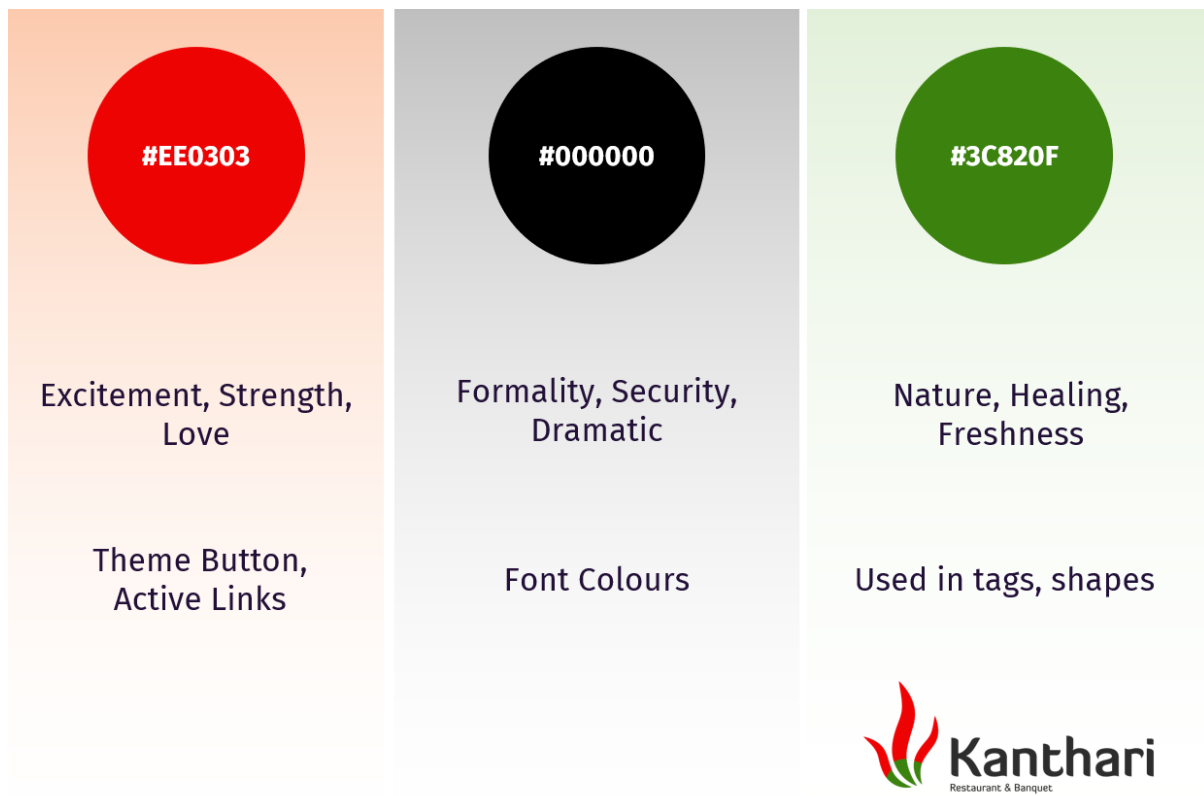


Figure 43 Colour Scheme of the System

Figure 43 shows the colours used in the design of the system and its usage. The colours are derived from the logo of the restaurant.

#### 4.5.2 Font Family

The font family used throughout the system is **Poppins**. This would create consistency in the design. The selected font is readable enough for the users.

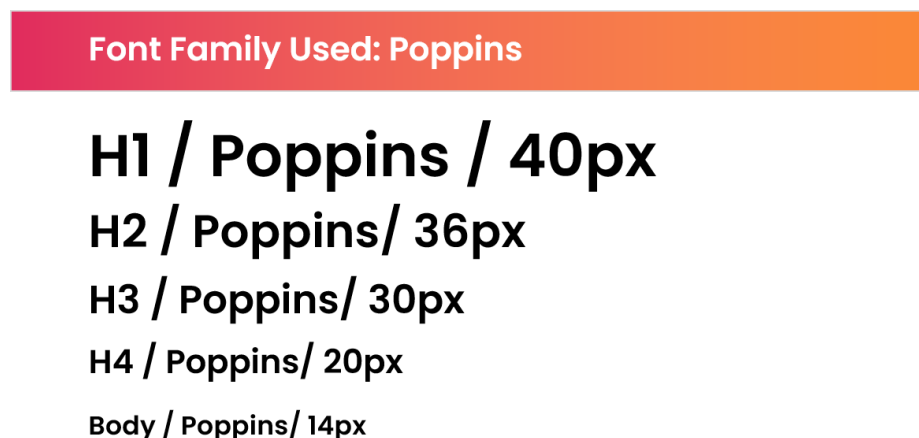


Figure 44 Font Family for the System Design

## 5 Development

With the designs established from the above sections, this chapter focuses on the implementation of the proposed system using technologies. To meet the requirements of the various users of the system, three different applications are implemented. A mobile friendly web application for the diners, a mobile application for the waiter and a web application for the kitchen staff of the restaurant. This section discusses the various steps taken to develop these applications.

### Github Repos:

<https://github.com/JaiseP/tablesider-ordering-kitchen>

<https://github.com/JaiseP/tablesider-ordering-customer>

<https://github.com/JaiseP/tablesider-ordering-backend>

<https://github.com/JaiseP/tablesider-ordering-waiter>

### 5.1 Technology Stack

The development of the system was divided to two stages as Front-End Development and Back-End Development. Various technologies were utilised for the implementation of the system. Figure 45 shows the technology architecture of the proposed tableside ordering system.

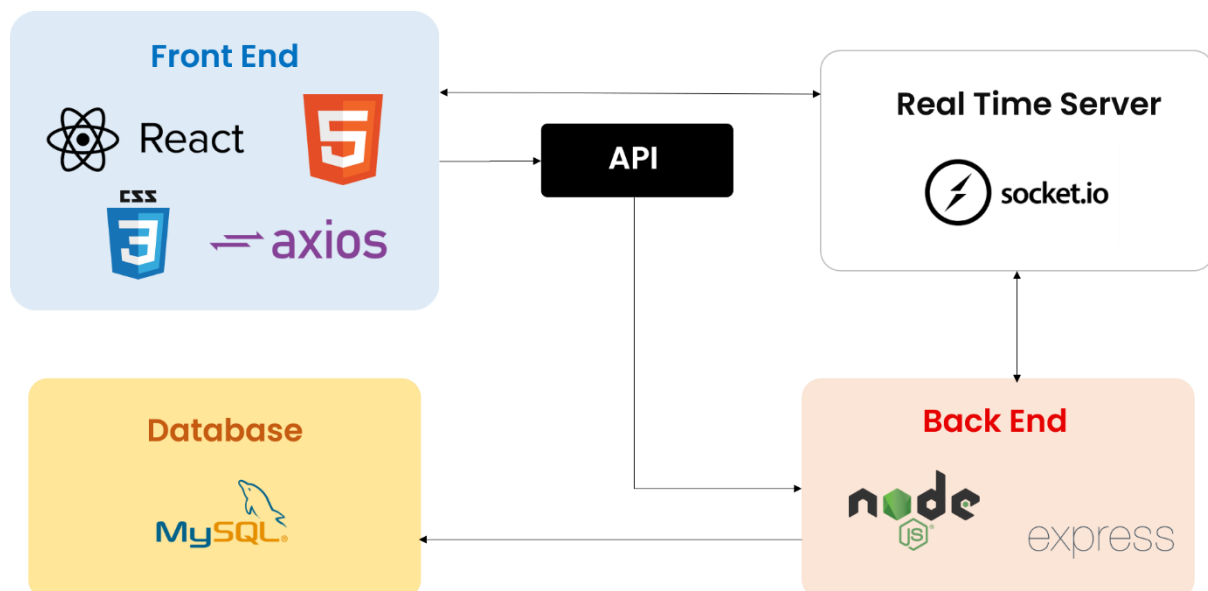


Figure 45 Technology Stack of Proposed System

After having conducted detailed research on various frameworks, React was selected for the front-end development of the system. React.JS and React Native is used respectively for developing web and mobile applications. Several reasons were considered while choosing React framework for the system development. As the system requires to handle various states, the declarative approach of React would be beneficial for the system development. Also, the ability to create reusable components would make the development of the system faster. Furthermore, as React Native is a cross platform language, with the single codebase written, it is possible to build applications for both Android and iOS.

As the system generates many data, it is essential to store data and retrieve it efficiently. MySQL database is used as the database for the system. Since it is a relational database, it is possible to store data in an organized and tabular form in MySQL. In addition to that, security of MySQL is another factor that made to decide MySQL as the database of the system.

Furthermore, it is essential to have a middleware in the system for interacting front-end with the database of the system. For developing APIs, Node.JS framework is used as the backend language with the Express.JS library. As the system would be used by many users at a single time, the efficiency of Node.JS to handle multiple simultaneous connections with maximum throughput made it to decide this framework for the API development of the system. In addition to that, Socket.IO is also utilised in the backend development of the system to make the system real time.

## **5.2 Class Diagram**

Class diagrams illustrates the layout of the system by arranging its classes, characteristics and relationship with each other. As it describes what should be included in the system, it is essential to design the class diagram before the implementation begins. The class diagram of the proposed tableside ordering system is shown in Figure 46. This diagram shows the various entities of the system and their characteristics.

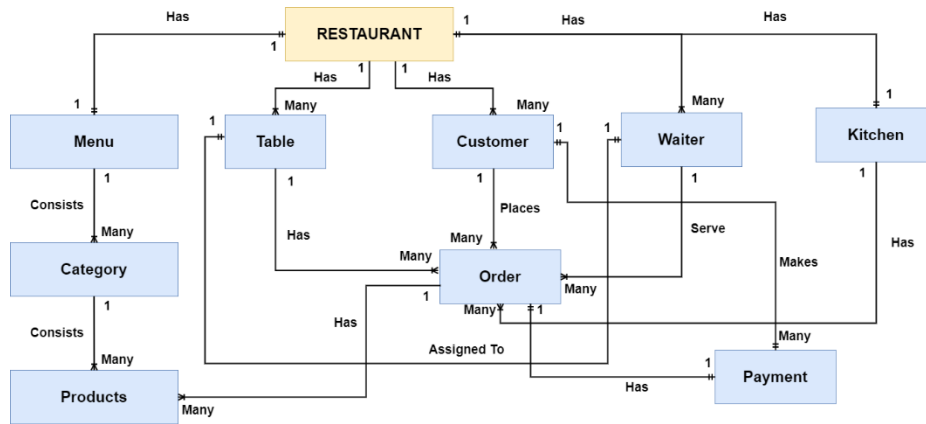


Figure 46 Class Diagram

## 5.3 Database Development

As the first phase of system development, the database for the system is designed and developed. As mentioned earlier, the system uses MySQL database for storing and retrieving data. This section discusses the various steps performed to develop the database of the system using MySQL.

### 5.3.1 ER Diagram

An Entity Relationship Diagram (ERD) is a diagram that shows the relationships between various entities in a system. A highly helpful foundation for building and modifying databases is provided by ER diagrams. The first benefit of using ER diagrams is that they are simple to grasp and don't require much training to use effectively. Second, relational tables that can be utilised to swiftly construct databases can be easily created using ER diagrams (Nishadha, 2022). ER Diagram of the proposed system is shown in Figure 47. The rows in blue colour denotes the primary key of the table and orange denotes the foreign key of the table.

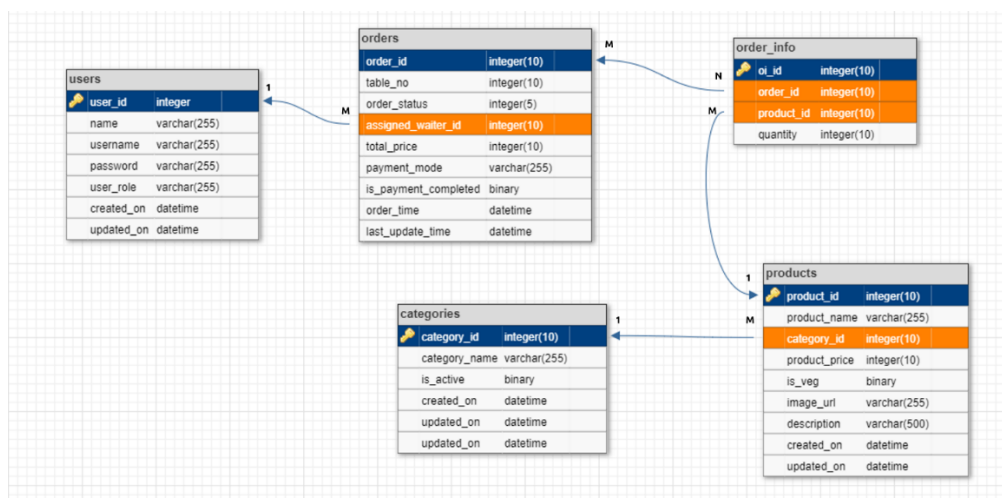


Figure 47 ER Diagram

### 5.3.2 MySQL Queries

Some of the queries that were used to create the tables of the database are shown further. The tables were created and added relationship between each tables using Foreign Keys.

```
CREATE TABLE `users` (  
  `user_id` INT NOT NULL AUTO_INCREMENT,  
  `name` varchar(255) NOT NULL AUTO_INCREMENT,  
  `username` varchar(255) NOT NULL UNIQUE,  
  `password` varchar(255) NOT NULL,  
  `user_role` varchar(255) NOT NULL,  
  `created_on` DATETIME NOT NULL,  
  `updated_on` DATETIME NOT NULL,  
  PRIMARY KEY (`user_id`)  
);  
  
CREATE TABLE `products` (  
  `product_id` INT(10) NOT NULL AUTO_INCREMENT,  
  `product_name` varchar(255) NOT NULL,  
  `category_id` INT(10) NOT NULL,  
  `product_price` INT(10) NOT NULL,  
  `is_veg` BINARY NOT NULL,  
  `image_url` varchar(255) NOT NULL,  
  `description` varchar(500) NOT NULL,  
  `created_on` DATETIME NOT NULL,  
  `updated_on` DATETIME NOT NULL,  
  PRIMARY KEY (`product_id`)  
);  
  
CREATE TABLE `order_info` (  
  `oi_id` INT(10) NOT NULL AUTO_INCREMENT,  
  `order_id` INT(10) NOT NULL,  
  `product_id` INT(10) NOT NULL,  
  `quantity` INT(10) NOT NULL,  
  PRIMARY KEY (`oi_id`)  
);  
  
CREATE TABLE `categories` (  
  `category_id` INT(10) NOT NULL AUTO_INCREMENT,  
  `category_name` varchar(255) NOT NULL,  
  `is_active` BINARY NOT NULL DEFAULT true,  
  `created_on` DATETIME NOT NULL,  
  `updated_on` DATETIME NOT NULL,  
  `updated_on` DATETIME NOT NULL,  
  PRIMARY KEY (`category_id`)  
);  
  
CREATE TABLE `orders` (  
  `order_id` INT(10) NOT NULL,  
  `table_no` INT(10) NOT NULL,  
  `order_status` INT(5) NOT NULL,  
  `assigned_waiter_id` INT(10) NOT NULL,  
  `total_price` INT(10) NOT NULL,  
  `payment_mode` varchar(255) NOT NULL,  
  `is_payment_completed` BINARY NOT NULL,  
  `order_time` DATETIME NOT NULL,  
  `last_update_time` DATETIME NOT NULL  
);  
  
ALTER TABLE `products`  
ADD CONSTRAINT `products_fk0` FOREIGN KEY (`category_id`)  
REFERENCES `categories`(`category_id`);  
  
ALTER TABLE `orders`  
ADD CONSTRAINT `orders_fk0` FOREIGN KEY (`assigned_waiter_id`)  
REFERENCES `users`(`user_id`);  
  
ALTER TABLE `order_info`  
ADD CONSTRAINT `order_info_fk0` FOREIGN KEY (`order_id`)  
REFERENCES `orders`(`order_id`);  
  
ALTER TABLE `order_info`  
ADD CONSTRAINT `order_info_fk1` FOREIGN KEY (`product_id`)  
REFERENCES `products`(`product_id`);
```

Figure 48 MySQL Queries for the table creation

## 5.4 Back-End (API) Development

The back-end of the system is developed using Node JS and Express JS. This was utilised for the API development of the system which is to be integrated in the front-end of the application for retrieving and updating data.

### 5.4.1 Authorization of APIs with JWT Token

The API's developed for the system must be secured so as to prevent its access from unauthorized users. JWT (JSON Web Token) is utilised in the backend development for implementing this functionality. When a user is registered in the system, a token would be generated for the corresponding user and sends it back to the client as response. So, whenever the client requests an API to the server, the token must also be attached in the body. Upon receiving the request from the client, the server verify the authorization of the client through the token which is attached in the request body. The request would only be completed if the client has proper authorization.

```
const { verify } = require("jsonwebtoken");

module.exports = {
  checkToken : (req, res, next) => {
    let token = req.get("authorization");
    if(token) {
      token = token.slice(7);
      verify(token, "*****", (err, decoded) => {
        if(err) {
          res.json({
            success: 0,
            message: "Invalid Token"
          });
        } else {
          next();
        }
      })
    } else {
      res.json({
        success : 0,
        message: "Access Denied. Unauthorized User"
      })
    }
  }
}
```

Figure 49 Function to verify the client authorization using JWT

Figure 49 shows the code snippet of function to verify the client authorization. The “\*\*\*\*\*” in the code is be the secret key, which is any alphanumeric code.

### 5.4.2 API Structure

The main endpoints of the APIs of the system are **users**, **products** and **orders**. User endpoint handles all requests based on user registration, login and so on. Product endpoint is utilised to get all the products in the menu. And finally orders endpoints would be used to view, create, and edit orders in the system. The APIs are handled using three stages – router, controller and service.

**Router** – It routes the request based on the path that client requests,

**Controller** – It is responsible for managing incoming requests and returning responses.



**Service** – This is responsible for performing the request function by retrieving and manipulating data from the database.

#### 5.4.2.1 Router

The router of order endpoint is shown in Figure 50. It navigates the request to appropriate controller based on the request type and path. As it is shown in the snippet, before executing the controller of each request, the checkToken function is executed so as to validate the user authorization.

```
const { createNewOrder, getServerOrderById, getOrderedProducts, getAllOrders, updateOrder } = require("../orders.controller");
const router = require("express").Router();
const { checkToken } = require("../auth/token_validation");

router.post("/", checkToken, createNewOrder);
router.get("/server/:id", checkToken, getServerOrderById);
router.get("/serverOrder/:id", checkToken, getOrderedProducts);
router.get("/kitchen", checkToken, getAllOrders);
router.put("/", checkToken, updateOrder);

module.exports = router;
```

Figure 50 Order Router

#### 5.4.2.2 Controller

Figure 51 shows the code snippet of order controller of a request to get all orders of a waiter based on the user Id.

```
getServerOrderById: (req, res) => {
  const id = req.params.id;
  return new Promise(function(resolve, reject) {
    getServerOrders(id, (err, results) => {
      if(err) {
        console.log(err);
        return;
      } else {
        if(!results) {
          return res.json({
            success: 0,
            message: "Record Not Found",
          });
        }
        let response = [];
        results.forEach(order => {
          getOrderedProducts(order.order_id, (err, results) => {
            if(err) {
              console.log(err);
              return;
            } else {
              response.push(order);
            }
          });
        });
        return res.json({
          success: 1,
          data: results
        });
      }
    });
  });
}
```

Figure 51 Controller Code Snippet

### 5.4.2.3 Service

Figure 52 shows the code snippet of service to get orders of a waiter by accessing data from the database.

```
getServerOrders : async (id, callBack) => {
  try {
    pool.query(
      `SELECT * FROM orders WHERE status != 5 AND status != 6 AND assigned_server_id = ? ORDER BY order_id`,
      [id],
      (error, results, fields) => {
        if(error) {
          return callBack(error);
        }
        return callBack(null, results);
      }
    )
  } catch (err) {
    console.log(err);
  }
},
```

Figure 52 Order Service Code Snippet

### 5.4.2.4 API Response

For testing purpose, the Postman software tool were utilised to test the responses from the developed APIs. Figure 53 shows the response of a GET request to fetch the list of assigned orders of a waiter id 1.

The screenshot shows the Postman interface for a GET request to `http://192.168.0.183:3000/api/orders/server/1`. The response status is 200 OK, with a time of 16 ms and a size of 762 B. The response body is displayed in JSON format, showing a successful response with a list of orders.

```
{
  "success": 1,
  "data": [
    {
      "order_id": 169,
      "table_no": 24,
      "status": 1,
      "assigned_server_id": 1,
      "total_price": 120,
      "payment_mode": "cash",
      "is_paid": 1,
      "order_time": "2023-01-07T18:40:13.000Z"
    },
    {
      "order_id": 171,
      "table_no": 24,
      "status": 1,
      "assigned_server_id": 1,
      "total_price": 120,
      "payment_mode": "cash",
      "is_paid": 1,
      "order_time": "2023-01-07T18:40:13.000Z"
    }
  ]
}
```

Figure 53 Postman API Response

## 5.5 Front-End Development

As mentioned earlier, React framework is utilised for the development of the user interface of the system. This section discusses the various steps made to develop the front-end of the application.

### 5.5.1 Customer Web Application Development

Customer access the menu of the restaurant through web application by scanning the QR Code on the table. This website displays the menu available so that the customer would be able view and select the items they preferred to order. This website would enable customer to add items to the cart and place order from their table itself without any support from the restaurant staff to attend them.

#### 5.5.1.1 Project Setup

The following commands are used to create a React JS project and run the application,

```
npx create-react-app tableside-ordering-customer
cd tableside-ordering-customer
npm start
```

#### 5.5.1.2 Routing Between Screens

React JS uses a package called “**react-router-dom**” to handle routes and navigate between multiple screens.

Following command is used to install this package to the project.

```
npm install react-router-dom
```

And to use this package we import multiple functions from this library as follows.

```
import {BrowserRouter, Routes, Route} from 'react-router-dom';
```

```
<BrowserRouter>
|
| <Routes>
| | <Route element= {<SplashScreen />} path = "/" />
| | </Route>
| </Routes>
</BrowserRouter>
```

Figure 54 Routing Syntax

The above code snippet defines the route of the Splash Screen which is made to the root of the application. So, whenever, a customer visits the website, they would be navigated to a Splash Screen.

### 5.5.1.3 Splash Screen

Splash screen is implemented in the customer website as a welcome screen which displays the logo of the restaurant. This is a timed screen and after few seconds, the user would be navigated to the main menu screen. The other functionality implemented in this screen are, it requires to capture the table number from QR Code that customer scans and store in a state variable.

```
import React, {useEffect} from "react";
import { useNavigate, useParams } from 'react-router-dom';
import './styles.css';

const SplashScreen = ({setTable}) => {
  const navigate = useNavigate();
  const { table } = useParams();

  useEffect(() => {
    setTable(table);
    setTimeout(() => {
      navigate('/menu');
    }, 2000);
  }, []);

  return (
    <>
      <div className="splashContainer">
        <img className="logo" src={"/images/kanthari_logo_dark.png"} alt="Logo" />
      </div>
    </>
  )
}
export default SplashScreen
```



Figure 55 Code Snippet and Result of Splash Screen

#### 5.5.1.4 Menu Screen

One of the main screens of the system is the menu screen that customer interacts a lot. This screen contains all the items in the restaurants and a feature to add the item to the cart. To fetch the data from the server, a GET request method is called from the application.

**useEffect** hook is used in this screen so that, whenever this page mounts on DOM, **fetchData** function would be executed.

```
useEffect(() => {
  fetchData();
}, []);

const fetchData = async () => {
  axios.get('http://localhost:3000/api/products', {
    headers: {
      'Accept': 'application/json',
      'Content-Type': 'application/json'
    }
  })
  .then((res) => {
    setProducts(res.data.data);
  })
  .catch((err) => {
    console.log(err);
  })
}
```



Figure 56 Code Snippet and Result of Menu Screen

### 5.5.1.5 Order Checkout Screen

Figure 57 shows the code snippet of the function to creating new order by using a POST request.



Figure 57 Code Snippet & Result of Order Checkout

### 5.5.1.6 Error Screen

It is quite common to occur errors while accessing the URL's. To handle such errors, error screen was designed for better user experience.

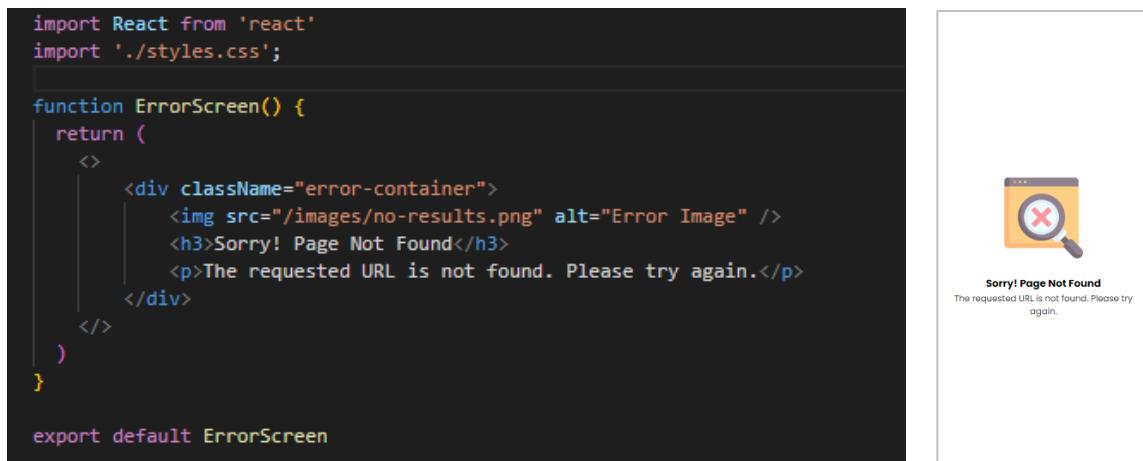


Figure 58 Code Snippet and Result of Error Screen

## 5.5.2 Kitchen Dashboard Web Application

Kitchen dashboard is used to handle the orders created by the customers. The system has a login screen and a dashboard screen to manage orders. The users would be able to view and change the status of orders.

### 5.5.2.1 Login Screen & Validation

Login screen is implemented with proper validations and error messages.

```
const handleLogin = async () => {
  const error = {
    userNameError : false,
    passwordError : false
  };

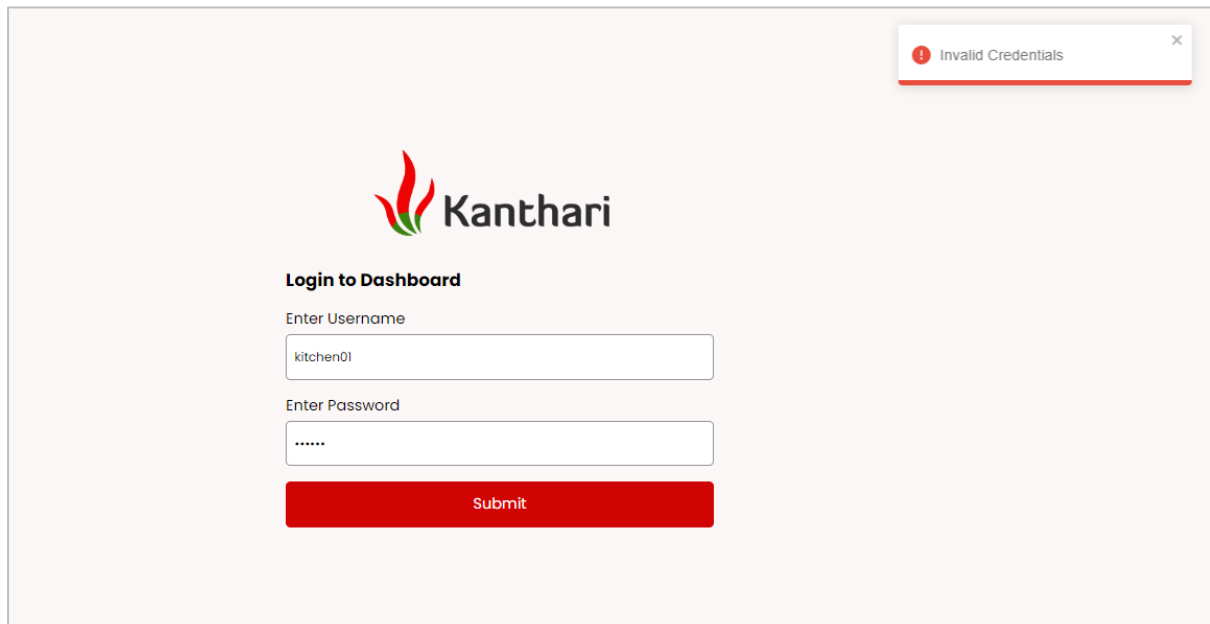
  if(username === '' || username === null || username === undefined) {
    error.userNameError = true;
  }
  if(password === '' || password === null || password === undefined) {
    error.passwordError = true;
  }

  if(!error.userNameError && !error.passwordError) {
    console.log('Im here');
    await loginUser(username, password);
  }

  setError(error);
}

const loginUser = async (username, password) => {
  console.log(password)
  let data = JSON.stringify({
    username : username,
    password : password
  });
  let headers = {
    headers: {
      'Accept': 'application/json',
      'Content-Type': 'application/json'
    }
  }
  axios.post('http://localhost:3000/api/users/login', data, headers)
    .then(res => {
      if(res.data.success === 1) {
        saveUserStatus(res.data).then(() => {
          navigate('/orders');
        })
      } else {
        toast.error("Invalid Credentials");
      }
    })
    .catch((e) => {
      console.log(e);
    })
}
```

Figure 59 Code Snippet of Login Screen Validation and Authorization



The screenshot displays the Kanthari login interface. At the top right, a red error message box states "Invalid Credentials". The main heading is "Kanthari" with a logo. Below it, the text "Login to Dashboard" is followed by two input fields: "Enter Username" (containing "kitchen01") and "Enter Password" (containing "....."). A red "Submit" button is positioned below the password field.

Figure 60 Invalid Credentials Error Message

### 5.5.2.2 Dashboard Screen

Dashboard screen displays all live orders and the kitchen user would be able to update the status of the order. Promises are used in the fetching order details function as it handles multiple asynchronous functions.

```
const fetchOrderData = async (id) => {
  const promiseArray = [];
  await axios.get(`http://localhost:3000/api/orders/kitchen`, {
    headers: {
      'Accept': 'application/json',
      'Content-Type': 'application/json'
    }
  })
  .then((res) => {
    let response = [];
    const orders = res.data.data;
    orders.forEach((order) => {
      promiseArray.push(fetchOrderProducts(order.order_id).then((res) => {
        let data = {
          order_id : order.order_id,
          table_no : order.table_no,
          status : order.status,
          items : res.data,
          assigned_server_id : order.assigned_server_id
        }
        response.push(data);
        // if (index === array.length - 1) resolve();
      }));
    });

    Promise.all(promiseArray)
    .then((res) => {
      console.log(response);
      response.sort((a, b) => a.order_id - b.order_id);
      setOrders(response);
    })
  })
}
```

Figure 61 Code Snippet of Fetching Order Details

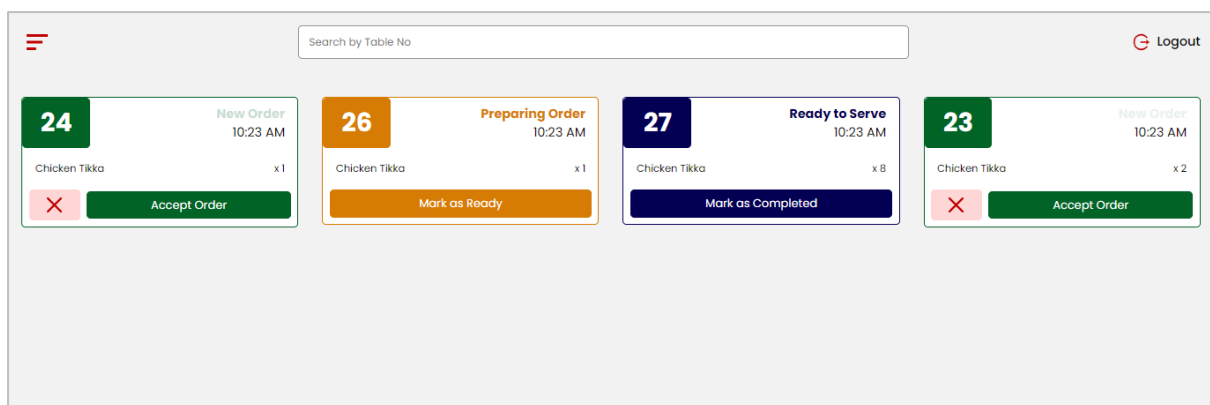


Figure 62 Result of Dashboard



### 5.5.3 Waiter Mobile Application – React Native

The mobile application for the waiters in the restaurant is used for viewing their assigned orders and update the status of each order once they served it. This section discusses the steps taken to develop the front-end of this mobile application.

#### 5.5.3.1 Project Setup

The following commands are used to create a React JS project and run the application,

```
npx react-native init tableside-ordering-waiter
cd tableside-ordering-waiter
npx react-native run-android
```

#### 5.5.3.2 Order Update

To update the order, a PUT request method is called from the waiter app. This would update the status of the order to status number “5” which is completed status.

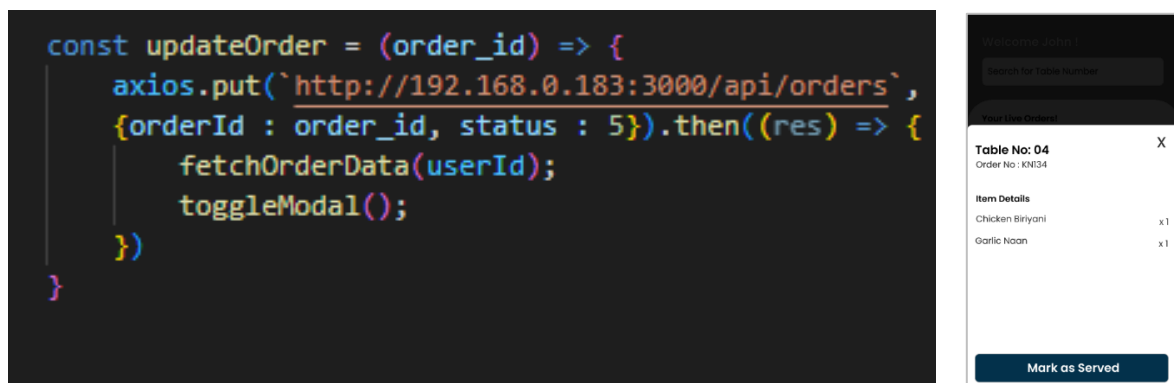


Figure 63 Code Snippet and Result of Order Update in Waiter App

### 5.5.4 Real-Time Connections

The system should work in real time as a whole, and for implementing this, Socket.IO was utilised in both client and server side. Whenever a customer places an order, the client emit an “orderPlaced” message to the server. The server would be continuously listening for the messages from the client. As soon as the server receives the message, the server emits this same message to the kitchen client and assigned waiter client. As these clients are also continuously listening for the message from the server, they receive the data in real time.

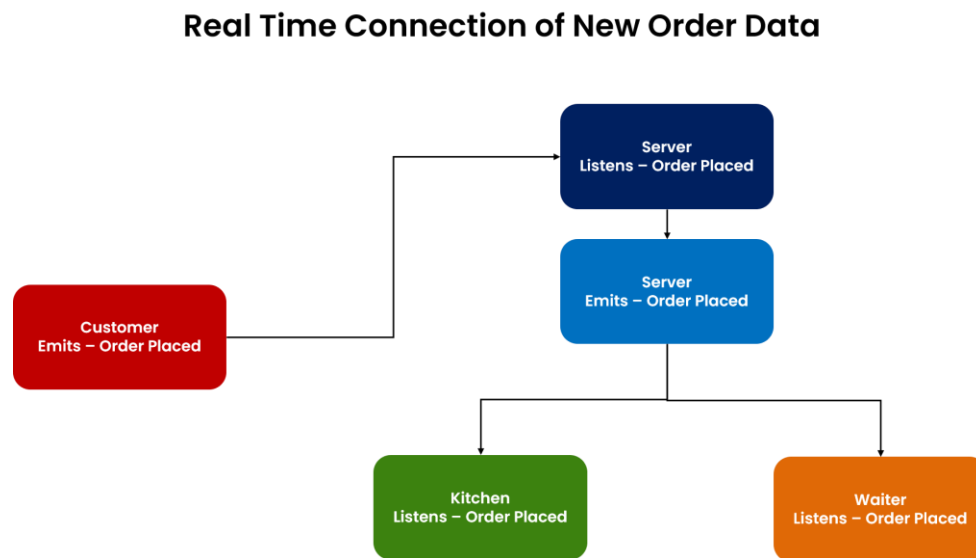


Figure 64 Real Time Connection of New Order Data

#### Customer - Client

```
socket.emit("orderPlaced", { item: 1, userId: res.data.data.assignedServerId });
```

#### Server

```
socket.on("orderPlaced", (data) => {  
  console.log("received order:", data);  
  io.to(data.userId).emit("orderPlaced", data)  
  socket.broadcast.to('kitchen').emit("orderPlaced", data);  
});
```

#### Kitchen - Client

```
socket.on("orderPlaced", (data) => {  
  console.log("order placed:", data);  
  fetchOrderData();  
  playAudio();  
});
```

#### Waiter - Client

```
socket.once("orderPlaced", (data) => {  
  console.log("order placed:", data);  
  fetchOrderData(data.userId);  
});
```

Figure 65 Code Snippets of Real Time Connection

## 6 System Testing

Software testing is a technique for determining if the actual software application complies with expectations and is error-free. It entails the human or automatic implementation of application modules in order to assess one or more interesting attributes. Software testing's goal is to find flaws, gaps, or unmet requirements compared to the requirements as written (Hamilton, 2022).

### 6.1 Testing Strategy

An iterative testing strategy is adopted in this study. As the study follows agile methodology in software development, testing was done after each sprint were completed. So, the development of the system go hand in hand with the testing of the developed module. With this strategy, it was possible to identify the errors in the earlier stage of development. The techniques used for this study are **White Box** Testing which tests how the system works and **Black Box** Testing which tests the behaviour of the system. These techniques were utilised in different levels of the system including Unit Testing, Integrated Testing and so on.

### 6.2 Testing Plan

Before beginning the implementation of a module in each sprint, test plans were written which comprises the test cases, test objectives and test strategies. This document is used as a guide for the testing process of the system. The testing was performed based on the test cases which includes the sample data, expected output and the procedure.

#### 6.2.1 Test Cases

Further illustrates some of the test cases that were performed during the system testing. Manual testing was carried across each test cases.

### 6.2.1.1 White Box Test Cases for User Authorization

A white box test case was performed across the code snippet of the login code.

```
const loginUser = async (username, password) => {  
  console.log(password)  
  let data = JSON.stringify({  
    username : username,  
    password : password  
  });  
  let headers = {  
    headers: {  
      'Accept': 'application/json',  
      'Content-Type': 'application/json'  
    }  
  }  
  axios.post('http://localhost:3000/api/users/login', data, headers)  
  .then((res) => {  
    if(res.data.success === 1) {  
      saveUserStatus(res.data).then(() => {  
        navigate('/orders');  
      })  
    } else {  
      toast.error("Invalid Credentials");  
    }  
  })  
  .catch((e) => {  
    console.log(e);  
  })  
}
```

Figure 66 Code Snippet for White Box Testing

Test Case ID		1	
Module Name		Kitchen User Module	
Test Case		Kitchen User Login	
Expected Output		Login user successfully. If successful, the user should navigate to dashboard, else show error messages.	
No	Test Case	Actual Output	Status
1	(Positive) Kitchen User Login	Kitchen User enters username and password field. The user is validated. Redirected to Dashboard	Pass
2	(Negative) Waiter User Login – Should not authenticate in kitchen system. Invalid User message should display.	Waiter User enter username and password field of Kitchen system. The user is validated. Redirected to Dashboard	Failed

### 6.2.1.2 Black Box Test Cases for Real Time Connection

A black box testing was performed to test whether the data in waiter application is updating real-time without refresh. This was done without the access to code, but only with the user interface for testing like an end-user.

<b>Test Case ID</b>		2	
<b>Module Name</b>		Waiter App	
<b>Test Case</b>		Real Time Data Update	
<b>Expected Output</b>		Whenever the user is using the application, the application should fetch real-time data of order without any refresh.	
<b>No</b>	<b>Test Case</b>	<b>Actual Output</b>	<b>Status</b>
1	(Positive) New Order- A new table card displays in the application	As the customer places a new order, and the order is assigned to the particular user, then a new table card is rendered in the screen.	Pass
2	(Negative) New Order – Different Waiter – The application of the user should not display orders of other waiters.	No Order was rendered in the screen.	Pass
3	Order Update - The screen should re render with updated data	When an order is updated from the kitchen system, the screen re rendered with updated data without page refresh.	Pass
4	Sound Notification – When new order is received or order is updated	No sound notifications were active at the time of testing of the module.	Failed

## **7 Conclusion**

### **7.1 Research Overview & Findings**

In this study, a detailed literature review was conducted on the Indian Restaurant Industry to understand the restaurant structure in India and to identify the pain points faced by the customers and owners of restaurant with the existing ordering process. Also, various literatures were critically reviewed to identify the existing technologies that are currently incorporated in the industry. Along with that, a case study was examined to understand the working of tableside ordering system in a leading restaurant. Furthermore, the various methodologies used in the research was discussed. With the collected data and its analysis, a detailed system design was completed for the proposed system. In addition to that, after designing the proposed system, the implementation of the system is also discussed.

After designing and implementing the proposed system, it was identified that the system would be beneficial for the diners to view and place order from their table itself without the support of restaurant staff. Also, the staffs of the restaurant, particularly the waiter and the kitchen staff could use the system to get the order status in real-time. As a result, the system as a whole would enhance the customer experience of the diners as the system demands limited waiting time for the customers in ordering process.

### **7.2 Research Contribution**

After completing the study, following contributions were made to the community.

- Identification of the issues in existing ordering process of Indian Restaurant Industry.  
Various literatures were reviewed to identify the issues faced by the diners and restaurant owners with the exiting ordering systems.
- Validated through research study that tableside ordering system would enhance the dining experience of the users especially after the COVID-19 pandemic.  
Conducted case study research on the success of tableside ordering system implementation in a leading restaurant group.
- A tableside ordering system design for Indian Restaurants that meets some of the needs of Indian diners and restaurant owners to enhance the dining experience and to make the restaurant workflow easier.

Conducted various user interviews and analysed the data to identify the system specifications and followed various design principles to establish the system design.

### **7.3 Research Limitations and Future Work**

Although the proposed system meets most of the requirements from the users, the system lacks to meet some demands of the users which could be incorporated in future. It would be more engaging for the diners, if a game-based activity is integrated in the system while the customer waits for the food to prepared. This could improve the customer experience further. Also, the system would be more efficient if the orders displayed in kitchen sorts based on the average cooking time, so that, an order with least amount of cooking time could be prepared first before an order requiring more time, even if it is ordered first. Currently the system lacks this feature, which could be added in the future work.

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