



Final Report

Team A+

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1. Problem Statement

Time management is a problem commonly faced by students today according to Indiana University-Purdue University Fort Wayne (2016). Indeed, as students, we are often short of time rushing for assignments and meeting project deadlines. Some days, students with back-to-back classes are often seen skipping meals in order to be punctual. Regardless of the amount of work we have, meal times are essential. The long queues at food stalls can be frustrating. When we do not have the luxury of time, we often give up what we want to eat and settle for the stall with a shorter queue. This problem also applies to school staff, who share the same canteens as students. What if everyone could order at their own convenience and collect the food on the way to the next schedule? What if everyone could place their orders from their seats and collect when it's ready?

Therefore, our team came up with NomzQ, a one-stop mobile platform connecting students and stall owners to address 4 key issues: (1) Long waiting time for food, especially in popular stalls (2) Time spent queuing for food could be used more productively (3) Food goes to waste when unsold (4) Food stalls can operate more efficiently.

2. Business Environment

2.1 Target Market

2.1.1 NUS Canteens

During peak hours, queue times can get longer than the time we can afford to spare. At times, the Chinese noodles stall at the Science Canteen and the Yong Tau Foo stall at the Arts Canteen of NUS can go up to 15-20 minutes wait. The long queues also cause disruption in packed canteens, where other customers have to weave in and out in between queues. If there is a way to eliminate the queue, the canteen will look a lot less cluttered and will be a safer environment for consumers walking around with their food trays. Secondly, the manual taking of orders is slow, and causes uncertainty and delays in food ordering if it is done inaccurately. Collection of payment is also a task that can easily be automated. The manpower required to collate orders and payment can be put into better use elsewhere and increase efficiency for the stall.

We conducted a short survey with 156 NUS students from various faculties. A high percentage (78.7% of respondents) stated that they would be willing to try out a queue app to order their food with greater convenience. Some of them commented that there is no harm giving this new queue app a shot if it is able to reduce their wait time and bring them convenience at the same time.

Hence, we will be having 2 target groups: NUS students and canteen stall owners.

2.1.2 Target Group 1: NUS Students

Students from Faculty of Law have been excluded as they mostly dine at Bukit Timah campus. The undergraduate student cohort data is presented below.

Faculty	Full Time	Part Time	Nearest Canteen
Engineering	5376	1023	Techno Edge
Computing	1967	-	The Terrace, The Deck
Business	2789	-	The Terrace
Arts & Social Science	6199	-	The Deck
Dentistry	219	-	Frontier
Medicine	1904	-	Frontier
Design & Environment	1939	-	Techno Edge
Music	215	-	Techno Edge
Science	5204	-	Frontier
Total	25812	1023	-

Figure 2.1: Table of number of undergraduate students per faculty, updated for AY2015/2016

From Figure 2.1, we have a grand total of 26,835 NUS Students belonging to our target group. The students are further categorised into their respective faculties to allow room for better analysis. Based on geographical reasons and assumption that students will dine at the nearest canteen, we have listed the nearest canteens for each faculty.

2.1.3 Target Group 2: NUS Canteen Stall owners

Canteen	Number of stalls	Seating Capacity
The Deck	13	1018
Techno Edge	14	852
Frontier	5	400
The Terrace	12	948
Total	44	3218

Figure 2.2: Table showing number of stalls and seating capacity per NUS Canteen.

There are a total of 44 stalls which our business could possibly collaborate with to bring greater convenience to the students.

2.2 Field Study

A survey on NUS Canteens was conducted on 156 NUS students.

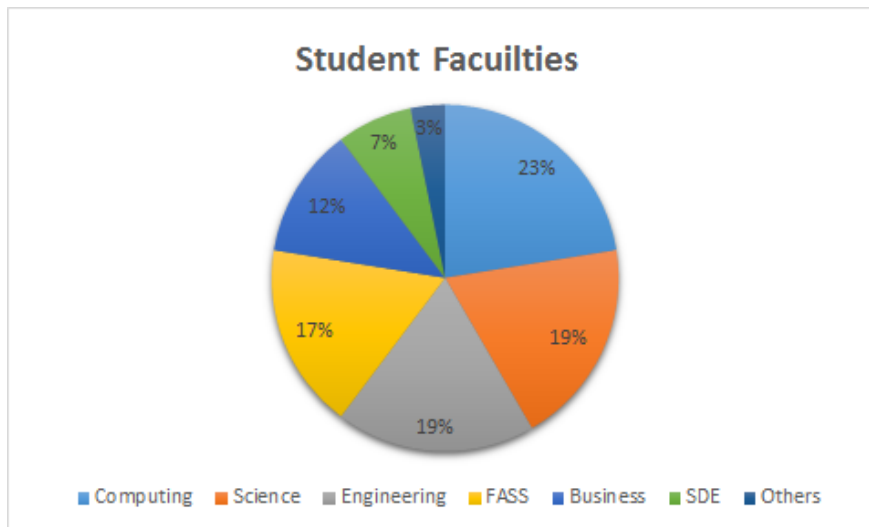


Figure 2.3: Faculty breakdown of sample population

2.2.2 Customer frequency per Canteen

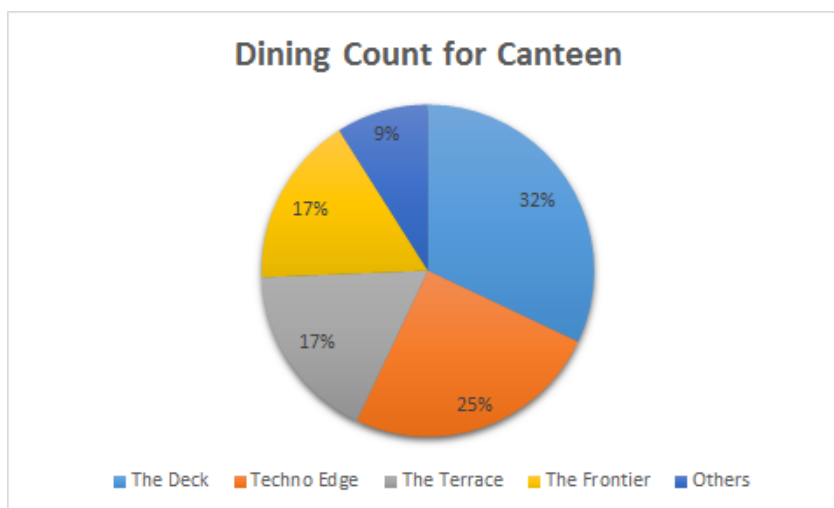


Figure 2.4: Dining count per canteen

Based on the survey, The Deck is the most frequented canteen in NUS, with 32% of respondents picking The Deck as their most frequented canteen.

2.2.3 Average Cost per Meal

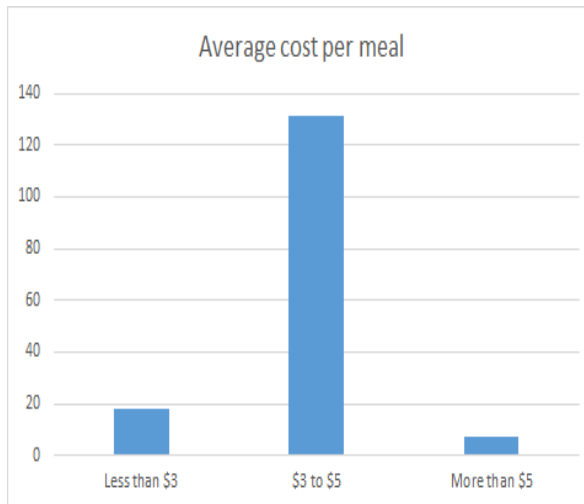


Figure 2.5: Average cost per meal

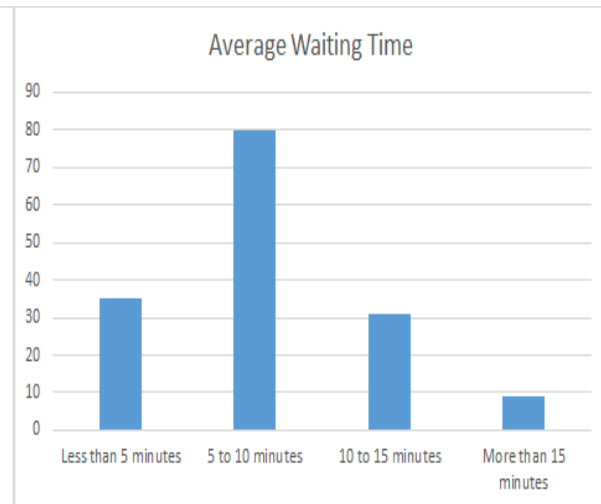


Figure 2.6: Average Waiting time

From Figures 2.5 and 2.6, the average cost per meal is \$3 to \$5 in NUS with an average waiting time of 5 to 10 minutes. When asked to rank the importance of quality of food, waiting time, type of cuisine, price of food, it was found that quality of food ranked highest, followed by waiting time. Individuals were also asked if they would use a mobile app to order food for convenience. 123 (79%) voted 'Yes' and 33 (21%) voted 'No'.

2.2.4 Survey Conclusion

NomzQ addresses the opinions expressed in the responses to our survey. Since waiting time ranked the second highest in importance, NomzQ allows customers to view the estimated waiting time before they order, so that they are well-informed of when they can receive their orders. Furthermore, NomzQ aims to reduce the waiting time since it automates the ordering and payment process, which contributes a significant amount of time in the traditional queues.

Also, some respondents suggested that they would like to know how the food looks like. Their preference for menu browsing with pictures are incorporated into NomzQ's menus, which features images of food items.

Some respondents indicated that they would not use the app suggested that they prefer to queue physically, as they consider downloading the app a hassle. NomzQ takes both virtual and physical queues into consideration for the estimation of waiting time, and non-users' waiting time are inclusive of our app users who have already ordered and are waiting for collection. Also, downloading the app is only a one time effort. Hence, we hope to show that the convenience NomzQ brings outweighs the initial effort.

2.3 SWOT Analysis

	Helpful	Harmful
Internal	Strengths <ul style="list-style-type: none"> ✓ Enable customers to plan their meals in advance ✓ Allow customers to leave for a while instead of standing in the queue ✓ Allow customers to queue without being physically present at the stall ✓ Saves space by avoiding long queues and thus provides a less crowded, more comfortable dining environment ✓ Mobility 	Weaknesses <ul style="list-style-type: none"> ❖ Possibility of inaccurate estimation of waiting time ❖ Small team in charge of maintenance of the information system may be slow to respond to enquiries and problems
External	Opportunities <ul style="list-style-type: none"> ✓ Stall owners can collect information about peak hours and use it to plan staffing ✓ Schools may use information about average waiting time to decide when it is appropriate to open another stall ✓ Full Wi-Fi coverage in school allows ordering and queueing anywhere and anytime ✓ University students are familiar with technology and are likely to be receptive to this new way of purchasing food ✓ Financial support from school 	Threats <ul style="list-style-type: none"> ❖ Competitors with similar applications such as <u>QJump!</u>, <u>TickTok</u> ❖ Stall owners may not be comfortable with using applications ❖ Customers' privacy concerns regarding sharing personal information when using the app ❖ Customers may fail to turn up for pre-order or queue number

Figure 2.7: SWOT Analysis table

From Figure 2.7, it can be deduced that queue application industry faces relatively high competition due to the ease of developing an app and thus entering the industry. NomzQ needs innovative feature(s) to surpass our competitors and gain competitive advantage. Currently, queue apps are only targeted at the working class. Hence, NomzQ is developed for students and school staff, who are more likely to possess the skills and knowledge to use the app.

On the other hand, the outlook for the queue app market is generally positive with increasing access to the Internet and affordability of smartphones. Long waiting time can be frustrating and adversely affect customers' experience¹. Hence, there would be an increasing demand for such queue apps once users find out the increase convenience that they can get with the help of queue apps.

2.4 Competitors

Queue applications are not a new idea as there have been similar mobile applications released both locally and globally in recent years.

¹ *Consumers' Reaction to Waiting: When Delays Affect the Perception of Service Quality*, Laurette Dube-Rioux, France Leclerc, Cornell University; Bernd. H Schmitt, Columbia University, Retrieved from: <http://www.acrwebsite.org/volumes/6881/volumes/v16/NA-16>

2.4.1 Local

There are 2 local queue applications, Chope and Qjump!.

Chope



Chope is a restaurant reservation platform that was launched by a Singaporean startup in 2011. The successful model of Chope shows us that there is a demand for such services that makes use of technological innovation to aid business processes. It provides both benefits for consumers and restaurants. The screenshot below (Figure 2.8) was retrieved from Chope's webpage on the Google Play store. It received an average rating of 3.7 with more good ratings than bad. There is an estimate of 100,000 – 500,000 downloads. The uptake of Chope is high and they have consistently been expanding their operations and business model.

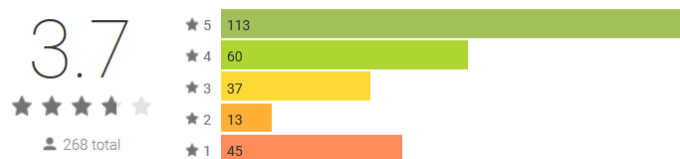


Figure 2.8 Chope's rating on Google Play Store

Most users of Chope are Asian diners. Chope possesses the following competitive advantages:

- Expanded to different Asian regions including Bali, Phuket, Hong Kong and Shanghai, and acquired Singaporean startup TickTok in 2014, Chope has rich market resources and expertise in Asian market. They have also recently acquired an Indonesian restaurant reservation platform, MakanLaur.com, in April 2016.
- Chope allows customers to make reservation through multiple platforms and channels, including: the company's website, mobile application, plug-ins for restaurant websites and Facebook pages.
- They also includes a reward systems -Chope Dollars- to retain their users through point redemption for Vouchers to encourage repeated usage.
- After acquiring Singaporean startup TickTok, which is an app that provides real-time queue time information, Chope now also includes queue monitoring services in their app.
- Four features are available to restaurant managers in this app:
 1. Reservation management - manages making, cancelling and confirming reservations.
 2. Guest management - keeps track of customer preferences and repeat customers and allows targeted marketing
 3. Table management - assists restaurant staff in seating customers and tracking table status

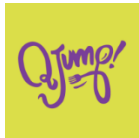
4. Report - provides advanced analytics to sustain and improve restaurant efficiency

A key feature of Chope is the advanced analytics it provides to restaurants to help sustain and improve restaurant efficiency. We can draw on the success of Chope and analyze their features, and look at how they can be adapted into our app since we are targeting a different audience.

Weaknesses:

- This application and system are designed for restaurant management. The inputs into database require standardization to enable restaurant managers to use the four features provided by Chope. However, features such as table management may not be applicable to adaptation to other industries. For example, it is difficult to arrange seating for stalls in school canteens as the seats and tables are shared by different stalls within the canteen instead of one particular owner.
- There is no penalty for last-minute cancellation. This may decrease the chance for Chope to secure a reservation and results in ineffective business management.

QJump!



QJump! was started in 2015 and boasts features such as a location-based search service, and scheduling mealtimes in advance. It mainly targets the working class in the Central Business District. The screenshot below (Figure 2.9) was taken from QJump!'s page on Google Play store. We can see that there is a very high rating of 4.9/5 stars with many positive reviews. This data is not entirely reliable due to the low number of reviews, but it is an indication that those who use the app are positive towards its functions and services. However there is only an estimated of 100-500 installs, which tells us the uptake of this app is low, and hence may not be viable for the merchants.

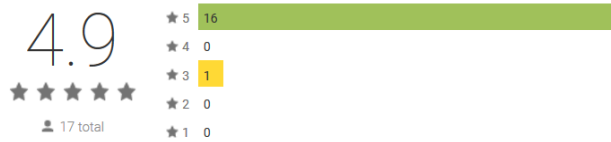


Figure 2.9 QJump! rating on Google Play Store

Typical Users: Singaporean working class

Competitive advantages:

- Qjump! integrated user-generated contents into its database. This includes ratings and reviews for different restaurants, as well as recipes contributed by users. It targets at home-cooked food and provides recipes for simple meals for the average urbanite.
- Qjump! invites guest bloggers to write reviews for restaurants and the app to further enrich its database. If Qjump! manages and makes use of this data well, it can become a strong competitive advantage.
- Dietary restriction filters are available on Qjump!, making ordering easier for those with particular dining needs.

Weaknesses:

- Estimation of waiting time is not applicable as Qjump! displays time periods for collection instead. Hence, walk-in queueing up and immediate ordering are not applicable.
- Qjump! does not provide business analytics or involve any decision support information system to help manage business more efficiently.
- No incentives (promotions, vouchers, etc) are provided for users to take up this app or to repeat usage.

We attribute Qjump!'s low uptake to the lack of proper marketing strategies. On their Facebook page, they only have 595 total page likes (as of 2nd November 2011). Although they frequently post on their Facebook page (3-4 times per week), they do not receive any likes, comments or shares. As a new entrant to a market that already have many established apps, it is important for the team to increase the brand awareness through effective marketing strategies.

2.4.2 Overseas

Nowait



Nowait is an app based in the United States with features such as location-based search service, and estimated waiting time. Nowait allows customers to see where they stand in the virtual queue, and to give feedback to restaurants after dining. It also boasts an analytics report for business owners to provide insight into customer trends and overall performance.

Typical users: American diners

Competitive advantages:

- Nowait provides business analytics to help restaurants improve management and increase efficiency.
- Customers are able to view their positions in a “virtual queue” from the estimation of waiting time provided in the application.
- Nowait enjoys a dominant market position in the US market, and expertise.

Weaknesses:

- As Nowait is a US-based app, its algorithms may not be applicable in a Singapore or Asian context. The system will require modifications in order to be launched in Singapore.

Overall, we found that the available applications in the queueing app market do not cater to small stall owners, such as those serving in school canteens. Applications such as Chope have many management functions which may be too complicated to implement for small stall owners. Qjump! does not predict waiting time or produce business analytics to facilitate business decision making. Hence, we will target students and staff eating in NUS canteens to develop our queueing application first. This app will include features that we deem as important and critical to Chope’s and Nowait’s success. In the following sections, we will discuss how we arrive at our final solutions, after studying about our target audience and combining the findings we derive.

3. Business Model

3.1 Value Proposition

To create greater convenience and ease of transaction for both students and stall owners, NomzQ’s features allows both students and stall owners to reap greater benefits than they would if they used the traditional queueing system in NUS.

3.1.1 Students

Students save up to 15 minutes² for each meal, since their waiting time is reduced, allowing them to have more time for themselves. They are also able to enjoy an easier mode of payment without worrying about having sufficient cash on hand since payment can be done on NomzQ. Furthermore, students benefit from the ease of ordering without the hassle of rushing down to the canteens to beat the queue, since they can place their orders in advance using NomzQ.

3.1.2 Stall Owners

Stall owners also save time since they do not need to manually take orders and process payments, allowing for more time to prepare food for the queue. They also benefit from easier collection of money through NomzQ, and do not need to worry about the handling of change. With NomzQ, they can make greater revenue, as their ability to process more orders in a day will allow them to earn more money as they sell more food orders. They can also implement smarter business strategies by using the business analytics component to review their sales tactics and food prices. They can even find out how much food to prepare in advance to reduce food wastage.

Furthermore, Chebat et al.'s (1994) conducted a study on bank customers, evaluating the factors contributing to the customer's perception of service quality. He found that the service delivery process, which includes waiting time, will affect customer satisfaction. Hence, the reduction of waiting time for its customers will help stall owner's improve their customer satisfaction.

3.2 Revenue Model

We will be adopting a transaction-based revenue model, deducting 10% from each transaction as commission from stall owners. The transaction-based revenue model is well-suited to our business model since our profits gained will increase exponentially as more stall owners adopt NomzQ for their stall operations. Furthermore, stall owners may experience an increase in revenue if they use NomzQ to optimize their business processes. A transaction-based commission also means that our profits will increase exponentially as stall owners increase their revenue, resulting in a win-win situation. Hence, there will be no fixed cost incurred by the stall owners to encourage the uptake of our solution.

3.2.1 Revenue Forecast

Assuming an average transaction amount is \$4 (based on survey findings) and every full-time student makes a minimum of 1 transaction per working day. This is our forecasted monthly revenue, including pessimistic, neutral and optimistic outlook.

² As compared to current maximum waiting time.

Average Transaction Amount	Commission (%)	Total Number of Transaction per Day	Total Revenue per Day	Total Revenue per Month (22 Days)	Pessimistic (50% uptake)	Neutral (65% uptake)	Optimistic (80% uptake)
4	8	25812	8259.84	181716.5	90858.24	118115.7	145373.2
4	9	25812	9292.32	204431	102215.5	132880.2	163544.8
4	10	25812	10324.8	227145.6	113572.8	147644.6	181716.5
4	11	25812	11357.28	249860.2	124930.1	162409.1	199888.1
4	12	25812	12389.76	272574.7	136287.4	177173.6	218059.8

Figure 3.1: Table comparing the commission to predicted revenue according to uptake

3.3 Competitive Advantage

In order to gain the upper hand in our target market, we have aligned our proposed features to allow NomzQ to possess an advantage over its competitors.

3.3.1 Advantage over Local Competition

Other local queue apps do not allow orders to be made without customers being physically present. Hence, our feature of ordering using NomzQ provides greater convenience for consumers. Furthermore, local queue apps target only the working class, and no apps have been targeted at students yet. NomzQ has the advantage of being the first entrant in the target market for school canteens. Also, our business analytics feature for stall owners is a feature not found in other apps. Business analytics is a business tool that is rising in popularity, and we are bringing it to stall owners in a simple manner through NomzQ.

3.3.2 Advantage over Overseas Competition

Overseas applications such as Nowait uses short messaging services (SMS) to notify consumers when it is their turn in the queue. In contrast, NomzQ will use in-app notifications so that no extra costs will be spent on sending SMS notifications. Furthermore, Nowait does not allow customers to place orders nor pay for their meals via the app, which are key events in a customer's visit to an eatery. NomzQ covers all the aspects of a customer's visit, and hence its business analytics report will boast larger sets of data with more valuable insights.

4. Our Solution

4.1 Introduction

NomzQ facilitates ordering, payment, and produce business analytics reports. This virtual queuing system will allow stall owners to translate the work saved from ordering and collecting payment to other aspects such as processing food orders, increasing their efficiency and their revenue. Our main target group will be students who patronize canteens at the National University of Singapore (NUS).

There are various key features in NomzQ that are not in other queue apps. Customers can order through the app, and they do not have to be physically present to place their order. We also allow customers to pay through the app using a credit payment system which provides both businesses and consumers greater convenience. NomzQ also consolidates the data collected and produce monthly business reports and recommendations for the stalls.

NomzQ is created using Appery.io, a platform for app building which encompasses both front-end and back-end components of the app.

NomzQ boasts the following features which will be explained in detail:

- 1) Allow users to order their food through the app
- 2) The estimated waiting time will be shown for each stall
- 3) Cashless Payment
- 4) Business Analytics

4.2 Ordering directly through the app

This is the main selling point of NomzQ, and addresses problem #1 and #2 (reduce waiting time and eliminate queues). Students do not have to physically be down at the stall to make their orders. This reduces the time spent waiting for their food to be prepared, especially during peak hours. Whenever an order is made, it will be added into the virtual queue. A notification will be sent out 5 minutes before their order is ready for collection.

Additionally, allowing students to send orders through NomzQ means they only need to be present for collection, which will prevent long queues. This will make canteens less crowded and thus provide a more comfortable dining environment.

4.3 Estimated Waiting Time

All orders made through NomzQ and walk-in orders will be added into a virtual queue system. We have an algorithm in place to compute the current waiting time of the stall. This algorithm takes into account the virtual queue system, the quantity of food orders in the queue, and historical data that will be collected over time. This also means that the waiting time will get more accurate as time passes, as more historical data will be used for prediction.

The estimated waiting time is displayed in the app on the customer's interface and will also be displayed at the physical stall itself, so that customers without the app can access it too. This addresses problem #2 since customers can remain at their seats or otherwise spend their time more efficiently rather than queueing in front of the stalls.

4.3.1 Waiting Time Algorithm

The algorithm for the estimated waiting time is based on a formula obtained from the High School Operations Research (HSOR), which was found using Little's Law, a basic queueing time formula. Another algorithm was also presented by the Department of Engineering Management and Systems Engineering, Missouri S & T, and we found that it affirmed the simplified formula from HSOR. The following describes the waiting time formula adapted from HSOR:

$$\text{Estimated Waiting Time} = \frac{\text{Average number of Customers in Queue}}{\text{Rate of arrival of customers per minute}}$$

4.3.2 Field Study

In order to find out the rate of arrival of customers per minute, we carried out a field study to find out the estimated rate of arrival for each hour interval. This is to provide us with the necessary information needed to predict the waiting time for our customers. We conducted our field study in 4 main NUS canteens, Techno Edge (Engineering), The Deck (Arts and Social Science), The Frontier (Science) and The Terrace (Business) from Monday to Friday. We calculated the number of customers in the queues for each stall in hourly intervals, as well as the time taken for the last person to reach the front of the queue and collect his or her food at a single point of time. We then calculated the estimated rate of arrival by using the formula:

$$\text{Estimated Rate of arrival} = \frac{\text{Average number of Customers in Queue}}{\text{Waiting time}},$$

which is a rearranged version of the formula as explained above in Section 4.3.1. We narrowed down our field observation in the following table to show the estimated rate of arrival for selected stalls at The Deck on a Thursday afternoon.

Stall	Rate of Arrival at 12PM (Persons per Minute)	Rate of Arrival at 1PM (Persons per Minute)
Chinese Cooked Food	2.70	3.00
Clay pot Seafood Soup	2.40	2.33
Indian	2.50	3.00
Japanese	1.27	1.50
Muslim	1.67	3.00
Noodle	2.00	1.50
Sin Kee Chicken Rice	1.53	2.13
Vegetarian	2.00	0.00
Western	2.57	1.40
Yong Tau Foo & Laksa	2.18	1.70

Figure 4.1: Table displaying calculated rate of arrival from 12P.M. to 1P.M. on Thursdays

The values displayed in Figure 4.1 above are stored in our app database to provide the values needed to estimate the waiting time for each stall at each hour and on different days of the week. As more customers use the app, more data will be collected and used to improve the accuracy of our algorithm.

4.4 Cashless Payment

According to a mobile consumer survey done by research firm Deloitte, 57% of Singaporeans polled would be willing to use their phones as a way to pay in physical stores³. NomzQ makes use of a credit system, where customers can top up payment credits into their account on NomzQ. Payment for their orders will then be deducted from their credit accounts.

With the increasing sophisticated technology improvements, doubts about the security of cashless payment have been cleared up, and many companies are promoting the use of virtual wallets. It is convenient, and reduces chances of human error (i.e. wrong change provided). These transactions are recorded automatically, making accounting a lot more convenient and accurate. This addresses problem #4 by allowing stall owners to focus on their service and food quality, as well as tackle possible hygiene issues when handling money.

4.5 Business Analytics

The use of Business Intelligence (BI) can help businesses to make timely, and more accurate decisions, allowing them to gain a competitive advantage over other stalls⁴. As such, NomzQ features a Business Analytics component for the benefit of stall owners.

Our app will inevitably collect lots of data especially through transactions, and the use of our application allows for large amounts of data to be collected. Raw data alone do not provide much value and insights. The purpose of our business analytics element will serve to convert such data into useful knowledge and information for the stall owners.

Our business analytics component has 4 main features:

- 1) Time of Day/Day of Week Analysis
- 2) Demand Forecasting
- 3) Menu Optimization
- 4) Consolidated Monthly and Quarterly Reports (actually this isn't exactly a feature?)

There are 3 types of analytics – descriptive, predictive and prescriptive analytics. Descriptive analytics is the simplest form of analytics where raw data is summarized and hence can be easily visualized. This normally provides us with trends. Predictive analytics is the next step where techniques such as data mining and machine learning are used to study current and historical data. This is important as it will aid in forecasts. Lastly, prescriptive analytics is where an action is “prescribed” or recommended to the business owner. This is the highest level of data analytics where tools are used to determine the best course of action to take. All 4 features will consider either of the 3 types of analytics, which will be further explained in this report.

³ As reported in Future Ready Singapore <https://www.futurereadysingapore.com/2016/asias-hunger-for-mobile-food-apps.html>

⁴ According to Phocas Software <https://www.phocassoftware.com/business-intelligence-blog/key-metrics-in-food-beverage-industry-ebook>

4.5.1 Time of Day/Day of Week Analysis

As part of descriptive analytics, we analyse the transaction history of each stall at different days of the week and their respective time segments. The time segments will specifically focus on the busier time periods: 1100-1200, 1200-1300, 1300-1400. This feature will map past transaction records to the different time segments and provide the stall owner with a visualisation to show the peak hours. This will enable stall owners to better plan for their peak timings and manage their resources efficiently. For example, the chicken rice stall owner knows that the crowd on Tuesdays only comes at 12 noon, he or she can plan for additional manpower to come only at 12 noon to minimise costs and prepare the ingredients timely to maintain its freshness. By knowing an estimated number of customers for the day, stall owners can cater the necessary resources to meet the demand and reduce unnecessary leftovers. Hence, this feature helps to address food wastages (problem #3) and assist food stalls to make more informed business decisions (problem #4). Also, the accuracy of our analysis will improve with more data being collected.

4.5.2 Demand Forecasting

Forecasting demand, a form of predictive analytics, is important because it enables a firm to accurately and efficiently allocate resources to a level of production that meets anticipated demand. Incorrect forecasts, overestimation or underestimation, are both economically inefficient and unprofitable. NomzQ uses quantitative methods relying on statistical and data analysis to examine historical consumption pattern to make forecast demand.

There are 3 factors which we used to help forecast our demand. The first factor is time of day/day of week, which is explained in Section 5.5.1 Time of Day/Day of Week Analysis. The second factor is holiday evaluation. This refers to special occasions, such as public holidays and examination periods, which will affect crowd flow and hence sales. For example, an examination day will see an increase in demand for food at the Yusof Ishak House's food court, and a fall in demand for food at The Terrace. The last factor is weather. The temperature and humidity will affect our demand for certain types of food. Research has shown that ambience, which is made up of both environmental and physical factors, affects our food choices (Stroebele & De Castro, 2004).

Forecasted figures and side-by-side comparison with actual sales will be given to stall owners, this helps stall owners to have a gauge of their daily/weekly/monthly performance. Stall owners will then better understand what might be causing them to under perform if sales are below predicted or what might be contributing to their sales allowing them to perform better than predicted. Hence, this aims to assist food stalls in their resource allocation in terms of food preparation and staff management, addressing food wastage issues (problem #3) and allow stalls to operate more efficiently (problem #4).

4.5.3 Menu Optimization

It is important for food stalls to have a menu that falls within the limitations of its operations. A broad menu can be complicated and is taxing on the food stall's operations. A narrow menu may lead to additional sales opportunities being missed. Menu optimization will help to keep track of food items sold and helps merchants understand which food items will generate the highest profit. Since menu prices are the backbone of sales, there are a few factors to be

taken into consideration while setting them. As pricing affects consumer perception, it should be carefully thought out in the menu.

In order to determine the right menu price, stall owners have to take into consideration raw ingredient cost, competitor pricing, actual quality, portion size and labor into account. Ultimately, the prices need to be competitive and resonate with the demographic of their customers, i.e students and staff. If the customers feel that it is not worth the money, it is unlikely for the stall owners to retain them. Thus, our app provides several different visualisations for stall owners to assess gross profit on their individual offerings and determine how each item contributes to their menu as a whole. In the event that stall owners wish to increase menu prices, it has to be done strategically and with care. Increasing prices across-the-board can lead to a decrease in perceived value by customers and ultimately reduce customer counts.

Stall owners can consider other strategies to increase profitability such as promotion and product line extensions. For example, introducing a promotion price if a customer orders a main dish and side dish together. A popular main dish might actually bring up the sales of a less popular side dish and increase profits overall. On the other hand, stall owners can introduce new dishes onto the menu and assess its performance through our menu analytics before determining whether to continue or try something new.

4.5.4 Consolidated Monthly and Quarterly Reports

The monthly and quarterly reports summarize the 3 types of analysis as mentioned in the earlier 3 sections. These reports neatly consolidate all the information gathered so that stall owners can easily visualize their stall's performance over the month/quarter. This allows stall owners to observe trends in their business performance as well. Our report will aim to achieve simplicity in its design such that it is easy for the stall owners to understand. The quarterly report will go further to provide recommendations for the stall in terms of menu design (i.e. to include or remove certain food items, include popular customized orders into the main menu) and suggestions to reduce waiting time for their customers (i.e. analyse if certain food orders are taking an exceptionally long time to prepare). This relates to prescriptive analytics, the last and final step of business analytics.

4.6 Summary of features

Our app aims to change the way customers and businesses place and receive their orders. From a customer's perspective, a typical order would follow the following procedure:



Figure 4.2: Flowchart showing the typical order procedure for the customer

As shown in Figure 4.2, the integration of our features add value and convenience to a customer's experience when ordering through our app.

From a business's perspective, a typical order process would follow the following procedure:



Figure 4.3: Flowchart showing the typical order procedure for the merchant

As shown in Figure 4.3, businesses also stand to benefit from our proposed features.

5. Prototype of our solution

Our mobile application, NomzQ, was created using Appery.io, a cloud-based platform that provided us with visual development tools and integrated backend services. This was suitable for our project as we needed a platform that could allow us to connect our front end interface with a backend database service. Appery.io allows us to make use of HTML, JavaScript, CSS, jQuery Mobile and Apache Cordova plugins, which will aid us in the addition of our features as we will discuss later in the report. There are 2 separate apps - one for the merchants and one for the consumers.

5.1 Consumer Application

The consumer interface largely uses the color red, since psychologists have shown that red incites hunger⁵, making customers more likely to be tempted to make orders while browsing on the app.

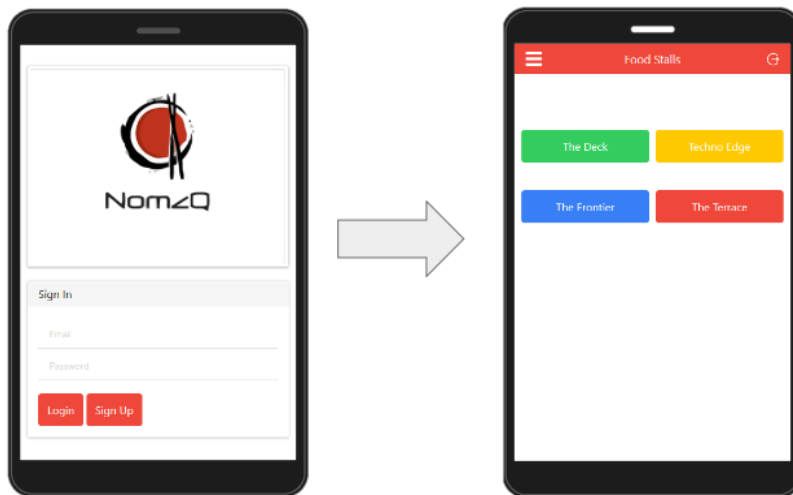


Figure 5.1: Login page navigates to food stalls page

⁵ As reported by P. Belluck the New York Times (2009),
<http://www.nytimes.com/2009/02/06/science/06color.html>

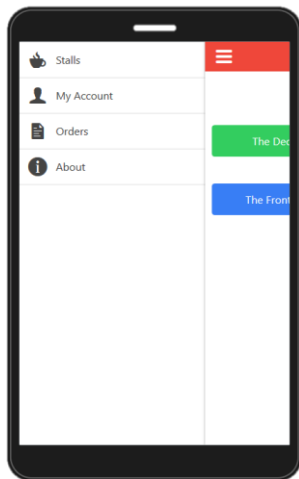


Figure 5.2: List of available services in the app

After login, users will be directed to main page, which will list the available canteens in the school (Figure 5.1). The top left list button will direct users to a list of available services in the app, namely the *Stalls*, *My Account*, *Orders* and *About* (Figure 5.2).

The Food Stalls page was made to be simple and easy to navigate so that users can conveniently navigate around the application.

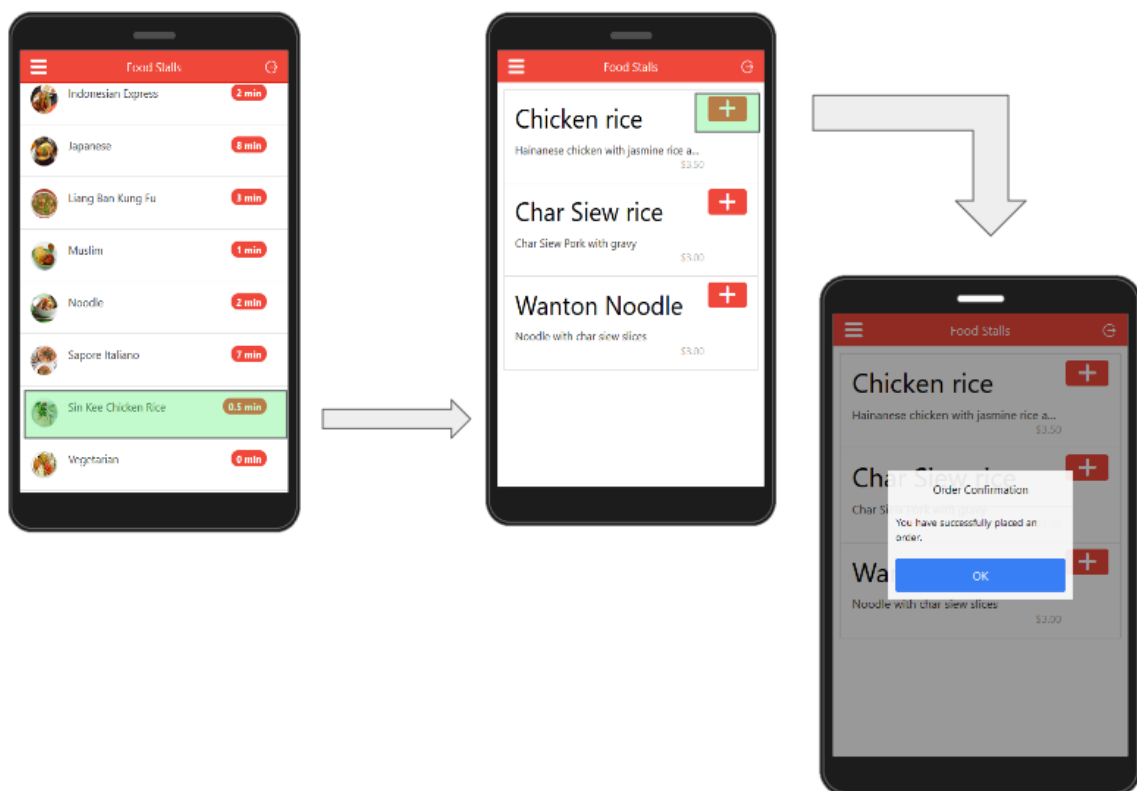


Figure 5.3: Screenshot diagram shows the food ordering process

User clicks on any stall and will be provided a list of food options. They can choose to add an order which will add an order into their account, and will be reflected in the database. The amount will automatically be deducted from his/her credit account.

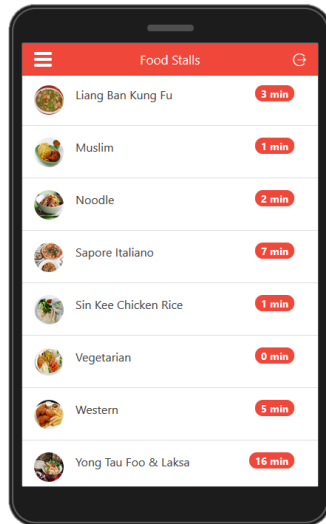


Figure 5.4: Screenshot illustrates the real-time waiting time feature

There will be an increase in waiting time based on the waiting time algorithm as explained in Section 4.3.1.

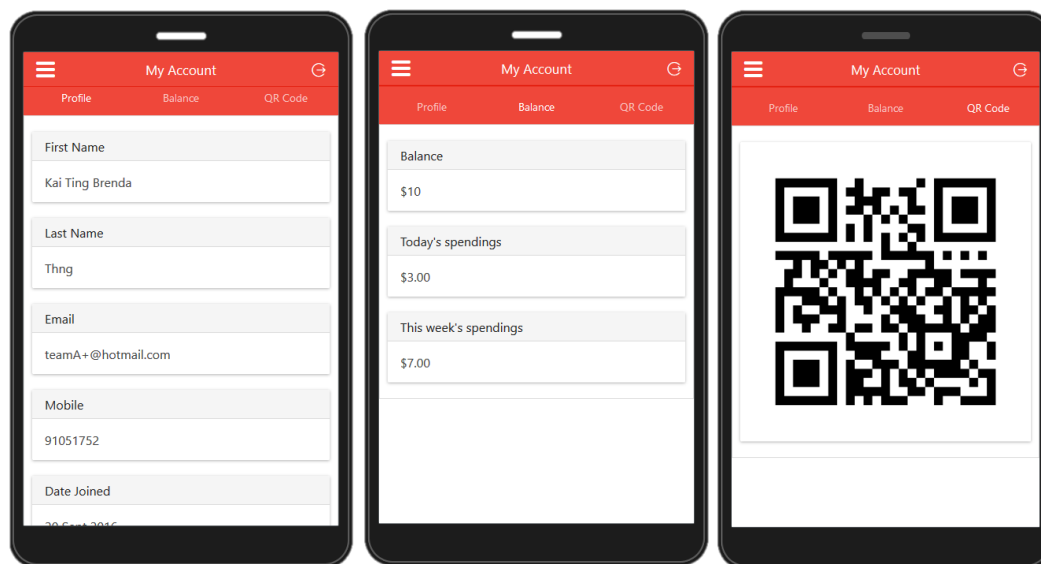


Figure 5.5: Screenshots shows the account page of the app

My Account will provide user's information. The user's account balance will be reflected as well. The "smart" feature here is the personalized QR code, which allows the user to top up credit and verify his/her orders. The QR code includes information of the user and will update the database accordingly to the instructions from the scanner.

5.2 Merchant Application

Merchants will have their own application as they have access to different functions of the app.

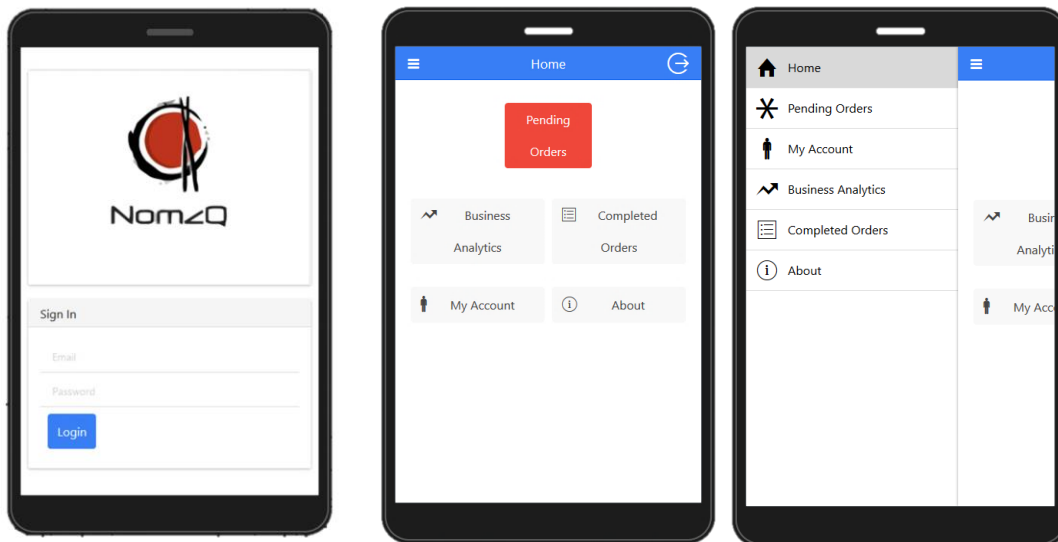


Figure 5.6: Screenshots of the login, home page, and list view of available services respectively

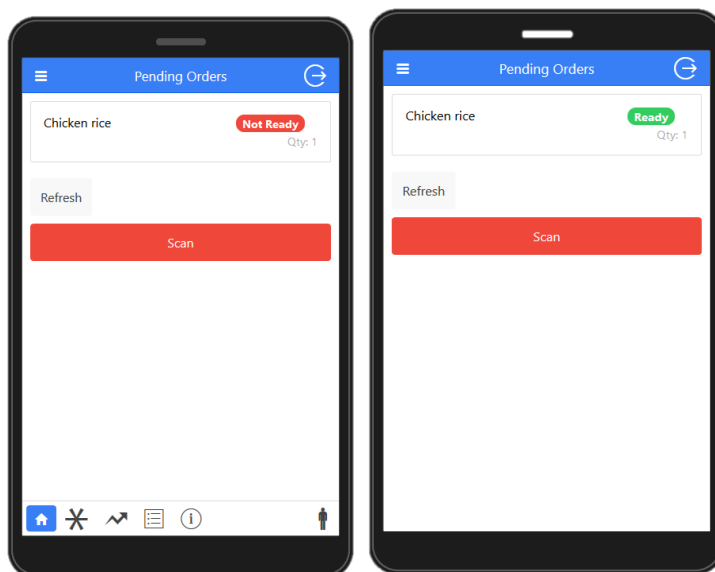


Figure 5.7: Screenshot of the pending order page

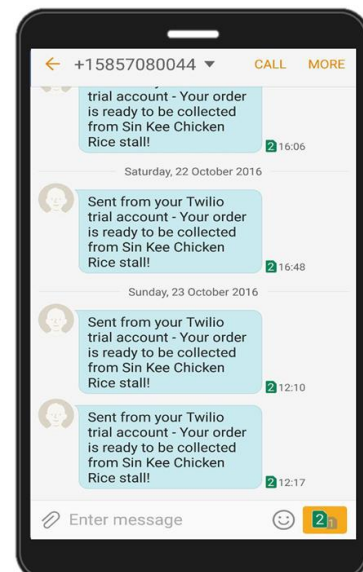


Figure 5.8: Screenshot of the SMS

The red pending orders button found on the home page will be used most often during stall operations. It will show a list of pending orders. There are a few steps that follows from the time the order is received to collection:

- 1) After the vendor have prepared the order, they simply click on the item listed and the red *Not Ready* tag will change to a green *Ready* tag. (Figure 5.7) The database will be updated accordingly.
- 2) At the same time, a SMS will be sent to the registered mobile number of the customer during sign up to inform them of the status of their order. (Figure 5.8) This function is possible because of the cordova-SMS plugin that we have included.
- 3) When the customer arrives at the stall to collect their food, the stall owner clicks the long red button *Scan*. The camera will be turned on and will be used to scan the customer's unique QR code that will run through the list of orders to find a match. We used the cordova-barcode plugin to achieve this.

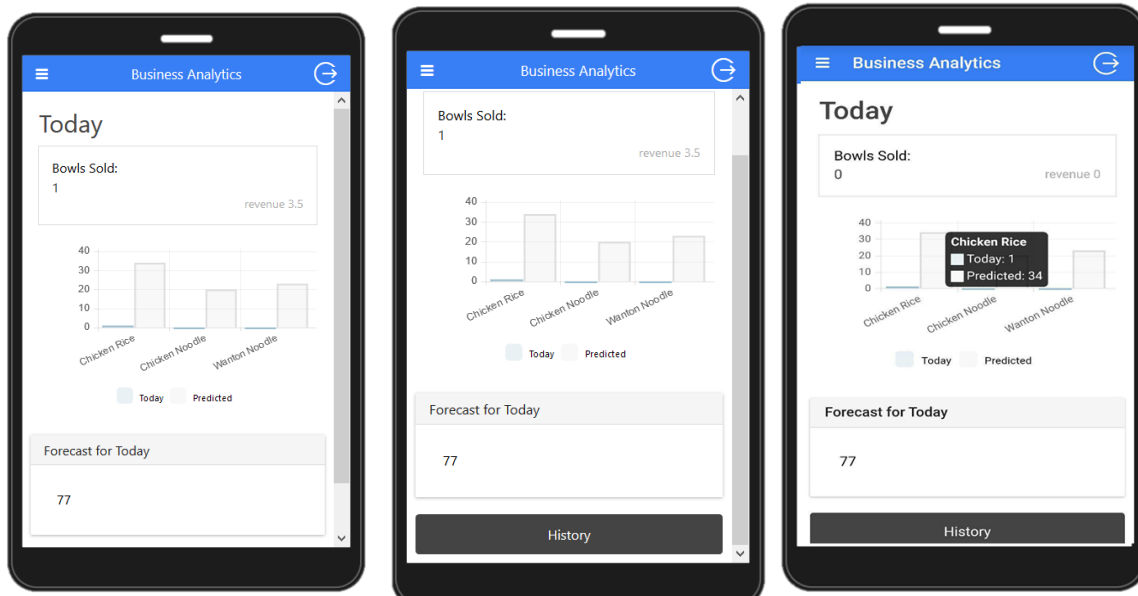


Figure 5.9: Screenshots of the Analytics page of the Business version of the app

Moving on to the main feature of our application, Figure 5.9 will provide a quick overview of today's sales and expected sales. Quick summaries of the total number of bowls sold and expected bowl sales according to individual main menu items. The bar chart included is dynamic and responsive, a tap on each individual bar will provide you with the exact numbers (as shown by the third screenshot in Figure 5.9).

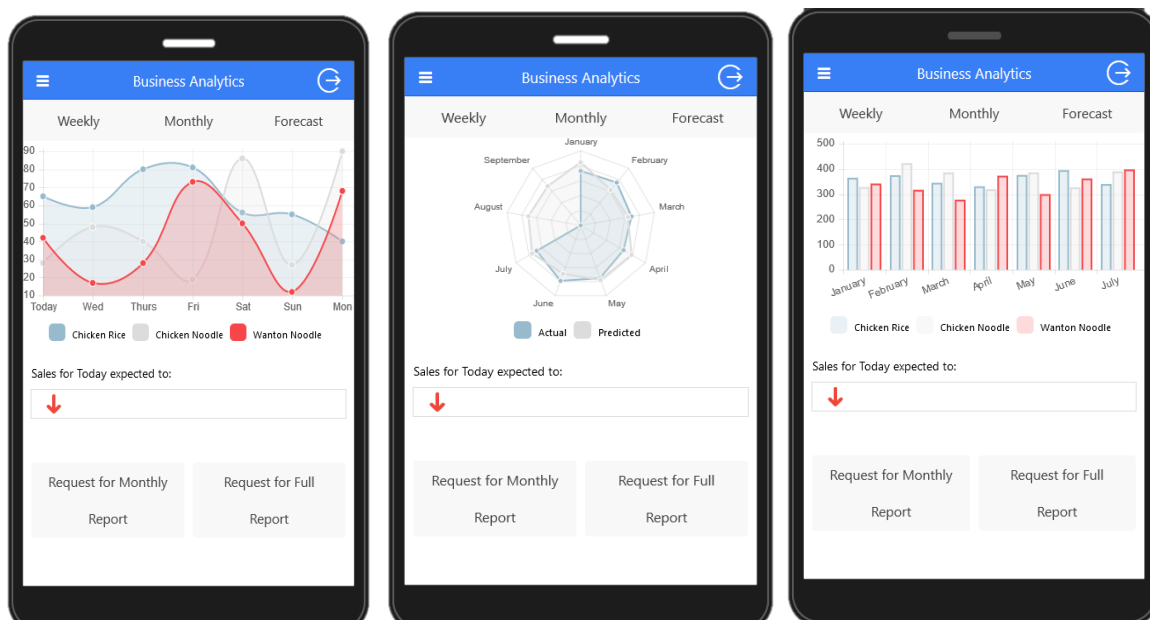


Figure 5.10: Screenshots of the History page under Analytics

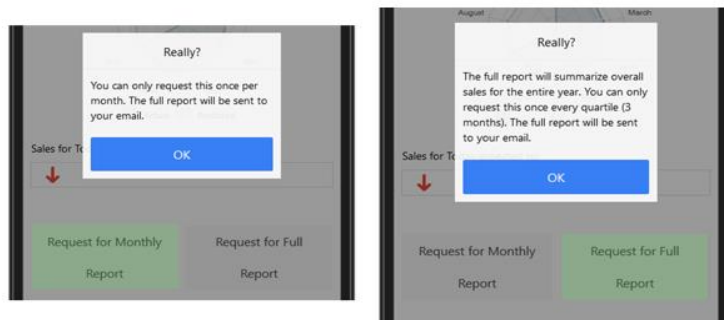


Figure 5.11: Screenshots of popup when Monthly Report or/and Full report is requested

The grey *History* button (Figure 5.9) will provide more in-depth data. They will consolidate weekly and monthly sales, and also provide a forecast for the subsequent months. This feature will aid business owners in their future planning of staffing allocation and food preparations. They can also click the 2 buttons below (*Request for Monthly Report* and *Request for Full Report*) for a consolidated and detailed summary of their operations. The Full Report will also include recommendations. The recommendations from the *Full Report* (refer to Appendix I) will include analysis from menu optimization and demand forecasting, which may require our team to study the trends and include our personal recommendations for the report to be even more useful for our merchants. Hence it is only provided once in awhile.

The screenshots above sums up the key features of our applications.

5.3 Database

The cloud database provided by Appery.io is based off a NoSQL database, MongoDB. MongoDB is a free, open-source cross platform document-oriented database program. The diagram below shows how the various collections in our database is linked.

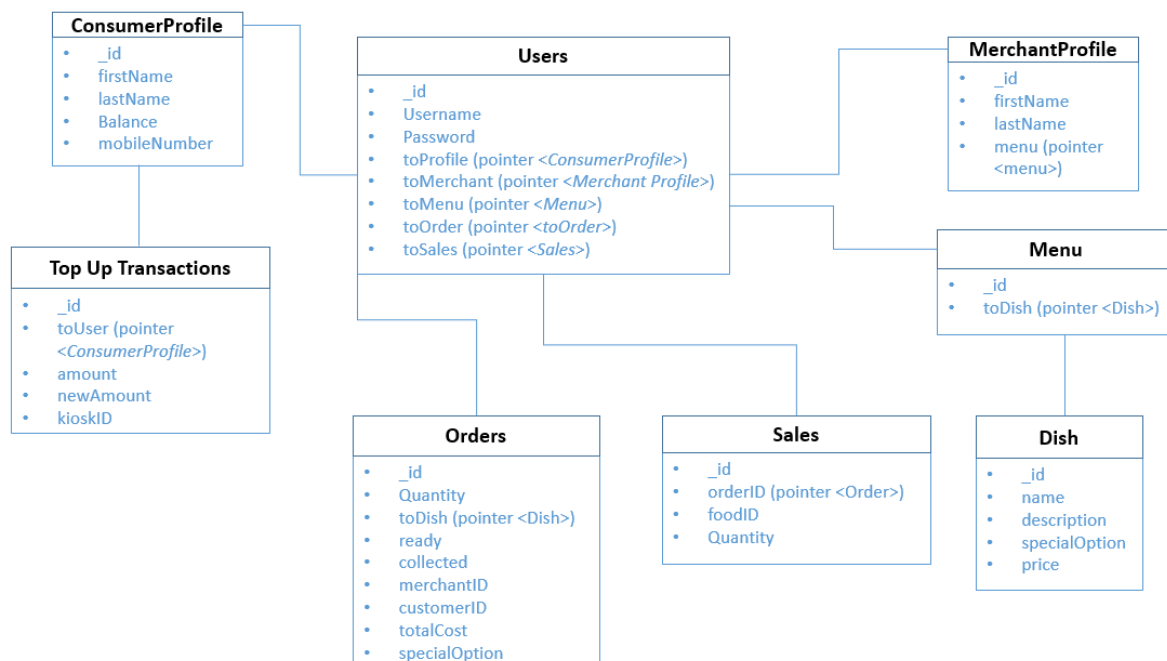


Figure 5.13: Representation of our Database

6. Limitations of our solution

Some customers prefer to physically queue up and may not be easily convinced to use the app. The food preferences of this particular group will not be recorded into NomzQ and thus not reflected in the data report that is presented to the stall owners. This can cause a certain degree of inaccuracy in the data.

During off-peak hours, the queues are short. It is not as time-consuming to queue up and thus customers may find ordering through the app troublesome.

Stalls with complex menus such as the Mixed Rice stall, require having several different menus as they tend to change the variety of dishes they offer daily. However, if they fix a day for each menu, this can be easily managed by storing the different menus into the databases and automating the change.

Stall owners may be inexperienced with using NomzQ and not be able to exploit the functionalities fully. Thus, time must be invested to help stall owners set up and familiarise with our system.

7. Future Directions

NomzQ is currently operating within the Food and Beverages (F&B) industry, and the scope of our field observation is within NUS canteens. With modifications on algorithms and other relevant field studies, we believe NomzQ's features can be adapted to the needs of other industries with greater geographical coverage. An advantage of this system is its future potential, which is achieved through accumulation of data in dataset as we collect customers' information through the application. A generalized model will be used at the start. However as time passes and with the collection of future data, more accurate features can be developed to calculate the estimated waiting time, improving the accuracy of NomzQ.

7.1 Food and Beverages (F&B) Industry

In the near future, we intend to continue to expand in the F&B industry by widening our target market to include students from other universities in Singapore, such as NTU, SMU, SIM. Due to the similarity of markets, we can use the data generated by NUS students to forecast the demand and preferences in other universities, providing valuable insights to stall owners. As for Polytechnics, we must first conduct a market research to understand the students' dining habits to see if there is a need for such app.

Should our app prove to be successful, we can integrate our system into other canteens, hawkers and restaurants. We can also improve our app features by providing other payment options such as near field communication (NFC) payment, where customers can pay using their mobile device's NFC feature without having to key in their credit card details.

Overall, adapting NomzQ to the F&B industry can be done relatively easily, as the current prototype is designed for this industry, but within the canteens in NUS. The general algorithms, dataset structure and management processes are similar.

We can also adopt advertising revenue model into NomzQ, where stall owners pay a fee to have their stall suggested to suitable users based on their order history without being too intrusive. As for now, we intend to focus our efforts on expanding the user base of our app.

7.2 Other Industries

NomzQ has the potential to suit into any industry that requires customers to queue, including banking services and healthcare services.

Banks can use our system to facilitate and monitor their queues at their branch locations. The business analysis report produced can help them to see branches with higher visits, and decide whether there is a need to increase counters and staff at these branches. Healthcare services can integrate this app into their existing queueing systems, to allow patients and customers to make appointment through mobile devices before going to the clinics and hospitals. The estimated waiting time can also help them to plan and schedule for the day in advance. In this case, as business report provided in NomzQ generates information about peak and off-peak hours, hospitals can arrange their staffing accordingly. NomzQ hence boasts a versatile system that would be valuable especially with its analytics features that can be applied across industries. Expanding NomzQ to adapt to various industry is a long term goal that we hope to achieve.

8. Conclusion

While several queue mobile applications have already been launched in Singapore, none are targeted at schools. We believe that NomzQ can bring greater convenience and efficiency to the operations of school canteens, and will revolutionize the way people queue and order their food. With the integration of business analytics for stall owners, NomzQ provides a smart solution for the future of the businesses in canteens. With wider usage, more data can be collected and NomzQ can provide more accurate services for both consumers and stall owners.

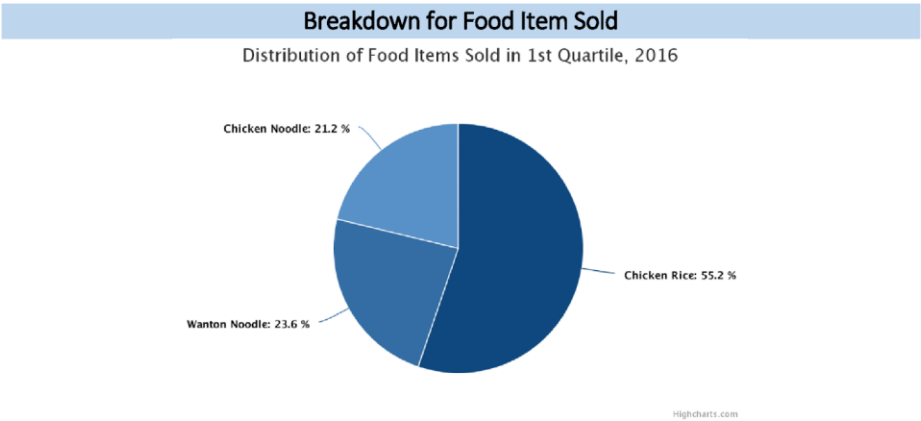
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10. Appendix I

Stall: Sin Kee Chicken Rice Detailed Consolidated Report for 1st Quartile of 2016



Most Popular Dish: Chicken Rice
Least Popular Dish: Chicken Noodle
Upcoming Dish:

Trendline

Brief Comments on above line graph:

Brief comment will aid the stall owners in the interpretation of the graph, in the event they are unsure of how to read and interpret it. We want to keep the report easy to read, visualize and understand.

E.g. We observe an overall increase in the number of chicken rice sold over the past 3 months.

Least Profitable Dish:

Trendline

Brief Comments on above line graph:

Revenue

Line graph showing daily revenue

Brief Comments on above line graph

Line graph showing daily revenue for individual menu item

Brief Comments on above line graph

Day of Week Analysis

Most Popular Day of the Week: Wednesday

Graph that shows the most popular dish for each day of the week

Time Segment Analysis

Most Popular Time of the Day: state

Least Popular Time of the Day: state

Graph that shows the most popular time of the day

Menu Optimization

Bar Graph to show popular 'special options'

E.g. Add egg + tofu
Add egg + vegetables

Pie Chart to show the top 5 most popular *customised orders**

E.g. Chicken rice with egg
Chicken rice with vegetable
Chicken rice with egg and vegetable
Chicken noodle with egg
Wanton noodle with vegetable
Other customised orders

**customized orders* = orders with special add-ons

Combine day of week analysis and time segment analysis graphs, to determine popular food items for different time segments

Most Popular Food Item per time segments:

10am – 11pm:	Wonton Noodle
11pm-12pm:	Chicken Rice
11pm-12pm:	Chicken Rice
12pm-1pm:	Wonton Soup

Recommendations

Ideas and recommendations that relates to management, menu items and queue time will be made to the stall owner.

E.g. We noticed that (e.g. Chicken Rice, add egg and vegetables) the most popular customized dish, making up 60% of all orders with special add-ons. We recommend that this is included in the main menu to make it more convenient for customers to order this dish. Also, we noticed that the time taken to prepare wanton noodles is the longest, causing the waiting time to increase if there are higher number of wanton noodles orders.